Department for Environment Food & Rural Affairs

DARWIN INITIATIVE

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Darwin Initiative: Final Report

*To be completed with reference to the "Writing a Darwin Report" guidance: (http://www.darwininitiative.org.uk/resources-for-projects/reporting-forms). It is expected that this report will be a **maximum** of 20 pages in length, excluding annexes)*

Darwin Project Information

Project reference	22-016
Project title	Securing livelihoods, health and biodiversity through seascape-scale sustainable fisheries co-management
Host country(ies)	Madagascar
Contract holder institution	Wildlife Conservation Society
Partner institution(s)	GRET, Ministry of Marine Resources and Fisheries (MRHP), Ministry of Public Health (MSP), Ministry of Agriculture and Rural Development (MINAGRI), Committee for the Sustainable Development of Antongil Bay (PCDDBA) - Harvard T.H. Chan School of Public Health
Darwin grant value	300,000
Start/end dates of project	1st April 2015 – 31 March 2018
Project leader's name	Chico BIRELL
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1 Project Rationale

Antongil Bay in northeast Madagascar is a semi enclosed bay of 3,746 km^2 containing coral reefs, mangroves, estuaries, seagrass beds, rocky shores, sandy substrates, small islands and 9 major rivers Antongil Bay is among the largest bays in the Indian Ocean. Population resides primarily in thirteen towns of the districts Antalaha, Maroantsetra, and Mananara. (Figure 1).

Antongil Bay embodies the challenge of balancing conservation and development priorities. The Bay supports spectacular coral reefs, 13 marine mammal species, 3 marine turtle species, and 140 fish species (including 19 shark species). The Endangered scalloped hammerhead (*Sphyrna lewini*), the Endangered green turtles (*Chelonia mydas*) and the Critically Endangered hawksbill turtles (*Eretmochelys imbricate*) are threatened by small scale fishery by-catch and direct hunting.

Overexploitation due to increasing human population, reduction of productive agricultural land, destructive fishing practices, lack of compliance with gear restrictions and a weak enforcement by community managers and local government are driving degradation of coastal habitat and the Bay's fisheries, loss of coral reefs and declines in fish and invertebrate abundance.

In 2015, around 100,000 predominantly poor, rural people living along 200 miles of the coastline rely on these waters to sustain their health and livelihoods. Fish is their primary source of iron, zinc, vitamin B12 and fatty acids. Nevertheless, these people experience anemia rates above 40% and stunting rates (short stature from chronic malnutrition) above 30% due to inadequate dietary intake and diversity. In addition to biodiversity loss, eventually the Bay will fail to deliver optimal economic and health benefits to local communities if actions are not taken.

These facts come from a decade of researches and surveys that WCS has developed in Antongil Bay.

To face these challenges, the project works on three key components: (a) reducing biodiversity and fisheries resources overexploitation through a better local based management of fishery resource while concurrently conserving biodiversity, (b) diversifying livelihoods and (c) improving food security and nutritional status, and reducing rates of low birth weight and stunting.

2 Project Partnerships

Groupe de Recherches et d'Echanges Technologiques (GRET): GRET is in charge of the component related to livelihood and provides technical training for farmers to increase rice production, improve diversification of income, especially for women through vegetable farming, poultry raising, and fish processing and marketing in eight pilot LMMAs. WCS and GRET work together since the preparation of the proposal. Coordination meetings were held, though not on a regular basis, to discuss the project progress as it is also linked with the FIHAVOTANA project, funded by French Agency for Development.

Ministry of Marine Resources and Fisheries (MRHP): Through collaborative efforts with WCS and local natural resource users in 2013, MRHP developed the Antongil Bay Fisheries Co-management Plan (ABFMP), which is the first national-level plan in Madagascar to empower local communities and locally-managed marine areas in securing sustainable fisheries management. The current project is one key component of the implementation of ABFMP. During the project, MRHP has been actively involved in 1) joint supervision, coordination and monitoring of the implementation process of the ABFMP; 2) joint patrols with local communities and WCS agents around the Bay and 3) support for local small-scale fishers to obtain official fishing licenses and facilitation of the issuing of these licenses. In December 2017, MRHP has reinforced its local based representative by assigning two technicians in Antongil Bay: a chief of fishery office in Mananara and a new technician to support MRHP team in Maroantsetra. These new persons facilitate the surveillance and patrol activities in the bay.

Ministry of Public Health (MSP): WCS has partnered with MSP to provide health status information to garner support for local health initiatives. The MSP Director has guaranteed collaborative efforts with MRHP and the Ministry of the Environment understanding the environmental underpinning of local health.

Ministry of Agriculture and Rural Development (MINAGRI): Through the Malagasy Centre for agronomic research (FOFIFA) and the Department of rural Infrastructure, GRET works closely with MINAGRI to give technical support to farmers mainly to launch the use of different varieties of rice, and to give technical support while implementing the micro-irrigation system for rice plots.

Committee for the Sustainable Development of Antongil Bay (PCDDBA): PCDDBA is a Malagasy association that was created in 2003 with the support of WCS. PCDDBA's mission is to ensure the integrity of the biological, ecological, socioeconomic functions of Antongil Bay and promote the sustainable development of its surrounding areas through consistent actions and consultations. PCCDBA brings together local officials, private sector representatives, fishermen and other relevant stakeholders. The collaboration with PCDDBA supports the institutionalization of the prohibition of unsustainable fishing techniques through the “Dina” –a social convention on local communities’ management of marine natural resources. PCDDBA participated also in the ABFMP Steering Committee and co-organized the Antongil Bay annual

LMMA forum.

Harvard T.H. Chan School of Public Health: Its supports enable the project to empirically quantify the current status of livelihood and nutritional dependencies on small-scale fisheries and to calculate the potential nutritional burden of disease averted through sustainable fisheries management. Harvard T.H. Chan School of Public Health collected continuous data in five villages along the coast of the Antongil Bay over the course of the project.

3 Project Achievements

3.1 Outputs

In line with the rationale outlined in section 1, the project addressed three outputs:

Output 1: *Nearshore fish and invertebrate abundance are increased and endangered species of sharks and marine turtles are protected through improved management capacities and engagement of communities and government in reducing overexploitation, illegal fishing and use of destructive gears in Antongil Bay.*

Local management of fisheries is well accepted by communities in Antongil Bay. However, the degree to which it is embraced differs for each LMMA.

Indicator 1.1: By year 3, in each village the number of fishers that are active members of the LMMA associations increases from 50% to 75%

As of March 2018, 1244 fishers have registered as members of 24 LMMAs, which represents **an increase of 45% above the baseline of 850 fishers**. Memberships increased in 9 LMMAs, mostly in the district of Maroantsetra. The largest increase was in Maintimbato, by 165%, from 17 members in 2009 to 45 members in 2018, which was driven by notable octopus catch increases following the implementation of a reserve and seasonal closures. In the Mananara district memberships decreased in 13 LMMAs due to:

a) lack of leadership from the LMMAs presidents

b) high vanilla prices, which caused fishers to be more concerned with protecting high value crops from theft than LMMA activities (see details on vanilla issue in the section “problems encountered during the implementation of the project), and

c) the concept of free access to marine resources as detailed in the next section.

Nonethless the communities within 10 of these 13 LMMAs accept LMMA regulations without being widely believing they need to become LMMA members.

2 new LMMAs has been implemented in late 2016 : Anove and Fontsimaro bringing up to 26 the number of active LMMAs operating in the Bay.

Indicator 1.2: By year 3, beach seines used in Antongil Bay drop from 229 to less than 100

The use **of beach seines has diminished notably**. If patrol records registered 42 cases in 2017, no practise was identified during the period of January – March 2018. Such results show the effectiveness of actions, including awareness-raising on fishery regulations, frequent joint patrols with the ad hoc committee, collaboration with the Fishery Monitoring Center (CSP) in patrol activities, and periodic community patrol and surveillance.

Practice of beach seines remains high mainly at Ambitsika and the main town of Mananara (district of Mananara), Nandrasana, Voloina, and Anantoraka (Maroantsetra) (Annex 7-Table 1), which is seemingly due to their proximity to main towns where demands for fish are relatively high.

Indicator 1.3: By year 3, a measured increased in compliance with LMMA restriction

WCS initiated the development of the *Dinabe* (local social convention between all villages bordering Antongil Bay), which consists of a set of rules and regulations on sustainable management of Antongil Bay small-scale fisheries. The *Dinabe* was validated by local communities and government authorities through different consultations and a workshop in 2015. The final step of formalization would be its approval by the Court, which is currently pending due to a second rejection in April 2018 due to pressure applied by a group of illegal

fishers who are in conflict with local villagers. The Court in Maroantsetra still requires additional documents from each village prior to its approval of the Dinabe. On this point, facing the first rejection in 2015, WCS worked with the MRHP, PCDDBA and the Federation of Fishers in Antongil Bay to review and re-submit the document for approval to authorities including the CiRRHP, 13 Communes in Antongil Bay and communities in 2017. In order to address the second rejection, PCDDBA and the Federation of Fishers in Antongil Bay have discussed about requiring the Analanjirofo Region's advocacy to get the Dinabe approved with support from the MRHP regional representative. Discussions are ongoing.

Output 2*. Livelihoods are diversified and food security is improved through the development of environmentally sensitive small-scale agriculture, economically benefitting at least 500 households across five LMMAs*

During the project period, 691 people from eight LMMAs have directly benefitted from income generating activities, including improved rice production, micro irrigation system, breeding, and farming. Some beneficiaries are involved in more than one type of activity and may be counted more than once (Annex7-Table 2):

Indicator 2.1**:** By year 3, at least 250 households adopt environment sensitive techniques for rice production, allowing an increase of yield of at least 20 % (measured on demonstration plots)

As we near the end of the project, 150 beneficiaries out of the 200 trained farmers have adopted at least one of the intensified rice cropping techniques. The data shows improvements in the yields obtained with all techniques in comparison with previous ones. The average yield from intensified **rice production has increased up to 47%** but as farmers adopted parts of techniques, this number may not reflect quantitative results but qualitative (Annex 7-*Table 3).*

The micro irrigation scheme (MIS) has been built and validated by representatives from the regional offices of Agriculture and Rural Engineering. The infrastructure **helps to irrigate 3 additional acres of rice cropping, which will benefit 35 more people.** The association of water users (AUE – Association des Usagers d'Eau) were trained for maintenance and sustainable management of this infrastructure. The AUE president, local authorities and Service Régional de la Génie Rural (SRGR) are in charge of accountability and raising awareness.

Indicator 2.2 By year 3, poultry for at least 250 households benefit from regular vaccination minimising the risk of zoonotic diseases, and reducing the mortality rate by 85%

By March 2018, **281 persons** (80 women and 201 men) from the villages of Androkaroka, Amboditangena, Antsirakivolo, Imorona, Vohitralanana, Hoalampano, Antanambe and Mandrisy were involved in chicken farming. Two vaccinators per site provided vaccination assistance. Negotiations with veterinary shops benefitted targeted households with a 20% discount on the price of two vaccines for *Newcastle Disease Virus* and *Fowl Cholera* for poultry in 2018. Data related to the access to vaccination and the impacts of vaccination on poultry mortality is currently unavailable due to resignations of the monitoring and evaluation officer and project manager.

