

Devils in Distress

The Plight of Mobula Rays

A school of Atlantic pygmy devil rays (*Mobula hypostoma*) off the Yucatán Peninsula in the Caribbean | Photo © Shawn Henrichs

Mobula rays (*Mobula* spp.; Family: Mobulidae; commonly referred to as devil rays) are at great risk of severe global population declines due to target and incidental fishing pressure¹.

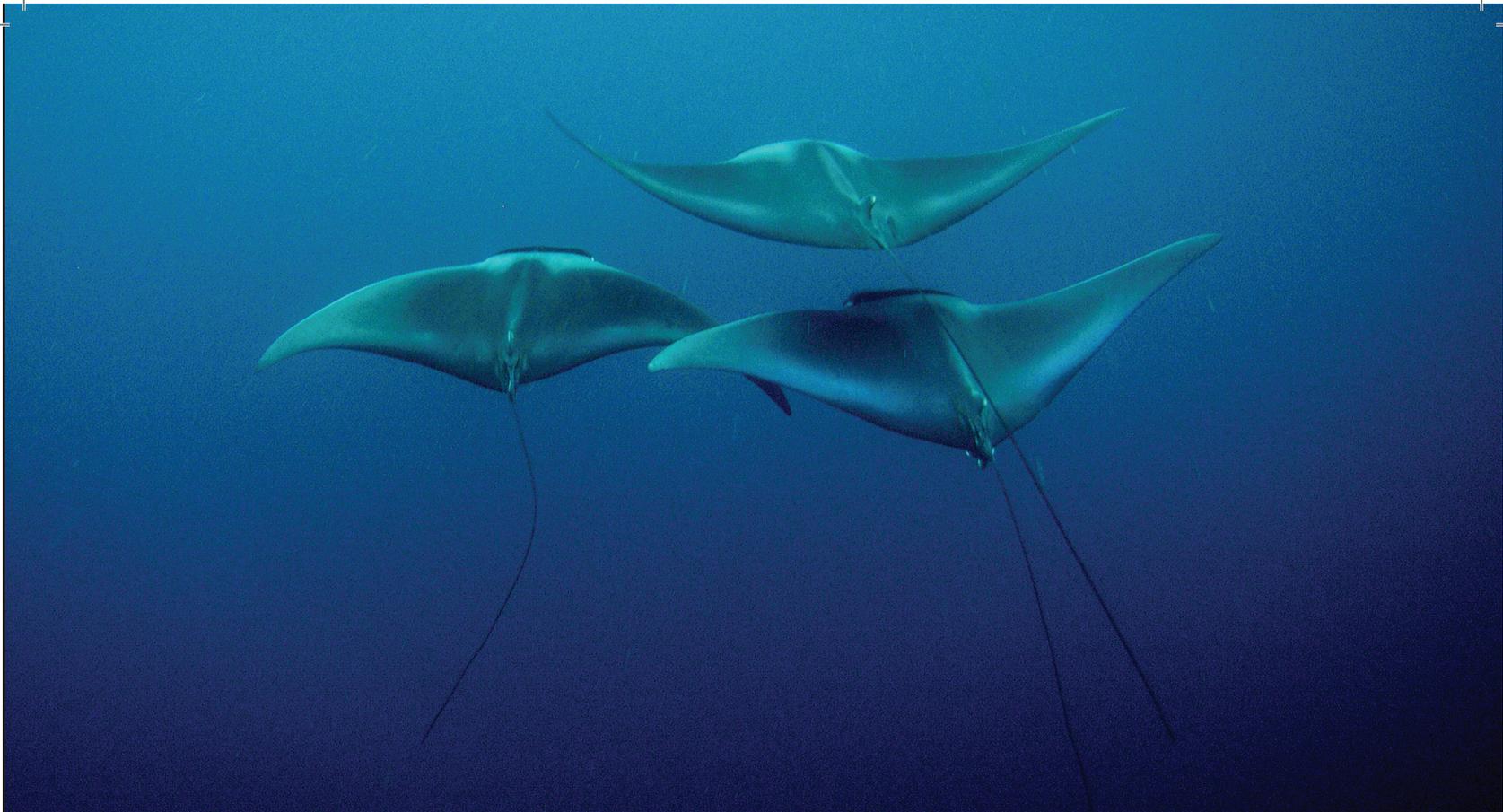
Similar to the closely related and larger manta rays (*Manta* spp.)*, *Mobula* generally grow slowly, mature late, and produce few offspring over long lifetimes^{1,2}. This life history strategy, coupled with their migratory nature and inherent schooling behaviour, makes these species extremely vulnerable to overexploitation.

