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Status of Mobulid Rays in Sri Lanka

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Abstract

Mobula rays, while pelagic in nature with a circumglobal distribution, have one of the most conservative life cycles among elasmobranchs. They are frequently encountered as bycatch in Sri Lankan fisheries targeting tuna and billfish, and retained and landed due to their highly valued gill plates that are exported. Sri Lanka is among one of the highest mobula catching nations due to single and multi-day fishing vessels capturing these species as bycatch off the continental shelf edge and in high seas. Over 303 surveys at 19 landing sites, a total of 632 mobula rays were recorded at 11 of the sites. Across all species, the proportion of juvenile, immature rays were greater than mature adults. This, together with their life history and the fact that multiple countries catch these species within the Indian Ocean, make them extremely poor candidates for commercial fisheries. Recommendations such as improved data collection, mitigation and retention measures, are strongly recommended to curb population decline and enable recovery.

Keywords: Manta, *Mobula,* fisheries

Introduction

The family Mobulidae (Superorder: Batoidae, Order: Myliobatiformes) of the cartilaginous subclass Elasmobranchii, following a recent taxonomic revision by White *et al*., 2017, now comprises of one genus; *Mobula* (Rafinesque-Shmaltz, 1810), representing 8 extant species found in tropical, subtropical and temperate waters worldwide. Under the current revision, a total of 6 species are found in the Indian Ocean; *Mobula birostris* (oceanic manta ray)*, Mobula alfredi* (reef manta ray)*, Mobula mobular* (spinetail/giant devil ray)*, Mobula tarapacana* (sicklefin devil ray), *Mobula thurstoni* (bentfin devil ray), and *Mobula kuhlii* (shortfin pygmy devil ray). It is however suggested by certain research groups (Notarbartolo-di-Sciara, Stevens and Fernando, pers. comms.) that *Mobula eregoodootenkee* (longhorned pygmy devil ray), currently considered a junior synonym of *Mobula kuhlii,* remains a valid species.

Unique among the batoids, these species are filter-feeders that are typically found in pelagic habitats (Couturier *et al*., 2012). Like many other elasmobranchs, mobulid[1] rays are highly susceptible to

[1] Refers to all *Mobula* spp., which are commonly called “manta” and “mobula/devil rays”.

overexploitation due to their K-selected life cycles including low fecundity, matrotrophic reproduction, large size at birth, slow growth, late maturity, and longevity (Pardo *et al*., 2016; Dulvy *et al*., 2014; Couturier *et al*., 2012).

In Sri Lanka, where fisheries are extremely important for food security, livelihoods, and export earnings, species like mobulid rays comprise a component of the retained bycatch, primarily by gillnet fisheries targeting skipjack tuna but on occasion also reported from longline fisheries (Croll *et al*., 2016). These species are retained due to their highly valued gill plates for international trade (Jabado *et al*., 2018; O'Malley *et al.*, 2017), and domestic consumption of meat primarily in dried form (Fernando & Stevens, 2012).

Methods

A total of 303 surveys (comprising 4 hours of surveying or surveying all landings, whichever is earlier) were conducted between August 2017 and August 2018 across 19 landing sites; 8 on the west coast, 3 on the north coast, 7 on the east coast, and 1 on the south coast. At these landing sites, both single and multi-day vessels that within and outside the EEZ, offload their catch. All encountered mobulid rays were identified to species level using Stevens *et al.*, 2018, whenever possible. Data on sex, and maturity for males based on clasper length (immature having undeveloped claspers that do not extend beyond the pelvic fin, while mature specimens have fully calcified claspers extending well beyond the margin of the pelvic fins), were collected where possible, in addition to disc width and disc length when time permitted prior to or just after auctioning. Sex and maturity could not be collected for all landed specimens since many were gutted at sea, prior to storage in the boat hold in order to increase the number of days the meat kept fresh. Additionally, at times the mobulids were landed in large piles, often preventing access to clearly determining sex of specimens at the bottom of the pile. In both cases, the total number of species were counted and documented as unsexed. As many specimens are landed in halves (due to the size of the boat hold storage door), each half was measured and added together to obtain total disc width (DW, in cm). When an encountered pile of rays had both left and right halves, only left halves were counted and measured. Tissue samples were collected and preserved in 99% ethanol.

Preliminary Analysis, Discussion, and Recommendations

Of the 19 landing sites monitored, mobulid rays were encountered at 11 landing sites (totalling 280 days of survey); 4 on the west coast, 1 on the north coast, 5 on the east coast, and 1 on the south coast (see Figure 1). A total of 634 specimens were encountered across 5 species (see Table 1).