Indicator 2.3: At least 250 women adopt a new income generating activity (gardening, production of smoked or dried fish)

220 women have been involved in new income generating activities, such as gardening (94), smoking fish (46), and poultry farming (80) that provide substantial additional income. Smoked fish generates an additional 1.000 MGA/kg compared to fresh fish. 22 women have more than 20 heads of poultry, which provide a minimum specific gross income of 150.000 MGA based on selling 5 heads per six months. The main target remains the local market at this stage.

Output 3 *The human health and livelihood effects in local populations are determined by analyzing linkages between expected improvements in dietary intake, nutritional status and*

commercial transactions and observing the role of fisheries co-management in facilitating these health effects in 100 households across five LMMAs.

Indicator 3.1: By year 3, there will be a 15% increase in dietary diversity at the household level and a 30% increase in food security through measurement of the number of food categories utilized and through adoption of regular consumption of dried and smoked fish during periods of hardship

Data on dietary diversity and food security status of 225 households were collected in five communities. LMMAs were found to have the highest percentage of households with high dietary diversity scores across all seasons. From May 2016 until December 2016, less than 2% of households were found to have low dietary diversity (0-4), with 60% of all households falling into the medium dietary diversity category (5-8), and the remaining households having high dietary diversity (9-12). We found that locally managed marine areas (LMMAs) and traditionally managed communities had nearly double the percentage of highest household dietary diversity scores (35% of households) than those households near the marine national park (20%).

Diets were slightly less diverse across all sites during the September to December season than they were during the May – August season (Mean HDDS scores of 7.81 vs. 7.97). This difference was most severe in LMMA and traditionally managed communities, where the percentage of households with high dietary diversity dropped by nearly 50% (LMMA: 28% vs. 45%, Traditionally Managed: 28% vs. 42%, National Park: 18% vs. 23%).

An assessment of coping strategies to best understand how local communities were coping with after the cyclone in 2017, has highlighted that a third (34%) of households have a Copying Strategy Index of 0, reflecting no food stress on this scale. The other two thirds experience food stress of various severities Annex 7-Figure 2). The incidence of Food Stress was measured using the Coping Strategy Index (CSI), which assessed key coping strategies, such as reducing food portions and skipping meals, and assigns a weight to these. This reflects a household short term level of food insecurity. The most common shock in villages was crop damage by the cyclone, with 15-40% of households reporting crop loss. Likely because of this, many of them anticipate running down their stocks of rice in the subsequent months.

Indicator 3.2: By year 3, there will be a 20% decrease in iron and zinc deficiency as measured by nutritional status from venous blood samples. This is the most comprehensive method for understanding real health effects of changes in fishery access.

Rantohely (LMMA) has the highest rate of iron/ferritin deficiency (10%), followed by Marofototra, marine park community (8%). In Iharaka, 2% of the samples have shown iron deficiency, 3% in Maintimbato (LMMA) and 5% in Ambodipaka. The rate of deficiency is quite different for a village to another and seems not to be linked with the management system of the area.

The level of zinc deficiency is higher compared to iron deficiency in the five villages. There are more people with zinc deficiency in traditionally managed areas (20% in Ambodipaka and 18% in Iharaka) than in the other villages (11% in Maintimbato LMMA, 14% in Marofotatra and 16% in Rantohely LMMA). Note that for Madagascar, 16% of the population is at a risk of inadequate intake according to the Food Fortification Initiative, 2018.

Indicator 3.3 By year 3, there will be a 20% decrease in underweight, stunting and wasting as measured by anthropometry.

The prevalence of wasting is quite low in the five villages : 2% (versus 15% at national level _ UNICEF, Country Profile 2013); and so are the prevalence of stunting 22% and underweight 16% which are notably lower compared to the national level respectively 50.1% (for moderate and severe category) and 36% for underweight. (UNICEF, Country profile 2013).

Problems encountered during the project implementation

Free access to marine resources demotivated fishers

Fishery regulations require that small-scale fishers have licenses, which are delivered to fishers who are affiliated to an association. Given that any fisher can freely access marine resources and that there is no punishment to fishers who have no license, some fishers find no interest in LMMA membership. Though political issue are part of the project's assumption, this incoherence in the text was not considered but remained a challenge as the project itself could not change any text. A large lobbying with other stakeholders involved in fishery activities would be important.

A well-organized beach seine industry in the Northeast with social implication

Periodical joint patrols and SMART data analysis of beach seine practices have highlighted a well-organized beach seine "industry". Beach seines belong to wealthier villagers, with small scale fishers' renting the nets. Confiscations of beach seines deprive small scale fishers of their livelihoods but will not affect the owners who will continue to lend or rent beach seines. The confiscation and destruction of beach seine nets by CSP in December 2017 caused social movement in Maroantsetra. Beach seines owners led protests in town and threatened WCS staff. Local authorities tried to minimise such movements and negotiated with offenders and freed them, which in turn demotivated CCS and LMMA members.

Thus, an awareness-raising approach targeting both small scale fishers and beach seine owners has been discussed with local authorities. An ad hoc committee will both organize awareness-raising sessions in villages and on radio broadcasts and implement patrols to seize beach seines. Other strategies remain important, including promotion of alternative activities for small scale fishers and facilitating access to legal and affordable fishing gears to achieve tangible impacts.

High vanilla prices discouraged community engagement in fishery management or rice farming.

In 2016/2017, the price of prepared vanilla has increased 5 times compared to 2015: (100$/kg in 2015, 430$/kg in 2017). Households were attracted to vanilla crops compared to fisheries activities, or rice cultivation. It has impacted the number of beneficiaries we could involve and trainings and meetings during key cultural period attendance. Rice production activities specially suffered from this concurrency as households owning land have invested their efforts in vanilla much more than rice (and food security). The most vulnerable people (landless) suffered a lot from inflation created by this market.

Though we have identified in the project assumption the potential impact of local economies on supply chains, we had not expected such a huge increase in vanilla price. As Malagasy vanilla prices are volatile and always meet ups and downs, household strategies have short-term goals despite food security issues, cyclones and economic risks. We have decided to provide assistance to pilot households with counselling on household budget management - Conseil à l'Exploitation Familial (CEF). This improves capacity to monitor incomes and expenses and design more resilient short/mid and long term strategies. CEF was developed by GRET and experimented in Androy in the South of Madagascar where people are impacted by climatic hazard such as severe droughts. It is based on participatory and simplified economic tools animators build with households. The activity was recently launched in 3 of the 8 targeted villages funded by other donors (no matching funds): Amboditangena, Antsirakivolo, and Hoalampano.

High turn-over of staff at our partner - GRET

Three different project managers during the project, two different project officers at GRET headquarters as well as the resignation of the person in charge of agriculture and monitoring and evaluation at the end of 2017 have impacted on the results related to the livelihood component; especially regarding monitoring and evaluation system. Local inflation and the remoteness of Mananara demotivated the staff. Such turnover was not expected during the project preparation. Starting from 2018, GRET has decided to set up a bonus system for its staff based in Mananara.

3.2 Outcome: Sustainable fisheries management and livelihoods diversification in Northeastern Madagascar protects coral reefs (7,000 hectares), improves food security, livelihoods and health for 11,000 people, and becomes a model for the region.

So far, project's progress includes strengthened community involvement and understanding of the need for fisheries management, gear restrictions, zoning within the LMMA, and for fishing closures. Unforeseen factors, such as a coral bleaching event in 2016, may have affected the outcomes and have highlighted the need to diversify livelihoods to reduce pressure on marine biodiversity and coral reef and environments.

Indicator 1: By 2017, improved coral reef health, measured by a 20% increase in coral cover and fish biomass in at least one third of Antongil Bay LMMAs.

Reef monitoring was implemented in 24 transects within 11 LMMAs. The status of the coral reefs in Antongil Bay was assessed by monitoring coral cover and fish biomass in both no-take sites where fishing activity is forbidden, and in restricted fishing sites where few fishermen that have historically depended on the fishing site are currently allowed to continue to fish. Methodology and approach are detailed in Annex 2.

Coral cover was stable in Antongil Bay during the project

The overall coral cover in the LMMAs was 37.5 % (+/- 2.6 % 1 SEM) in 2015 and 33.5 % (+/- 2.6 % 1 SEM) in 2018, however data does not suggest there has been a significant change in coral cover between years (lmer, df = 1 , 23, F = 2.8462, p = 0.105), or as a result of the management regime in LMMA (lmer, df =1 , 12, F = 1.2856, p = 0.278). The difference in management regimes are minor, no take versus fishing restricted area, and it is therefore not surprising they do not impact coral cover. Potentially of more relevance is coral mortality from bleaching disturbance, which might be expected to have contributed to a decline in coral cover. However, WCS data from multiple sites and seascapes in Madagascar for coral cover prior to the 2016 global coral bleaching event and subsequently to this indicates coral cover has generally recovered to within 10% of pre-bleaching levels. This is consistent with the data for coral cover in the Bay of Antongil.

At the level of individual LMMA a decline in coral cover was observed for Antsirakivolo from 57.8 % (+/- 2.25 % 1 SEM) to 41.0 % (+/- 7.0 % 1 SEM), Imorona 44.7 (+/- 1.76 % 1 SEM) to 37.2 % (+/- 2.05 % 1 SEM) and Aniribe from 36.3 (+/- 9.25 % 1 SEM) to 19.3 % (+/- 7.75 % 1 SEM) (Annexe 7-Figure 3). The detailed coral cover at individual sites are presented in Annex 6b, and slight increases in coral cover occurred at 9 of the 24 sites monitored between 2015 and 2018; coral cover remained the same at 1 site (Manambato), and declined at the remaining 14 sites.

Decrease in fish biomass in Antongil Bay

The average fish biomass during the initial surveys in all LMMAs, with exception for Manambato and Aniribe, was below what is considered to be sustainable for a reef community in the Southern Western Indian Ocean (Annex7- Figure 5). *Graham et al. (2017)* in a study of fish communities that monitored on 253 reefs of 9 countries in the Indian Ocean, including data from WCS sites in Madagascar, suggests that the minimum fish biomass of a self-sustaining reef fish community is 650 kg/Ha. *Darling and D'agata (2017)* later suggested that a sustainable biomass for reef fish communities is above 1000 kg/Ha in the context of pressure from coastal fisheries. Therefore, a sustainable fish biomass for reefs in Antongil Bay is considered to be 1100 kg/ha.

It is therefore not surprising that regardless of community engagement and management actions taken, there has been a decline in the biomass of coral reef associated fish. The overall average fish biomass in an LMMA of Antongil Bay declined significantly by 666 kg/ha between 2015 and 2018 (F(1, 44) = , p < 0.001). Average fish biomass was 914 kg/ha (+/- 130 kg/ha, 1 SEM) in 2015, and 248 kg/ha (+/- 28.5 kg/ha, 1 SEM) in 2018. The management regimes (restricted fishing and no take) did not have different impacts on the decline in fish biomass (F(1, 44) = , p = 0.274), although average fish biomass was lower to start with in

restricted fishing sites at 741 kg/ha (+/- 211 kg/ha) versus 1117 kg/ha (+/- 115 kg/ha) in no take areas, and therefore the amount of possible decline was less (Annex 7-Figure 4). In 2018 average fish biomass in no take areas was 204 kg/ha (+/- 27.4 kg/ha) and 285 kg/ha (+/- 45.7 kg/ha) in restricted fishing areas.