Escalating demand for dried *Mobula* gill plates for use in Chinese medicine, as well as meat and cartilage, has led to targeting of these vulnerable species through fisheries that are largely unregulated and unmonitored. Significant catch declines have been observed in a number of locations in the Indo-Pacific, Eastern Pacific, and Indian Ocean regions, often despite evidence of increased fishing effort. Population declines are likely occurring in other locations, but have gone unnoticed.

Morphological similarities across the nine *Mobula* spp. and their traded gill plates, combined with overlapping geographic distributions, make species identification difficult. As a result, detailed reporting of catches from the vast majority of countries is lacking, presenting a challenge for population assessment. Measures to ensure sustainability of *Mobula* catch through fisheries management and international trade controls are also currently lacking. Change is needed now before overfishing leads to severe, perhaps irreparable depletion.

Listing *Mobula* under Appendix II of the Convention on International Trade in Endangered Species (CITES) is warranted to improve fisheries and trade data, establish science-based exports limits, bolster enforcement of national protections, and complement listing under the Convention on Conservation of Migratory Species of Wild Animals (CMS).

* *Manta* spp. are listed under CITES Appendix II and CMS Appendix I & II.



Spinetail devil rays (*Mobula japonica*) off Ari Atoll in the Maldives | Photo © Guy Stevens

Mobula Rays

Mobula rays are found across the world throughout tropical and temperate oceans. Like closely related *Manta* spp., *Mobula* are relatively large, slow-growing, migratory animals that form small, highly dispersed populations (and possibly subpopulations). They are among the least fecund of all sharks and rays, giving birth to a single pup every two to three years after a gestation period of about one year. Like *Manta*², such life history characteristics likely place them into the lowest productivity category with respect to FAO technical guidance for listing commercially-exploited aquatic species under CITES³.



A diver imitates a sicklefin devil ray (*Mobula tarapacana*) in the Azores, Portugal. | Photo © Tom Burd

Very little is known about mobula rays. Unlike manta rays, they are often timid around scuba divers, making it hard for scientists to observe their behaviour in the wild. *M. munkiana* seasonally aggregate, probably coming together to mate, while other *Mobula* species exhibit schooling behaviour, possibly seeking safety in numbers from natural predation. This schooling behaviour makes *Mobula* highly vulnerable to human exploitation, even from artisanal fisheries, while their small and dispersed populations, and low productivity limit their ability to recover from a depleted state. The migratory nature of many *Mobula* spp., with some travelling more than 1,000 km within one month^{4,5} and crossing multiple Exclusive Economic Zones (EEZs), greatly increases their chances of venturing into regions of heavy fishing.

The distinguishing anatomical feature of mobulid rays is the shape of the cephalic fins, which when rolled up look like horns projecting off their heads – hence the common name ‘devil rays’. The primary function of these fins is to help funnel plankton and small fishes into their gaping mouths. From there, these filter feeders use modified gill plates to strain planktonic food from the water. Mobula rays are generally much smaller than manta rays, and can be distinguished by morphological differences in their mouths. Mobula rays have a bottom jaw that is undercut so that the edge of the lower jaw rests further back than the upper when their mouths are closed, whereas the jaws of manta rays are aligned evenly.

Description

Nine extant species within the Genus *Mobula* (Rafinesque, 1810):

Scientific Name	Common Name
<i>Mobula mobular</i> (Bonnaterre, 1788)	Giant Devil Ray
<i>Mobula japanica</i> (Müller & Henle, 1841)	Spinetail Devil Ray
<i>Mobula thurstoni</i> (Lloyd, 1908)	Bentfin Devil Ray
<i>Mobula tarapacana</i> (Philippi, 1892)	Sicklefin Devil Ray
<i>Mobula eregoodootenkee</i> (Bleeker, 1859)	Longhorned Pygmy Devil Ray
<i>Mobula kuhlii</i> (Müller & Henle, 1841)	Shortfin Pygmy Devil Ray
<i>Mobula hypostoma</i> (Bancroft, 1831)	Atlantic Pygmy Devil Ray
<i>Mobula rochebrunei</i> (Vaillant, 1879)	Guinean Pygmy Devil Ray
<i>Mobula munkiana</i> (Notarbartolo-di-Sciara, 1987)	Munk's Pygmy Devil Ray

and any other putative *Mobula* species.

