Innovative Solutions for manta and devil Ray bycatch: Evidence for rapid release using manta sorting grids in the U.S. tropical tuna purse seine fleet

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Background

Manta and devil rays (Mobula spp.) are among the most vulnerable elasmobranchs to fishing mortality[1,2]. The tropical tuna purse seine fishery is a major source of mobulid bycatch, with thousands of individuals caught each year. However, recent and reliable global estimates of mobulid bycatch in these fisheries are lacking [3,4]. These species are slow-growing, have low reproductive rates, and are listed under several international conservation agreements [5,6]. Current handling and release practices on purse seine vessels often result in delayed release or physical injury to mobulids, particularly large individuals that require multiple crew to lift manually[7]. Recent research has indicated that time on deck is a critical predictor of mobulid mortality in tuna purse seine fisheries; thus, handling methods that minimize time on deck for large individuals are needed[8]. The use of bycatch reduction devices (BRDs), such as sorting grids, has been identified as a promising way to improve survival outcomes[9–11]. However, for such devices to be effective and widely adopted, they must be operationally feasible, safe for crew, and compatible with diverse vessel designs.

This report summarizes a participatory project with the U.S. tropical tuna purse seine fleet to design, deploy, and evaluate mobulid sorting grids across 12 large vessels operating in the

tropical Pacific[12]. Here we summarize the study's findings for utility in informing best handling recommendations for IOTC-managed fisheries.

Participatory approach and grid design

A key element of this project was active fisher involvement. Initial concepts were inspired by a fisher-created bamboo prototype used in the Atlantic Ocean[11]. U.S. fleet captains, engineers, and crew were engaged through virtual meetings, port visits in American Samoa and Ecuador, and onboard workshops. Each vessel completed a questionnaire and provided photos and measurements of deck layouts and hatches. These data informed the customized design of stainless-steel sorting grids with flexible rope or bungee systems to accommodate differences among vessels. Crews built the grids themselves using onboard materials, gaining hands-on experience to ensure they could repair or modify the device in the future. The grid was positioned over the hopper or directly over the loading hatch. Tuna pass through the grid into the hold, while mobulids remain on top and are lifted back overboard using the vessel's hydraulic crane, avoiding manual handling of heavy animals. This collaborative process fostered fisher buy-in and promoted consistent use of the device during fishing operations.

Data Collection

Data were collected between March 2022 and October 2024 through a mix of scientist-observed trips (three two-month trips) and crew-collected records after onboard training. For each mobulid capture event, the following variables were recorded: time and location, species and disc width, tuna set characteristics (target species, catch weight, FAD-associated vs. unassociated sets), brail number in which the mobulid appeared, release method (e.g., grid vs. manual methods), time on deck (from emergence in the brailer to release).

Sorting grids were successfully implemented across all 12 vessels in the U.S. tropical tuna purse seine fleet. Designs varied widely due to tailoring to each vessel characteristics, with some vessels using rigid grids, others opting for flexible rope models, and several incorporating raised grid designs. This high level of customization increased the practicality of the tool and encouraged consistent use during fishing operations.

A total of 41 mobulid capture events were recorded across the eastern and western Pacific Ocean. Most captures occurred in sets associated with fish aggregating devices (FADs) targeting skipjack tuna, with a mean set size of 59.6 tons. Among individuals identified to species, the most common were *Mobula mobular*, *M. tarapacana*, *M. thurstoni*, *M. munkiana*, and *M. birostris*.

Seven different deck-based release methods were documented, including sorting grid (n = 10), stretcher (n = 9), cargo net (n = 6), and manual lift (n = 6). In three cases, mobulids were released before reaching the deck, either directly from the net or while still in the brailer.

Analysis of 21 individuals with complete data showed that larger mobulids were preferentially released using the sorting grid, with a mean disc width of 222 cm compared to 173 cm for other release methods ($p < 0.05$). Importantly, handling time did not differ significantly between methods: the mean time on deck for grid releases was 3:10 minutes, compared to 3:52 minutes for other methods. This suggests that the sorting grid enables the rapid release of very large individuals without slowing overall fishing operations. These results indicate that sorting grids address a critical operational gap by allowing the safe, quick and efficient release of mobulids that are too large to be handled manually.

Implications

The results demonstrate that mobulid sorting grids are an operationally feasible solution to improve handling outcomes for vulnerable manta and devil rays in tropical tuna purse seine fisheries. They allow for the rapid release of large animals without additional time costs, reduce stress and injury by minimizing manual handling, and promote long-term adoption through strong fisher engagement in the design process.

Given these findings, tropical tuna RFMOs, including the IOTC, could consider standardizing the use of mobulid sorting grids across fleets as a recommended best practice. Providing training and resources to support fleet-specific customization and integrating grid use into bycatch mitigation and safe-release guidelines would further enhance effectiveness and consistency across regions.

This study highlights the value of participatory approaches to bycatch mitigation. Mobulid sorting grids represent a practical, fisher-driven solution that supports the conservation of threatened manta and devil rays while maintaining efficient tuna fishing operations. Scaling up the adoption of these devices across fleets and regions could significantly reduce bycatch mortality for these vulnerable species and contribute to broader ecosystem-based management goals.

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