The decline in average fish biomass was observed at 9 of the 11 the LMMA monitored . At 2 LMMA, Antsirakivolo and Vatolava, change in average fish biomass is not clearly observed because the variability in fish biomass among the sites of these LMMA is greater than the potential change in biomass between years. We cannot discard the possibility that fish biomass has declined across the whole of Antongil Bay as a result of events not related to management. For example the 2016 bleaching event is likely to have had impacts on communities of reef associated fish. Coral community composition and cover is likely to have changed available habitat for reef associated fish (Wilson et al. 2006). Seasonal variations in fish presence may also contribute to the change, however is unlikely to alone explain the magnitude of change in fish biomass between years. However, a likely explanation for the observed declines in fish biomass is that an initially degraded fish community - that requires extreme management for a timeframe that will allow fish communities to recover without human pressure. For example fisheries closures for more than one reproductive cycle and elimination of fishing gear (e.g. fine mesh nets) that catch key fish groups such as herbivores (e.g. Scaridae), and individuals that have not yet reached a reproductive size.

The following may have also partly contributed to the patterns observed in fish biomass:

- Complication with field work resulted from a plague outbreak and cyclones which led to the 2018 surveys being undertaken in March/April whilst initial surveys were undertaken in October-November. Seasonal variation in fish presence is not described in published studies for the Antongil Bay, and interpreting local knowledge is complicated by differences in fish names between villages and general local names for multiple fish taxa at the family level. Some insight into seasonal variation of fish biomass may be interpreted from CPUE data. However, this should be done with caution because fishing effort, practices and species targeted vary throughout the year.
- Surveys were undertaken by different observers, which may have introduced observer bias. Data is interpreted at family level. Therefore, it is unlikely that taxonomic identification of fish differed sufficiently to have affected the interpretation of fish abundance from the data. Any differences in the estimation of fish size would influence the estimation of fish biomass. However, this is also unlikely to have produced the magnitude of change observed in the data.

Regardless of the potential causes of declines in fish biomass observed in the data, WCS recognizes that it is important to use these results to continue to increase community awareness of these issues and to increase community support for management and compliancy with closures and fishing gear regulation.

Indicator 2 : By 2017, improved fisheries yield, measured by a 20% increase in fish and macro-invertebrate catch (especially species from the following families and groups: carangidae, lethrinidae, siganidae, nemipteridae, sphyraenidae, scaridae, mulidae, lutjanidae, serranidae and octopus) per unit of effort in 24 Antongil Bay LMMAs

Two WCS agents monitored catch per unit effort (CPUE) in each village (Annex 7-Figure 6), by interviewing fishermen returning from fishing once a week. Fish were identified and described with weights and lengths recorded along with information such as the fishing gear used and fishing sites. Fishermen were interviewed on the beach as they returned to facilitate observation of whole catches.

CPUE data was successfully collected for the villages of Analanjahana, Androkaroka (except for 2015), Anove (from April 2016), Antanambe, Imorona, Mandrisy, and Tampolo (Annex 7-Figure 7). Catches in Analanjahana, Androkaroka, Anove, Mandrisy and Tampolo appear to have increased during the project, although it is likely that lack of data in the initial months of the project ever emphasizes these trends.

There are also reasons to expect fisheries yields to fluctuate throughout each year. Natural CPUE fluctuations partly result from seasonal habits of the target taxa, and seasonal patterns in fish behavior are unknown for the region. Secondly, the degree of fishing activity throughout the Antongil Bay varies seasonally, as fishermen may dedicate several months to other livelihood activities such as the cultivation of vanilla and cloves, which demand significant effort and protection from theft. Weather patterns may also dictate fishing activity, with the bay being highly susceptible to southeasterly winds and sediment run-off in the rainy season (January – April).
CPUE data was interpreted for the key fish families: Carangidae, Lethrinidae, Siganidae, Nemipteridae, Sphyraenidae, Scaridae, Mullidae, Lutjanidae, and Serranidae. Where sufficient data existed for a village and family, it was possible to explore CPUE trends, whilst if data was non-existent for a fish family this may indicate they have low abundance or are rarely targeted. Graphs of the monthly average CPUE, together with fitted linear models and regression analysis, were interpreted to suggest trends for each key fish family and villages (Figure 7, Table 4). However, CPUE data was collected by numerous observers and fisheries and ecological data is naturally variable, which results in R2 regression coefficients below 0.4 for linear models fitted to the data and the following interpreted trends should be accepted with caution. It is also cautioned that fish biomass may be relatively low in the Antongil Bay in general as a result of historical overfishing, thus contributing to low catches, and therefore making it harder to detect further declines in fish catches. Catches of Carangidae increased in Analanjahana, Androkaroka, Anove, Mandrisy, and Tampolo, whilst data was insufficient at Antanambe and no change in catches was seen at Imorona. Catches of Lethrinidae increased at Androkaroka and Anove. No change in catches was seen at Imorona and data was insufficient at other villages. Catches of Siganidae increased at Antanambe and Mandrisy, yet they remained unchanged at Analanjahana, Androkaroka, Anove, Imorona, and Tampolo. The data was insufficient to interpret changes in catches of Nemipteridae and Mullidae. There were no changes detected at individual villages for Sphyraenidae despite an apparent overall increase in catches for the Antongil Bay. Catches of Scaridae increased at Anove, Antanambe and Mandrisy, remained unchanged at Analanjahana, Androkaroka and Imorona and data was insufficient to interpret changes elsewhere. Catches of Lutjanidae increased at Androkaroka, Anove, Antanambe, and Mandrisy and showed no changes at Analanjahana, Imorona and Tampolo. Catches of Serranidae increased at Mandrisy and remained unchanged at Analanjahana, Androkaroka, Anove, Antanambe, Imorona, and Tampolo. Data was insufficient to enable an interpretation of trends at other villages (Ambodimangamaro, Amboditangena, Aniribe, Antanandava, Antsirakivolo, Fahambahy, Hoalampano, and Mahasoa).

When comparing the daily catch rates in the Bay of Antongil to mean daily catch rates of 10 to 15 years ago, daily catches in 5 of the villages have increased and daily catches have declined in 2 villages, Analanjahana and Androkaroka (Annex7-Figure 7). This comparison is made against the published baseline of 4.4 kg/day/fisher (Doukakis, et al. 2007). Although we report average catches per fishing trip it is important to note that during 2016 and 2017 77.9% of fishing trips were undertaken by an individual fisherman in a canoe, and 18% by two fishermen in a canoe. Larger numbers of fishermen are rare for a trip targeting fish and are mostly associated with targeting larger prey and using large nets, for example to target sharks in offshore waters.

To estimate the variability in fishing effort we also record the number of canoes that leave a village each day. This data suggests that the fishing effort during the length of the project has increased at Mandrisy (Adjusted R-squared: 0.0111, F-statistic: 10.54 on 1 and 849 DF, p-value: 0.001) and Tampolo (Adjusted R-squared: 0.01542, F-statistic: 7.313 on 1 and 402 DF, p-value: 0.007), whilst it has not changed noticeably at other villages (Annex 7-Figure 8). This suggests that increased catches at either Mandrisy or Tampolo could be at least partly explained by increases in fishing effort and not by increases in fish stocks, whilst stable catches could represent declines in fish stocks.

Monitoring of octopus catches during this project did not detected an increase in octopus fisheries yields for Antongil Bay in general (Annexe7-Figure 9). Catch data is primarily from two villages, Antanambe and Mandrisy with almost no octopus catches in other villages. There was no apparent change in the yields at Antanambe and an apparent increase in catches at

Mandrisy. The scarcity of data before June 2016 could overemphasize apparent increase in catches at Mandrisy. However, this may also represent low fisheries yields, resulting from low targeting of octopus or an undescribed survey bias, which led only to few interviews with octopus fishers. The fluctuations in octopus catches throughout the year do not show a pattern that can be associated with season in the data collected. The current analysis does not consider production from octopus reserves.

Catch data for squid indicate that yields have increased during the duration of the project. The catches of squid were recorded primarily in the villages Analanjahana, Antanambe and Mandrisy with insufficient data available for other villages. Amongst these 3 villages catches were generally larger in Mandrisy which was also the only village where catches were observed to increase during the study

Indicator 3 : By 2017, a 50% decrease in poaching and by-catch of endangered marine species (sharks and marine turtles) in 24 Antongil Bay LMMAs

Catch of sharks in the Antongil Bay

Landing site surveys have been conducted in the LMMAs to identify the numbers, species and sizes of caught sharks and rays. While Antongil Bay was classified as a shark sanctuary (i.e. no-take for sharks) in December 2015, sharks and rays are still captured and all capture after this date is considered poaching. WCS animators hold regular public sessions to raise awareness and understanding of shark and ray protection and their ecology.

Survey results indicate that sharks were captured throughout 2016, at approximately 1 kg per fishing trip, but peaked at a monthly average of 2 kg/trip in March 2017. However, that decreased in April 2017. No shark catches were recorded during the last half of 2017. Catches are predominantly hammerhead sharks, being the most abundant sharks in the Antongil Bay in previous studies (Doukakis et al. 2011). Data show a gradual decline towards the end of 2017 without any shark catch (Figure 10). Shark catches occur primarily in two villages, Anove and Tampolo, and no catch is recorded in other villages.

Anecdotal evidence from fish markets indicate that sharks continue to be caught in the Antongil Bay in early 2018. Informal observations, apart from WCS interviews and fishers' catches, report individuals' catching of zebra sharks *(Stegostoma fasciatum)* and scalloped hammerheads *(Sphyrna lewini*), which are both classified as Endangered on the IUCN red list of threatened species.

Overall the catches of sharks and rays are unlikely to be frequent in Antongil Bay because these animals are rare. A baited remote underwater stereo-video survey (stereo BRUVS) was undertaken at 130 sites in October 2017 using standardized methods (Cappo et al 2004, 2007; Goetze et al. 2011, Rizzari et al. 2014). Each video recorded for one hour, with 1 kg of bait, and at a maximum depth of 40 m depending on the site. A total of four animals, one species of Rhinobatidae (guitarfish) and three species of Dasyatidae (stingray) were detected. Anecdotal evidence and reports (Doukakis et al. 2007, Humber et al. 2015) of historically high levels of shark and ray fishing suggest abundance of territorial species and species with relatively small home ranges is greatly reduced. It is not surprising that the most frequently caught sharks are hammerheads, which have relatively large home ranges and inhabit deeper waters, and therefore are unlikely to permanently reside in Antongil Bay. There are relatively frequent anecdotal reports of juvenile hammerhead sharks in fishermen's catches, which continues to support the idea that Antongil Bay is a nursery at least for these species (Doukakis et al. 2007).

WCS interviewed fishermen in four towns of Antongil Bay, Maroantsetra, Maintimbato, Nandrahana, and Rantohely in February 2018 and found that all fishermen currently consider shark fishing as an activity of the past although in the year 2000, 88% of them would have fished for sharks as part of their livelihoods. The awareness raising campaign on shark ban in Antongil bay implemented with representative of monitoring department CSP at the MRHP may have contribute to the shift in shark catch. The fishing gear most used was nets of at least 3 cm mesh deployed by teams of 2 to 10 fishermen. Currently, sharks are generally caught accidentally and most frequently when bonito are abundant in the winter months of June and

July. Fishers claim that they do not release sharks because they are already dead. Ray and guitarfish meat is considered “fady” and not eaten, although the fins of these animals can fetch high market prices and guitarfish in particular are highly targeted.