Examples of Declines

Estimated Decline	Region	Time Period	Species
INDO-PACIFIC			
86%	Lamakera, Indonesia	12 years (2002 to 2014)	<i>M. tarapacana</i> , <i>M. japanica</i> and other <i>Mobula</i> spp.
99%	Tanjung Luar, Indonesia	7-13 years (2001-5 to 2013-14)	<i>M. tarapacana</i>
96%	Tanjung Luar, Indonesia	7-13 years (2001-5 to 2013-14)	<i>M. japanica</i>
77%	Cilacap, Indonesia	8-13 years (2001-5 to 2014)	<i>M. tarapacana</i>
50%	Cilacap, Indonesia	8-13 years (2001-5 to 2014)	<i>M. japanica</i>
PACIFIC			
78%	Cocos Islands, Costa Rica	21 years (Jan 1993 to Dec 2013)	<i>M. tarapacana</i> and other <i>Mobula</i> spp.
89%	Tumbes, Peru	14 years (1999 to 2013)	<i>M. japanica</i> , <i>M. munkiana</i> , <i>M. thurstoni</i> and <i>M. tarapacana</i>
>50%	Eastern Pacific	3 years (2006 to 2009)	<i>Mobula</i> spp.
ATLANTIC			
61%	Guinea	4 years (2004 to 2008)	<i>Mobula</i> spp.
INDIAN OCEAN			
>50%	India	10 years (1993-5 to 2012-13)	<i>M. tarapacana</i> , <i>M. japanica</i> and other <i>Mobula</i> spp.
Unspecified Declines	Sri Lanka	2-5 years (2010 to 2015)	<i>Mobula</i> spp.



A spinetail devil ray (*Mobula japanica*) having its gill plates removed at a fish market in Sri Lanka | Photo © Steve De Neef

Population Trends

Indo-Pacific

In Indonesia catches of *M. tarapacana* and *M. japanica* recorded from the country's three largest mobulid landing sites (Tanjung Luar, Lombok; Lamakera, Solor; Cilacap, West Java) declined dramatically over 10 to 15 years despite evidence of increased directed fishing effort in Tanjung Luar and Lamakera⁶. *M. tarapacana* landings declined by 77% in Cilacap comparing landings from 2001-2005 to landings in 2014; and by 99% in Tanjung Luar from 2001-2005 relative to 2013-2014. Over the same time periods, *M. japanica* landings declined by 50% in Cilacap and 96% in Tanjung Luar. Landings of *Mobula* spp. in Lamakera, primarily *M. tarapacana* and *M. japanica*, declined by 86% from 2002 to 2014.

Pacific Ocean

A decline of 78% in *Mobula* abundance has been recorded over the past 21 years in the Cocos Island Marine Protected Area off Costa Rica⁸. While species-level identifications were not available in this study, area dive operators report *M. tarapacana* as the devil ray species that is generally sighted there⁹.

In Peru, reported landings of *Mobula* fluctuate considerably from year to year, but show a downward trend from peak landings of 1,188t in 1999¹⁰ to 135t in 2013, a decline of 89%¹¹. The IMARPE¹¹ landings reports identify all *Mobula* landed as *M. thurstoni*, but recent fishery surveys conducted by Planeta Océano¹² (2015) and APECO¹³ (2014) reported landings in northern Peru with *M. japanica* most abundant, followed by *M. munkiana* and *M. thurstoni*, and *M. tarapacana* also identified.

Inter-American Tropical Tuna Commission (IATTC) catch data for *Mobula* from purse seine fisheries in the Eastern Pacific between 1998-2009 show a slow increase in landings to a peak in 2006 when >80t of *Mobula* were caught, followed by a steep decrease over three years until 2009, when the reported catch was 40t¹⁴.

In Puqi, Zhejiang Province in China, anecdotal reports from one processing plant indicate the processing of an estimated 1,000 kg of dried gill plates from *M. japanica* annually^{15,16}. These *Mobula* are landed at Chinese ports but reportedly are caught in the high seas.



A dried gill plate | Photo © Daniel Fernando

Atlantic Ocean

Liberia reported “*Mantas, devil rays nei*” catches of 2,507t to the FAO from 2000-2006 in the Eastern Central Atlantic, but have not reported landings in this category since 2006^{17,18}. Surveys carried out in Guinea recorded annual mobulid catch (predominantly *M. rochebrunei* and *M. thurstoni*) ranging from 3 to 18t per year between 2004 and 2009, with increases linked to expansion of fleet range to include waters off Sierra Leone and Liberia¹⁹. Recent observational surveys repeated in Guinea between 2014 and 2015 reveal that *Mobula* landings have declined since 2009¹⁸.

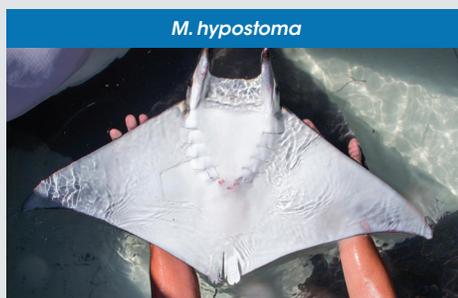
Indian Ocean

In India, *Mobula* catches have declined in several regions (including Kerala, along the Chennai and Tuticorin coasts and Mumbai) despite increased fishing effort, suggesting serial depletion^{1,20}. Fisheries surveys off Mumbai revealed maximum landings of 6.3t for “*M. diabolus*” (likely refers to *M. japanica* and/or *M. tarapacana* based on species occurrence in the region) in 1993-1995 surveys, dropping to 4.8t in 1996-1998, and then to 3.1t in 1999-2001 and 2002-2004²¹.

