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Fisheries Improvement Partnership Fund 2014 - Submit Final Programmatic Report (New Metrics)
Grantee Organization: Smithsonian Institution
Project Title: Science Based Decision Making for Spiny Lobster Management in Honduras

Project Period	4/07/2014 - 4/30/2016
Project Location Description (from Proposal)	Northeastern Honduras
Project Summary (from Proposal)	Improve the efficacy of spiny lobster fishery management in Honduras using emerging technologies and analysis techniques. Project will work with fishermen and local communities to foster stakeholder engagement in the management process and improve the availability of information for decision-making.
Summary of Accomplishments	Our project in has achieved significant results and tangible outcomes to improve the management of spiny lobster in Honduras. Our work has led built the enabling conditions so that full digital traceability system is now installed in 80% of the packing plants and 60% of the commercial fleet – not only for lobster but for all commercial fisheries. We have provided scientific evidence for the need to establish a network of fully protected marine reserves to ensure the sustainability of the fishery and that these reserves must be matched by a limit to the total fishing effort at current levels. We have also completed the design of this reserve network using a globally unique "fisheries focused" approach and these plans have been passed to government and stakeholders for immediate implementation. This is the first no take network in the world to have been designed with explicit benefits to fisheries as a core principle and has led to new science and research publications on this approach. We have worked successfully to strengthen governance systems for marine fisheries and solved complex challenges to improve the control and monitoring of lobster and all other commercial fisheries. Our science based approach combined with sustained commitment to problem solving has catalyzed a sea change in the lobster fishery in Honduras which has dominoed into other sectors. Honduras is now positioned to be the first country globally to have all its marine fisheries fully traceable from boat to consumer. Our collaboration with the Centre for Marine Ecology along with the strong partnership with the government of Honduras has enable sustained engagement on these issues, translated scientific evidence in to targeted activities and lead to truly important outcomes for the sustainability of Honduran lobster and the fisheries sector as a whole.
Lessons Learned	Collaboration with local NGOs and governments committed to problem solving when combined with sustained engagement on the issues, a science based approach and targeted activities can lead to significant change in fisheries management. In addition, successful outcomes in one fishing sector or locality catalyzes change in additional sectors and creates a model for sustainable fisheries management.

Activities and Outcomes

Funding Strategy	Planning, Research, Monitoring
Activity / Outcome	FIF - Tool development for decision-making - # tools developed
Required	Recommended
Description	Enter the number of tools developed

# tools developed - Current	0.00
# tools developed - Grant Completion	4.00

Notes

Tool 1 - Landing Data Collection System: We will build a cloud database system for the packing plants to record landing data from the commercial fishery and for that data to be connected to the fisheries department for use. The database will also automatically analyze the data to provide production statistics and per boat catch statistics for the use of management authorities and boat owners.
FINAL REPORT: Complete - This system was transitioned to the Frequentz traceability platform. Provides data to Smithsonian for ongoing monitoring and enables e-reporting to government for catch statistics

Tool 2: Industrial Fisher License system - We will expand the existing artisanal fisher license and registry system to incorporate a new license for fishers working on the industrial boats.
FINAL REPORT: Complete - System finished and active with fisheries department and local partners registering industrial fishers.

Tool 3: Vessel Monitoring System map generation - We will work with the national government to improve the use of the existing VMS and automate the data analysis to produce fishing effort maps for the lobster fishery.
FINAL REPORT: Complete - Developed system to automate the analysis of VMS data. This tool is being improved through a collaboration with UC Daves. Honduran government strengthened use of VMS system for control and monitoring and removed loop holes in oversight and governance. Committee for the control and monitoring of fisheries established, and closer ties between fisheries department, navy and port authority enabled better coordination and use of VMS data. upload report to fisheries department on VMS issues (NB report in spanish - not for public dissemination).

Tool 4 - Origin ID - We will produce a test "tool" for identifying the bank of origin of landed lobster using either morphometric, genetic or molecular techniques. We will work with packing plants and boat owners from the pilot groups to test this tool's ability to accurately determine origin.
FINAL REPORT: Not Complete - complexity of challenge greater than time and resources available. Follow on funding secured to continue the genomic trace portion of this work for completion in 2017

Tool 5 - Fishery GIS - We will build the first data layers to integrate social data (e.g. fishery licensing information detailing number of fishers from each community and number of boats in each port) fishing information (e.g. the main fishing banks and

their use by the artisanal and industrial fleets, boarders of MPA designations) and ecological data (e.g. connectivity patterns as defined by the genetic work). This tool will be used by government institutions such as fisheries department, protected areas department and natural resources department to be able to visualize the data being generated by this program. The tool will be google earth kmz files to enable free access and ease of use. FINAL REPORT: Complete - all data related to fisheries has been centralized in an archive. Data layers include fishing banks, MPA demarcation etc. During this process errors in the projection of GIS data by national government were found, including in the boarders of MPAs. We worked with them to correct and standardize how geographic data is presented. Corrected data provided to international MPA mapping groups and incorporated into their existing portals.