Catches of rays in Antongil Bay

Catches of rays in Antongil Bay are generally higher than sharks, with an overall monthly average of approximately 10 kg per fishing trip (Anex7-Figure 11). Rays catches were recorded in the villages of Analanjahana, Mahasoa, Anove, Antanambe, Fahambahy, Mandrisy, and Tampolo. A peak in catches was observed in October 2015, with a monthly average of approximately 85 kg/trip – more than twice the average observed in other months surveyed. As catches immediately dropped the following month, it is possible this resulted from a brief influx of ray species such as manta or mobulid rays given Myliobatids were frequently recorded in catches. From November 2015 to August 2017 mean monthly catches of rays increased gradually with a secondary peak of approximately 40 kg/trip in August 2017. Minimal records of catches after that may indicate seasonal fluctuation similar to 2015-2016 and 2016-2017 summers and not necessarily a decline. Catch data continues to be recorded.

Catches of turtles in the Antongil Bay

Interviews undertaken with fishermen in four towns of Antongil Bay, Maroantsetra, Maintimbato, Nandrahana, Rantohely, during February 2018 indicate turtles are generally caught accidentally in Antongil Bay and that fishermen are aware that turtles are endangered and their conservation is important. Approximately 5 % of fishermen stated that if they caught a turtle in their net they would not release it. These fishermen’s stated that the low fish catches and the limited means of subsistence for some families justify keeping turtles that are caught.

Indicator 4: By 2017, a 15% increase in dietary diversity, a 30% increase in food security, and a 15% increase in income diversity in 100 households across the five targeted sites

LMMAs were found to have the highest percentage of households with high dietary diversity scores across all seasons. From May 2016 until December 2016, less than 2% of households were found to have low dietary diversity (0-4), with 60% of all households falling into the medium dietary diversity category (5-8), and the remaining households having high dietary diversity (9-12). Diets were slightly less diverse across all sites during September to December season than they were during the May – August season.

Indicator 5 : a 20% decrease in iron and zinc deficiency and a 20% decrease in underweight, stunting and wasting in 100 households across the five targeted sites.

The prevalence of underweight, stunting and wasting in the five villages are notably lower compared to national level. The rate of people suffering from zinc deficiency is different from a village to another (from 11% to 20%), and is quite higher compared to national rate (16%).

Indicator 6 : a 20% increase of rice productivity in plots in 250 households applying improved practices; an 85% decrease in poultry mortality and a 20% increase in income from poultry raising and gardening in 250 households in the villages of the five targeted LMMAs.

About 150 beneficiaries have adopted intensive techniques for rice cropping with an average yield increase of 47%. Mortality rate is about 64% for non-vaccinated chicken when disease appears. This number is reduced to 13%, which represent 80% less of poultry for vaccinated poultry. Data on household incomes evolution are not available as farmers were reluctant to share data on their income according to local customs.

4 Contribution to Darwin Initiative Programme Objectives

4.1 Contribution to Global Goals for Sustainable Development (SDGs)

The project contributes to (i) the SDG 2 by supporting more sustainable fishing and agricultural practices that improve productivity and incomes of small scale producers and fishers; (ii) to the SDG 14 by contributing to the protection and sustainable use of marine resources through co-management approaches. Improved local fisheries management plans and co-management approaches to improve the management of small-scale fisheries have been developed and are under implementation leading to more sustainable fishing practices. Small scale farmers adopt improved rice farming techniques that increases productivity. By promoting income generating activities that target women and through the promotion of women involvement in fishery management, the project contributes also to SDG 5 : ensuring women's full and effective participation and equal opportunities for leadership at local level of decision making in economic and public life.

4.2 Project support to the Conventions or Treaties (CBD, CITES, Nagoya Protocol, ITPGRFA)

The project has contributed valuable information towards WCS' broader activities in Madagascar to develop a national roadmap and action plan for sharks and rays, and to inform the proposed listing of species under the annexes of the Nairobi Convention Protocol Concerning the Protected Areas and Wild Fauna and Flora in the Eastern African Region. These findings, and the absence of sharks and rays in the study region, despite this being a no-take zones for sharks, has also provided baseline data to highlight the extent to which these animals are threatened, and which could inform future IUCN Red List assessments. WCS' shark and ray activities in this area provide data that can inform effective management and sustainable harvesting of the resources within this area (Aichi target 6), contributed to the design and implementation of area management specifically aimed at sharks within this ecological important area (Aichi target 11) and which in turn (based on the species present) should in time result in a reduction of fishing pressure and protection of important ecological areas (parturition sites and nurseries) for at least two endangered ("facing a very high risk of extinction in the wild") shark species (Aichi target 12). However, the extent to which these activities translate into tangible positive outputs will depend on future compliance and cooperation by the resource users, and effective enforcement of regulations.

While supporting the implementation of the Antongil Bay Fishery Management Plan which aims include sustaining fish supplies to final users, the project contributes to CBD strategic goals : support to 26 LMMAs on joint patrol between local communities and local authority help to reduce direct pressures on biodiversity and promote sustainable use of marine resources (strategic objective A and B), zoning in the LMMAs, and promotion of shark conservation safeguard ecosystems, species and genetic diversity (strategic objective C), CPUE improvement and temporary reserves along with promotion of livelihood enhance the benefits to all from biodiversity and ecosystem services (strategic objective D).

4.3 Project support to poverty alleviation

Increase in fish catch from temporary reserves and daily catch have substantially improved small scales fishers 'incomes. During informal interviews during CPUE monitoring and opening reserve events, fishers recognized that they have noticed increase in their revenue. But due to local customs, they were evasive on how much additional revenue did they gain. It is worth noting that around 1050 fishers are currently involved in reserve management.
Moreover, 150 small scale farmers have seen increase in their rice productivity; 220 women adopted new income generating activities (smoked fish, gardening and poultry) that provide additional revenue to their households (cf section 3.1).

4.4 Gender equality

It has generally been assumed that fishing activities are predominantly undertaken by men in Madagascar. Thanks to this project, women are currently involved in the management of LMMAs as: (i) CCS members - women represents 22% of CCS members in 12 LMMAs from

Mananara, (ii) CPUE agents - there is one female CPUE agent among the current 20 agents. A limitation is that few women are literate, which is a requirement for CPUE agents.
Introduction of livelihoods has also helped promoting gender approach in fishery management with 220 women adopting gardening, fish smoking and poultry farming activities.

4.5 Programme indicators

- **Did the project lead to greater representation of local poor people in management structures of biodiversity?**

Yes. The project supported locally managed marine areas, with surveillance by local village association members. The model has been well accepted in the Bay of Antongil with 26 LMMAs fully operational around the Bay; other groups have shown interest in implementing LMMAs within their village. Fishers 'community are amongst the most impoverished, isolated, and marginalized communities in Madagascar

- **Were any management plans for biodiversity developed?**

The project has contributed to the development of Dina Be, a social convention that addresses specific issues such as overfishing, use of illegal gears, and protection of key habitats and species. Data collected on shark and ray status in the Bay of Antongil has contributed to national level discussions - including the Ministry of Marine Resources and Fisheries, the Ministry of Environment, Ecology and Forest, international and national NGOs and research institutes and fishers - for the development of a 5-year sustainable management and conservation plan.

- **Were these formally accepted?**

The Dina Be is approved by the 13 Communes, the representatives of the Ministry of Fisheries in Maroantsetra and Atsinana Region; the next step is to have it approved by the court. The National Road Map related to conservation and sustainable use of Shark and Rays has been approved by the Shark and Rays Working Group (comprising the Ministry of Fisheries, Ministry of Environment, NGOs working in marine resources, research institutes, fishers' representatives) and has been presented and approved by the government.

- **Were they participatory in nature or were they 'top-down'? How well represented are the local poor including women, in any proposed management structures?**

The development process of these plans has included stakeholders at all possible levels in all instances. Local communities and fishers are involved and government is also engaged.

- **Were there any positive gains in household (HH) income as a result of this project?**

Households have seen their income improved thanks to the project: improved in catch, improved in rice productivity, adoption of new income generating activities.

- **How many HHs saw an increase in their HH income?**

At least 1330 have declared improvement in their income.

- **How much did their HH income increase (e.g. x% above baseline, x% above national average)? How was this measured?**

Local communities in Antongil Bay are reluctant to talk about figures on their income. During the interviews/discussions, they shared qualitative perception of their income : increase; decrease or remaining stable.

4.6 Transfer of knowledge

WCS field staff in Antongil Bay, LMMAs leaders and representatives from the Ministry of Fishery in Maroantsetra have been trained by WCS Madagascar marine program officer on use of SMART – Spatial Monitoring and Reporting Tools – for patrol and surveillance. WCS field

staffs are currently adopting the tool, but communities and authority need more practice to be able to run SMART by themselves.
Restitutions of results from catch surveys, patrol and surveillance activities to local stakeholders (Authorities, LMMA leaders, communities) help them to better understand the impact of fishing practices to biomass, and to suggest suitable measures to improve management of fishery activities.
At least 80 LMMAs leader have the capacity to better advocate on the importance of the management of marine resources thanks to the awareness raising, training and coaching provided by WCS team on leadership, fishery regulations, management of community associations.

4.7 Capacity building

Two male field staffs from Antongil Bay as well as 3 staffs from Tana (2 women and one man) have been selected by WIOMSA to present their work during WIOMSA meeting in 2017. Our junior scientist Christelle Razafindrakoto has received the American Elasmobranch Society 2017 Young Professional Recruitment Fund Scholarship, giving her opportunity to deepen her knowledge and expertise for sharks and rays with support from experts and peers worldwide
Arielle Ines Hoamby, a female intern whom WCS supported during her masters studies, has gained experience and skills development in ecological field assessments of fish biomass and coral reef community status. This includes development of taxonomic identification skills and scientific diving skills.

5 Sustainability and Legacy

Community based management of marine resource and livelihood activities
Existing LMMA will continue to ensure management of fisheries and marine habitat; households involved in gardening will likely to continue the activities as they have received tangible benefits. Supported by funding from KfW for the sustainable reef fish project (Projet PCD – Pêche Côtière Durable), WCS will continue to build capacity of current LMMAs while expanding the network through support to the implementation of 15 new LMMAs in order to set up a “blue belt” around Antongil Bay. Another component in the PCD project is focused on promoting alternative livelihoods to motivated LMMAs through an industry approach to ensure an effective additional income for fishers. Thus, WCS will pursue working with the MRHP to implement ABFMP, and will reinforce the Federation of fishers – a key stakeholder in fishery management, officially created within the frame of the current project.

Next steps for staff and resources from the project
Project staff from both WCS and GRET will continue to work on the current topics with the PCD project. GRET, as a beneficiary of the PCD project, will continue to promote poultry and gardening activities in Mananara.