Sri Lankan fishers have reported declines in *Mobula* catches over the past five to ten years as targeted fishing pressure has increased^{22,23}. Anecdotal data reported by fishers and traders in 2014 indicate steep declines in mobulid landings compared to 2013, without any decrease in fishing pressure²². It is estimated that over 50,000 *Mobula* are landed annually in Sri Lanka, primarily *M. japanica* (86%) and *M. tarapacana* (12%)²⁴.

Mediterranean Sea

A new report²⁵ documents directed catch of *M. mobular* in Gaza, Palestine, with 370 recorded landed in 2013 and only 30 and 86 individuals in 2014 and 2015, respectively. Fishers report that *Mobula* are primarily used locally for their meat. However, investigations in 2013 have identified trade in gill plates for export to China²⁵, which could drive increased targeting of *M. mobular*.



M. hypostoma



M. japanica



M. kuhlii

Photos © Daniel Fernando

Morphological Similarities (look-alike species)

M. tarapacana, and particularly *M. japanica*, are often confused with other *Mobula* due to extremely similar morphology across species. These similarities have resulted in ambiguities in catch data, especially in light of overlapping distributions and the occurrence of fisheries for multiple species within the same locations.

These morphological similarities extend to the gill plates in trade. While an informed non-expert can visually identify *Manta* from *Mobula* gill plates, identification to species level is extremely

difficult. For example, *M. japanica* dried gill plates are similar in size and appearance to *M. thurstoni*. The bi-coloured gill plates, referred to as “flower gills”, are generally considered to be *M. tarapacana*, though recent investigations reveal that some gill plates from *M. thurstoni*, *M. kuhlii*, and *M. hypostoma* are also bi-coloured. During trade, gill plates are separated into *Manta*, *M. tarapacana* (including bi-coloured gill plates from other species), and *M. japanica* (likely also mixed with gill plates of similar species), however the trade name, “*peng yu sai*”, refers to all mobulid gill plates.

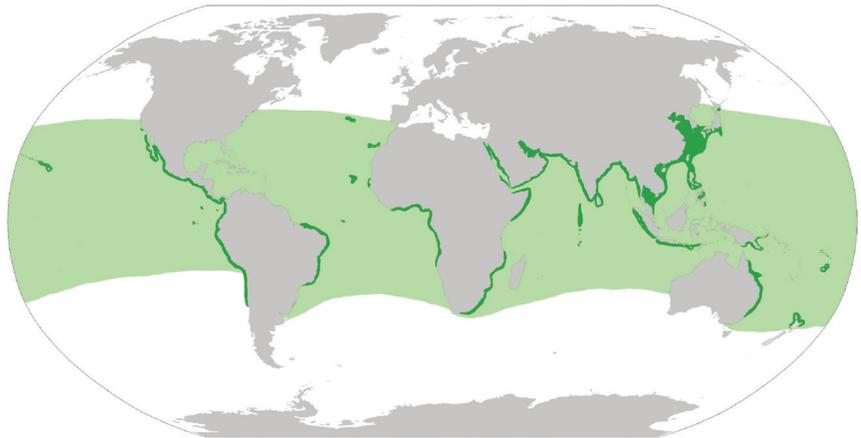
In Profile

Mobula japanica (Spinetail Devil Ray)

M. japanica is categorised by the International Union for Conservation of Nature (IUCN) on the Red List™ as Near Threatened globally and Vulnerable in Southeast Asia.



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M. japanica's probable range (light shading) and confirmed sightings (dark shading)

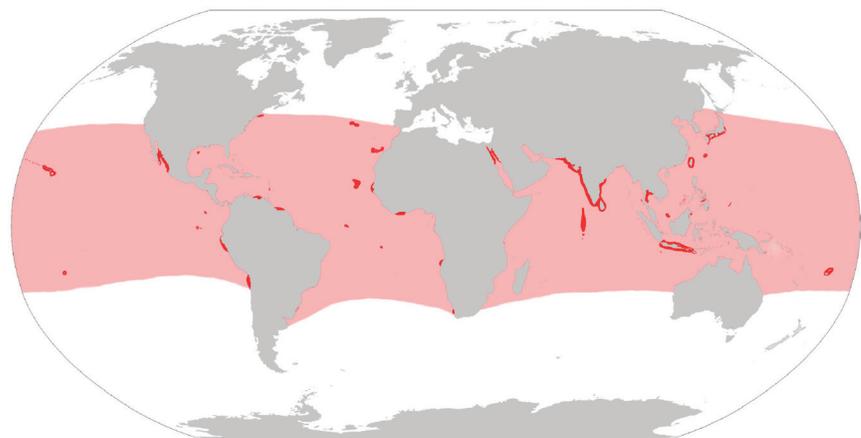
In Profile

Mobula tarapacana (Sicklefin Devil Ray)

The Sicklefin Devil Ray *M. tarapacana* is categorised by IUCN as Data Deficient globally and Vulnerable in Southeast Asia.



