IMPACTS, ALTERNATIVE SOLUTIONS AND AWARENESS OF MOBULA FISHERIES IN INDONESIA

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CONSERVATION LEADERSHIP PROGRAMME

The Mobula Project INDONESIA

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Project Partners & Collaborators

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SECTION 1

Summary

Great concern is raised concerning the vulnerability of mobula rays to overfishing in Indonesia, due to the increasing demand for mobulid gill plates in the Chinese medicine market. Stakeholders are often unaware of the similar threats posed to mobulids and of the value of mobulas alive. Through fishing market surveys and interviews, the project provided urgently needed information on mobula rays in Indonesia to support conservation at a national level by (1) providing life-history parameter estimates to assess vulnerability posed by fisheries, (2) providing information on species-specific abundance and aggregation sites, and (3) raising stakeholder awareness of the problem while exploring solutions reduce mobula fisheries. Implementation of a national mobula ray protection has been recommended to the Government of Indonesia, due to slow growth and late maturity of mobulas, current fishing of pregnant females and juveniles, and relatively low value of mobula rays at fishing markets relative to other taxa. An education outreach program was conducted in schools of local communities, raising awareness in the future generation. Prior to and since the recent listing of mobula on Appendix II of CITES, results from the project have fueled ongoing discussions towards the implementation of adequate legislation measures in Indonesia.

Introduction

Mobulid rays (mantas and mobulas) are caught in target and bycatch fisheries in Indonesia, mainly for export of their gill plates as a product in the 'traditional' Chinese Medicine and dried seafood markets (Dewar, 2002; Heinrichs et al., 2011). The exportation of mobula parts (primarily gills) from Indonesia and other countries poses threats for population sustainability. The volume of gill plates sold between 2011 and 2013 was multiplied by +107% for *Mobula tarapacana* and by +204% for *Mobula japanica* (O'Malley et al., 2016). Four mobula species have been recorded in drift gillnet landings: *Mobula japanica*, *Mobula tarapacana*, *Mobula thurstoni* and *Mobula kuhlii*. Based on research conducted in Indonesia (White et al., 2006; Heinrichs et al., 2011; Dharmadi & Fahmi 2014; Lewis et al., 2015) and based on data reported to the FAO, 2013, there is evidence of declining trend in fisheries for mobula rays in Indonesia. More concerning is the fact that 96% of gills recorded in the Chinese market from 2011 to 2013 were from mobula species, while 4% belonged to Manta spp. (O'Malley et al., 2016).

Mobulids are considered vulnerable to overfishing because they possess long reproductive cycles, low fecundity, and late maturation (Notarbartolo-di Sciara, 1988; Dulvv et al., 2014). Due to the growing concern for population sustainability, and the high value of live manta rays for the Indonesia's tourism industry, a policy protecting manta rays at a national level was adopted in 2014. However, mobula rays do not currently benefit from any national protection, and have only recently been added to Appendix II of CITES (CoP17, 2016). Efforts are needed to assess life history parameters, distribution patterns and fishery trends of mobula species to understand the impact of exploitation and to provide recommendations for policy change (Couturier et al. 2012). The market value of gills acts as a strong incentive to land mobulas (O'Malley et al., 2016), and alternative income from these animals through ecotourism, has generally not been exploited in Indonesia, although it provides an important source of income to the Azores, where *Mobula tarapacana* aggregate seasonally (~8M USD derived from combined mobula and blue shark ecotourism per year) (Ressureicao, pers. comm.).

In an effort to gather important species-specific biological and ecological information on mobula rays, our project focused on key artisanal fishing sites in Indonesia (**fig. 1**): Muncar, Tanjung Luar and Lamakera.

Each of these sites possesses tremendous biological diversity, as being part of the coral triangle, and because they harbor at least three mobula species, including another two potential species previously recorded in Indonesia. This project was undertaken in partnership with the Manta Trust, a UK based charity that works worldwide to study mobulid rays and promote conservation through research and education. We also partnered with MantaWatch, who primarily organizes internships for Indonesian students to learn about manta rays in Komodo through photo-identification techniques.

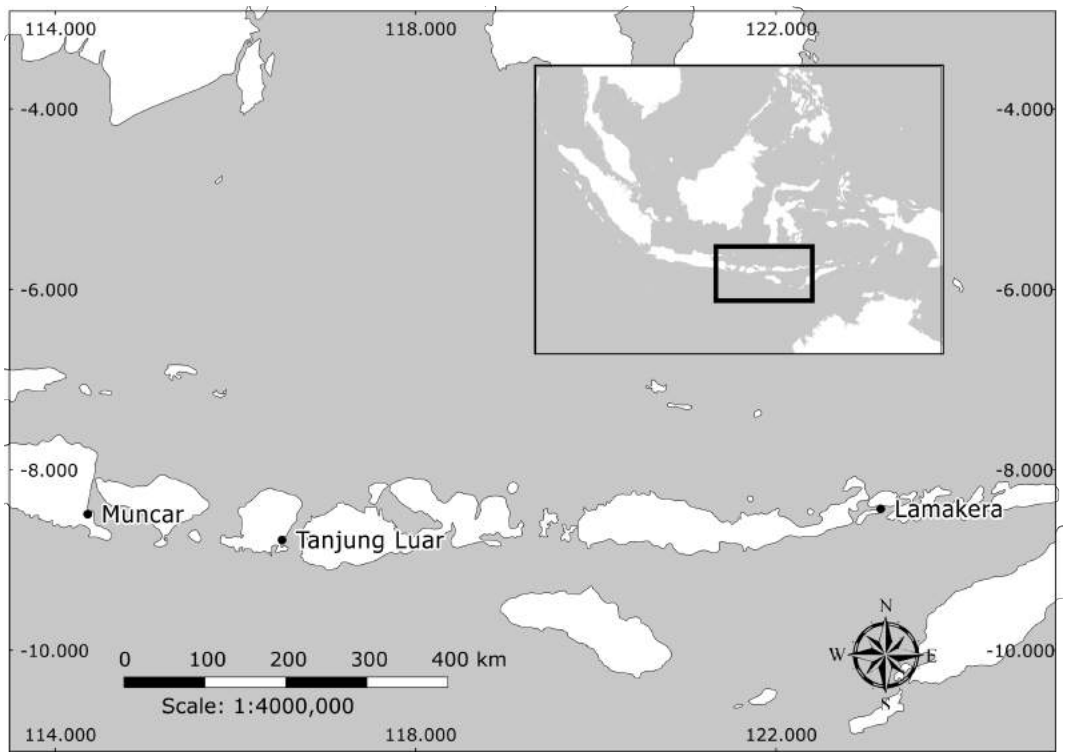


Fig. 1: Study locations: Muncar (East Java regency), Tanjung Luar (West Nusa Tenggara regency), and Lamakera (East Nusa Tenggara regency).