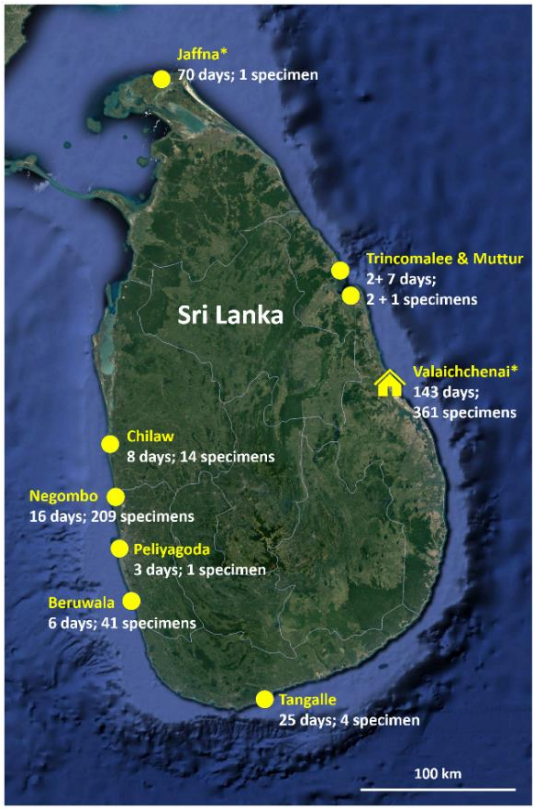

Figure 1: Locations of landing sites where mobulid rays were encountered (* denotes 3 landing sites amalgamated)

Table 1: Number of mobulid specimens observed across 11 (out of 19) fisheries survey sites between August 2017 and August 2018.

Survey Site	Survey days	*Mobula birostris*	*Mobula mobular*	*Mobula tarapacana*	*Mobula kuhlii*	*Mobula thurstoni*	*Total mobula*
Jaffna* (*3 sites)	70	0	0	0	0	1	1
Trincomalee	2	0	1	1	0	0	2
Muttur	7	0	1	0	0	0	1
Valaichchenai* (*3 sites)	143	28	227	102	0	4	361
Chilaw	8	0	8	1	2	3	14
Negombo	16	4	176	23	4	2	209
Peliyagoda	3	0	0	1	0	0	1
Beruwela	6	3	27	11	0	0	41
Tangalle	25	0	4	0	0	0	4
TOTAL:	**280**	**35**	**444**	**139**	**6**	**10**	**634**

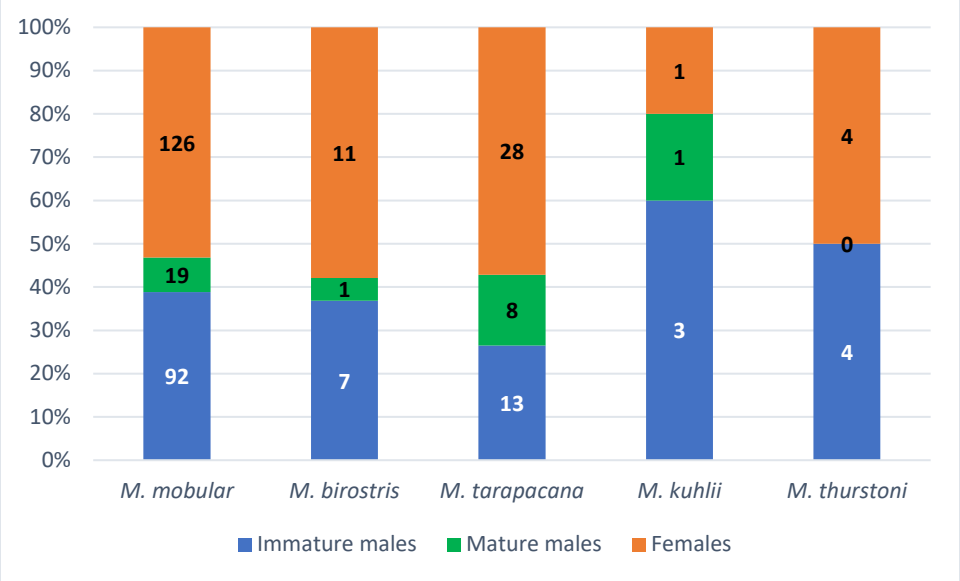

Figure 2: Proportion of females to males, and immature to mature males, across all species. Unsexed individuals have been excluded