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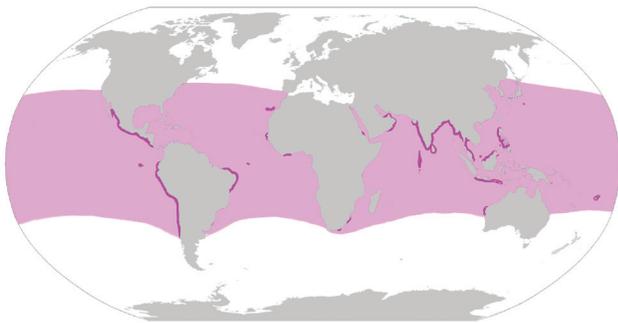


M. tarapacana's probable range (light shading) and confirmed sightings (dark shading)

Global Distribution

M. japanica and *M. tarapacana* have worldwide distributions, with each species reported from both the tropical and temperate waters of the Pacific, Atlantic, and Indian Oceans^{1,7,26,27}. Within this broad range, *M. japanica* and *M. tarapacana* populations are sparsely distributed and believed to be highly dispersed, likely due to their resource and habitat needs. Mobula rays may be encountered in both shallow inshore environments and deeper offshore waters²⁸⁻³⁰. There are significant overlaps in ranges for all *Mobula*. Region-specific threats are therefore likely to affect all species present, although decline data are only available for *M. tarapacana* and *M. japanica*.

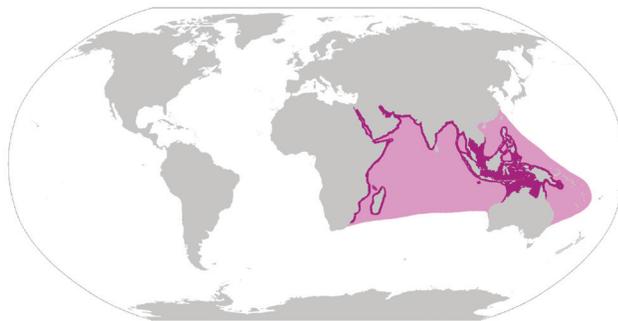
Morphological similarities among all *Mobula*, combined with overlapping global distributions, makes species-specific identification highly challenging.



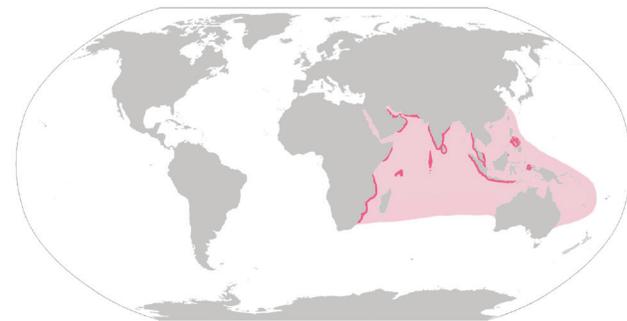
M. thurstoni



M. rochebrunei (in yellow), *M. hypostoma* (in orange), and *M. munkiana* (in brown)



M. eregoodootenkee



M. kuhlii



*M. mobular**

*Morphological similarities between *M. japanica* globally and *M. mobular* from the Mediterranean Sea, raise questions regarding the validity of these two separate species. Investigations are currently underway to determine validity of species and possible existence of an isolated subpopulation.

Light shading denotes respective species probable range while dark shading are confirmed sightings.

Key Threats

International Trade

Mobula are at great risk from strong and growing demand for their dried gill plates, which are exported to China for use in a health tonic purported to treat a wide variety of conditions^{1,15}.

Mobula are targeted for this trade by fishers from Indonesia^{6,31}, Malaysia^{25,32}, the Philippines³³, Sri Lanka²⁴, India^{34,35}, Myanmar³⁶, and Mozambique³⁷. Gill plate vendors in China also report China, Vietnam, Thailand, Japan, Africa, South America, the Middle East and Europe as mobulid gill plate source regions, suggesting additional targeted fisheries may exist in these regions¹⁶.

