Progress in addressing key research to inform Mobulid ray conservation

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SUMMARY

Manta and devil rays (mobulids) are globally threatened species. Their preference for productive tropical and subtropical habitats where tropical tunas also aggregate increases their vulnerability to tuna purse seine fishing. However, interaction rates between the tropical tuna purse seine fishery and different mobulid species have not been quantified in detail. One of the challenges to quantifying the impact of the fishery on mobulids is unreliable species identification by crew and observers onboard the vessels, potentially due to poor training and/or lack of time for identification. Additionally, to evaluate the impact on mobulids and test possible interventions, it is necessary to assess mobulid post-release mortality using proper handling and release methods. This project aims to address key research to inform mobulid conservation. Bycatch reduction devices in the form of modified sorting grids were constructed and deployed to perform rapid release for the mobulids captured by 12 purse seine vessels from the U.S. fleet operating in the Pacific Ocean. Since June 2022, 29 mobulid captures were documented, and seven mobulids were released using these devices. Preliminary evidence suggests that sorting grids did not increase the duration of captures, even though the grids are used for larger individuals that would otherwise take longer to release. Satellite tags were deployed on three mobulids to estimate survival after release, but further research is necessary to examine the impact of the devices on mortality. In addition to testing the grids, eleven mobulid tissue samples were collected to contribute to knowledge of population genetic structure for mobulids. Lessons learned from applying current protocols and practices will allow developing improved best practices to be implemented by the U.S. tropical tuna purse seine fleet, which can be scaled up to other purse seine fisheries in the Indian and Atlantic Oceans.

1 Introduction

Manta and devil rays, together known as mobulids, are experiencing global population declines (Ward-Paige et al. 2013). While national and international fisheries and trade regulations have recently sought to prevent the targeted fishing of mobulids, many are caught as unintentional bycatch (Croll et al. 2016). In the U.S., the giant manta ray (*Mobula birostris*) has been listed as threatened under the federal Endangered Species Act, prompting the need for fisheries to reduce impacts on the species (NOAA 2023). The tropical tuna purse seine fishery contributes to Mobulid bycatch; however, the rate of interactions and mortalities associated with purse seine fishing are not well understood (Stewart et al. 2018; Griffiths & Lezama-Ochoa 2021). Additionally, relatively minor operational modifications have been identified that have the potential to increase post-release survival in the fishery (Murua et al. 2019, 2021; Cronin et al. 2022).

This project, funded by NOAA Pacific Islands Regional Office and led by the International Seafood Sustainability Foundation (ISSF) in collaboration with University of California, Santa Cruz, and the Centro de Investigación Marina y Alimentaria (AZTI), helps fill key research gaps related to mobulid bycatch in tuna purse seine vessels, with the collaboration of the U.S tuna purse seine fleet operating in the Pacific Ocean. In particular, this project aims to 1) quantify the rate of interaction of the U.S. purse seine fishery with mobulids, 2) design and test safe handling and release best practices and evaluate mobulid ray post-release survival rate using survivorship tags, and 3) train fishers and observers to identify and sample mobulid rays and educate crew on best safe handling and release practices for mobulids. This document summarizes objectives, preliminary results, and recommendations from the project.

2 Objectives

The objectives of this project were:

1. To quantify rates of interaction of the purse seine fishery with mobulid species, with emphasis on giant manta rays, and to collect **tissue samples** to contribute to the identification of unique stocks for management using genomic methods.
2. To **define and test safe-handling** and release best practices for mobulid rays, including gear modification or the use of BRDs and evaluate mobulid ray post-release **survival rate using survivorship satellite tags**
3. To **train fishers and observers** to identify, tag, and sample mobulid rays and educate crew on best safe-handling and release practices for Mobulids.
4. To **disseminate the results** of this project to fishers, scientist, managers, and general public.

3 Methods

3.1 Purse seine - mobulid interactions and population structure

To quantify the rate of interaction of the purse seine fishery with the various mobulid species, 15 tissue sampling kits were distributed to purse seine vessels participating in the project. Fishers were trained to take the tissue samples and started collecting data in June, 2022. Apart from fishers, scientists onboard purse seine vessels, during three cruises collected mobulid tissue samples. Those samples can contribute to the identification of unique stocks and species interacting with the purse seine fleet.

