



UNIVERSITY OF CALIFORNIA
SANTA CRUZ



NOAA
FISHERIES

Title: Addressing key research to inform Mobula rays conservation in the Pacific Ocean

Project duration: One and a half years - October 1, 2021 to March 31, 2023

Project Location: Western and Central Pacific Ocean

Principle investigator:

Drs. Victor Restrepo, Gala Moreno and Hilario Murua
International Seafood Sustainability Foundation (ISSF)
1440 G St. NW, Washington D.C. 20005
Phone: +1 703-226-8101

Email: VRestrepo@iss-foundation.org; gmoreno@iss-foundation.org

Science partners:

Dr. Yonat Swimmer & Dr. Keith Bigelow
NOAA NMFS Pacific Islands Fisheries Science Center

Dr. Nerea Lezama-Ochoa
Postdoctoral Research Scientist.
Environmental Research Division, NOAA Southwest Fisheries Science Center

Melissa Cronin
Ph.D Candidate (5th year), Conservation Action Lab, U.C. Santa Cruz

Dr. Jefferson Murua
AZTI research institute, Spain

Industry partners:

- **American Tunaboat Association (ATA)**
Mr. William Gibbons-Fly
- **10 Fishing companies, 14 vessels** (representing 80% of the US-flagged tropical tuna purse seine vessels):
Tradition Mariner, Western Pacific Fisheries, Pacific Princess Partnership, DeSilva Encounter Corp, Freisland Fishing Company, JM Fisheries LLC, AACH Holdings Co., LLC, AACH Holding Co.No. 2, LLC, M & F Fishing Inc, Cape Fisheries

1. Background

Considering the decline of their populations, all Mobula ray species have been recently added to the Convention on International Trade in Endangered Species (CITES) Appendix II (CITES, 2016). The giant manta ray (*Manta birostris*) is listed as threatened under the U.S. Endangered Species Act. While fisheries regulations have sought to prevent the retention and landing of Mobula rays, the vast majority of Mobula captures are a result of unintentional bycatch (Croll et al., 2016). The level of bycatch depends greatly on the fishing method used, with the highest bycatch rates reported from gillnets and purse seiners (Alfaro-Cordova et al., 2017). The habitat preference of Mobulas to productive tropical and subtropical habitats where tropical tunas also aggregate, increase their vulnerability to purse seine fishing. However, the rate of interaction of purse seine fishery targeting tropical tuna, with the different Mobula ray species has not been quantified in detail, especially in the western and central Pacific Ocean. One of the difficulties found to understand and quantify this interaction is the identification of Mobulas at the species level by the crew and observers onboard purse seiners. In addition, it remains unclear whether the five species of Mobulas found in the Pacific Ocean are panmictic, genetically similar stocks, or whether there are multiple, genetically distinct sub-populations within each stock (Hosegood et al., 2020). There is an urgent requirement to resolve genetic population structure in the genus Mobula. This is crucial information for management for wide-ranging, data-poor marine species, as it determines whether conservation and management actions should occur at the local, small scale, or at the ocean basin scale. Understanding the population structure of Mobulas will allow for conservation efforts to identify and target unique and threatened populations for bycatch mitigation and conservation. In this regard, it should be noted that bycatch mitigation methods have not been explored in depth for Mobulas, and proposals for mitigating interactions between fishing gear and Mobulas through technological innovations or gear modifications are needed (Stewart et al., 2018) (Cronin et al., in prep). It is also necessary that those studies evaluate the impact of handling and release methods, assessing Mobula post-release mortality. A comprehensive study is needed to understand purse seine - Mobula spp. interaction, to advance knowledge on Mobula population structure in order to identify unique stocks for management (Cronin et al., in prep) and finally to reduce the mortality derived from purse seine - Mobula interaction by identifying best practices for handling and release and evaluating post-release mortality. This proposal aims to address that key research with the collaboration of the U.S. purse seine fleet. Due to the extensive spatial and temporal coverage of U.S. purse seine vessels that operate in the Pacific Ocean, those vessels represent ideal platforms to collect information on Mobula spp. interactions, test best handling practices learned for Mobulas and collect tissue samples to ascertain their population structure across the Pacific using genomic methods. Resulting protocols and practices will be systematically developed and implemented during the study period and they could be scaled to other fisheries and nations in the longer term.