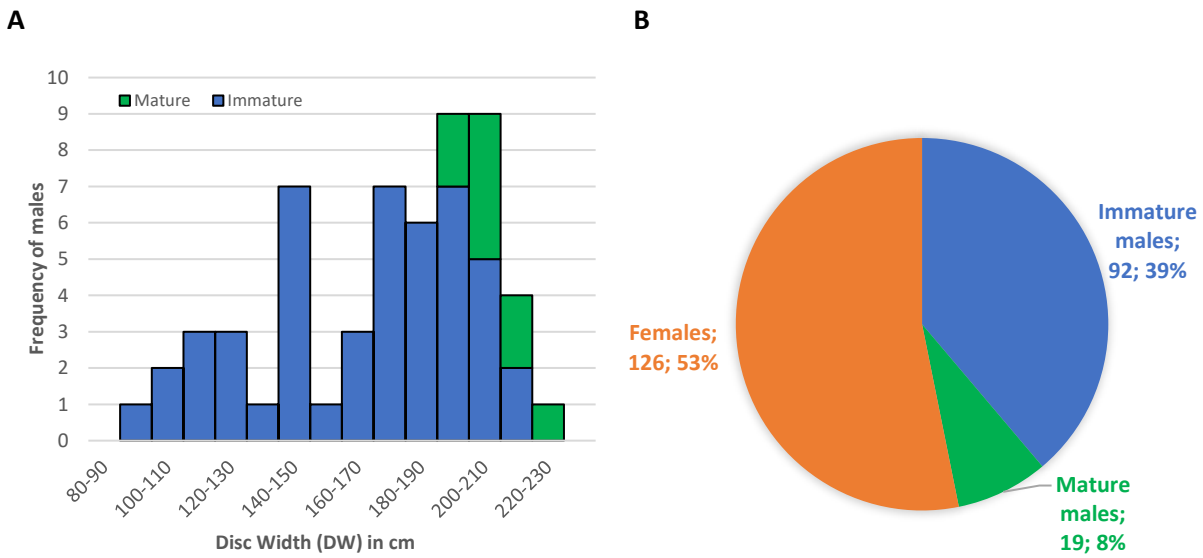

Figure 3: (**A**) Disc width (cm) across measured mature and immature males of *M. mobular*; (**B**) distribution among females and males of sexed *M. mobular* (207 specimens were unsexed)

It is quite apparent that certain landing sites, such as Negombo and Beruwela land a larger number of mobulid rays per day on average (Table 1). This has been recorded in previous studies from Sri Lanka (Fernando & Stevens, 2011; Fernando & Stewart, unpublished), highlighting Negombo, Beruwela, and Mirissa (not included in this study) as key mobulid landing sites, primarily due to a higher proportion of

multi-day versus single-day fishing fleets at these landing sites, whose endurance and seaworthiness enables fishers to fish much further offshore (off the continental shelf). In contrast it is expected that fisheries in Jaffna for example, being far more coastal in nature and coupled with a wider continental shelf edge compared to other regions of Sri Lanka, will land fewer pelagic species.

Proportions between identified male and female specimens of each species showed no significant bias, however for certain species such as *M. kuhlii*, the sample size was too small to determine gender ratios, and other demographic statistics, conclusively. Across all species, the proportion between identified mature and immature males revealed a bias towards immature males (see Figure 2).

Based on *M. birostris* data from Indonesia (White *et al*., 2006) suggesting that males mature at 375 cm and females at 413 cm, and a logistic regression of disc width at which 50% of the males were sexually mature (L_{M50}) from data collected in Sri Lanka between 2011 and 2015 identifying maturity at 390 cm (Fernando & Stewart, unpublished), it reveals that of the 8 male *M. birostris* recorded in this study, 7 were immature (87.5%). Of the 11 females, only 4 were measured but all those were immature. Of the 16 unsexed individuals, the 3 measured were also immature. Similar results were obtained from the previous study in Sri Lanka that revealed 90.5% (of 74 measured specimens) of *M. birostris* were juveniles or sub-adults (Fernando & Stewart, unpublished). In addition, using the appropriate species-specific size at maturity currently available for the region (White *et al*., 2006; Fernando & Stewart, unpublished), this study shows that 83.6% of recorded male *M. mobular* are immature (see Figure 3), with the greatest proportion of individuals landed being close to the size at which they become mature, estimated at approximately 200 cm. Of the male *M. tarapacana*, 61.9% were juveniles, while of the 9 measured *M. thurstoni*, all of them were immature based on size at maturity. The total number of *M. kuhlii* specimens was only 6 and therefore excluded as sample size is likely too small to determine any bias, however of the 4 male specimens, only 1 was mature. It is also interesting to note however that to date, *M. kuhlii* has only been encountered on the west coast (Negombo and Chilaw).