Project members

Betty Laglbauer (Project leader)

Betty is a French/ English Marine Biodiversity and Conservation MSc. graduate and founder of the Mobula Project Indonesia, a research, conservation and education project focusing on mobulid ray fisheries. Betty gained experience in mobulid fishing ports in South America and Southeast Asia, and has worked on a mobula ray feeding ecology project in the Azores. Her role is to lead and train the team, manage the project, prepare protocols, perform laboratory work, data analysis and drive policy change through communication of findings with the Government and other stakeholders, in collaboration with The Manta Trust. Betty is about to start a PhD for which she will receive a full scholarship at the University of the Azores in collaboration with The University of Queensland to study mobula ray and blue shark sensory biology and feeding ecology to inform bycatch reduction measures.

Vidlia Putri Rosady

Vidlia is an Indonesian biologist who recently graduated from the Marine Sciences BSc. Program at Padjajaran University. Vidlia studied mobulid rays in the Komodo National Park during an internship with MantaWatch in 2013, returning to Komodo as a mentor for new interns on a yearly basis. There, she was trained in mobulid biology and ecology theory, manta ray photo-identification methods, and she partook in the organization of education outreach activities. Vidlia has two years' experience as an assistant for swimming, diving and coral subjects during her Marine Science major. Vidlia started the project as Education Outreach Leader, creating materials for school children and organizing outreach activities in our study locations, while participating in field research (fishery surveys, sample collection, conducting interviews), laboratory work, data compilation, workshop organization. She is now taking on the role of project co-leader, with shared responsibilities of project management, field work, data analysis, new team member training, and stakeholder liaison.

Anindita Rustandi

Anindita is an Indonesian MSc. Student at Victoria University of Wellington (New Zealand) since 2016. Anindita joined the Mobula Project Indonesia as a co-leader after graduating from a BSc. in Marine Sciences at Padjajaran University. Anindita was selected by the YSEALI program to take part in a one-month internship in the USA in 2015, where she gained leadership training relevant to the project. After gaining experience in mobulid research and conservation through the MantaWatch internship in Komodo, Anindita worked as stakeholder liaison officer for the program. Previously, Anindita completed an internship in Wakatobi National Park in Indonesia. Her roles in the project have included project planning, education outreach, field work (fishery surveys, sample collection, conducting interviews), laboratory work, and data compilation.

Fritzgerald WY Wenur

Gerald is currently a BSc. Student at the University of Indonesia in Jakarta. He completed his thesis on manta ray distribution trends in the Komodo National Park, as a follow-up to his participation in the MantaWatch Internship program. Gerald worked as a tutor (in biology) and as a mentor to expat students for a private school which conducts ecotourism projects in Jabodetabek (Jakarta, Bogor, Depok, Tangerang, Bekasi). Through these experiences, Gerald gained an ease in public speaking which he applied to lead education outreach activities and presentations to the Indonesian Government during our project. His roles have also included project preparation, field work (fishery surveys, sample collection, conducting interviews), laboratory work and data compilation.

SECTION 2

Aim and objectives

Project aim

The project aims to initiate conservation of mobula rays in Indonesia by initiating the implementation of appropriate management, and providing urgently needed information on the genus. The purpose of the project was to produce valuable information to assess vulnerability of the genus to Indonesian fisheries, information on species-specific abundance of mobulas at key landing sites, a map of mobula main aggregation sites, and increased awareness of mobula biology, ecology and conservation through increased communication gradually inspiring long-term changes in the behavior of stakeholders on a local and national level.

Project objectives

1. Determine life-history parameters of mobula species to assess their vulnerability to target and by-catch fisheries in Indonesia by estimating species-specific extinction risk;
2. Determine the habitat use (abundance and aggregation sites) of mobulas in East Java, West and East Nusa Tenggara to target conservation measures;
3. Develop an educational program to raise the awareness of stakeholders about the importance of conserving mobulas for long-term sustainability and identify alternative solutions to reduce target and by- catch mobula fisheries.

Changes to original project plan

Within objective 2, fishing market surveys were extended to a site in East Java. The photo-database expected to provide information on location of aggregation sites outside of fishing zones did not attain the desired number of photo entries (50 by the end of the project). Hence, further efforts will be put into obtaining sightings from other parts of Indonesia through the collaborations established during this project and through communication with new dive site collaborators.

Within objective 3, the education outreach and workshops with fishermen were cancelled in Lamakera due to instability in that location associated with enforcement of the national manta ray protection policy, and the arrest of a middleman. Only limited data could be collected in that location, such that no photos of landings or morphometric measurements were collected as these endeavors were not welcomed by fishermen.

Methodology

<u>Objective 1:</u> Life history parameter estimation

Vertebrae centra from the tail base of 45 *Mobula japanica*, 15 *Mobula thurstoni*, and 5 *Mobula tarapacana*, were embedded into resin, sectioned (0.35 mm-wide) on the sagittal plane using a low-speed diamond-blade saw, and imaged under transmitted light microscope (Leica). Centrum edge was measured with Image-J. Two readers independently counted annuli (translucent and opaque band pairs) on centra twice. We estimated reader bias through Wilcoxon matched-pairs signed rank tests (deVries & Frie 1996), and precision as percent reader agreement (percentage number of equal reader counts, from total samples aged) (Goldman, 2005). Six models were fitted to disc width-at-age data, using non-linear sum-of-squares in R: three-parametric (VB3) von Bertalanffy growth function (von Bertalanffy, 1938, 1957; Fabens, 1965), three parametric (GOM3) Gompertz model (Ricker, 1975, 1979), and three parametric (LOGI3) logistic model (Ricker, 1979) and their two-parametric versions. Akaike's (1973) Information Criterion (AIC = $n\ln(\sigma^2) + 2p$), where n is the sample size, σ is the residual sum of squares divided by n, and p is the number of variables, was adjusted for small-sample sizes (AICc) (Harry et al., 2011).

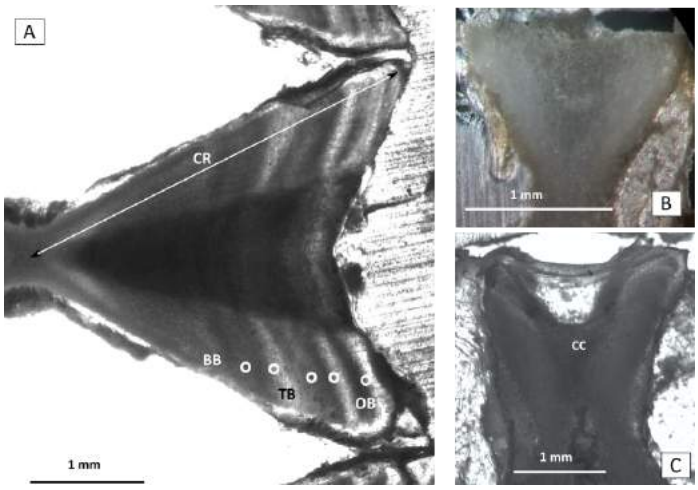


Fig. 2: Caudal vertebrae sections of **(A)** *Mobula japanica* displaying five growth bands, **(B)** *M. japanica* fetus (no growth band), and **(C)** *M. tarapacana* female (DW = 2910 mm). Sections are viewed under transmitted light. BB: birth band; TB: translucent band, OB: opaque band, CR: centrum radius, CC: corpus calcareum.