2. Project Objectives

The specific objectives of the present proposal are:

1. To quantify the rate of interaction of the purse seine fishery with the various Mobula species, with emphasis on giant manta rays, and to collect samples to identify unique stocks for management using genomic methods
2. To define and test handling and safe-release best practices for Mobula rays, including gear modification and evaluate Mobulid ray post-release survival rate using survivorship tags
3. To train fishers and observers to identify and sample Mobula rays and educate crew on best handling and safe-release practices for Mobulas.
4. To disseminate the result of this project to fishers, science, managers and general public.

Thus, the current project will address various cooperative research priorities identified under Section 318 (c) of the MSRA:

- Innovative gear modifications designed to **reduce bycatch**, including avoidance of **post-release mortality** in high seas fisheries, and transfer of such fishing technologies to U.S. fleets and other nations (Section 318(c)(iii));
- Collecting **genetic** data to improve knowledge on **population structure** of Mobula rays, species that are considered Endangered or Vulnerable on the IUCN Red List of Threatened Species, and are listed on CITES Appendix II (CITES, 2016), using fishing vessels as sampling platforms (Section 318(c)(i).

3. Justification

Tropical tunas support some of the largest and most valuable artisanal and industrial fisheries worldwide (FAO, 2020). Presently, on an industrial scale, the largest tuna catch by weight is taken by purse seine (PS) fisheries. This catch accounts for a significant portion of the income for many countries in the Pacific region through employment, revenue from licensing and access fees, and economic spin-off (Barclay and Cartwright, 2007). The importance and extensive catches of this fishery has raised attention to its potential impacts on target and non-target species (Dagorn et al., 2013). Mobulas are incidentally caught in one in every six PS sets in the Pacific Ocean (Croll et al., 2016) and those interaction need to be well documented at the species level in order to design conservation measures and management actions at the local, small scale and at the ocean basin scales. Strong associations with the thermocline in some Mobulas species suggests that setting PS nets above the thermocline depth could reduce bycatch rates of these species. However, the feasibility of limiting gear depth in PS commercial fisheries is questionable, as it would greatly affect target catches. Therefore, more practical alternatives should be developed and tested. For this reason, one of the foci of this project is the development and testing of a sorting grid for Mobulas, a device that has the potential to significantly increase post-release survival for this species group. In the past, onboard handling practices have resulted in high levels of post-release

mortality for this group (Hall and Roman, 2013). ISSF has pioneered, in collaboration with fishers, best practices to handle bycatch in tropical tuna PS fisheries (Justel-Rubio and Restrepo, 2017; Restrepo, 2017; 2018; Moreno et al., 2019; Restrepo, 2019; Restrepo et al., 2019; Moreno et al., 2020). This research has served as a reliable reference for tuna Regional Fisheries Management Organization's (RFMOs) decision-making. Evaluating survival rates of Mobulas released alive in PS fisheries will help guide management decisions, as simply banning retention onboard will not be an effective strategy in the case of PS where a high proportion of individuals die after release under current practices. This project will also define data collection protocols for fishers and observers to conduct species-level differentiation and sampling (Lezama-Ochoa et al., 2018), which will allow for future collection of samples from across the Pacific Ocean to study Mobulas population structure.

4. Project description

Objective 1: Purse seine - Mobula spp interactions and population structure

Task 1.1. *Training fishers on Mobula spp. identification and sampling* (Months 1- 3): Scientists from UCSC and ISSF will design protocols for data collection and train U.S. fishers participating in this project to identify Mobula spp. and sample tissue for genetic studies. Special emphasis will be placed on giant manta rays which are listed under the ESA. Training workshops will be held both in Pago-Pago, their home port, and also in San Diego, when some skippers are at home. Frozen specimens will be used as a training tool to facilitate identification and demonstrate the tissue sampling technique. Scientists in this project will also train members of the NOAA office in Pago Pago in order to train those fishers that were not able to attend the workshops with projects scientists.

Task 1.2. *Data collection from purse seiners* (Months 3-15): two types of data collection will be conducted:

- (i) During one year, fishers onboard the participating vessels will record interactions and identify Mobula spp. as well as collect tissue samples, in order to cover different spatial and temporal strata.
- (ii) UCSC and AZTI scientists will carry out 3-5 trips onboard purse seiner vessels to record Mobula spp. interactions, test handling best practices onboard (in conjunction with task 2 – see below) and collect as many samples from bycaught Mobulas as possible, with a target of 100 samples.