Funding Strategy Planning, Research, Monitoring
Activity / Outcome   FIF - Management or Governance Planning - # plans developed
Required   Recommended
Description   Enter the number of plans developed that had input from multiple stakeholders

| # plans developed - Current | 0.00 |
| # plans developed - Grant Completion | 3.00 |

Notes

1. Data for Management Plan:
On the basis of the preliminary stock analysis we will build a plan for how to work with stakeholders and managers to refine the data collection process to enable a full stock assessment to occur with updated data sets at the appropriate scales. The plan will include the development of reference points and harvest control rules which will form the backbone of a management plan to be developed in year 2.
FINAL REPORT: Preliminary stock assessment completed by WWF (uploaded as extra materials) informed strategy to implement data collection system with packing plants. Data collection system now implemented through Frequentz traceability platform with data passed to Smithsonian for ongoing fisheries assessment and to link production data with biological and ecological data for national government decision making.

2. Plan for Digital Trace implementation:
Following the assessment by Shell Catch we will produce a plan on how to implement a tag track and trace system for the lobster trap fishery. This plan will include both a feasibility assessment, chronogram and budget as well as a sustainable financing proposal to ensure the tag and trace system is sustainable once established.
FINAL REPORT: Project delivered enabling conditions an planning to establish full traceability across industrial fisheries in Honduras.

3. Plan for biological trace implementation:
This plan will be based on an assessment of the results of the biological trace systems providing the cost and benefits of the different mechanisms and a road map on how to incorporate the most suitable method into national management strategies and

international trade control.
FINAL REPORT: Biological trace development took longer than originally hoped. Plan for using tool cannot be written until tool finished. Continuation funding has now been secured from the summit Foundation to finish the research behind the tool development during 2016-2017.

4. Legal status review
Report for government and stakeholders that will provide a review of legal status of marine resource and area ownership in Honduras and any related legal rights. As there is a general movement towards rights based management in fisheries especially granting exclusivity to different groups, it is important to determine that those who eventually grant exclusive rights (presumably the government) are not infringing on the legal rule of "Nemo dat quod non habet", (no one gives what he doesn't have). In other countries (such as the UK) there have been some legal issues due to existing precedents set in old legislation or legal cases which had confused who had the authority and mandate to grant ownership and exclusive use rights for marine resources.
FINAL REPORT: Rights based management is being included in new fisheries law. This law has passed through congress but has not yet been ratified by the executive office.

Funding Strategy	Capacity, Outreach, Incentives
Activity / Outcome	FIF - Outreach/ Education/ Technical Assistance - # people with changed behavior
Required	Recommended
Description	Enter the number of individuals demonstrating a minimum threshold of behavior change

# people with changed behavior - Current	0.00
# people with changed behavior - Grant Completion	1360.00

Notes	Working with APESCA and Shell Catch, we aim to form a core group of 12 boat owners and 2 packing plant owners who will develop the tag track a trace pilot. Their boat's crew (12 per boat) and the people employed by the plants (50 per plant) will all have to be involved in this behavioural change. That equals 258 people who will change behaviour for the tag track and trace program. FINAL REPORT: We didnt work with shell catch but did work directly with APESCA. Through the program we were directly engaged at multiple levels with the fishing industry. The outcome in behavior change is to have 80 boats (80 x 12 = 960) and 8 plants (8 * 50 = 400) on the trace platform and leading the transformation of the industry with the aim to make Honduras the first country to have a fully traceable seafood industry in 2017. Total = 1360

Funding Strategy	Capacity, Outreach, Incentives
Activity / Outcome	FIF - Outreach/ Education/ Technical Assistance - # people reached
Required	Recommended
Description	Enter the number of people reached by outreach, training, or technical assistance activities

# people reached - Current	0.00
# people reached - Grant Completion	2570.00

Notes We have the opportunity through the licensing system where we have to meet the fishers to register them to provide information directly into the hands of fishers. We aim to license 1500 fishers during 2014 so will provide an information sheet (produced by a parallel project) with the fisheries regulations to each of these individuals. We will also give out 50 posters on lobsters to community groups, packing plants, community centres, local government offices and the national government offices for fisheries, protected areas and natural resources. These posters have already been donated by the Perry Institute of Marine Science (see pdf of example poster in English - actual poster will be in spanish).