<u>Objective 2:</u> Mobula abundance and aggregation sites

Market surveys

Mobula disc-width (mm), disc-length (mm), weight (kg), sex, and external maturity evidence of maturity was collected at fishing ports in Tanjung Luar, Muncar, and Lamakera. Mobula landings were expressed in number of individuals per week. Differences in the proportion of species between sites were assessed using Z-tests. Differences in the proportion of males and females in each species were assessed in a binomial test, with 0.5 as the expected proportion for equal occurrence of males and females.

Fishermen interviews

After a mobula-ID introduction, at total of 37 Interviews were carried out with fishermen in Tanjung Luar and Muncar. A total of 47 questions focused on (1) social background, (2) spatio-temporal trends in mobula fisheries, and (3) alternatives to mobula fisheries. Responses were described in terms of percentage respondents per QCM answer, while open-ended quantitative questions were analyzed using descriptive statistics.

***Objective 3:* Awareness and alternative solutions**

Education awareness

Education awareness materials were designed and targeted to different age groups: a booklet for primary school children (in annex) and a leaflet for secondary school and above (in annex). A 1-hour session was conducted in a classroom in the presence of the teacher. First, a short presentation about mobulid rays was given including key facts, threats and conservation needs, followed by a short video to showcase mobulas in their natural environment, followed by a quiz and the distribution of stickers from the project and a snack. Booklets distributed to children contained a story with a mobula ray as the main protagonist, who is caught by a gillnet and further released. Key facts about mobula rays are provided as well as a coloring page. The leaflet contained a summary of mobula biology, ecology, threats and conservation needs, an infographic of the mobulid ray supply chain from Indonesia to the Chinese market, and a short comic portraying fishermen thinking of alternative solutions to mobulid/ shark fisheries.

Workshops

Workshops were conducted with two groups of stakeholders: (1) fishermen at fishing ports, (2) governmental and non-governmental organizations (NGOs). Fishermen were given mobula identification training prior to interviews in small groups (Tanjung Luar) or individually (Muncar). Official workshops were also conducted with governmental and NGOs to present data collected during the project, and to initiate open discussions to incentivize voting in favor of the addition of mobulas to Appendix II of CITES, while promoting policy change at a national level.

Outputs and Results

<u>Objective 1:</u> Life history parameter estimation

A linear relationship between centrum radius (mm) and disc width (mm) provided the basis for age estimations in *M. japanica* and *M. thurstoni* (**fig. 3**). Percent reader agreement between growth band count estimates (in annex) are presented in **figure 4**. Due to small sample size in *M. thurstoni*, growth modelling was only applied to *M. japanica*.

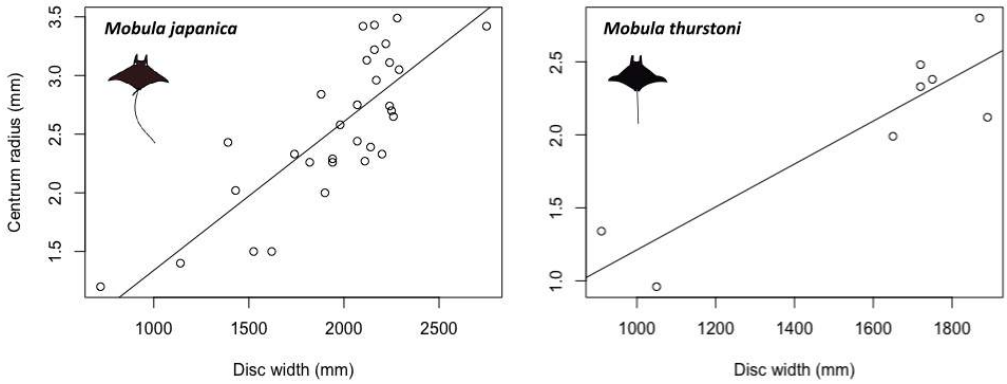


Fig. 3: Relationship between centrum radius (mm) and disc width (mm) in *Mobula japanica* (left panel, n = 30) and *Mobula thurstoni* (right panel, n = 8) from Indonesia. The full line represents the linear regression model.

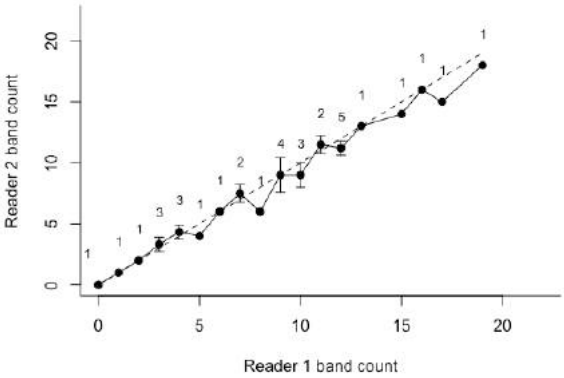


Fig. 4: Between reader age bias plot for *Mobula japanica* from Indonesia. Line representing hypothetical equal growth band counts between readers (--). Vertical error bars represent the two standard errors.

Maturity

Considering only those individuals for which maturity stage could be recorded, the youngest estimated age for a mature *Mobula japanica* male was 6 annuli (DW = 2070 mm), while the oldest juvenile male (non-calcified claspers) displayed 7 annuli (DW = 2160 mm). Estimated DW at maturity for 50% of *Mobula japanica* males, DW_{50} (± 95% C.I.) was 2042.68 (1943.18-2153.23) mm (n = 15) (**fig. 5**). Estimated

age at maturity, A_{50} (± 95% C.I.) was 6.06 (3.98-8.48) years for *Mobula japanica* males (n = 8) (**fig. 5**). Given that maturation could not be confirmed through the dissection of female gonads, females were considered mature only if they were found pregnant. According to this criterion, the youngest estimated age for a mature female *Mobula japanica* was 12 annuli (DW = 2290 mm). The youngest estimated age for a mature *Mobula thurstoni* male was 9 annuli (DW = 1720 mm), although this represented the only aged male of the species. The youngest estimated age for a mature *Mobula thurstoni* female was 7 annuli (DW = 1870 mm).