Task 1.3 *Data analysis* (Months 12-18):

Information from the cruises on Mobula-PS vessel interactions will be processed and analyzed. DNA extraction will be conducted using Qiagen DNEasy Blood and Tissue kits. We will use Restricted-Site Associated (RAD) Sequencing, a fractional genome sequencing technique that allows for high genome coverage at a relatively inexpensive cost. After library preparation sequencing will be conducted at the QB3 Vincent J. Coates Genomics Sequencing Laboratory at UC Berkeley. We will use the UCSC

Hummingbird supercomputer cluster to conduct species identification, test for population structure and/or the presence of identifiable stocks and calculate effective population size.

Objective 2: Design and testing of a sorting grid for Mobulas and evaluate post-release mortality

Task 2.1. *Defining materials and designs for sorting grids* (Months 1-3):

At an early stage, ISSF, AZTI, and US fleet industry (10 companies representing 80% of the US-flagged purse-seine vessels) will organize a series of meetings to develop and refine bycatch sorting grids to be tested and the protocols to test them at sea. These workshops will be held together with the workshops in Task 1.1.

Task 2.2. *Trials at sea to test sorting grids* (Months 5-15):

The sorting grids will be constructed for each of the 14 participating PS vessels. Scientists from UCSC will be on board PS vessels during 3-5 trips, depending on number of Mobulas encountered, (targeting spatial and temporal strata with the highest probability of the presence of Mobulas). During trips, scientists will (i) evaluate the efficacy and time of release Mobula using sorting grids and (ii) evaluate post-release mortality using sPAT¹ tags. Fishers will also evaluate the efficacy of the sorting grid as tuna-Mobula sorting tools during the fishing operation by filling out a form designed in Task 2.1. These trials will take place together with trials in Task 1.2.

Task 2.3. *Data analysis and definition of best handling practices* (Months 9-12): Data analysis will be conducted on (i) the efficacy of the sorting grid as a sorting and release tool, and (ii) post-release survival of Mobulas using the sorting grid. From those analyses and with the input of captains and crew, best handling practices will be defined, including modifications to the sorting grid design, if needed.

Objective 3: Reporting, Outreach and Education

The partners will provide a final report including i) results of the quantification of purse seine fleet Mobula spp interactions ii) results of the genetic study on the advances on population structure and/or the presence of identifiable stocks iii) results of post release mortality using the sorting grid, iv) best practices to handle Mobula spp. onboard purse seiners, and v) recommendations and future steps towards the long-term systematic data collection on Mobula spp interactions and tissue sampling with purse seine fleets. The results will be disseminated through the following tasks:

Task 3.1. *Continue training purse seine fishers* (Months 15-18): Training of U.S skippers and crew operating in the Pacific Region will be completed taking into account the outputs of this project. Continued training as new information arises on the best-practices to handle and release Mobulas will take place throughout the project. Also, tuna purse-seine fishers from other nations in the Pacific region will be trained through the ISSF skippers' workshop program organized since 2009 (Moreno, 2018a; b; Murua et al., 2019) (Fig.1) (in-kind contribution from ISSF).

¹ sPaT satellite tags are used to study the survivorship of marine species during 30 or 60 days. They collect information in detail (depth, position) of the last 5 days before the tag is released.