During this first year of activities to develop the information and tools required to improve management in subsequent years we will be working side by side with stakeholders. We envisage the following number of people from each group will be involved directly in our work and we will hold meetings and explain the work with these sets of people:
Representatives from local NGOs - 16, Local government officials - 12, National Government officials - 12, Members of Association of Caribbean fishers (APESCA) - 60, Members of community Fishing groups - 80.

Further we will work directly with the 60 APESCA members on track and trace issues and the fisheries exchange (these are counted above).

FINAL REPORT: Registration system has included over 2400 fishers with each receiving information about fisheries regulations and responsible fishing practices. Through Frequentz more than 80 lobster boat captains have received information on the importance of traceability. We worked continuously with the board of APESCA (10 people) and their wider members (60 boat and plant owners). Ongoing engagement with government at all levels including national office and eight regional offices (20 government staff).

Funding Strategy Capacity, Outreach, Incentives
Activity / Outcome FIF - Building institutional capacity - # FTE with sufficient training
Required Recommended
Description Enter the number of staff or full-time equivalents with sufficient training and skills engaged in conservation activities

# FTE with sufficient training - Current	0.00
# FTE with sufficient training - Grant Completion	38.00

Notes We will work with the 8 Centre for Marine Ecology scientists to train them in how to collect genetic samples and use genetic information for marine spatial planning. Further we will work with 2 fisheries personnel on improving the vessel monitoring system. We will work with 6 technicians (2 from each government institution relevant to marine resource management) on how to use GIS for marine spatial planning and decision

making in fisheries management. We will also work with 2 fisheries field officers on the implementation and use of the fisher licensing system.
 Total with training - 18

FINAL REPORT: We did work closely with the 8 members of CEM throughout this project and organised a workshop to train technicians in the use of GIS and VMS data for decision making (12 people) and with 18 fisheries field officers on the licensing system. Total = 38

Funding Strategy	Capacity, Outreach, Incentives
Activity / Outcome	FIF - # participants complying with their incentive agreement - # participants in compliance
Required	Recommended
Description	Enter the number of participants complying with their incentive agreement

# participants in compliance - Current	0.00
# participants in compliance - Grant Completion	50.00

Notes · · · · · · For the tag track and trace program we aim to have a compliance agreement signed by the 12 boat owners and their captains along with the 2 plant owners and their managers. This is 26 people

FINAL REPORT: There are 10 US importers who have signed the lobster pledge for traceability of lobster in the supply chain (lobster pledge.com). So far 5 of the 8 packing plant ownerss have signed a compliance agreement contract with Frequentz that matches the pledge requirements of the importers. The remainder are still working on finalizing these documents. 35 boat owners have signed trace agreements. Owners own more than one boat and some boats are operated by the plants.

Total: 10 + 5 + 35 = 50

Funding Strategy	Planning, Research, Monitoring
Activity / Outcome	FIF - Monitoring - # monitoring programs
Required	Recommended
Description	Enter the number of monitoring programs established or underway

# monitoring programs - Current	0.00
# monitoring programs - Grant Completion	3.00

Notes · · · · · · 1. The licensing registry system we monitor how many people are involved in the lobster fishery.
2. We will monitor fishing activity across the seascape using VMS
3. The cloud database will help monitor production in the fishery
4. The genetics program will monitor the population structure of the fishery

FINAL REPORT: Licensing system is completed. VMS system enables tracking, Frequentz enables production and traceability. the Genetics program cannot yet monitor the population but has divided the population up into sub populations and our work has

shown for the first time that Honduran lobster population can be managed at a country wide scale.

Funding Strategy   Planning, Research, Monitoring
Activity / Outcome   FIF - Monitoring - # vessels in monitoring program
Required   Recommended
Description   Enter the number of vessels engaged in monitoring programs.

vessels in monitoring program - Current   0.00
vessels in monitoring program - Grant Completion   220.00

Notes   We aim to improve the VMS data use for the 123 lobster boats
                    (86 traps and 37 dive) currently monitored by the satellite system,
                    to produce usable maps of the spatial distribution of
                    fishing effort for the fisheries department and fisheries
                    stakeholders.
                    Further we aim to have 12 of the trap vessels ready to implement
                    tag track and trace system by the end of this grant period

                    FINAL REPORT: We have mapped the fishing effort for the trap
                    (93 boats) and dive fleets (47). Examples of the effort maps from
                    archived data are uploaded. 80 lobster vessels are on the
                    traceability platform.
                    Total = 220

Funding Strategy   Planning, Research, Monitoring
Activity / Outcome   FIF - Monitoring - tons traced through supply chain
Required   Recommended
Description   Enter the number of tons that are traced through the supply chain.

tons traced through supply chain - Current   0
tons traced through supply chain - Grant Completio   150

Notes   We do not aim to implement the tag track and trace system
                    during year 1 but aim to build the enabling conditions to be ready
                    for tag track and trace from 12 vessels through 2 packing plants
                    by the end of this grant period. The aim is to have the monitoring
                    capacity established to verify around 150 tons of lobster tail.