The target number of samples to be collected by the project was initially set at 100 but due to the low interaction, this number was adjusted to fewer samples, which were then combined for sequencing with mobulid tissue samples collected by observers on board purse seine vessels flagged to Ecuador for a parallel project. In February 2024, DNA extraction was conducted using Qiagen DNEasy Blood and Tissue kits. Restricted-Site Associated (RAD) Sequencing, a fractional genome sequencing technique that allows for high genome coverage at a relatively inexpensive cost. After genetic library preparation, sequencing was completed at the QB3 Vincent J. Coates Genomics Sequencing Laboratory at UC Berkeley. Bioinformatic analyses of the sequences is currently underway using 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 if sample size allows it. This activity was conducted throughout the duration of the project until July 2024.

3.2 Best safe-handling practices and post-release survival rate

To define and test safe-handling and release best practices for mobulid rays, including the development of BRDs and gear modification, 12 sorting grids designed by AZTI were constructed for each of the 12 participating purse seine vessels (Figure 1). For this activity, scientists from UCSC and AZTI monitored sorting grid use on board purse seine vessels, during three trips. During those trips, scientists (i) evaluated the efficacy and time of release of mobulids using sorting grids or another release method (i.e., stretchers, manual, etc.) and (ii) evaluated post-release mortality using survivorship tags (sPAT tags). Fishers also evaluated the efficacy of the sorting grid during the fishing operation by filling out a form specifically designed for the project.

Figure 1. Sorting grid (left) and a mobulid released using the sorting grid (right).

One scientist from the University of California, Santa Cruz, conducted two six-week cruises on board the US purse seiner F/V Pacific Princess and the F/V Andrea 1, departing from Mazatlán, Mexico in December 2022, and Manta, Ecuador in March 2024, respectively. Another scientist embarked on April 2023 on board the US purse seiner F/V Cape Finisterre departing from Pago Pago, American Samoa.

The primary goals of the cruises were to:

- Collect tail tissue samples for species identification and population genetics
- Collect mucous samples to aid in rapid species identification
- Collect size and species data for mobulid bycatch
- Deploy sPAT (in the EPO and WPO) and miniPAT tags (WPO) to measure post-release mortality
- Deploy and test a sorting grid bycatch release mitigation device designed by AZTI for rapid mobulid release
- Conduct fisher workshops to improve species identification and knowledge of proper handling and release methods
- Train crew members to deploy tags and collect samples after scientist departs

Post-release mortality was evaluated using tag data from Wildlife Computers processed by the software IGOR Pro from Wavemetrics version 9. Dive profiles transmitted via the tags were evaluated for indication of normal mobulid dive patterns to determine fate. Tag light levels were examined to rule out predation by another animal. Mortality was concluded if a tag reported that an individual exceeded the depth threshold of critical depth threshold of 1,400 meters, e.g., the individual died and sank through the water column. Survival was concluded if a dive profile reflected predictable diel migration.

4 Preliminary Results

4.1 Mobulid captures

A total of 29 mobulid captures by participating vessels were documented by scientists on three cruises and vessel crew during the project (Figure 2). Of those mobulids identified to the species level (n=14), *M. mobular* was the species most frequently captured (n=5), however these identifications have not yet been confirmed with genetic data (given the identification of *M. munkiana* outside of its known coastal distribution, identification error is likely occurring). Most individuals were relatively small (mean disc width = 176.1 ± 45 cm). Eleven tissue samples and two mucous samples were collected by the fleet (Table 1).

The target species composition of all but two sets with mobulids were primarily skipjack tuna (*Katsuwonus pelamis*), and the mean size of these sets was 63.3 tonnes. On four occasions, two individual mobulids were captured in the same set or, in one case, in two different sets but on the same day.