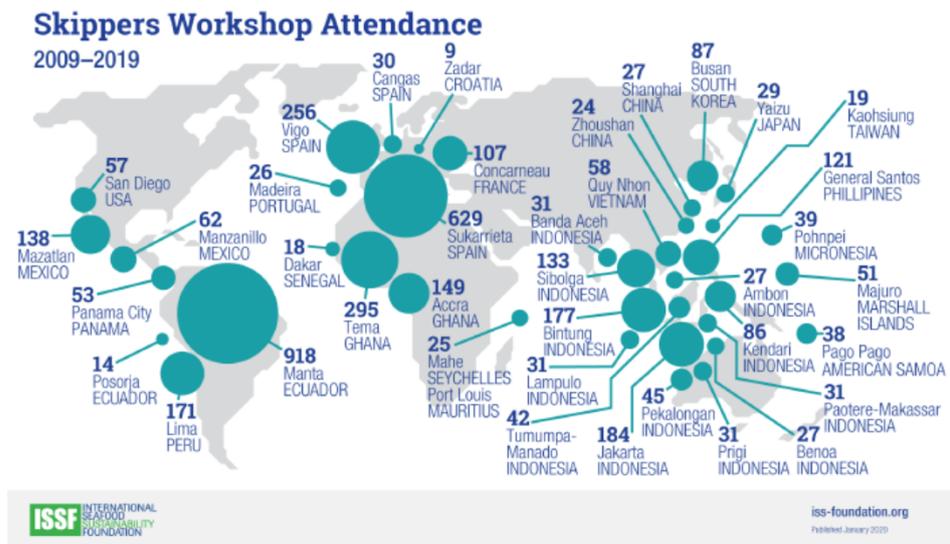


Fig. 1. ISSF skipper workshops held with purse seine fleets

Task 3.2 Dissemination to scientific community (Months 10-18): progress throughout the project and results on best practices will be disseminated in (i) IATTC and WCPFC, through the participation on scientific working groups and Scientific Committee and Commission meetings, (ii) to the scientific community, through a peer-reviewed publication and presentations in scientific symposia. A specific online workshop will be organized with scientists from NOAA participating in WCPFC, IATTC and ICCAT to discuss the results and recommendation of this project. An open-access peer-reviewed publication will be prepared based on results of the project.

Task 3.3 Outreach to management bodies (Months 4-18): managers from NOAA/NMFS and from other countries that are active in tRFMOs will be informed about the results of this project and, more specifically, on the potential new management measures that could be adopted, in relation to the degree of effectiveness of handling practices and tools to release Mobulas. Outreach to managers of different member countries will be also conducted through meetings in tRFMOs (ICCAT, IOTC, WCPFC and IATTC), by presentations during scientific committee meetings as well as through side events organized by ISSF on the margins of tRFMO's Commission meetings (see as example: <https://iss-foundation.org/issf-pew-charitable-trusts-and-birdlife-international-host-joint-side-event-at-wcpfc-annual-meeting/>).

Task 3.4 Outreach to the general public (Months 4-18)
 ISSF keeps the public informed of its work through a variety of communications vehicles. Thousands of users regularly visit the ISSF website — <https://iss-foundation.org> — which is updated with the latest tuna research findings and data, including data visualization tools. ISSF also distributes a weekly newsletter to more than 8,000 subscribers from across a diverse list of fisheries sustainability stakeholders — retailers, NGOs, charitable foundations, tuna processors, scientists, and more. And the ISSF communications team shares news and updates through popular social media platforms (Twitter, Facebook, Instagram, YouTube, and LinkedIn), while maintaining a robust media outreach effort to ultimately inform the public of critical developments.

Chronogram of tasks, Deliverables and Milestones

		2021/2023																	
Phases and Associated tasks		Mo1	Mo2	Mo3	Mo4	Mo5	Mo6	Mo7	Mo8	Mo9	Mo10	Mo11	Mo12	Mo13	Mo14	Mo15	Mo16	Mo17	Mo18
Objective 1 PS-Mobula interactions and population structure																			
Task 1.1	Training fishers on Mobula spp ID and sampling	M1.1																	
Task 1.2	Data collection from PS			D 1.2						M1.2									
Task 1.3	Data analysis															D1.3			
Objective 2 Design and test of sorting grids for Mobulas																			
Task 2.1	Defining materials and designs for sorting grids	M2.1																	
Task 2.2	Trials at sea to test sorting grids			D 2.2						M2.2									
Task 2.3	Data analysis and definition of best handling practices															D2.3			
Objective 3 Reporting and outreach																			
Task 3.1	Outreach to fishers																		
Task 3.2	Outreach to scientists and managers																		
Task 3.3	Outreach to managers																	M3 D3	
M1.1= Protocols for data collection and training completed		D1.2. Mid-term report on the number of interactions and number of tissues sampled																	
M2.1= Design of sorting grids completed		D1.3=Report on the results of PS interactions and genetic study																	
M1.2 and 2.2= Trials at sea completed		D2.2 = Mid-term report on the number of trials and performance of sorting grids																	
M3= Outreach completed/ End of the project		D2.3= Results of the performance of sorting grids																	
		D3= Final report																	

5. Permitting

There are no special permit requirements to conduct the proposed work.