                    FINAL REPORT: The transition to the full trace is underway.
                    However, the system only went online in July 2016 at the start of
                    the new lobster season. So only about 10 tons of lobster has been
                    through this trace system during the course of this grant. The
                    system does now have the capacity to record total production
                    going forward.

Final Programmatic Report Narrative
Science Based Decision Making for Spiny Lobster Management in Honduras

1. Summary of Accomplishments

Our project in has achieved significant results and tangible outcomes to improve the management of spiny lobster in Honduras. Our work has led built the enabling conditions so that full digital traceability system is now installed in 80% of the packing plants and 60% of the commercial fleet – not only for lobster but for all commercial fisheries. We have provided scientific evidence for the need to establish a network of fully protected marine reserves to ensure the sustainability of the fishery and that these reserves must be matched by a limit to the total fishing effort at current levels. We have also completed the design of this reserve network using a globally unique "fisheries focused" approach and these plans have been passed to government and stakeholders for immediate implementation. This is the first no take network in the world to have been designed with explicit benefits to fisheries as a core principle and has led to new science and research publications on this approach. We have worked successfully to strengthen governance systems for marine fisheries and solved complex challenges to improve the control and monitoring of lobster and all other commercial fisheries. Our science based approach combined with sustained commitment to problem solving has catalyzed a sea change in the lobster fishery in Honduras which has dominoed into other sectors. Honduras is now positioned to be the first country globally to have all its marine fisheries fully traceable from boat to consumer. Our collaboration with the Centre for Marine Ecology along with the strong partnership with the government of Honduras has enable sustained engagement on these issues, translated scientific evidence in to targeted activities and lead to truly important outcomes for the sustainability of Honduran lobster and the fisheries sector as a whole.

2. Project Activities & Outcomes

This report is based on the activities outlined for phase 1 and phase 2 of the project.

Phase 1 Activities
1) Identify appropriate scales for ecosystem based management

We worked at two spatial scales during this project to define the ecologically relevant spatial scale for lobster management in Honduras. We explored whether lobster populations could be managed within the Exclusive Economic Zone of Honduras as well as how the Honduras population is connected to the wider Caribbean. This expanded the geographic scope of the original project and we leveraged partnerships with institutions across the Caribbean to collaborate on sample collection as well as additional research being conducted by the Smithsonian with support from the Summit Foundation to develop a network of no take areas across the Honduran Caribbean.

Evidence that Honduran lobster can be sustainable with country scale management
Within Honduras our work focused on the how a reserve network would be optimized to replenish and sustain Honduran lobster fisheries. This was a complex task because although marine reserves are often considered to be replenishment zones for adjacent fishing grounds, prior to our work in Honduras, reserve networks were not being designed to explicitly consider fisheries objectives. Honduras´ reserves have previously been located to protect high biodiversity areas with a focus on conserving hard corals. This is a great conservation target but, due to the difference in life cycle histories between corals and spiny lobster, a reserve optimized to protect corals may not function as a tool to benefit lobster fisheries.

We focused our approach on the fishing banks of Eastern Honduras where 95% of the fishing effort for lobster occurs. We incorporated core data sets produced through our research including habitat maps and specifically downscaled oceanographic models for dispersal, a spatially explicit population model for lobster and genetic connectivity data to look for naturally occurring segregation of populations. The design matrix then required super computing power (available through the Smithsonian cluster) to be able to run the models simultaneously to develop a reserve plan. The output from this work was a network design for the off shore banks and Miskitu cays of Honduras which is the first such "fisheries focused" reserve network in the region. Importantly, our model analysis provides four key findings:

1) That despite long larval durations, the management of lobster at the <u>country wide scale for Honduras</u> can bring sustainability to the Honduran lobster fishery
4) That a fully protected <u>reserve network of 20%</u> is needed to ensure enough of the population is protected to sustain the wider exploited population
3) A no take reserve network focused just around the Miskitu cays would not provide sufficient protection to the wider population to sustain the fishery: The network needs to <u>encompass both the cays and the off shore banks</u>.
4) That reserves alone cannot sustain the fishery if fishing pressure increases and must be accompanied by management to limit <u>total fishing pressure at current levels</u> in the remaining fishable areas.

Our work has led to the first scientific evidence that the lobster fishery can be managed sustainably within the territorial waters of Honduras. The research provides clear recommendations on how to achieve that: Establishing a network of no take reserves and putting a cap on fishing vessels no to exceed current numbers. Both these strategies are achievable. The no take network, even off shore, can be enforced using the existing VMS monitoring of the industrial fleet and there is clear interest from the industrial sector to set a fleet limit to ensure the future of their fishery. These proposals are now being transferred to the national government and the Centre for Marine Studies to work with industry partners for designation and implementation. The government has already committed to the target of a 20% no take network. The research for this work is submitted to Current Biology.