Recent surveys reveal an alarming escalation in Chinese demand for mobulid gill plates, with the estimated number of mobulids represented in Guangzhou, China markets more than doubling from early 2011 to late 2013¹⁶. The *Mobula* spp. most prevalent in these markets were *M. tarapacana* (~ 17,000 represented) and "other" *Mobula* spp. (~ 109,000 represented), of which the majority were believed to be *M. japanica*.

While mobulid meat is generally not highly valued in most parts of South Asia^{1,24}, small scale fisheries land *Mobula* for local consumption in the Philippines, West Africa, Mexico, Peru, Costa Rica and the Gaza Strip, and international trade of *Mobula* meat has been identified in several countries.

Fisheries

Mobula are killed or captured by a variety of fishing methods including harpooning, longlining, netting and trawling^{6,7,12,15,24}. Targeted fishing at critical habitats or aggregation sites, where these species can be caught in large numbers over a short time, is a serious threat¹, particularly as the low reproductive rates of these rays constrains their ability to recover from a depleted state. While *Mobula* might be legally protected in some regions, migrations into areas with unregulated fisheries put these species at risk.

Mobula rays are also incidentally caught in fisheries^{14,38,39} due to their presence in regions of high productivity that overlap with the ranges of tuna and other highly valued species^{1,7,40}. Mobulids were among the top 10 elasmobranch species identified by purse seine fisheries observers off Pacific Island countries and territories⁴¹. Estimated global bycatch in tuna purse seine fisheries is around 13,000 mobulids per year³⁹. Significant mobulid bycatch has also been documented from large-scale trawlers operating off the northwest African coast^{1,42}.

Gillnet fisheries take large numbers of mobulids as incidental catch in Indonesia, the Philippines, Mexico, India, the eastern and western coasts of Africa^{1,19}, and Sri Lanka²⁴. While highly susceptible to gillnets and purse seines, *Mobula* are also captured on longlines off Peru¹², Costa Rica⁴³, Malaysia³², the Gulf of Aden⁴⁴, and the SW Atlantic⁴⁵.



Mobula gill plates are left in the sun to dry in Sri Lanka (left), before the feather-like plates are exported for use in Chinese medicines. The bicoloured gill plates of the sicklefin devil ray (*Mobula tarapacana*) (right) are traded under the name 'flower gills'. | Photos © Daniel Fernando



Illegally traded manta ray gill plates seized by customs officials in Indonesia | Photo © Paul Hilton

Management Gaps

Sri Lanka, India, Peru, Indonesia and China account for an estimated 95% of the world's recorded *Mobula* catch¹⁵, yet have no national catch or trade controls and extremely limited monitoring of *Mobula* status and use.

Mobulid landings around the world are frequently not distinguished from other rays and species-specific details are rarely recorded. This most likely leads to under-estimation of declining trends in these species. Improved clarity in catch records and standardized reporting of mobulid bycatch by national fisheries and the Regional Fishery Management Organizations (RFMOs) is needed to provide a basis for monitoring. To date, the IATTC is the only RFMO that has taken measures to minimize mortality of *Mobula*. The 2015 IATTC agreement to prohibit retention and mandate safe release of manta and devil rays in the region represents a significant step forward, yet allows exceptions for unquantified *Mobula* mortality from small-scale fisheries in developing countries.

All species from the genus *Mobula* were added to Appendix I and II of CMS in 2014, designating them as migratory species at high risk of extinction. While Appendix II listing signals general agreement to cooperate toward regional conservation, Appendix I obligates Parties to strictly protect the species. CMS listing represents another key step in international recognition of *Mobula* vulnerability, though it is important to stress that most CMS Parties have yet to adopt national protections for *Mobula*, and that several top mobulid fishing and trading countries are not party to CMS.

Ecuador, Israel, the Maldives, Mexico, New Zealand, the Raja Ampat Regency in Indonesia, the US state of Florida and the territories of Guam and the Commonwealth of the Northern Mariana Islands restrict trade in *Mobula*¹⁵.

Some or all *Mobula* spp. are protected in Brazil, Croatia, Ecuador, Israel, the Maldives, Malta, Mexico, New Zealand, the US states/territories of Florida, Guam and the Commonwealth of the Northern Mariana Islands, and the Raja Ampat Regency in Indonesia. However, enforcement of landing and trade bans is often insufficient, and mobulids are still taken illegally in places such as Mexico⁴⁰.

Conclusion

Action on a global scale is urgently needed to safeguard vulnerable *M. japonica*, *M. tarapacana*, and other look-alike *Mobula* spp. from poorly controlled fisheries and international trade, driven largely by strong demand for gill plates.