6 Lessons learned

Official recognition of CCS that serves as reference on national levels
Thanks to collaboration with the CSP department, they have officially trained and recognized CCS members as local patrol agents; only LMMAs working with WCS have such privilege; and this model has served as reference at national level. CCS was initiated in Antongil Bay then in three MPAs that WCS co-managed with local communities; Blue Ventures and WWF were inspired and implement patrol agents in their sites after a field visit in WCS sites.

Effective involvement of local stakeholders,
Around 410 persons run on-ground activities actively: 390 community control and surveillance (CCS) members within the 26 LMMAs and 20 fish-catch monitoring agents. CCS benefits support from ad hoc committees comprising representatives from local authorities, PCDDBA, Federation of fishers, and police in joint patrols. Ad hoc committees are effective in both Mananara and Maroantsetra. Moreover, villagers were active during the implementation of the MIS by providing in-kind contribution during the construction. Such involvement ensures ownership and sustainability of the project achievement.

Launching adaptive management approach

12 LMMAs in Mananara have adopted adaptive management – adjustment of management measures based on results from different surveys (ecological survey, catch survey, SMART/control and surveillance) regarding decisions taken during the restitution of Catch Per Unit Effort - CPEU and SMART surveys. Local authorities have manifested their support in control and surveillance. All participants have asked WCS to continue awareness-raising on fish conservation measures. CCS will continue law enforcement using *Dina.* LMMAs staffs as well as authorities and local communities were aware of the importance of data they collected and they were motivated to continue collecting and sharing data.

Integrating gender in fishery activities

It was always assumed that fishery activities were predominantly for men. Thanks to the project, women are currently involved in the management of LMMAs as CCS members (women represents 22% of CCS members in 12 LMMAs from Mananara), as CPUE agents where there is one female CPUE agent among 20 existing ones. This may be due to the fact that few women have writing and reading skills, which is a mandatory requirement for CPUE agents.
Introduction of livelihoods targeting specifically women (gardening, smoked fish, poultry farming) had also helped promoting gender approach in fishery management.

Importance of integrating governance of fisheries and tangible benefits for local communities

While governance activities including patrols and catch and ecological surveys are important to preserve marine resources, profitable activities such as fishery management activities through marine reserves with tangible benefits to LMMA members are also key pillars to better involve them in marine resource management, thus ensuring efficiency and sustainability of the LMMA concept. Currently, 13 LMMAs have marine reserves including 12 octopus reserves and 3 sea cucumber reserves in Mananara. Members are keen to preserve LMMAs as they have noted improvement of quality and quantity of the production, particularly during the opening period of the octopus and sea cucumber reserves. In addition to this, promotion of new alternative livelihoods for motivated LMMAs is important to ensure sustainable involvement of local communities.

Maintaining positive change at local level requires strong support from government

The current project has enabled WCS to reinforce community involvement in fishery and marine resource management and governance and to establish sound collaboration with local authorities. However, facing well-organized offenders such as beach seine users, this achievement is quite fragile without strong support from national government mainly in law enforcement application.

Coordination with partners

While each project partner has its specific component, on ground coordination since the beginning of the project (identification and selection of the beneficiaries, defining approach to sensitize local community on the project, etc.) will help achieving project common objective.

Logistical issues

The logistics of coordinating data retrieval from numerous surveillance officers in remote locations, with different dialects and without access to computers and internet, has identified many hurdles and challenges to achieving consistency and maintaining data up to date. We are currently taking steps towards streamlining data entry and analysis that reduce the delays in returning feedback to the fishing community. This facilitates discussions, increasing awareness of the importance of management initiatives and also increases support for the LMMAs.

In water surveys of coral cover and fish biomass in Antongil Bay are more challenging for logistical reasons (e.g. road infrastructure, cyclones, wind exposure and marine conditions) compared to other areas in Madagascar, this hindered fieldwork.

6.1 Monitoring and evaluation

There were no major changes in the project design. However, there are key facts that could have been greater attention while defining the biological indicators and baseline for the study.

Increasing coral cover and fishable biomass was ambitious in the context of overfishing and low level initial biomass. It is apparent that a longer timeframe than 3 years is required along with intensive governance measures (strict law enforcement in terms of fishing gears, fishing calendar). Key to success is a greater understanding and acceptance by the community of the impacts of destructive fishing practices (e.g. beach sein nets and small net mesh sizes) to coral reef habitats, reproductive potential of fish communities and to livelihoods. Joint patrols are efficient but also expensive (fuel for boat, accommodation and meals for ad hoc committee members, transport and travel expenses for CSP based in Antananarivo), and it is ultimately community understanding, adherence to, and support for management practices that will enable the effective management and conservation of biodiversity.

For the livelihoods component, M&E system should have been adjusted to local context and competences to have simple but useful data.

To have a good comparison regarding the effect of LMMA on food security and health, we have modified the sampling for 2 LMMAs, 2 “unmanaged area” and 1 marine park community – instead of 5 LMMAs, as presented in our Year 1 report.

6.2 Actions taken in response to annual report reviews

Comments	When	Observation
Please submit sources of verification with each annual report. Failure to do so could give you a weaker mark (which can affect future funding prospects) since the reviewer will be unable to verify your statements of progress/outcome	Final report	Sources of verification are joint for this final report : - Synthesis of ecological Survey report 2015 – 2018 (section 3.2) - Catch analysis (in section 3.2) - Samples of communication tools : brochures on fish catch in Mandrisy, on SMART restitution to communities; - Health sample result (annex 6.a)
Annual Report 1 asked for “clarification on the terminology – what are fisheries restricted areas? What is the extent of the MPA? A map would be useful” – please answer this clearly in your next report	Final report	“Fisheries restricted areas” are part of the zoning within an LMMA where fishing activities are limited in terms of fishing gears, fishing calendar according tp the LMMA management plan and local convention *“Dina”* : MPA stands for Marine Protected Area Map is integrated in section 1 Project overview – Project location
Why is section 13 Darwin Identity not applicable to this project? Is there no branding of this project as being Darwin funded? Have there been no open acknowledgements of the funding provided by the Darwin Initiative? There was to be up to £150k of matched funding – how are the various funders being represented? Please clarify	Final report	There was a misunderstanding in the previous report. As part of branding, we applied Darwin logo as well as those of the other donors on all publications related to the project.

7 Darwin identity

We have promoted partnership with Darwin at international and national level through communication of the project and related activities.

a) At international level: A preliminary result of the project has been presented during (i) CDB COP in Cancun in December 2016 and (ii) a consultation meeting with CDB/WHO at SESYNC headquarters in March 2017 with the participation of academicians from 5 universities, the Director General of the Malagasy Ministry of Health, the Chief of Surveillance from the Malagasy Ministry of Health, and the Chief Technical Officer from the Ministry of Marine Resources and Fisheries. We have also produced an article related to "Empowering local communities to manage small-scale fisheries" on Panorama Solution website where Darwin was mentioned among the project partners. The article was published in 2016 and has been selected to be promoted during the "Challenge-Solution weeks" on Panorama Solution social media (Twitter, Facebook) in May 2018 as well as in a publication "Panorama Brochure" (July 2018)

b) Two posters were presented during the WIOMSA meeting in 2017: "Monitoring and Surveillance Committee for Locally Managed Fisheries in Antongil Bay "and "Dina or social convention for the community management of marine resources: what are the factors of success and / or failure?"

c) At national level, we applied Darwin Logo along with other donors on all publications, communication tools related to the project.

Finance and administration

7.1 Project expenditure

Project spend (indicative since last annual report	2017/18 Grant (£)	2017/18 Total actual Darwin Costs (£)	Variance %	Comments (please explain significant variances)
Staff costs			10%	
Consultancy costs				
Overhead Costs			-28%	Change requested in year 2 and 3 for partner GRET didn't factor in WCS overheads, leading to overspending in year 2 and underspending this year
Travel and subsistence			-6%	
Operating Costs			9%	
Capital items				
Others				
TOTAL				

Staff employed (Name and position)	Cost (£)
Project Leader and coordination (Tana)	
Reef and Fisheries monitoring (Tana)	
Coordination of field activities (Maroantsetra)	
Community-liaison field staff (Rantohely)	
Community-liaison field staff (Mananara)	
Community-liaison field staff (Antanambe)	
Admin staff (Tana et Maroantsetra office)	
Leader of health research initiative	
GRET – Supervision of livelihoods development initiatives	
GRET – Coordination of livelihoods development activities	
GRET – Agricultural extensionist	

GRET – Accountancy, financial reports, logistic…	
TOTAL	

Capital items – description	Capital items – cost (£)
Not applicable	
TOTAL	

Other items – description	Other items – cost (£)
Not applicable	
TOTAL	

7.2 Additional funds or in-kind contributions secured

Source of funding for project lifetime	Total (£)
European Union /GRET)	
Agence Française pour le Développement	
THE JOHN D. AND CATHERINE T. MAC ARTHUR	
WATERLOO FOUNDATION	
The Leona M. and Harry B. Helmsley	
Shark Conservation Fund	
TOTAL	

Source of funding for additional work after project lifetime	Total (£)
KfW	
TOTAL	

7.3 Value for Money

Thanks to financial support from Darwin, we have been able to reinforce marine field staff by: (i) hiring two new persons (Manager of Antongil Bay Seascape, one animator); (ii) co-funding the salary of marine field staff and support staff in Antongil Bay; (iii) acquiring 02 motorbikes which are crucial to implement our ground activities and maintaining equipment and boat. Darwin Financial contribution has also helped us securing additional funding from other donors (as mentioned above) to support conservation and sustainable management of Antongil Bay marine biodiversity.

Annex 1 Project's original (or most recently approved) logframe, including indicators, means of verification and assumptions.

Note: Insert your full logframe. If your logframe was changed since your Stage 2 application and was approved by a Change Request the newest approved version should be inserted here, otherwise insert the Stage 2 logframe.