Caribbean spiny lobsters are not one large randomly mixed population
Leveraging collaborations with Caribbean partners we supported research to investigate the connectivity of spiny lobster populations throughout the greater Caribbean. This study integrated two established techniques, microsatellite genetics and biophysical larval transport modeling. We used samples of lobsters that had been collected previously from across the region and added additional samples from Honduras to conduct genetic analysis. Our study found that *Panulirus argus* does not form a single panmictic (randomly mixed) population in the Caribbean. This is an important finding as lobster populations had been believed to be "mixed" amongst countries across the wider Caribbean because of their long (6 month) larval duration which could enable larvae to travel great distances on ocean currents.

Microsatellite genetics identified significant levels of genetic differentiation between neighboring basins in the Caribbean as well as within basins (e.g. Caye Caulker and Sapodilla Cayes in Belize), but not between the most geographically distant basins separated by > 2,000 km (e.g. Venezuela and Bermuda). Our results suggest that geneflow across Caribbean basins was not constrained by geographic distance; rather that larval biology coupled with complex oceanographic circulation may isolate *P. argus* populations in retentive basins. This has key relevance to management as countries, such as Honduras, may have distinct enough sub-populations to be able to manage their lobster populations at a country wide level but other countries, such as Belize, have a retentive basin population in the south and a distinct sub-population in the north more reliant on recruitment from distant locations. Our results are helping to identify country and regional specific management strategies for the maintenance of sustainable lobster fisheries. Our results have been submitted to Coral Reefs. Building on from these findings we conducted further genetic work under phase two of this project.

Through Activity 1 we have successfully achieved Outcome 1 from the original proposal: *The appropriate scales for ecosystem based management can be defined for the lobster fishery and areas for conservation prioritized.*

2) Tools for data collection and trace systems
Activity 2a - Development of digital tag, track and trace
Honduras aims to become the first country in the world with fully traceable commercial fisheries
The original proposal aimed to use the partner "Shell Catch" to develop a strategy for track and trace in the lobster fishery. However this company became unable to complete the proposed work. We therefore restructured this activity to conduct our own assessment of the existing traceability system in the packing plants and across the fishing vessels and developed a strategy to implement traceability with the lobster fishery. As part of this activity we formed a core working group with the Association of Industrial Fishers (APESCA) and reviewed the existing trace systems in place in all the packing plants. We developed a standalone digital data collection system for lobster fisheries but at the same time started to look for commercial companies that provide traceability platforms to industry and could exceed what we were able to build in-house as well as providing other benefits such as new market access.
Our sustained engagement on this traceability theme over the course of the project raised awareness of the need for trace both with the government and with industry. Further our work on developing digital track and trace to differentiate trap caught from dive caught lobster culminated in two important outcomes. Firstly, a focus on the importance of this

differentiation and engagement with importers in the US lead to an industry pledge from ten major importers not to buy dive caught lobster. The importers announced they would be adopting a trace system to confirm that dive caught lobster did not make it into their supply chain. In parallel our program was given unprecedented access to the packing plants in Honduras to review landing data collection systems and understand how they were monitoring their production. Many plants already had internal trace systems and our program focused on formalizing and harmonizing these to ensure they would be ready to conform to the demands of the importers.

Our work built the enabling conditions and understanding to catalyze a significant change in Honduran commercial fisheries with pressure from the US importers for end to end (catch to consumer) traceability to be established. In 2015 we introduced a global traceability company *Frequentz* to the association of industrial fishers and the national government. Frequentz provide a fully integrated traceability platform and are integrated to the major seafood buyers in the United States and Europe. Through our existing understanding of the trace requirements and the knowledge generated by having reviewed all the packing plants in Honduras we were able to act as an essential bridge to connect the industry with this service provider.

As a result the industrial fisheries sector including plant owners and vessel owners were receptive to the technology solution provided by Frequentz and wanted to have the system installed by the beginning of the 2016 fishing season. By July 2016 8 of the 10 Honduran packing plants and 120 vessels including 80 of the 110 lobster vessels had installed the system. The second round of installation will occur during August 2016 and the aim is to have 100% of the fishing fleet, for all commercial fisheries – not just lobster- on the traceability platform. The government is very supportive of this initiative and is drafting legislation to make traceability mandatory as a condition of a commercial fishing license with the aim that Honduras becomes the first country globally to have all of its commercial fisheries fully traceable.