A CITES Appendix II listing for all *Mobula* spp. would:

- bolster national and regional protections;
- complement CITES measures for *Manta* spp. and CMS listings for all mobulids;
- encourage sustainable international trade;
- help determine trends in population and use, and
- contribute to implementation of the UN FAO International Plan of Action for Conservation and Management of Sharks.



Left: *Mobula* meat at fish markets in Sri Lanka are among the lowest valued commodities, while dried gill plates destined for international markets are highly valued | Photo © Steve De Neef

Above: A sicklefin devil ray (*Mobula tarapacana*) at a fish landing site in Sri Lanka | Photo © Thomas P. Peschak

References

1. Couturier, L. I. E. *et al.* Biology, ecology and conservation of the Mobulidae. *J. Fish Biol.* **80**, 1075–1119 (2012).
2. Dulvy, N. K., Pardo, S. A., Simpfendorfer, C. A. & Carlson, J. K. Diagnosing the dangerous demography of manta rays using life history theory. *PeerJ* **2**, e400 (2014).
3. FAO. Report of the second technical consultation on the suitability of the CITES criteria for listing commercially-exploited aquatic species. *FAO Fish. Rep. No. 667. Rome, FAO.* **87** (2002).
4. Thorrold, S. R. *et al.* Extreme diving behaviour in devil rays links surface waters and the deep ocean. *Nat. Commun.* **5**, 1–7 (2014).
5. Francis, M. P. & Jones, E. G. Movement, depth distribution and survival of spinetail devilrays (*Mobula japonica*) tagged and released from purse-seine catches in New Zealand. *Aquat. Conserv. Mar. Freshw. Ecosyst.* (in review).
6. Lewis, S. A. *et al.* Assessing Indonesian manta and devil ray populations through historical landings and fishing community interviews. (in prep).
7. White, W. T., Giles, J. & Potter, I. C. Data on the bycatch fishery and reproductive biology of mobulid rays (Myliobatiformes) in Indonesia. *Fish. Res.* **82**, 65–73 (2006).
8. White, E. R., Myers, M. C., Flemming, J. M. & Baum, J. K. Shifting elasmobranch community assemblage at Cocos Island—an isolated marine protected area. *Conserv. Biol.* **00**, 1–12 (2015).
9. E. Herreño. pers. comm.
10. Llanos, J., Inga, C., Ordinola, E. & Rujel, J. Investigaciones biológico pesqueras en la región Tumbes, Perú. 1996 – 2005. *Inf. IMARPE* **37**, 95–112 (2010).
11. IMARPE. Boletín informativo pesquero Abril 2014 No. 9. *Inst. del Mar del Peru Lab. Costero Tumbes* (2014).
12. Avila, J. G. J. *et al.* The fishery for manta and devil rays in Northern Peru. (in prep).
13. Ayala, L., Alcántara, P., Pazo, Á., Olaya, V. & Ramos, H. *First assessment of mobulid rays fishery in Peru - a report by Asociación Peruana para La Conservación de la Naturaleza (APECO)*. (2015).