Project summary	Measurable Indicators	Means of verification	Important Assumptions
Impact: Madagascar's artisanal fisheries are effectively managed to simultaneously optimize coral reef biodiversity protection and sustainable harvests that deliver benefits for human health and livelihoods			
Outcome: Sustainable fisheries management and livelihoods diversification in Northeastern Madagascar protects coral reefs (7,000 hectares), improves food security, livelihoods and health for 11,000 people, and becomes a model for the region.	Indicator 1 : By 2017, improved coral reef health, measured by a 20% increase in coral cover and fish biomass in at least one third of Antongil Bay LMMAs. Indicator 2 : By 2017, improved fisheries yield, measured by a 20% increase in fish and macro-invertebrate catch (especially species from the following families and groups: Carangidae, Lethrinidae, Siganidae, Nemipteridae, Sphyraenidae, Scaridae, Mullidae, Lutjanidae, Serranidae and octopus) per unit of effort in 24 Antongil Bay LMMAs Indicator 3 : By 2017, a 50% decrease in poaching and by-catch of endangered marine species (sharks and marine turtles) in 24 Antongil Bay LMMAs Indicator 4 : By 2017,a 15% increase in dietary diversity, a 30% increase in food security and a 15% increase in income diversity in 100 households across the five targeted LMMAs Indicator 5 : a 20% decrease in iron and zinc deficiency and a 20% decrease in low birth weight in 100 households across the five targeted LMMAs. Indicator 6 : a 20% increase of rice productivity in plots in 250 households	Coral reef health reports. LMMAs fish landing surveys and fisheries interview LMMAs fish landing surveys and fisheries interview Household survey data and dietary record analysis. Anthropometry and clinical nutrition results Rice yields surveys, poultry mortality monitoring, and poultry and gardening income surveys	Government authorities have sufficient authority and motivation to control illegal activities and enforce the rules in Antongil Bay LMMAs. Strengthening small-scale fisheries co-management will be supported by all stakeholders from local to national levels as tangible benefits are perceived. The fishery will recover fast enough to deliver nutritional and health benefits. Outcomes like iron and zinc deficiency can recover quickly, but we may not see changes in stunting and low birth weight which have a longer etiology and trajectory.

	applying improved practices; an 85% decrease in poultry mortality and a 20% increase in income from poultry raising and gardening in 250 households in the villages of the five targeted LMMAs		
Outputs: **1**. Nearshore fish and invertebrate abundance are increased and endangered species of sharks and marine turtles are protected through improved management capacities and engagement of communities and government in reducing overexploitation, illegal fishing and use of destructive gears in Antongil Bay.	1.1 By year 3, in each village the number of fishers that are active members of the LMMA associations increases from 50% to 75% 1.2 By year 3, beach seines used in Antongil Bay drop from 229 to less than 100 1.3 By year 3, a measured increased in compliance with LMMA restriction	1.1 LMMA association registration books 1.2 Report of the census of fishing gears in year 3 1.3 Data collected using SMART software	Compliance with management interventions such as gear restrictions and no-take zones won't be impaired by political instability
2. Livelihoods are diversified and food security is improved through the development of environmentally sensitive small-scale agriculture, economically benefitting at least 500 households across five LMMAs	2.1 By year 3, at least 250 households adopt environment sensitive techniques for rice production, allowing an increase of yield of at least 20 % (measured on demonstration plots) 2.2 By year 3, poultry for at least 250 households benefit from regular vaccination minimising the risk of zoonotic diseases, and reducing the mortality rate by 85% 2.3 At least 250 women adopt a new income generating activity (gardening, production of smoked or dried fish)	2.1 Household agricultural surveys (on yields and practices), pilot plot yield measurements carried out every cropping season 2.2 Vaccination records (by project first, then progressively by village-vaccinators) carried out at every vaccination campaign 2.3 Project monthly survey on a sample of women (on number and amount of sales)	Potential natural disasters (such as hurricanes) do not impair the development of sustainable livelihoods
3. The human health and livelihood effects in local populations are determined by analyzing linkages between expected improvements in dietary intake, nutritional status and commercial transactions and observing the role of fisheries co-management in facilitating these health effects in 100 households across five LMMAs. Madagascar is the 6th most stunted country in the world and this output will be hugely influential for demonstrating potential impacts of fisheries management	3.1 By year 3, there will be a 15% increase in dietary diversity at the household level and a 30% increase in food security through measurement of the number of food categories utilized and through adoption of regular consumption of dried and smoked fish during periods of hardship.	3.1 Household surveys that will include coping strategies indices, food security ratings, dietary and income diversity scoring, and social and economic wellbeing measures. Each of the 100 households enrolled in the health study will maintain a dietary calendar so that we can observe the ways in which food consumption changes based on our intervention. We will use a BACI (Before After Control Intervention) study design where we work both inside and outside of areas where the intervention is	The time over which the project occurs will allow for the realization of the observation of fishery effects and the indirect effects of fishery conservation on health and livelihoods.

on human health. The findings are disseminated and inform management and policy decisions of LMMAs, relevant local and regional networks and decision-making bodies, and the CBD/WHO task force.	3.2 By year 3, there will be a 20% decrease in iron and zinc deficiency as measured by nutritional status from venous blood draws. This is the most comprehensive method for understanding real health effects of changes in fishery access. 3.3 By year 3, there will be a 20% decrease in underweight, stunting and wasting as measured by anthropometry.	taking place to determine impact. 3.2 Clinical visits with healthcare professionals will include blood draws. The blood will be analysed for a suite of nutritional markers to understand changes in the levels of iron and zinc deficiency within individuals over time. 3.3 Clinical visits with healthcare professionals will also include anthropometric assessments to understand changes in underweight, stunting and wasting.	

Activities (each activity is numbered according to the output that it will contribute towards, for example 1.1, 1.2 and 1.3 are contributing to Output 1)
Activity 1.1 Improve engagement and accountability of all stakeholders in ABFMP implementation by organizing annual meetings of the ABFMP Steering Committee.

Activity 1.2 Strengthen the ability of coastal communities to more effectively manage the network of 24 LMMAs through capacity building activities (formal training in administration, financial management, leadership, fisheries management and enforcement; organization of debates and networking between LMMA representatives and local authorities at an annual Antongil Bay LMMA network forum and national LMMA network forum).

Activity 1.3 Raise knowledge and awareness about existing fishing regulations, unsustainability of destructive fishing practices and benefits of LMMAs through learning visits for fishers at the newly inaugurated WCS-managed environmental campus in Maroantsetra, exchange visits to LMMA sites, production of regular issues of the Malagasy language 'Dalaly' magazine and radio broadcasts.

Activity 1.4 Organize joint community and local authority patrols to enforce fishery regulations in LMMAs, and trial the use of SMART (Spatial Monitoring and Reporting Tool - http://www.smartconservationsoftware.org) to support collection and analysis of threat data in real-time and optimize planning of enforcement patrols.

Activity 1.5 Conduct reef surveys and fish catch monitoring to assess impacts of LMMAs on coral reef health and fisheries.

Activity 2.1 Train and support a network of 50 pilot farmers on rice production. Prepare technical leaflets, organise trainings, exchange visits and cropping cycle collective assessments, and facilitate access to equipment to facilitate the adoption of tested and approved practices by 200 additional households.
Activity 2.2 Train 2 village vaccinators in each site to organise vaccination campaign and perform injections. Support the creation of a village vaccinators' network to organise the vaccines supply.

Activity 2.3 Identify vulnerable households/women and give them technical and financial support (but with a financial share form beneficiary) to develop a new income generating activity (gardening or production of smoked-fish). Implement two supply-chain studies to define a strategy to improve the commercialisation of these products, targeting the local market. Provide training and technical support (with regular visits from animators) on production, processing and/or marketing of products to at least 250 women. Organize exchange visits among women and support them to get organized to facilitate marketing

Activity 3.1 In five communities adjacent to the LMMAs, train female heads of households to record their diets using kitchen scales into standardized dietary journals.

Activity 3.2 Train local health professionals to obtain blood samples from local participants to test for iron and zinc deficiency every six months. These blood samples will benefit local participants as our agreement with MSP allows us to determine infections with malaria and provide Point of Care treatment

Activity 3.3 Conduct anthropometric assessments every 3 months to determine how growth trajectories (both stunting and wasting) are affected by the availability and access to nutritious diets

Activity 3.4 Communicate results to LMMAs, regional and national networks and the CBD/World Health Organization (WHO) joint task force.

Annex 2 Report of progress and achievements against final project logframe for the life of the project

Project summary	Measurable Indicators	Progress and Achievements for the life of the project
Impact: Madagascar's artisanal fisheries are effectively managed to simultaneously optimize coral reef biodiversity protection and sustainable harvests that deliver benefits for human health and livelihoods		Project results as detailed below have highlighted that fisheries management (with gear restrictions, zoning within the LMMA, and fishing calendar), along with livelihood diversification with the right target may contribute altogether to protect coral reef.
Outcome Sustainable fisheries management and livelihoods diversification in Northeastern Madagascar protects coral reefs (7,000 hectares), improves food security, livelihoods and health for 11,000 people, and becomes a model for the region.	Indicator 1: By 2017, improved coral reef health, measured by a 20% increase in coral cover and fish biomass in at least one third of Antongil Bay LMMAs. Indicator 2 : By 2017, improved fisheries yield, measured by a 20% increase in fish and macro-invertebrate catch (especially species from the following families and groups: Carangidae, Lethrinidae, Siganidae, Nemipteridae, Sphyraenidae, Scaridae, Mullidae, Lutjanidae, Serranidae and octopus) per unit of effort in 24 Antongil Bay LMMAs Indicator 3 : By 2017, a 50% decrease in poaching and by-catch	Overall coral has been stable within the LMMAs in the Antongil Bay between 2015 -2018.The detailed coral cover at individual sites show slight increases in coral cover at 9 of the 24 sites monitored between 2015 and 2018; coral cover remained the same at 1 site (Manambato), and declined at the remaining 14 sites The overall average fish biomass in an LMMA of Antongil Bay declined significantly by 666 kg/ha between 2015 and 2018 ($F(1, 44) =$, $p < 0.001$). Average fish biomass was 914 kg/ha (+/- 130 kg/ha, 1 SEM) in 2015, and 248 kg/ha (+/- 28.5 kg/ha, 1 SEM) in 2018. The decline in average fish biomass was observed at 9 of the 11 the LMMA monitored Catches in Analanjahana, Androkaroka, Anove, Mandrisy, and Tampolo appear to have increased during the project. Monitoring of octopus catches during this project did not detected an increase in octopus fisheries yields for Antongil Bay in general (Figure 8.). Catch data is primarily from two villages, Antanambe and Mandrisy with almost no octopus catches in other villages. There was no apparent change in the yields at Antanambe and an apparent increase in catches at Mandrisy. Overall the catches of sharks and rays are likely to be infrequent in the Antongil Bay because these animals are believed rare in abundance.

	of endangered marine species (sharks and marine turtles) in 24 Antongil Bay LMMAs Indicator 4 : By 2017,a 15% increase in dietary diversity, a 30% increase in food security and a 15% increase in income diversity in 100 households across the five targeted LMMAs Indicator 5: a 20% decrease in iron and zinc deficiency and a 20% decrease in underweight, stunting and wasting in 100 households across the five targeted LMMAs. Indicator 6 : a 20% increase of rice productivity in plots in 250 households applying improved practices; an 85% decrease in poultry mortality and a 20% increase in income from poultry raising and gardening in 250 households in the villages of the five targeted LMMAs	Catches of rays in Antongil Bay are generally higher than sharks, with an overall monthly average of approximately 10 kg per fishing trip. Landing site surveys previously did not record the incidence of turtle catches. There is anecdotal evidence from photographs of turtle captures, although these incidences are low, and at least on one occasion the fisher was prosecutedLMMAs were found to have the highest percentage of households with high dietary diversity scores across all seasons. From May 2016 until December 2016, less than 2% of households were found to have low dietary diversity (0-4), with 60% of all households falling into the medium dietary diversity category (5-8), and the remaining households having high dietary diversity (9-12). Diets were slightly less diverse across all sites during September to December season than they were during the May – August season. The prevalence of underweight, stunting and wasting in the five villages are notably lower compared to national level. The rate of people suffering from zinc deficiency are different from a village to another (from 11% to 20%), and is quite higher compared to national rate (16%). About 150 beneficiaries have adopted intensive techniques for rice cropping with an average yield increase of 47%. Mortality rate is about 64% for non-vaccinated chicken when disease appears. This number is reduced to 13%, which represent 80% less of poultry for vaccinated poultry. Data on household incomes evolution are not available as farmers were reluctant to share data on their income according to local customs.
Output 1. Nearshore fish and invertebrate abundance are increased and endangered species of sharks and marine turtles are protected through improved management capacities and engagement of communities and	1.1 By year 3, in each village the number of fishers that are active members of the LMMA associations increases from 50% to 75%	The concept of local and sustainable management of fishery is well spread among the Bay. However, ownership is quite different in each LMMA. 1244 fishers were registered as members of the 24 LMMAs, highlighting an increase of 45% beyond the baseline of 850 fishers. Memberships in LMMAs are stable in Andreba but they increased in 9 LMMAs – 5 of which are are located in Maroantsetra. The highest increase rate (+165%) is found in Maintimbato In Mananara, memberships have decreased in 13 LMMAs