Unstructured interviews with fishers confirm that mobula rays are caught and landed as non-target catch, predominantly from gillnets targeting skipjack tuna (*Katsuwonus pelamis*), yellowfin tuna (*Thunnus albacares*), and billfish. They also revealed that a significant proportion of the rays caught were still alive when hauled onto deck. This information is reflective of that collected during surveys conducted between 2011 to 2015, which also confirmed that mobula rays were frequently caught together with tuna (Fernando & Stevens, 2011; Fernando unpublished). Fishers also report that it is quite common to capture multiple mobula (*M. mobular, M. tarapacana,* or *M. thurstoni*) in a single haul, suggesting that these species tend to school. It must be noted that although *M. kuhlii* have been recorded to school based on records from scuba divers across multiple regions (e.g. the Maldives, Malaysia, Indonesia), documented landings in Sri Lanka are typically of single individuals, which may be due to the fact that this species is far more coastal in nature and therefore less frequently encountered by pelagic fisheries.

The primary incentive to land captured mobula rays are their highly valued gill plates for the export market. The larger the gill plate, the more valuable, but in general average sale prices per kg of *M. birostris*

gill plates in dried form is between Sri Lanka Rupee (LKR) 20,000.00 to 30,000.00 (~USD 127.39 to 191.10), while large *M. tarapacana* gill plates (referred to as "flower-gills" due to bicolouration) are sold for over LKR 15,000.00 (~USD 95.54), and other species anywhere between LKR 2,000.00 to around 10,000.00 (~USD 12.74 to 63.69). Only two sites on the west coast (Negombo and Chilaw) consume mobulid meat fresh, while all other landing sites only sell meat after drying, at prices lower than that for dried tuna.

Given these species' conservative life history, migratory nature, and the fact that a majority of specimens encountered at landing sites in Sri Lanka (this study; Fernando & Stevens, 2011; Fernando & Stewart, unpublished) are juveniles and sub-adults, there are concerns on the viability of this fishery. These concerns are likely further exacerbated by ghost fishing and the lack of species level, or genus level, data on discards. *Mobula mobular, M. tarapacana*, and *M. thurstoni* are also categorised as Endangered by the IUCN Species Survival Commission Shark Specialist Group for the Arabian Seas region (Jabado *et al*., 2017), which includes the western coast of Sri Lanka. *Mobula kuhlii* is categorised as Near Threatened with poor documentation and misidentification listed as concerns, while *M. birostris* is considered Vulnerable (Jabado *et al*., 2017). All mobulid species are currently listed on Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and on both Appendix I and II of the Convention on the Conservation of Migratory Species of Wild Animals (CMS).

As a result of similar fisheries to Sri Lanka occurring across the region including in India, Pakistan, and Bangladesh, and other nations fishing within the IOTC Area of Competence, it is highly recommended that additional measures are introduced at a regional scale to halt overexploitation and pressure of extinction on these vulnerable species, and give them the opportunity to recover.

It is recommended to collect data to genus level for all retained or discarded (dead and alive) mobulid specimens, and where possible, data to species level. For example, *M. birostris* and *M. alfredi* (both commonly referred to as "manta") can be easily identified by their terminal mouth, versus the subterminal mouth found on the other mobulid species. *Mobula tarapacana* can also be differentiated due to unique dorsal and ventral colouration and shading. Recognising the overall complexities of these species, the Manta Trust have developed an identification guide (Stevens *et al.*, 2017) that is available for purchase online, and can also be made available upon request to government fisheries departments or agencies[2]. Given that further morphological and phylogenetic studies are being conducted to verify that *M. eregoodootenkee* are a separate species, it is recommended to monitor this species independently to *M. kuhlii* when encountered.