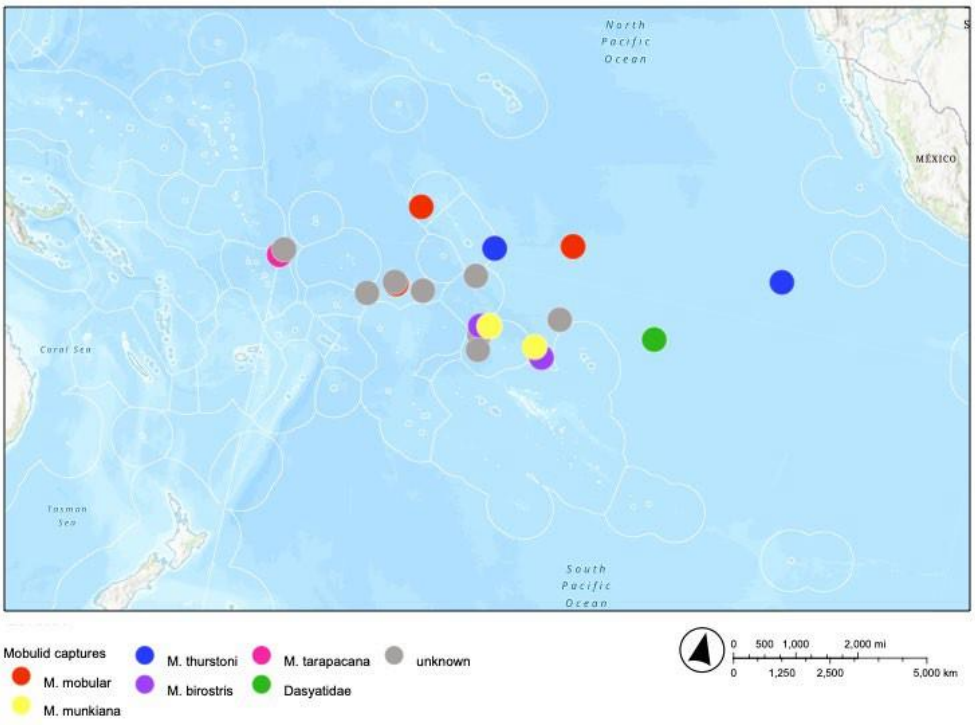

Figure 2. Mobulid captures by participating vessels documented by this project.

Table 1. Tissue samples and putative species identification collected by the U.S. purse seine fleet as of May 2024.

ID	VESSEL	SPECIES IDENTIFICATION
PP_01	Pacific Princess	M. mobular
PP_02	Pacific Princess	M. mobular
FR_02	Friesland	M. mobular
FR_03	Friesland	M. thurstoni
FR_01	Friesland	M. tarapacana
CF_01	Cape Finisterre	Unknown
CF_02	Cape Finisterre	M. thurstoni
CF_03	Cape Finisterre	M. thurstoni
WP_01	Western Pacific	M. thurstoni
CFR_01	Cape Ferrat	M. munkiana
PP_03	Pacific Princess	M. mobular

4.2 Release methods

Seven different release methods were documented, in order of frequency of reported use: sorting grid (n=7), stretcher (n=4), manual release from deck (n=3), manual release from the hopper (n=3), cargo net (n=3), release from the sack (n=1), and release from brailer (n=1). Fishers reported that they released small individuals by hand, as it was easier than using the sorting grid or other equipment.

Five mobulids were tagged by scientists and crew, three tags of which reported (Table 2). Two tagged individuals, both *M. thurstoni* released manually from the deck, were considered mortalities, evidenced by the tag reaching the depth threshold shortly (1-2 days) after deployment. These mortalities occurred after different visual cues: one of these animals was released “very active and energetic” and one “sank with little movement” after release.

The third reporting tag, deployed on a *M. mobular* individual released via a stretcher, was considered a survival. Though this tag was likely affected by poor satellite coverage and therefore reported incomplete data, this individual is considered a survival, evidenced by interval release (tag reached full deployment and then popped off at a depth of 24 m on 3/16/23) and last five days of deployment, which indicate diel vertical movement.