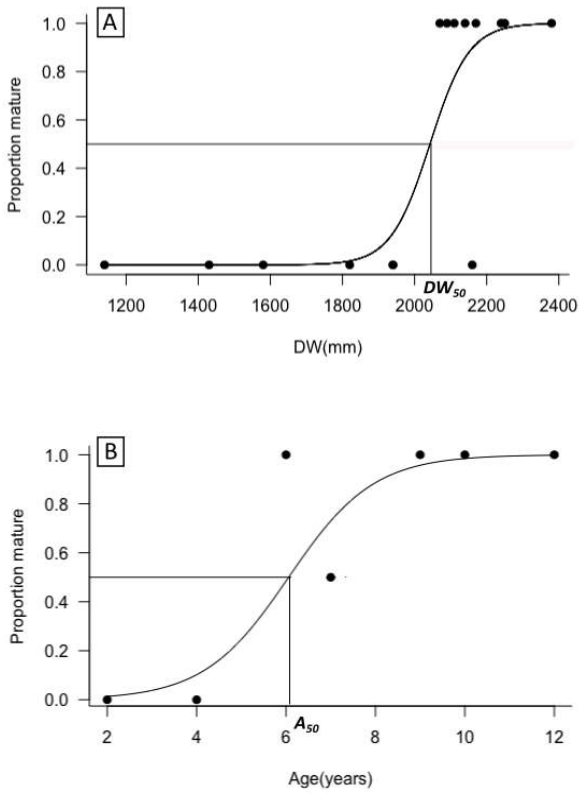


Fig. 5: Estimated disc width (DW) at maturity (DW_{50}) and age at maturity (A_{50}) for *Mobula japanica* males landed in Muncar.

Growth rate

When combining both sexes (n = 25), the best-fit model for *Mobula japanica* disc width-at-age post-natal data was the two-parametric Gompertz model (GOM2), according to the AICc value (**table 1**). The model estimated a maximum disc width (DW_∞ 95% C.I.) of 2349 (2234-2512) mm and a growth rate (k 95% C.I.) of 0.28 (0.22-0.37) $year^{-1}$ (**fig. 6-A**). When considering only female disc width-at-age post-natal data (n = 15), the best-fit model was found to be the two-parametric von Bertalanffy model (VB2), which estimated a maximum disc width (DW_∞ 95% C.I.) of 2524 (2296-3071) mm and a growth rate (k 95% C.I.) equal to 0.15 (0.09-0.24) $year^{-1}$ (**table 1, fig. 6-B**). For males' only post-natal disc width-at-age data (n = 9), the best-fit model was the three-parametric logistic model (LOGI3), which estimated a maximum disc width (DW_∞ 95% C.I.) of 2287 (2173-2456) mm, a size at DW_0 (95% C.I.) of 1103 (965-1225) mm and a growth rate (k 95%

C.I.) equal to 0.37 (0.26-0.50) year^{-1} (**table 1, fig. 6-C**). Growth was not modeled for *Mobula thurstoni* given the small sample size of readable vertebrae (n = 5).

Table 1: Growth model parameters for post-natal *Mobula japanica* for individuals of both sexes combined (n =25), only females (n = 15), and only males (n = 10), from Indonesia, excluding pre-natal individuals. AICc: Akaike's Information Criterion corrected for small sample size; Δ: Akaike score; ω: Akaike weighting; RSE: the residual standard error; DW_∞: mean disc width at age infinity; DW_0: mean disc width at age zero, fixed at 957 mm for the two-parametric models. CI is the confidence interval determined by bootstrapping (10000 iterations). DW_{inf} and DW_0 are expressed in millimeters. The VB3 model did not converge for female data, so multi-model analysis was computed for the five remaining models.

Model	AICc	Δ	ω	RSE	DW_∞ (95% CI)	DW_0 (95% CI)	k (95% CI)
Both sexes							
VB3	334.1	3.2	8.24	168.4	2430 (2262-2800)	954.1 (715.9-1199.0)	0.19 (0.10-0.29)
VB2	336.0	5.1	20.35	165.3	2413 (2263-2653)	*NA*	0.20 (0.14-0.28)
GOM3	333.5	2.6	11.09	166.4	2369 (2239-2607)	970.2 (757.5-1204.0)	0.26 (0.17-0.38)
GOM2	**330.9**	**0.0**	**25.05**	**163.9**	**2349 (2234-2512)**	***NA***	**0.28 (0.22-0.37)**
LOGI3	333.3	2.4	12.09	165.8	2333 (2221-2527)	991.2 (792.2-1206.0)	0.33 (0.22-0.47)
LOGI2	331.1	0.2	23.19	164.4	2310 (2211-2441	*NA*	0.38 (0.31-0.48)
Females							
VB3	203.6	3.3	9.51	170.4	2563 (2274-4482)	1015 (242-1400)	0.13 (0.03-0.33)
VB2	**200.3**	**0.0**	**25.22**	**163.9**	**2524 (2296-3071)**	***NA***	**0.15 (0.09-0.24)**
GOM3	203.4	3.1	10.50	169.2	2503 (2255-3828)	1081 (575-1422)	0.18 (0.06-0.43)
GOM2	200.4	0.1	23.83	164.6	2432 (2265-2744)	*NA*	0.21 (0.15-0.33)
LOGI3	203.2	2.9	22.40	168.3	2462 (2245-3548)	1126 (725-1469)	0.22 (0.08-0.48)
LOGI2	200.8	0.5	19.54	166.8	2377 (2238-2623)	*NA*	0.29 (0.21-0.41)
Males							
VB3	129.1	1.6	13.40	101.10	2377 (2222-2673)	1097 (957-1235)	0.21 (0.14-0.33)
VB2	128.2	0.7	9.50	108.20	2336 (2181-2598)	*NA*	0.26 (0.17-0.38)
GOM3	128.2	0.7	21.11	96.62	2323 (2193-2544)	1098 (957-1226)	0.29 (0.20-0.40)
GOM2	127.7	0.2	12.52	105.20	2285 (2155-2458)	*NA*	0.35 (0.25-0.48)
LOGI3	**127.5**	**0.0**	**29.73**	**93.37**	**2287 (2173-2456)**	**1103 (965-1225)**	**0.37 (0.26-0.50)**
LOGI2	127.6	0.1	13.74	104.30	2250 (2140-2389)	*NA*	0.45 (0.36-0.60)