Through Activity 2 we successfully reached Outcome 2: *Enabling conditions established and tools available to implement reliable and cost effective trace systems to determine lobster origin and verify legal acquisition* and have gone a step further to facilitate implementation. This is a key outcome and we hope this will become a model for other countries both in the region and around the world.

Activity 2b) Biological Trace Systems
Identifying biogeographic differences in spiny lobster was a complicated sub-activity. We piloted techniques to use morphometrics and image analysis to identify differences in lobster along ide our genetics work on the species. For the image analysis we developed 3D images of lobster tails and started to identify key morphometric characteristics that could potentially be used to differentiate origin. However this work did not lead to conclusive results and so we realigned our work to focus on the genetic approaches. We still believe this image and morphometric approach does have potential and would like to build on our initial study but it will need a significant investment of time to build up a much larger library of images and a new method to automate image classification as doing this manually was too time consuming to be practicable at scale. Our genetic work, however, showed significant promise. The expansion of our genetic work to a regional scale enabled us to sample from biogeographically distinct locations across the region and we found significant differences in the genetic signatures using microsatellite markers among these regions. To expand this work we needed to increase the resolution of the genetic techniques and started to focus on genomic approaches to increase the "genetic firepower" we could apply to this problem. Through the extension of this proposal in phase 2 we were able to pursue this research further and results are presented below in the section on phase 2 below.

3 - Build tools for data collection and evaluate the status of the lobster resources of Honduras
Activity 3a) Cloud database for landing data
Transferring the digital data system for the industrial fleet to the Frequentz platform means that high resolution landing data will now be collected on an ongoing basis from the industrial fisheries. Frequentz and the Smithsonian have signed an agreement so that catch data will be shared with the Smithsonian to incorporate in to ongoing assessments of the fisheries in Honduras and to link this information to other research and monitoring activities. Importantly this data will be able to start measuring the efficacy of the reserves as they are put in place as well as any other management strategy that the government implements. This is a key agreement, because while traceability is essential to ensure legal fishing and enable preferential market access, traceability alone does not mean sustainability. Mechanisms need to be in place to connect up this data to decision making and provide ongoing guidance to ensure the fishery becomes and remains sustainable. Through this project we have developed important tools and established crucial partnerships to enable data collection to drive decision making. Now our work will continue to use these data to provide technical assistance to the government and fisheries stakeholders so that we can provide feedback and close the loop on the management cycle.

With Frequentz now focusing on the industrial sector our digital data collection system has prioritized the artisanal fleet. With support from parallel funding we evolved the digital system from this project to become an app based data collection system to be used by fish buyers. The app "ourfish" is specifically designed for small scale fisheries and can be customized to reflect the way small buyers purchase fish from fishers. Importantly the system links to the fisher registration system (See below) so that the buyer can scan the registration card of the fisher and link up the landing to the individual fisher. With the system developed we are now poised to launch this nationwide for all types of small scale fisheries including lobster and have secured funding from Oceans 5 to bring this to scale. We are also aiming to "export" this technology to Belize and work with the fishers, cooperatives and other stakeholders there to implement digital catch recording using the app. The current project provided crucial support to enable the early development of these systems that has led to the evolution of digital record systems for artisanal fishers. Our aim now is to roll out the system so that all catches from the small scale fisheries are recorded. In parallel with Frequentz capturing the industrial fleet data it means the government will have a true understanding of fishing productivity across all fisheries in the Honduran Caribbean and be much better positioned to manage these resources.

Activity 3b) Expand fisher registry and licensing
The registration system originally built for artisanal fishers has been expanded to include not only the industrial fishers but to all fisheries sectors including buyers. The government developed 11 different categories of license including artisanal, industrial and sports fishers as well as small buyers, intermediaries and seafood retailers. We adapted the data base system to reflect the government requirements and then working with partners at CEM provided training to the fisheries department to expand the roll out of this work.
The system has been officially adopted as the mechanism to register and license fishers in Honduras and there is an annual registration drive. In 2016 the entire system is being transferred to be operated by the fisheries department with each office being equipped with card printers and the software for database integration using funding from the MAR Fund secured by CEM.
This transition demonstrates that the work to develop, test and expand the system has now developed the capacity within the government to continue effectively registering fishers in to the future. In 2015 there were 2400 fishers registered in the system. We expect there to be all 6,000 fishers by the end of 2016.

