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**ADDRESSING KEY RESEARCH TO INFORM MOBULA RAYS CONSERVATION IN
THE PACIFIC OCEAN**

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SUMMARY

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. It is also necessary to evaluate the impact of handling and release methods, assessing Mobula post-release mortality. This project aims at addressing key research to inform Mobula species conservation 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 handling and safe-release best practices learned for Mobulas and collect tissue samples to ascertain their population structure across the Pacific. Lesson learned from applying current protocols and practices will allow developing improved best practices to be implemented by the US fleet which could be scaled to other fisheries and nations in the longer term.

RESUMEN

La preferencia de las Móbulas por las zonas tropicales y subtropicales productivas en las que también se agrupan los atunes tropicales, aumenta su vulnerabilidad a la pesca con redes de cerco. Sin embargo, no se ha cuantificado en detalle la tasa de interacción de la pesca de cerco dirigida al atún tropical, con las diferentes especies de rayas Mobula, especialmente en el Océano Pacífico occidental y central. Una de las dificultades encontradas para entender y cuantificar esta interacción es la identificación de las Móbulas a nivel de especie por parte de la tripulación y los observadores a bordo de los cerqueros. También es necesario evaluar el impacto de los métodos de manipulación y liberación, evaluando la mortalidad de las Móbulas tras su liberación. Este proyecto tiene como objetivo abordar, con la colaboración de la flota de

cerco de Estados Unidos, esta investigación clave para informar sobre la conservación de las especies de *Mobula*. Debido a la amplia cobertura espacial y temporal de los buques de cerco que operan en el Océano Pacífico, estos buques representan plataformas ideales para recoger información sobre las interacciones de *Mobula* spp., probar las buenas prácticas de manipulación para las *Mobulas* y recoger muestras de tejidos para determinar su estructura poblacional en todo el Pacífico utilizando métodos genéticos. Los protocolos y prácticas resultantes permitirán el desarrollo de buenas prácticas mejoradas a implementar por la flota cerquera USA y podrían ampliarse a otras pesquerías y naciones a largo plazo.

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 those key research priorities 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.

OBJECTIVES

The specific objectives of the present project are:

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

To quantify the rate of interaction of the purse seine fishery with the various Mobula species, scientists from UCSC and ISSF will design protocols for data collection and train U.S. fishers on Mobula spp. identification and sampling tissue for genetic studies. Special emphasis will be placed on giant manta rays which are listed under Endangered Species Act (ESA).

Once training is completed, data collection from purse seiners 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, AZTI and ISSF scientists will carry out 3-5 trips onboard purse seine vessels to record Mobula spp. interactions, and collect as many samples from bycaught Mobulas as possible, with a target of 100 samples.

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

ISSF, AZTI, and US fleet industry (10 companies representing 80% of the US-flagged purse-seine vessels) will organize a series of meetings to design and develop sorting grids and, protocols for testing them at sea, for the safe-release of mobulas to be tested in real fishing conditions.

Once sorting grids are constructed, for each of the participating purse seine vessels, scientists from UCSC, AZTI and ISSF, 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 these 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 the project.

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, or designing new tools, if needed.

Objective 3: Reporting, Outreach and Education

The following results will be delivered to fishers, scientists, managers and other relevant stakeholders:

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.

- Results on quantification of US purse seine fleet interaction with *Mobula* spp.
- Results of the genetic study on the advances on population structure and/or the presence of identifiable stocks.
- Results of post release mortality using the sorting grid.
- Results on handling and safe-release best practices of *Mobula* spp. onboard purse seiners.
- Recommendations and future steps towards the long-term systematic data collection on *Mobula* spp interactions and tissue sampling with purse seine fleets.

RECOMMENDATIONS

That the 11th Meeting of the Bycatch Working Group NOTES paper BYC-11-INF-C, on the project to define best handling practices and conservation recommendations to reduce the impact of purse-seine fishery on *Mobula* species.

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