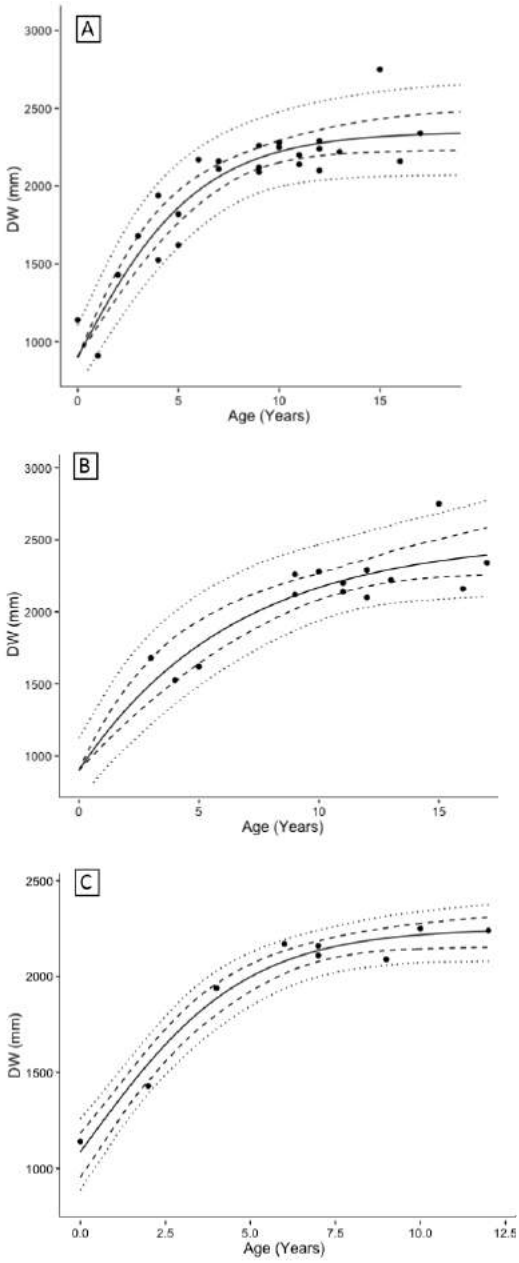


Fig. 6: (A): The two-parametric Gompertz model (GOM2), best-fit model, fitted to the disc width-at-age data (continuous line), for both sexes of *Mobula japanica* from Indonesia (n = 25). (**B):** the two-parametric von Bertalanffy growth model (VB2), best-fit model for *Mobula japanica* post-natal females (n = 15) Plots represent: 95% confidence intervals (---), 95% prediction intervals (…) and raw data (points). **(C):** the three-parametric logistic model (LOGI3) fitted to post-natal *Mobula japanica* males (n = 10).

<u>Objective 2:</u> Mobula abundance and aggregation sites

Species-specific abundance

Taking into account only the specimens for which sex could be identified, the sex ratio of *Mobula japanica* was significantly different from equal proportions (N = 42, p = 0.28), with females representing 59.5% of the sample and males representing 40.5%. The sex ratio of *Mobula thurstoni* was also significantly different from equal proportions (N = 14, p = 0.42), with females representing 64.3% of the sample and

males representing 35.7%. All *Mobula tarapacana* specimens were females. Proportion of mobulas recorded and their average disc width during 2015 surveys is presented in **figure 7**. In Muncar, the female maturity stage varied as a function of species, with juvenile and mature (non-pregnant) females representing most of the *Mobula japanica* sample, while pregnant females were the most abundant category of females in *Mobula thurstoni* (**fig. 7**). Although no *Mobula tarapacana* fetuses or pregnant females were found, at least one of the specimen present was likely a juvenile due to their relatively small disc width (194 cm), which was much smaller to the estimated size at maturity of 270-280 cm disc width (Notarbartolo-di-Sciara, 1988). The proportion of each mobula species landed in Muncar was similar in October 2015 and 2016, although it differed in November 2015 and 2016 (**fig. 8**), with only *M. japanica* landed in the latter year. No mobula landings were recorded in December 2016, which was explained by fishermen as due to "exceptional environmental conditions this year with lower amounts of productivity and small fish in the area", and "bad weather leading to fewer boat trips". In Tanjung Luar fishermen-perceived mobula abundance seasonality is shown in **fig. 9.** Key fishery characteristics and spatio-temporal trends are reported in **boxes A** and **B**.

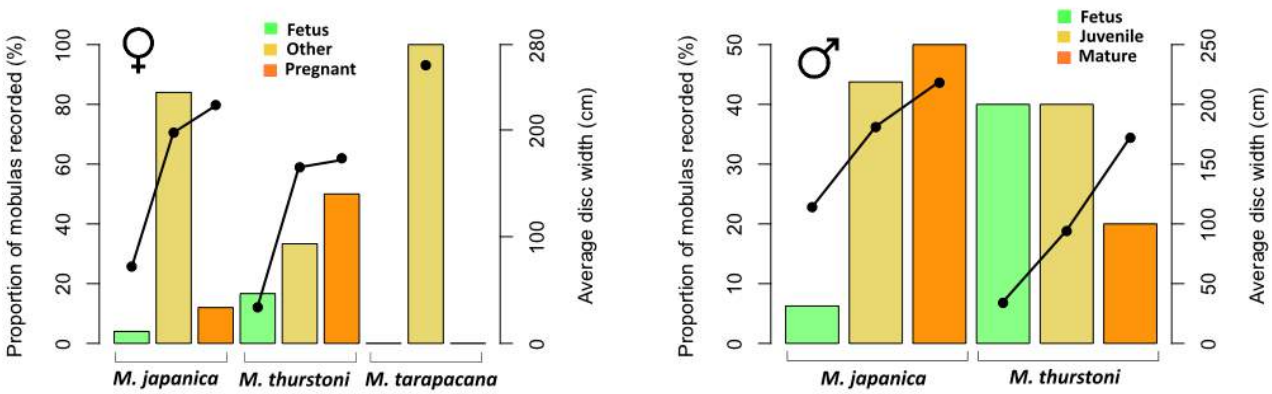
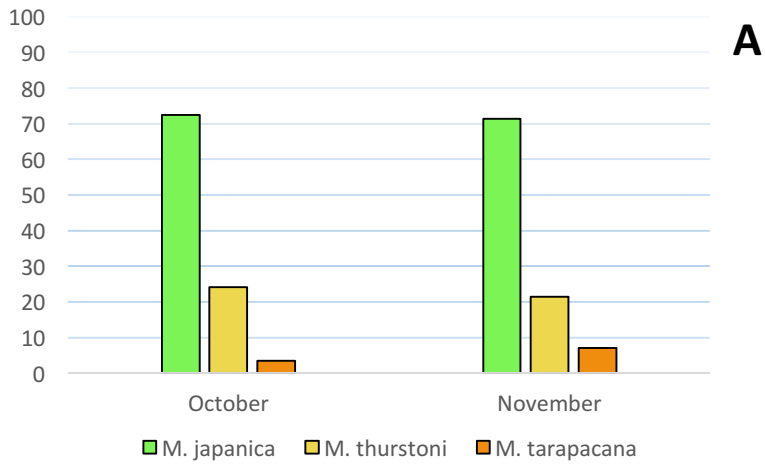


Fig. 7: Bar plots representing the proportion (%) of fetuses, pregnant, and other maturity stage (juvenile or mature) females (left panel), and the proportion (%) of fetuses, juveniles, and mature males (right panel) recorded in Muncar. Points represent the average disc width (cm) for each maturity category.