government in reducing overexploitation, illegal fishing and use of destructive gears in Antongil Bay.	1.2 By year 3, beach seines used in Antongil Bay drop from 229 to less than 100 1.3 By year 3, a measured increased in compliance with LMMA restriction	The use of beach seines has diminished notably. Patrol records registered 42 cases in 2017 and no practise was identified during the period of January-March 2018. The Dina is currently pending at the Court for additional documents further to a second opposition (in April 2018) from a group of illegal fishers (the first opposition was in 2015).
Activity 1.1 Improve engagements and accountability of all stakeholders in ABFMP implementation by organizing annual meetings of the ABFMP Steering Committee.		3 ABFMP steering committees meetings held 2015 – 2016- 2017 to assess the implementation of ABFMP. Key decisions : identification of process to have the homologation of the Dina Be, importance of a data base of all traditional fishers (already initiated by FPBA) , recognition of the Federation of the tradition fishers in Antongil Bay - FPBA, pursuing and reinforcing law enforcement application (joint and communities patrols)
Activity 1.2 Strengthen the ability of coastal communities to more effectively manage the network of 24 LMMAs through capacity building activities (formal training in administration, financial management, leadership, fisheries management and enforcement; organization of debates and networking between LMMA representatives and local authorities at an annual Antongil Bay LMMA network forum and national LMMA network forum		- Collaboration with MRHP to officially recognize CCS as manager of local fishery resources - Trainings on : (i) fishery management tools for WCS staff, LMMA managers CiRRHP, PCDDDBA, ad hoc committee (participants); (ii) organization and running associations to 26 LMMA managers: meeting facilitation, awareness raising, and roles and responsibilities of association members, establishing meeting report, tools (iii) leadership for LMMA and FPBA leaders (28) (iv) use of SMART to 7 WCS staff and 6 representatives from LMMAs (v) law enforcement provided by CSP (7 CCS members from Anove and Fontsimaro) - Establishment of a regional decree N° 2012-008 to eradicate the use, sale and possession of beach seines in Antongil Bay - Participations of LMMA managers to MIHARI national forum in Mananara (2015) and in Fort Dauphin (2017); as well as to MIHARI regional forum in Mananara (2016). - Organizing annual forum of LMMA in Antongil Bay in 2017 - 3200 fishing licenses provided to traditional fishers - Official establishment of the FPBA registered (63-PREF/FEN-EST/ASS),

	that comprises 112 fishers associations
Activity 1.3 Raise knowledge and awareness about existing fishing regulations, unsustainability of destructive fishing practices and benefits of LMMAs through learning visits for fishers at the newly inaugurated WCS-managed environmental campus in Maroantsetra, exchange visits to LMMA sites, production of regular issues of the Malagasy language 'Dalaly' magazine and radio broadcasts.	- One video highlighting community-based fishery management in Maintimbato and Rantohely LMMAs (published on You tube for two years - https://www.youtube.com/watch?v=6ikTP2VPykI) - Partnership with two radio stations in Maroantsetra and Mananara established to diffuse specific periodical broadcast on fishery regulations (8 sessions), LMMA information (on forums, meetings), opening of octopus reserves (four times per year) - three public meetings on ABFMP and fishery regulations held - One specific awareness raising with CSP on shark conservation implemented - 3 radio reports on issues related fishery management, on climate change and its impact on marine ecosystem, and on the importance of community patrols - 3 representatives participating to an exchange visit in Soariake Association in Toliara, a local association that co-managed Soariake MPA. The exchange visits focuses on the role of local community in natural resources managers, aquaculture, implementation of CCS. CPUE - 4 awareness-raising on fishery and beach seines regulations implemented by a hoc committee
Activity 1.4 Organize joint community and local authority patrols to enforce fishery regulations in LMMAs, and trial the use of SMART (Spatial Monitoring and Reporting Tool - http://www.smartconservationsoftware.org) to support collection and analysis of threat data in real-time and optimize planning of enforcement patrols	- 40 joint patrols with ad hoc committees, one mission with CSP were implemented during the project in addition to periodical community patrols by CCS members. As results: seizure and incinerations of 33 beach seines and 109 illegal nets, pursuit of 3 offenders to local authorities. 3 offenders presented to local authorities are penalized by 2-days detention, 24 offenders have been subjected to pay fines; key offenses include: use of beach seines, mosquito nets, fishing in restricted areas, mangrove cutting - CyberTracker is used in 12 LMMAs where offenses are quite high and frequent.
Activity 1.5 Conduct reef surveys and fish catch monitoring to assess impacts of LMMAs on coral reef health and fisheries	- 10 CPUE agents ensure weekly catch survey within 6 LMMAs. Catches are identified and described with fish weight and length recorded along with information such as the fishing gear used and fishing spots visited. - 2 ecological survey where implemented in 2015 and 2018 : The status of

		the coral reefs in Antongil Bay was assessed by monitoring coral cover and fish biomass in both no take sites where fishing activity is forbidden, and in restricted fishing sites where few fishermen that have historically depended on the fishing site are currently allowed to continue to fish. Benthic communities were described at each site using a point intercept transect 50 m in length with observations every 25 cm. In general two sites were monitored for each LMMA, a no-take and restricted fishing activity site, with the exceptions of Antanambe and Imorona, where 2 restricted and 1 no-take sites were monitored. Data presented represents 11 LMMAs, which were successfully monitored in both 2015 and 2018. Fish were surveyed simultaneously to corals at all sites with visual census undertaken along a 50m × 10 m transect. Results of the data analysis are details in Section 3 - Restitution CPUE and SMART analysis conducted through workshops (3) and site visits (cf. section 5 – adaptive management)
Output 2. Livelihoods are diversified and food security is improved through the development of environmentally sensitive small-scale agriculture, economically benefitting at least 500 households across five LMMAs	2.1 By year 3, at least 250 households adopt environment sensitive techniques for rice production, allowing an increase of yield of at least 20 % (measured on demonstration plots) 2.2 By year 3, poultry for at least 250 households benefit from regular vaccination minimising the risk of zoonotic diseases, and reducing the mortality rate by 85% 2.3 At least 250 women adopt a new income generating activity (gardening, production of smoked or dried fish)	691 direct beneficiaries from eight LMMAs have benefited from the activities of rice production, MIS, breeding and farming. 150 beneficiaries out of the 200 trained adopt at least one intensified crops technics for rice (parts of technics or all technics). The average yield from intensified rice cropping has increased up to 47% By March 2018, 281 persons (80 women and 201 men) from 8 villages are involved in chicken farming; 2 village vaccinators per site provided assistance on vaccination 220 women have been involved in new income generating activities gardening (94 women), smoked fish (46), poultry farming (80); that provide substantial additional income.
Activity 2.1 Train and support a network of 50 pilot farmers on rice production. Prepare technical leaflets, organise trainings, exchange visits and cropping cycle collective assessments, and facilitate access to		- 200 beneficiaries have received training on improved rice production ; 150 among the trainees have adopted at least one technic - 1 micro irrigation system implemented in Hoalampano, benefitting 70

equipment to facilitate the adoption of tested and approved practices by 200 additional households.		households
Activity 2.2 Train 2 village vaccinators in each site to organise vaccination campaign and perform injections. Support the creation of a village vaccinators' network to organise the vaccines supply.		- 16 village vaccinators supported vaccination of poultry for 281 farmers. - Partnership with veterinary in Mananara established to provide with 20% discount two key vaccines to fight common poultry diseases
Activity 2.3 Identify vulnerable households/women and give them technical and financial support (but with a financial share form beneficiary) to develop a new income generating activity (gardening or production of smoked-fish). Implement two supply-chain studies to define a strategy to improve the commercialisation of these products, targeting the local market. Provide training and technical support (with regular visits from animators) on production, processing and/or marketing of products to at least 250 women. Organize exchange visits among women and support them to get organized to facilitate marketing		- Awareness raising sessions on gardening (treatment, plantation), poultry vaccination implemented n 8 LMMAs - 220 vulnerable women involved in breeding chicken 80, smoked fish 46, gardening 94 - Supply chain analysis was not conducted due to lack of potential consultant to conduct the analysis.
Output 3. The human health and livelihood effects in local populations are determined by analyzing linkages between expected improvements in dietary intake, nutritional status and commercial transactions and observing the role of fisheries co-management in facilitating these health effects in 100 households across five LMMAs. Madagascar is the 6th most stunted country in the world and this output will be hugely influential for demonstrating potential impacts of fisheries management on human health. The findings are disseminated and inform management and policy decisions of LMMAs, relevant local and regional networks and decision-making bodies, and the CBD/WHO task force.	3.1 By year 3, there will be a 15% increase in dietary diversity at the household level and a 30% increase in food security through measurement of the number of food categories utilized and through adoption of regular consumption of dried and smoked fish during periods of hardship. 3.2 By year 3, there will be a 20% decrease in iron and zinc deficiency as measured by nutritional status from venous blood draws. This is the most comprehensive method for understanding real health effects of changes in fishery access. 3.3 By year 3, there will be a 20% decrease in underweight, stunting	LMMAs were found to have the highest percentage of households with high dietary diversity scores across all seasons. Locally managed marine areas (LMMAs) and traditionally managed communities had nearly double the percentage of highest household dietary diversity scores (35% of households) than those households near the marine national park (20%). Diets were slightly less diverse across all sites during the September to December season than they were during the May – August season (Mean HDDS scores of 7.81 vs. 7.97 Rantohely (LMMA) has the highest rate of iron/ferritin deficiency (10%), followed by Marofototra (marine park community) (8%). In Iharaka, 2% of the samples have shown iron deficiency, 3% in Maintimbato (LMMA) and 5% in Ambodipaka. The rate of deficiency is quite different for a village to another and seems not to be linked with the management system of the area. The level of zinc deficiency is higher compared to iron deficiency in the five villages. There are more people with zinc deficiency in traditionally managed area (20% in Ambodipaka and 18% in Iharaka); than in the other villages: Maintimbato (LMMA) with 11%, Marofototra 14% and Rantohely LMMA 16%. Note that for Madagascar, 16% of the population is at a risk of inadequate intake according to Food Fortification Initiative, 2018 The prevalence of wasting is quite low in the five villages : 2% (versus 15% at national level _ UNICEF, Country Profile 2013); and so are the prevalence