Activity 3c) Preliminary stock analysis
The preliminary stock assessment was conducted by WWF through a subaward on this grant. WWF collated available information on catch and fishing effort levels from the fisheries department and the fishing industry, such as packing plant records and boat logs. This was combined with life history data in a Simplified Stock Assessment Model. The model estimated that the annual recruitment into the population of year 2 size classes was 10 – 12 million lobsters. Based on the predictive model, the recent trends in abundance of spiny lobster over the five year data range included in the study suggest that lobster abundance is remaining relatively stable at current fishing effort. However, the model also suggested that the fishing mortality varied between 0.69 and 0.75 which is very high, especially when compared with estimated natural mortality of 0.36. The main finding from the WWF assessment was to confirm that the lobster population is subject to high fishing pressure and it provides evidence that there should be a cap on fishing pressure at or below existing levels so that the number of boats, fishers or traps should not be increased. These results from the stock assessment are similar to our other modelling approach detailed in section 1 that suggested current levels of exploitation should not be increased if the fishery is to be sustainable moving forward.

Activity 3d) Develop a gap analysis of data limitation and a framework for iterative improvement
WWF's work also highlighted the gaps in data that are needed to be able to complete a full stock assessment and produced a framework for future data collection and a standardized table for inputting fisheries data to be able to repeat the stock assessment in the future. Their work highlighted the need for ongoing data collection on fisheries production and the need for boat specific catch data to be able to better estimate catch per unit effort. With the introduction of the digital catch reporting system we are now able to fulfill the recommendations made in the report in terms of systematic data collection and we will start to connect these data up to ongoing evaluations of the status of the resource.

Activity 3e) Review legal statutes and precedents relating to marine resources and marine areas
Our review of existing legislation for marine resource management in Honduras and a summary of emerging governance frameworks for fisheries from other parts of the world identified important areas that could be improved in the governance of marine fisheries in Honduras. During the course of this project the government drafted new legislation to completely revise the fisheries law in the country. We do not work on providing advice or guidance on specific legislation but we were encouraged to see that the new fisheries law submitted to congress included key articles about empowering fishers to

be co-managers of marine areas, providing secure tenure to fishing communities for discrete areas and the legal power for the fisheries department to declare responsible fisheries zones (that require a specific management plan to be developed and adhered to) and fully protected marine areas. This is a significant evolution in the legal framework governing marine resources and provides an important legislative umbrella under which future programs can work to implement no take areas as a fisheries management tool (as designed in activity 1 of this project) and to directly engage fishers as key stakeholders and empower them with management responsibility.

This legislation has now passed through congress but is waiting ratification from the executive branch.

As part of this activity we also worked with small fishing communities in the Bay Islands to develop fisher led marine reserves. On the island of Guanaja fishers then proposed two large areas covering about 20% of their local reefs to be fully protected. This proposal was submitted by the fishers themselves to the local mayor who created a municipal protected area. We then helped to bridge this initiative to national government and the Minister of Agriculture. The Minister visited the island and subsequently passed a ministerial decree confirming the protected areas under national (rather than municipal) legislation. This initiative, supporting fishers with information to then become champions of marine protection, showed that it is possible for fishers to be active participants in conservation and that declaring no fishing zones under fisheries regulations was a practicable way of implementing fully protected marine areas. This is now becoming a model for the country on how to implement this approach.

Through Activity 3 we have achieved Outcome 3: *Improved understanding of the status of the lobster fishery and the ability to collect reliable fisheries data for use in decision making for management*. We have also demonstrated a workable mechanism to use information locally to empower communities to enact change and span from local government to national government to enact legislative protection of marine resources.

Phase 2

The first phase of this project produced key tools and built government and industry capacity to improve the management of lobster fisheries in Honduras. The continued development and implementation of these tools required sustained engagement with industry and we were grateful for continued support from NFWF to extend this project. Results presented above include achievements that occurred by being able to extend our engagement with key partners to ensure goals were successfully achieved. In addition we expanded the activities to include the activities reported on below.

Phase 2 - Activity 1) Establish an alert system that can use market forces to deter illegal fishing

The success of the lobster pledge from US importers and the development of a traceability system that could satisfy their requirements also helped forge increased interest from the government authorities in charge of the monitoring and control of fisheries. Our original plan was to build an automated alert system for the government that would link the VMS system up to the fisheries department. However, as we began developing this option we identified that there was a key institutional gap and a loop hole in enforcement that meant that there was a strong possibility that even if the fisheries department received the alerts no specific action would be taken. We were concerned that internal corruption within the fisheries department may enable illegal fishing to continue despite detection by VMS.