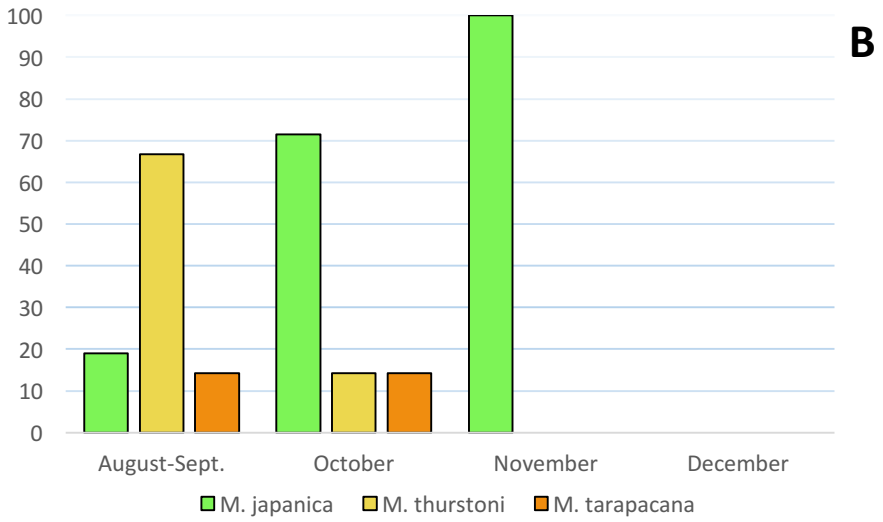


Fig. 8: Top panel (A): Bar plots representing the proportion (%) of each mobula species landed in Muncar fishing market in 2015 surveys, and **lower panel (B):** during 2016 surveys.

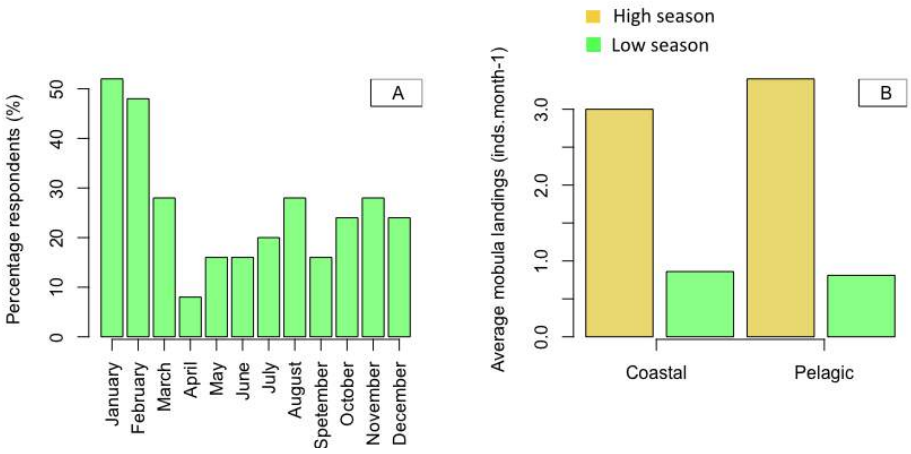


Fig. 9: Mobula landings seasonality, as perceived by fishermen in Tanjung Luar. **Left panel (A)**: barplots representing the percentage of respondents considering the given month is part of the high season for mobula landings. **Right panel (B)**: barplot representing the average mobula landings during the high (yellow), and the low (green) season.

Drift gillnet Muncar

1 day trip, mainly night
Boat ~ 7.5 m (2 GT), ~ 16 L fuel per trip
Year round, fluctuating
Main target: large teleosts (billfishes, tuna, cod, mahi-mahi)
Net soak 4 hours, twice

- ***"Do you notice any trend in mobula abundance over the past 3 and 10 years?"***
  100% answered "Yes" in both cases
- ***"Have your fishing grounds changed over the past 3 and 10 years?"***
  83.3% "Yes" over 3 years, 100% "Yes" over 10 years
  Comment: "I have to go out further to fish mobulas than before, from ~ 4 to 7 nm."
- Market price in Muncar: Small mobula 10.000 IDR/ Kg
  Large mobula 6.000-7.000 IDR/ Kg

Box A: Summary of fishery characteristics and fishery trends as reported by fishermen during interviews in Muncar.

Lombok pelagic fishery

~ 16 day trip (mainly daytime)
Boat ~ 15.5 m, ~ 303 L/ trip (19 L/ day)
Mobula landings: fluctuating
Main target: sharks

"Do you notice any trend in mobula abundance over the past 10 years?"
47.6% answered "Yes, decreasing"

"Have your fishing grounds changed over the past 3 and 10 years?"
83.3% "Yes" over 3 years, 100% "Yes" over 10 years

Lombok coastal fishery

1 day trip (mainly at night)
Boat ~ 6 m, ~ 16 L fuel/ trip
Mobula landings: fluctuating
Main target: small to medium size teleosts (such as tuna)

Box B: Summary of fishery characteristics and fishery trends as reported by fishermen during interviews in Tanjung Luar.

Aggregation sites

Aggregation sites that correspond to fishing grounds for gillnetters from Muncar were determined through fishermen interviews are presented on **figure 10**, which has been adapted from the base map created by the Ministry of Fisheries and marine Affairs of Indonesia. These represent main fishing grounds, hence fishermen do occasionally fish in areas outside this zone, for example further North in the Bali Strait (eg. around zone 1). Productivity is likely to be a key driver in mobula at aggregation at sites around Muncar, as inferred from mean chlorophyll-*a* concentration (Chl-a, in mg/m^3), and mean sea surface temperature (SST, °C) measured by Aqua MODIS, for the period of sample collection in Muncar (October 15th to October 31st and from November 1st to November 6th 2015), with relatively higher productivity that surrounding areas associated with the El Nino Southern Oscillation phenomenon of late 2015 (**fig. 11**).