Table 2. Satellite tags deployed on mobulids to estimate post-release mortality after capture in purse seinse.

Date	Vessel	Duration of capture	Brailer number	Species	Release method	Condition on release	Fate
5/21/23	Cape Finisterre	4:00	5	*M. thurstoni*	manual	good ("active and energetic"	mortality
5/21/23	Cape Finisterre	3:00	12	*M. thurstoni*	manual	poor ("sank with little movement")	mortality
2/14/23	Pacific Princess	3:00	4	*M. mobular*	stretcher	good	survival

4.3 Sorting grids

Using designs provided by AZTI, vessel crews fabricated manta sorting grids for release of large individuals. Fishers reported that the construction of the sorting grid was feasible for all the vessels in the fleet due to easy access and low-cost materials employed.

The seven mobulids released using the sorting grid were larger (mean disc width = 200 ± 29 cm) than those released using other methods (mean disc width = 162.8 ± 48 cm). Tags could not be deployed on these animals. However, fisher responses to the use of the grids reflect that in most cases, the grid seemed to work well. In one case, a mobulid on the grid became lodged between the door of the vessel's hopper and the grid; in this case the crew decided to modify the operation for the next capture.

The mean duration of capture for releases using sorting grid (4:07 minutes) was similar to the mean duration of capture using other release methods (4:11 minutes), despite the larger size of the animals released via sorting grid.

4.4 Fisher training and education

Finally, one of the key objectives of the project was to educate and raise fishers' awareness on mobulid conservation, and train them on mobulid species identification, tissue collection and tagging (Figure 3). In person and online meetings were held with fishers as well as onboard purse seiners during port visits (e.g., Pago Pago, Manta). Generally, fishers demonstrated interest in improving handling practices and contributing to mobulid conservation, which will likely make it easier to implement better bycatch release practices in the long term.

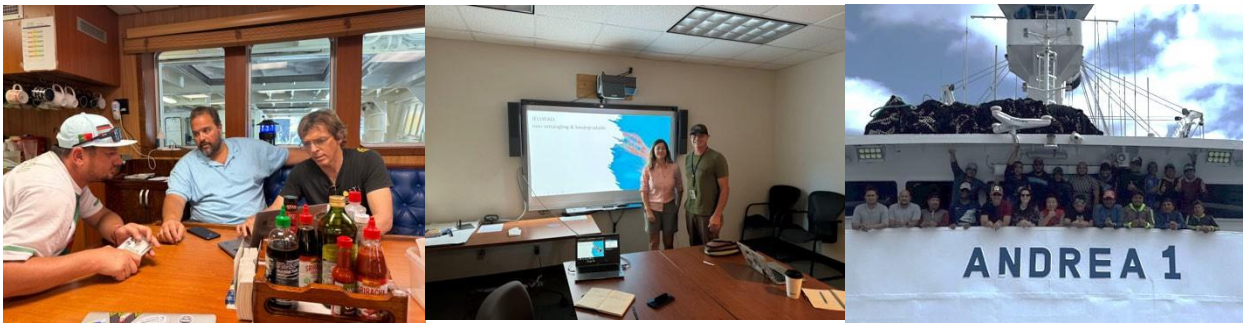

Figure 3. Project scientists training fishers on board purse seiners for mobulid tagging, sampling, and testing the sorting grid.

5 Conclusion

We find preliminary evidence suggesting that sorting grids for mobulids have been readily adopted by the U.S. fleet, and may not result in longer processing time, even for larger mobulids. In fact, the research cruises in this project found that the grid was efficient for fishers and did not disturb the fishing operation. In addition, fishers can construct sorting grids with low-cost materials already available on board. Ongoing genetic and tagging results will offer further insight into population structure and the potential efficacy of different handling methods.

Given the rarity of mobulids in fishing sets, future efforts should seek to target vessels fishing in areas and seasons of high catch to increase the likelihood of encountering mobulids. Additionally, focusing tagging effort on larger individuals will allow for usage and testing of the sorting grid. The development and distribution of an in-depth species identification guide would be useful to help fishers with species identification, which remained challenging.

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