To solve this problem we changed our approach. We worked to help instigate an interinstitutional committee for the control and monitoring of fisheries that would include not only the fisheries department but also the port authority (responsible for all vessels) and the navy (responsible for marine enforcement). This committee was formed through an agreement by the minister of agriculture (in charge of the fisheries department) and the minister of defense (in charge of the navy and the port authority). The Centre for Marine Studies was invited to be the secretary of the committee and provide a bridging role between the fisheries stakeholders and the committee. The committee now meets once a month to discuss enforcement priorities and review success. They are also kept informed on updates from the work conducted by CEM on work with the industrial sector and the fishing communities as well as briefed on results from relevant marine research produced by the Smithsonian and partners. Importantly this committee's first discussion point was how to ensure the VMS system was used as an enforcement tool. The solution was to mirror the fisheries VMS feed to an office at the port authority and for the navy to supply a rotation of people from marine intelligence unit to monitor the feeds both at the fisheries department and at the port authority office 24 hours a day. This means that there is no opportunity for circumventing the monitoring system as three separate government agencies are now involved based at two separate locations. All parties would now be aware if the VMS tracked vessels left the EEZ of Honduras, turned off their VMS transponder or other such suspicious activity. Further, because of the rotation of naval personnel there is less opportunity for illegal fishers to build up and sustain personal relations with individuals. This is different to the previous fisheries department monitoring personnel who were employed long term in the same monitoring position and worked alone in

their office to review the tracks. Further the marine intelligence unit can connect reports of illegal fishing activity directly to units based at naval bases on the coast so that vessels who have fished illegally can be intercepted.

This effort by the government to enforce against transboundary fishing has come about because of the focus on this activity that we highlighted through our prior analysis of the VMS data and presenting the scope and scale of the problem. Then by working with the government to suggest different options and finally helping to establish the mechanisms and government / civil society links to provide a viable solution. The committee still meets monthly and working with the port authority and navy has significantly improved the ability of the government to monitor and enforce fisheries regulations as they are providing oversight, increased transparency and institutional strength to a fisheries department that was exceedingly vulnerable and limited in its ability to enforce regulations.

We have been developing a five years strategy of priorities for the interinstitutional committee and with CEM remaining on the committee it provides an ongoing partnership between the government and civil society, to develop effective management and enforcement strategies for the countries' fisheries.

Now that the Frequentz traceability platform is installed in 8 of the10 packing plants and the data includes georeferenced catch statistics from the boats the mechanism is now in place to ensure that the products entering the supply chain were legally acquired. Importantly for the interinstitutional committee and the enforcement agencies they can now focus on the activities of the two remaining plants and the boats that supply them. The question for the committee is "why didn't these plants sign up?" But now it is an easier task for enforcement agencies as the boats with trace and the plants with trace are much easier to monitor so they can focus efforts on the ones who are not in the system. The government is also considering legislation to mandate traceability as a condition of vessel license and plant operation so it is likely that all plants will soon have to be providing verifiable digital data logs. At which point the efforts of the enforcement agencies can shift to random inspection and verification at the plants and to targeting and tracking "black" vessels that are not registered to fish. But bit by bit the project is peeling away the layers to make it simpler to distinguish legal activities from illegal ones. Honduras continues to lead the region in mechanisms to solve these complex problems, with much of this progress due to the sustained efforts under this project.

Develop trace tools for lobsters from different areas of the Caribbean:
To develop biogeographic trace tools we focused on genomic analysis of lobsters. The aim was to use RNA-Seq technology to identify genome-wide population structure and signals of local adaptation in P.argus. We built on and expanded the same region wide partnerships from phase one so that the post-doctoral fellow could visit sites around the Caribbean and collect high quality genomic material. This required capturing live lobsters and a special sampling technique to ensure immediate preservation of their tissue. DNA and RNA degrades very quickly as the long strand molecules break up. For regular genetic work short strand DNA is acceptable but for next generation genomic work high quality DNA is imperative. We collected samples from ten locations around the Caribbean and stored them in liquid nitrogen. This sampling strategy was ambitious and logistically challenging and it is the first time that genomic quality genetic materials have been collected for this species at multiple sites across the region. We built a strong academic collaboration with the University of Stanford and their genomics team and the Smithsonian Post-Doctoral fellow became a visiting researcher at their lab to train in cDNA library preparation, bioinformatics, and genomic data analysis. This is a complex analytical problem as genomic research yields millions of pieces of information that have to pieced back together to form a "library" for the species. Then samples are analyzed using bioinformatics to start identifying areas of the genome that have variations that could be driven by geographic and environmental differences. This has never been done in spiny lobster before. Under this portion of the project the post-doctoral researcher has worked through each phase of this process and we have identified a genome-wide set if outlier loci that show potential to be used for traceability and monitoring environmental change. WE believe this approach has shown real promise as a traceability tool at country species scales, but we will need to conduct further studies to now test if these genomic "signatures" function in real world trials. We originally hoped to complete both the development and the testing of genomic trace within the budget and timeframe of this proposal. But the complexity of the research task and the level of development that was required means that we have accomplished ground breaking development work for genomics of lobster, but we have not managed to transition this to trials yet. We are currently seeking follow on funding to be able to continue building on this important scientific base to test the viability of these trace tools in a real world setting.