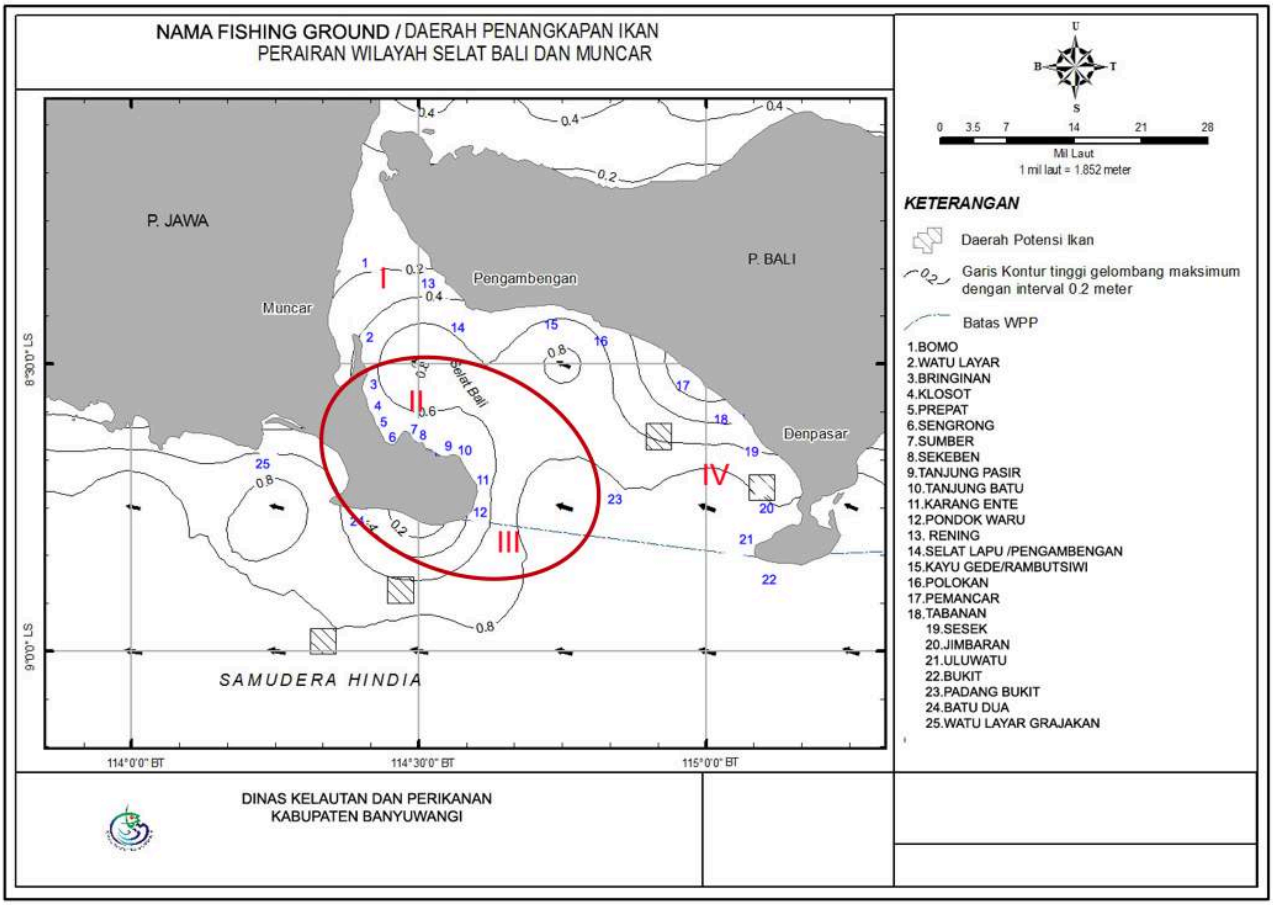


Fig. 10: Ministry of Fisheries recognized fishing grounds in the Bali strait, with mobula ray fishing grounds for Muncar fishermen circled in red, as per interviews conducted in December 2016.

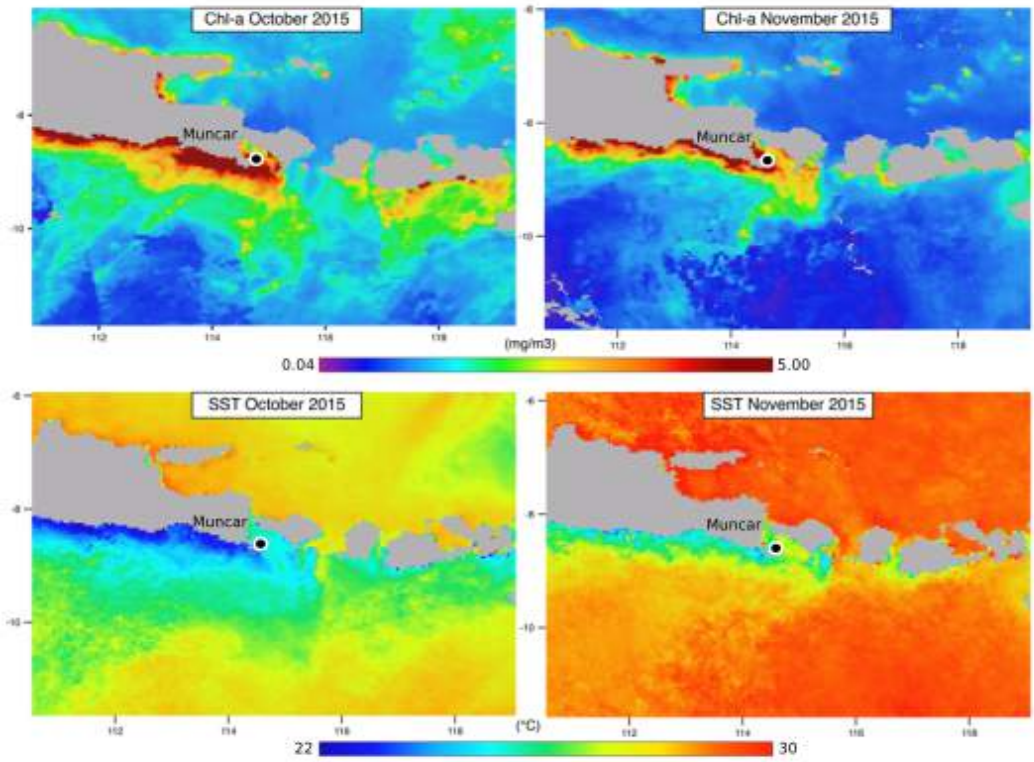


Fig.11: Indication of upwelling/ productivity gradients as inferred from mean chlorophyll-*a* concentration (Chl-a, in mg/m^3), and mean sea surface temperature (SST, °C) measured by Aqua MODIS (http://oceanwatch.pfeg.noaa.gov), for the period of sample collection in Muncar (October 15th to October 31st and from November 1st to November 6th 2015). The black circles represent the main mobula ray fishing ground in proximity of Muncar, where mobula rays used in the mixing model were landed.

***Objective 3:* Awareness and alternative solutions**

Education awareness

A total of 364 school children were reached through our project outreach activities. We reached 210 school children at two schools in Tanjung Luar, which gave more than 90% correct answer at oral quiz of students gave correct answers during quiz (the remaining 10% gave incomplete not incorrect answers) (**fig. 12**). Additionally, we reached 154 students (60 primary school students across 3 sessions and 94 11th graders) in Labuan Bajo during outreach in collaboration with MantaWatch interns. Primary school students answered correctly to the quiz 83% of the time in the first session (4th graders), 39% of the time in the second session (4th graders), and 100% of the time in the time in the third session (5th graders). The difficulty encountered by 4th graders in the second session was in a questions concerning the diet of mobulids, as they did not include plankton in the answer. Due to their young age and the novelty of plankton for these children, the question was likely too difficult for their age-group (and had not been included in the quiz at the first session). During the session with secondary school students, instead of a quiz with one possible correct response, students were encouraged to share opinions about what they had learnt concerning mobula threats and value, such as '*Why we should take care of Mobulids instead of killing/fishing them?*' and '*Why are mobulids valuable when they are kept alive?*'. Students provided rich and encouraging responses to these questions, which demonstrates the effectiveness of the outreach sessions as qualitative measure.

Fig. 12: Tanjung Luar education outreach, 14th & 15th August 2015.