14. Hall, M. & Roman, M. Bycatch and non-tuna catch in the tropical tuna purse seine fisheries of the world. *FAO Fish. Aquac. Tech. Pap. No. 568. Rome, FAO.* 249 pp (2013).
15. Heinrichs, S., O'Malley, M. P., Medd, H. & Hilton, P. *The global threat to manta and mobula rays. Manta Ray Hope* (2011).
16. O'Malley, M. P., Townsend, K. A., Hilton, P. & Heinrichs, S. Characterization of the trade in manta and devil ray gill plates in China and Southeast Asia through trader surveys. *Aquat. Conserv. Mar. Freshw. Ecosyst.* (in review).
17. Mundy-Taylor, V. & Vicki, C. *Into the deep: Implementing CITES measures for commercially-valuable sharks and manta rays. A TRAFFIC report.* (2013).
18. FAO Fishstat. FAO Fishstat capture production database 1950-2013. (2015). at <<http://www.fao.org/fishery/statistics/global-capture-production/en>>
19. Doumbouya, F. Rapport sur l'actualisation des études sur les raies mantas en Guinée. *Cent. Natl. des Sci. Halieutiques Boussouira. Ministère la Pêche l'Aquaculture. Repub. Guinée.* (2009).
20. Mohanraj, G., Rajapackiam, S., Mohan, S., Batcha, H. & Gomathy, S. Status of elasmobranchs fishery in Chennai, India. *Asian Fish. Sci.* **22**, 359–855 (2009).
21. Raje, S. G. & Zacharia, P. U. Investigations on fishery and biology of nine species of rays in Mumbai waters. **56**, 95–101 (2009).
22. Fernando, D. pers. comm.
23. Anderson, R. C., Adam, M. S., Kitchen-Wheeler, A.-M. & Stevens, G. Extent and economic value of manta ray watching in Maldives. *Tour. Mar. Environ.* **7**, 15–27 (2011).
24. Fernando, D. & Stevens, G. A study of Sri Lanka's manta & mobula ray fishery. *Rep. Submitt. to Manta Ray Hope Proj. WildAid, Shark Savers.* 1–29 (2011).
25. Abudaya, M., Notarbartolo-di-Sciara, G. & Fernando, D. Directed fishery of the endangered Mediterranean Sea, giant devil ray (*Mobula mobular*) in Gaza. (in prep).
26. Clarke, S. C. *et al.* Global estimates of shark catches using trade records from commercial markets. *Ecol. Lett.* **9**, 1115–26 (2006).
27. Bustamante, C., Couturier, L. I. E. & Bennett, M. B. First record of *Mobula japanica* (Rajiformes: Myliobatidae) from the south-eastern Pacific Ocean. *Mar. Biodivers. Rec.* **5**, 1–4 (2012).
28. Dulvy, N. K. *et al.* You can swim but you can't hide: the global status and conservation of oceanic pelagic sharks and rays. *Aquat. Conserv. Mar. Freshw. Ecosyst.* **18**, 459–482 (2008).
29. Scacco, U., Consalvo, I. & Mostarda, E. First documented catch of the giant devil ray *Mobula mobular* (Chondrichthyes: Mobulidae) in the Adriatic Sea. *Mar. Biodivers. Rec.* **2**, 1–4 (2009).
30. Canese, S. *et al.* Diving behavior of the giant devil ray in the Mediterranean Sea. **14**, 171–176 (2011).
31. Dewar, H. & Ph, D. Preliminary report: manta harvest in Lamakera. 1–3 (2002).
32. Hochstetter, A. pers. comm.
33. Alava, M. N. R., Dolumbaló, E. R. Z., Yaptinchay, A. A. & Trono, R. B. *Fishery and trade of whale sharks and manta rays in the Bohol Sea, Philippines. WWF* (1997).
34. Fernando, D. & Mohanraj, T. The seasonal mobulid bycatch fishery in Therapuram and Tharuvaikulam, South India. (in prep).
35. Kizhakudan, S. J., Zacharia, P. U., Thomas, S., Vivekanandan, E. & Muktha, M. Guidance on National Plan of Action for Sharks in India. *C. Mar. Fish. Policy Ser. No. 2* 104p (2015).
36. Tilley, A. pers. comm.
37. Dent, F. & Clarke, S. State of the global market for shark products. *FAO Fish. Aquac. Tech. Pap. No. 590. Rome, FAO.* 196 (2015).
38. Romanov, E. V. Bycatch in the tuna purse-seine fisheries of the western Indian Ocean. *Fish. Bull.* **100**, 90–105 (2002).
39. Croll, D. A. *et al.* Vulnerabilities and fisheries impacts: the uncertain future of manta and devil rays. *Aquat. Conserv. Mar. Freshw. Ecosyst.* (2015).
40. Croll, D. *et al.* Movement and habitat use by the spine-tail devil ray in the Eastern Pacific Ocean. *Mar. Ecol. Prog. Ser.* **465**, 193–200 (2012).
41. Lack, M., Meere, F. & Sellack Pty Ltd. Pacific Islands Regional Plan of Action for Sharks: guidance for Pacific Island countries and territories on the conservation and management of sharks. 123 (2009).
42. Zeeberg, J., Corten, A. & de Graaf, E. Bycatch and release of pelagic megafauna in industrial trawler fisheries off Northwest Africa. *Fish. Res.* **78**, 186–195 (2006).
43. Dapp, D., Arauz, R., Spotila, J. R. & O'Connor, M. P. Impact of Costa Rican longline fishery on its bycatch of sharks, stingrays, bony fish and olive ridley turtles (*Lepidochelys olivacea*). *J. Exp. Mar. Bio. Ecol.* **448**, 228–239 (2013).
44. Bonfil, R. & Abdallah, M. Field identification guide to the sharks and rays of the Red Sea and Gulf of Aden. *FAO Species Identif. Guid. Fish. Purp. Rome, FAO* 71 (2004).
45. Mas, F., Forselledo, R. & Domingo, A. Mobulid ray by-catch in longline fisheries in the south-western Atlantic Ocean. *Mar. Freshw. Res.* (2015). at <<http://dx.doi.org/10.1071/MF14180>>

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Contact: Isabel Ender (*Head of Conservation*) **Email:** isabel@mantatrust.org

The Manta Trust takes a multidisciplinary approach to the worldwide conservation of manta and mobula rays and their habitat through robust science and research, while raising awareness and providing education to the general public and community stakeholders alike.