Opportunities for bycatch mitigation should also be further explored. Trials on methods such as the use of various coloured lights on gillnets in Pakistan appear to be successful (Khan, pers. comms.), and detailed studies are underway to study which optical range would be the most effective against mobulid rays while enabling target species to be caught (Laglbauer, pers. comms.). A shift from techniques such as gillnets that do not target particular species should also be investigated. Finally, given that many mobula

[2] Contact info@mantatrust.org with a brief description of the needs and uses of this ID guide. Requests on official Government letterhead will be given due consideration.

specimens are still alive when hauled onboard, retention measures should be explored in conjunction with adapted safe release techniques endorsed by other fisheries (Poisson *et al*., 2014).

Such measures if introduced across the Indian Ocean, given fishing pressure from multiple countries and the migratory nature of these species, would provide these slow-growing rays with the opportunity to recover. And improved data collection would enable a more accurate record of encountered specimens to be maintained in order help calculate trends in stock status.

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References

Couturier, L.I.E., Marshall, A.D., Jaine, F.R.A., Kashiwagi, T., Pierce, S.J., Townsend, K.A., Weeks, S.J., Bennett, M.B. and Richardson, A.J., 2012. Biology, ecology and conservation of the Mobulidae. *Journal of fish biology*, *80*(5), pp.1075-1119.

Croll, D.A., Dewar, H., Dulvy, N.K., Fernando, D., Francis, M.P., Galván-Magaña, F., Hall, M., Heinrichs, S., Marshall, A., Mccauley, D. and Newton, K.M., 2016. Vulnerabilities and fisheries impacts: the uncertain future of manta and devil rays. *Aquatic Conservation: Marine and Freshwater Ecosystems*, *26*(3), pp.562-575.

Dulvy, N.K., Pardo, S.A., Simpfendorfer, C.A. and Carlson, J.K., 2014. Diagnosing the dangerous demography of manta rays using life history theory. *PeerJ*, *2*, p.e400.

Fernando & Stewart, unpublished. Trends, catch rates and demographics of non-discarded mobulid bycatch in Sri Lanka. *In prep.*

Fernando, D. and Stevens, G., 2011. A study of Sri Lanka's manta and mobula ray fishery. *The Manta Trust*, *29*.

Jabado, R.W., Kyne, P. M., Pollom, R. A., Ebert, D. A., Simpfendorfer, C. A., Ralph, G.M., and Dulvy, N.K. (eds.), 2017. The Conservation Status of Sharks, Rays, and Chimaeras in the Arabian Sea and Adjacent Waters. *Environment Agency – Abu Dhabi, UAE and IUCN Species Survival Commission Shark Specialist Group, Vancouver, Canada,* pp. 236.

Jabado, R.W., Kyne, P.M., Pollom, R.A., Ebert, D.A., Simpfendorfer, C.A., Ralph, G.M., Al Dhaheri, S.S., Akhilesh, K.V., Ali, K., Ali, M.H. and Al Mamari, T.M., 2018. Troubled waters: Threats and extinction risk of the sharks, rays and chimaeras of the Arabian Sea and adjacent waters. *Fish and Fisheries*.

O'Malley, M.P., Townsend, K.A., Hilton, P., Heinrichs, S. and Stewart, J.D., 2017. Characterization of the trade in manta and devil ray gill plates in China and South-east Asia through trader surveys. *Aquatic Conservation: Marine and Freshwater Ecosystems*, *27*(2), pp.394-413.

Pardo, S.A., Kindsvater, H.K., Cuevas-Zimbrón, E., Sosa-Nishizaki, O., Pérez-Jiménez, J.C. and Dulvy, N.K., 2016. Growth, productivity, and relative extinction risk of a data-sparse devil ray. *Scientific reports*, *6*, p.33745.

Poisson, F., Séret, B., Vernet, A.L., Goujon, M. and Dagorn, L., 2014. Collaborative research: Development of a manual on elasmobranch handling and release best practices in tropical tuna purse-seine fisheries. *Marine Policy*, *44*, pp.312-320.

Stevens, G., Fernando, D., Dando, M., Notarbartolo di Sciara, G., 2018. Guide to Manta and Devil Rays of the World. *Wild Nature Press*, pp.144.

White, W.T., Corrigan, S., Yang, L., Henderson, A.C., Bazinet, A.L., Swofford, D.L. and Naylor, G.J., 2017. Phylogeny of the manta and devilrays (Chondrichthyes: mobulidae), with an updated taxonomic arrangement for the family. *Zoological Journal of the Linnean Society*, *182*(1), pp.50-75.

White, W.T., Giles, J. and Potter, I.C., 2006. Data on the bycatch fishery and reproductive biology of mobulid rays (Myliobatiformes) in Indonesia. *Fisheries Research*, *82*(1-3), pp.65-73.