6. Impacts, benefits or results expected

ISSF and its research partners have pioneered the definition of best practices to reduce mortality of by-catch species in the global tropical tuna purse seine fishery, including the use of non-entangling as well as biodegradable FADs. ISSF research, conducted in collaboration with fishing fleets worldwide, has served as a reference in developing conservation and management measures (CMMs) adopted by the Inter-American Tropical Tuna Commission (IATTC), the Western and Central Pacific Fisheries Commission (WCPFC), the International Commission for the Conservation of Atlantic Tunas (ICCAT) and the Indian Ocean Tuna Commission's (IOTC). For instance, to define the technical criteria for FADs to be non-entangling (WCPFC, 2018; IATTC, 2019; IOTC 2019; ICCAT, 2019).

We propose to follow the same approach to inform CMMs on Mobula rays. The efforts, and outputs of this project on Mobula spp identification, best handling and release practices and population structure, will be disseminated to managers and fishers across the U.S. purse seine fishery to help leverage the political buy-in of best handling practices and conservation measures on Mobula rays in tRFMOs, especially the WCPFC. If fishers are part of the process and are convinced that best practices are a viable alternative, it will greatly help the adoption of conservation measures at tRFMOs. Finally, the present proposal will advance science on the population structure of Mobula rays in the Pacific Ocean which is a prerequisite to develop conservation measures at different spatial and temporal scales for Mobula spp.

7. Project management

(See Appendix II for summary CVs of our Principle Investigators and collaborators). Victor Restrepo, (ISSF, Vice-President for Science) Principal Investigator – VR will have overall project management oversight and will be responsible for budget management, review of statistical analysis and final report sign-off. Gala Moreno, (ISSF–Senior research associate)- GM in collaboration with Hilario Murua (ISSF Senior scientist)- HM, will work with scientific partners to coordinate the delivery of the project. GM will organize and facilitate the workshops planned in this project, assist in data analysis and final reporting with the help of HM. Melissa Cronin (UCSC) will embark on the fishing trips to collect samples, test the sorting grid and tag mobulid rays and she will be responsible for the analysis of the interaction, post-release mortality and population structure using genomic in Task 1 and 2 of the project. Cooperating scientists: Yonat Swimmer and Keith Bigelow (NOAA/NMFS at the Pacific Islands Fisheries Science Center) will be advisors throughout the project and will assist with dissemination of results to scientific community and management bodies through the Scientific Committee and working groups of WCPFC.

Fishers and ship-owners from the 10 participating U.S. fishing companies will be in charge of testing the sorting grids and reporting the performance of their trials. They will participate in all the workshops planned within this project (both, technical workshops to design mobulid rays sorting grids, workshops to evaluate progress and final workshop to discuss the results).

8. Evaluation of project

The guiding principles in the implementation of this project will be early establishment of procedures and protocols, and prompt resolution of issues. The following procedures will be implemented to facilitate the successful execution of the project:

-Internal brief quarterly report: The principal investigator of each institution as well as fishing companies, will produce an internal quarterly report detailing: (1) progress towards the scientific and technological objectives, (2) status of project deliverables and achievement of key milestones; (3) identification of any issues arising and suggested corrective action to be taken; and (4) progress towards expected impacts. These reports will be sent to the Project Coordinator, at the end of each quarter, who will compile in a project quarterly report and trigger any corrective actions required.

-Mid-term workshops: Half-way through the project, meetings (online and/or in person) will be conducted with fishers and ship-owners participating in the project. The aim is to evaluate progress, specifically on sorting grid performance and data collection and correct any deviation from the planned activities on time and adjust project activities, if required.

-Communication: Establishing open lines of communication between fishing industry and scientists will allow a fluid and real-time assessment of the project.

-Final evaluation: Final evaluation of the project results will be conducted focusing on the outcomes of the project and the likelihood that they will achieve impact. The final evaluation will provide an opportunity for in-depth reflection of the outcomes and to assess how well project-level outcomes link to and leverage higher level actions, such as the adoption of best practices and conservation measures in tRFMOs.