	and wasting as measured by anthropometry.	of stunting 22% and underweight 16% which are notably lower compared to the national level respectively 50.1% (for moderate and severe category) and 36% for underweight. (UNICEF, Country profile 2013
Activity 3.1 In five communities adjacent to the LMMAs, train female heads of households to record their diets using kitchen scales into standardized dietary journals.		- Data on the dietary diversity and food security status of 225 households were collected in five communities collected and analyzed - Assessment of dietary intake implemented among a limited individual sample to understand what individuals consume outside their household - A subset of 5 households are being observed once a week during the three meals to understand the weights of all foods consumed so we can create generalizing principles of how food is cooked, consumed, and allocated - An assessment of coping strategies was conducted to best understand how local communities were grappling with the post-cyclone disaster (see results in section 1) - Monthly socio-economic surveys (SES) through interviews of all 225 household heads are being performed in the 5 villages. Between April and August 2016 through detailed SES of income generating activities, we calculated that approximately 21% of income is derived from selling fish in 2016.
Activity 3.2 Train local health professionals to obtain blood samples from local participants to test for iron and zinc deficiency every six months. These blood samples will benefit local participants as our agreement with MSP allows us to determine infections with malaria and provide Point of Care treatment		- 2 physicians, 2 Emergency Medical Technicians, 1 laboratory technician, and 1 nurse trained to obtain blood samples - Clinical assessments of 848 people in our five target health communities conducted by researchers from Harvard T.H. Chan School of Public Health, physicians from the Maroantsetra regional hospital, and other local Malagasy researchers and technical specialists
Activity 3.3 Conduct anthropometric assessments every 3 months to determine how growth trajectories (both stunting and wasting) are affected by the availability and access to nutritious diets		- Baseline for anthropometric measurements at all five health tracking sites conducted in May 2016 - Anthropometric assessments implemented every 3 months starting from August 2016
Activity 3.4 Communicate results to LMMAs, regional and national networks and the CBD/World Health Organization (WHO) joint task force.		- Connection between marine conservation and nutrition/health presented during CBD COP in Cancun (December 2016) Consultation meetings with CDB/WHO on the diffusion of the project result held in April 2017 (cf. section 6)

Annex 3 Standard Measures

Code	Description	Total	Nationality	Gender	Title or Focus	Language	Comments
Training Measures							
1a	Number of people to submit PhD thesis	n/a					
1b	Number of PhD qualifications obtained	n/a					
2	Number of Masters qualifications obtained	n/a					
3	Number of other qualifications obtained	n/a					
4a	Number of undergraduate students receiving training	n/a					
4b	Number of training weeks provided to undergraduate students	n/a					
4c	Number of postgraduate students receiving training (not 1-3 above)	n/a					
4d	Number of training weeks for postgraduate students	n/a					
5	Number of people receiving other forms of long-term (>1yr) training not leading to formal qualification (e.g., not categories 1-4 above)	n/a					
6a	Number of people receiving other forms of short-term education/training (e.g., not categories 1-5 above)	80	Malagasy			Malagasy	
6b	Number of training weeks not leading to formal qualification	26					A total of one week per LMMA
7	Number of types of training materials produced for use by host country(s) (describe training materials)	3				Malagasy	Three types of training materials: one related to associations' management (meeting notes; accounting, internal

							regulation); one on catch survey; one related to patrol and surveillance. All these tools are available for LMMAs.
Research Measures		Total	Nationality	Gender	Title	Language	Comments/ Weblink if available
9	Number of species/habitat management plans (or action plans) produced for Governments, public authorities or other implementing agencies in the host country (ies)	1			National roadmap for the conservation and sustainable use of sharks and rays		Participatory process? Yes – the design of the roadmap has been done with representatives from the communities, NGOs, research centers; Ministry of Fishery ,Ministry of environment,
10	Number of formal documents produced to assist work related to species identification, classification and recording.	n/a					
11a	Number of papers published or accepted for publication in peer reviewed journals	n/a					
11b	Number of papers published or accepted for	n/a					Location?

	publication elsewhere						
12a	Number of computer-based databases established (containing species/generic information) and handed over to host country	n/a					
12b	Number of computer-based databases enhanced (containing species/genetic information) and handed over to host country	2				English/malagasy	Two database (one on ecological survey – one on catch survey); data base are for WCS internal use; results of data analysis are made public.
13a	Number of species reference collections established and handed over to host country(s)	n/a					
13b	Number of species reference collections enhanced and handed over to host country(s)	2				English/malagasy	1) list of existing reef fish from CPUE/catch survey, (2) list of sharks and rays available in Antongil Bay further to BRUV deployment, socio economic interview on shark catch

Dissemination Measures		Total	Nationality	Gender	Theme	Language	Comments
14a	Number of conferences/seminars/workshops organised to present/disseminate findings from Darwin project work						
14b	Number of conferences/seminars/ workshops attended at which findings from Darwin project work will be presented/ disseminated.						

Physical Measures		Total	Comments
20	Estimated value (£s) of physical assets handed over to host country(s)		
21	Number of permanent educational, training, research facilities or organisation established		
22	Number of permanent field plots established		Please describe

Financial Measures		Total	Nationality	Gender	Theme	Language	Comments
23	Value of additional resources raised from other sources (e.g., in addition to Darwin funding) for project work						

Annex 4 Aichi Targets

	Aichi Target	Tick if applicable to your project
1	People are aware of the values of biodiversity and the steps they can take to conserve and use it sustainably.	☑
2	Biodiversity values have been integrated into national and local development and poverty reduction strategies and planning processes and are being incorporated into national accounting, as appropriate, and reporting systems.	☑
3	Incentives, including subsidies, harmful to biodiversity are eliminated, phased out or reformed in order to minimize or avoid negative impacts, and positive incentives for the conservation and sustainable use of biodiversity are developed and applied, consistent and in harmony with the Convention and other relevant international obligations, taking into account national socio economic conditions.	☑
4	Governments, business and stakeholders at all levels have taken steps to achieve or have implemented plans for sustainable production and consumption and have kept the impacts of use of natural resources well within safe ecological limits.	☑
5	The rate of loss of all natural habitats, including forests, is at least halved and where feasible brought close to zero, and degradation and fragmentation is significantly reduced.	
6	All fish and invertebrate stocks and aquatic plants are managed and harvested sustainably, legally and applying ecosystem based approaches, so that overfishing is avoided, recovery plans and measures are in place for all depleted species, fisheries have no significant adverse impacts on threatened species and vulnerable ecosystems and the impacts of fisheries on stocks, species and ecosystems are within safe ecological limits.	☑
7	Areas under agriculture, aquaculture and forestry are managed sustainably, ensuring conservation of biodiversity.	☑
8	Pollution, including from excess nutrients, has been brought to levels that are not detrimental to ecosystem function and biodiversity.	
9	Invasive alien species and pathways are identified and prioritized, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment.	
10	The multiple anthropogenic pressures on coral reefs, and other vulnerable ecosystems impacted by climate change or ocean acidification are minimized, so as to maintain their integrity and functioning.	☑
11	At least 17 per cent of terrestrial and inland water, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes.	☑
12	The extinction of known threatened species has been prevented and their conservation status, particularly of those most in decline, has been improved and sustained.	
13	The genetic diversity of cultivated plants and farmed and domesticated animals and of wild relatives, including other socio-economically as well as culturally valuable species, is maintained, and strategies have been developed and implemented for minimizing genetic erosion and safeguarding their genetic diversity.	

14	Ecosystems that provide essential services, including services related to water, and contribute to health, livelihoods and well-being, are restored and safeguarded, taking into account the needs of women, indigenous and local communities, and the poor and vulnerable.	
15	Ecosystem resilience and the contribution of biodiversity to carbon stocks has been enhanced, through conservation and restoration, including restoration of at least 15 per cent of degraded ecosystems, thereby contributing to climate change mitigation and adaptation and to combating desertification.	
16	The Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization is in force and operational, consistent with national legislation.	
17	Each Party has developed, adopted as a policy instrument, and has commenced implementing an effective, participatory and updated national biodiversity strategy and action plan.	
18	The traditional knowledge, innovations and practices of indigenous and local communities relevant for the conservation and sustainable use of biodiversity, and their customary use of biological resources, are respected, subject to national legislation and relevant international obligations, and fully integrated and reflected in the implementation of the Convention with the full and effective participation of indigenous and local communities, at all relevant levels.	☑
19	Knowledge, the science base and technologies relating to biodiversity, its values, functioning, status and trends, and the consequences of its loss, are improved, widely shared and transferred, and applied.	
20	The mobilization of financial resources for effectively implementing the Strategic Plan for Biodiversity 2011-2020 from all sources, and in accordance with the consolidated and agreed process in the Strategy for Resource Mobilization should increase substantially from the current levels. This target will be subject to changes contingent to resource needs assessments to be developed and reported by Parties.	

Annex 5 Publications

Type * (e.g. journals, manual, CDs)	Detail (title, author, year)	Nationality of lead author	Nationality of institution of lead author	Gender of lead author	Publishers (name, city)	Available from (e.g. weblink, contact address, annex etc)
Factsheet	"Empowering local communities to manage small-scale fisheries Alison Clausen, 2016 - 2018			Female	Panorama Solution -	https://panorama.solutions/en/solutions/empowering-local-communities-to-manage-small-scale-fisheries
Poster	CPUE results WCS Madagascar, 2018					Annex 6b (a sample) – Malagasy version Available at WCS Office in Soavimbahoaka Antananarivo/Maroantsetra /Mananara; and in each targeted LMMA in Mananara
Poster	SMART results WCS Madagascar, 2018					Annex 6c – Malagasy version Available at WCS Office in Soavimbahoaka Antananarivo /Maroantsetra /Mananara, in each LMMA, CiRRHP Offices in Maroantsetra and Mananara
Poster	*Dina or social convention for the community management of marine resources: what are the factors of success and / or failure?* Huyghens	Malagasy		Male	WIOMSA	WCS Office in Soavimbahoaka Antananarivo

	Behanarina - WCS Madagascar, 2017					
Poster	*Monitoring and Surveillance Committee for Locally Managed Fisheries in Antongil Bay* Ludovic BETSIAHILIKA, Huyghèns Rock BEHANARINA, Regis ANDRIAMISAOMA, Tatita AVIMANANA - WCS Madagascar, 2017	Malagasy		Male	WIOMSA	WCS Office in Soavimbahoaka Antananarivo
Official text	Arrêté sur l'interdiction des sennes de plage et de filets moustiquaires MRHP, 2018					
Report	Project Half Year report 2017 WCS Madagascar , October 2017					Darwin Initiative website
Official text	Arrêté ministériel du Plan Aménagement Concerté des Pêcheries de la					

	baie Antongil MRHP 2017					
Report	Project Annual report 2016 WCS, April 2017					Darwin Initiative website
Report	Project Half year report 2016 WCS, October 2016					Darwin Initiative website
Report	Project Annual report 2015 WCS, April 2016					Darwin Initiative website
Poster	Aire de Pêche Gérée Localement (APGL) : un veitable outil pour la promotion d'une pêche responsable et durable. WCS Madgascar 2015					
Poster	Les dix commandements du PAP-BA (Plan d'Aménagement Concerté des Pêcheries de la Baie d'Antongil WCS Madagascar, 2015					
Poster	Community Surveillance in					Malagasy Version

	Antongil Bay WCS Madagascar 2015					
Report	Project Half year report 2015 WCS, October 2015					Darwin Initiative website

Annex 6 Darwin Contacts

Ref No	22-016
Project Title	Securing livelihoods, health and biodiversity through seascape-scale sustainable fisheries co-management
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