Potential solutions

Combined information from fishermen training/ interviews and policy workshops:

Interviews conducted with fishermen (**fig. 13**), along with other data from the project provided information on potential alternative ways to reduce mobula ray landings, which were further discussed at workshops with the government. Three major workshops, on April 13th 2016, on April 22nd (pre-CITES workshops) and on January 5th 2017 were conducted at the Ministry of Fisheries and Marine Affairs in Jakarta, with attendees from various key organizations (**fig. 14**), while meetings with individual governmental and non-governmental organizations took place throughout the project. The first and second workshops were aimed at introducing research that had been conducted previously in Indonesia and Worldwide, including by our project, to ask the Indonesian Government to support the addition of mobula rays to Appendix II of CITES (CoP17). The last workshop was held to present data collected during our project, to review the recent research published important to the conservation of mobula rays, and to discuss policy change in Indonesia to promote mobula conservation. National protection of mobula rays was recommended to the Government and supported by a number of organization representatives. Discussions in this direction are ongoing. The main alternative solutions to reduce mobula landings discussed at the workshop were:

1- Policy change:

Multiple policy change options were discussed during workshops, and our team recommended national protection for mobula rays to the Indonesian Government primarily due to decreasing trends in fisheries (Lewis et al., 2015), conservation life history parameters (this project; Cuevas-Zimbron et al., 2013; Pardo et al., 2016) and limitations associated with other potential policy measures such as seasonal fishery closures, quotas, and size limitations. A nation-wide work frame is already in place for the national protection of manta rays, which could be extended to mobula rays, and would facilitate enforcement by customs officials at borders, for example since any gill plate export would be prohibited. Quotas would likely not benefit mobula conservation because the amount of mobulas landed is already comparatively

low to historical data available, and comes with implementation difficulties. As for size restrictions on mobulas landed, quotas seem unfeasible because of the difficulty to correctly identify species before landing, mortality due to net soaking time, and lack of personnel at fishing ports to monitor landings. Size limitations would not necessarily help, because limiting catch to larger females and males for example would likely diminish reproductively active individuals. Moreover, it would difficult to determine pregnancy in females onboard to eventually release them before they are landed.

2- Bycatch reduction

Mobulas are often defined as bycatch in Indonesian gillnets, although our study suggests that mobula rays are often 'secondary targets', meaning that fishermen will target mobula rays and set nets at known mobula aggregation sites purposely in the absence of lights ("which repel mobula rays" fishermen interviews in Muncar). In Muncar, primary targets include tuna, marlin, swordfish, mahi-mahi, and thresher shark. In Tanjung Luar pelagic fisheries, the primary target of fishermen is large sharks (**fig. 15**), which are caught on longlines, and which occasionally hook large *Mobula tarapacana*, or *Mobula japanica* (the latter less frequently) individuals, however fishermen also use modified drift gillnets to target mobula schools. In coastal fisheries, when mobula rays are landed they are caught in gillnets along with tuna or targeted by harpoon. In Lamakera, mobula rays do not represent bycatch since they are targeted by harpoon. Currently, it is difficult to determine which proportion of the landings in Muncar and Tanjung Luar represent true bycatch (unintentionally caught specimens landed while targeting other species) and which proportion constitutes 'secondary target' or target fisheries. If a national protection on mobula rays in achieved, a zero-TAC regulation (no take allowed) would best enable to ensure that mobulas targeted by fishermen are not unlawfully declared as bycatch, hence escaping regulation in a situation other than zero TAC. Measures to reduce bycatch, both before it occurs and as post-catch release guidelines will be investigated in further project phases, in collaboration with the Ministry of Fisheries (e.g. sensory repellents such as visual or electrosensory repellents).

3- Ecotourism development

Mobula ray ecotourism is largely undeveloped in Indonesia and currently, tourism is targeted at manta rays in National Park regions such as Komodo National Park and Raja Ampat, where mobula rays can be seen occasionally (e.g. photo below). Given the proximity of aggregation sites in Muncar and Bali (as well as anecdotal accounts from South Flores) more research is needed to assess whether ecotourism is a realistic alternative solution to fisheries in these areas. Due to the intense fisheries in the Bali strait and strong currents towards the south of Muncar, adaptation measures would be necessary to start ecotourism in the area. However, increasing the demand for mobula ray ecotourism would provide a supplementary strong incentive for the government to protect these animals, such as has been the case for manta rays.

Photo: Copyright Nu Parnupong Photography, taken at Misool, Indonesia in 2016.

Fig. 13: Fishermen are interviewed by Vidlia Rosady and Eis Zulfaty at home for more in depth conversations in Muncar (December 2017).

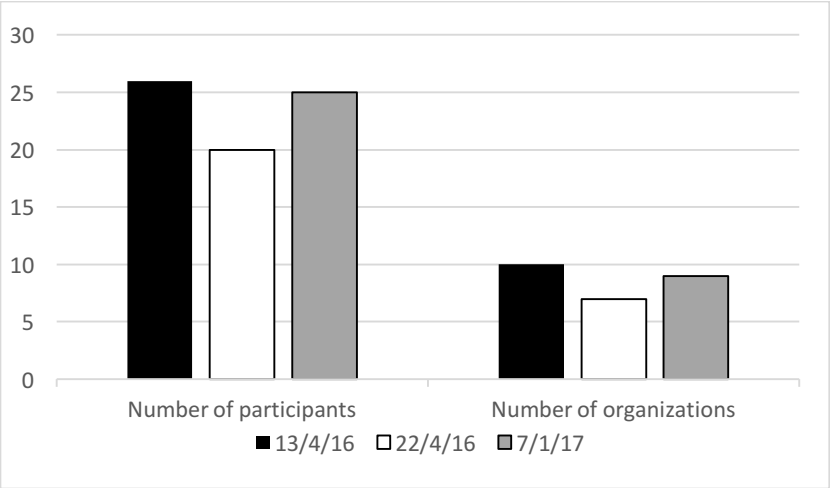


Fig. 14: Attendance statistics for workshops held at the Ministry of Marine Affairs and Fisheries.

Fig. 15: Main target of pelagic fishing boats departing from Tanjung Luar (large sharks- LEFT), and a typical fishing boat about to unload the catch in Tanjung Luar.

Communication & Application of results

The launching of our online photographic database collection was communicated online on our website and through posters distributed to dive centers (e.g. **fig. 16**). Project results have been communicated to the Indonesian Government at two stages of the project: intermediary (April 2016) and final (January-ongoing 2017) through a report and through presentation of findings during workshops conducted in Jakarta (**fig.17**). In April 2016, findings were presented within workshops aimed at gaining support of the Indonesian Government for the addition of mobula rays to Appendix II of CITES. Discussions concerning mobula ray national policy started in March 2016 and are ongoing with the Ministry of Fisheries and the National Institute of Sciences (LIPI), while conservation efforts and further directions are being discussed with other stakeholders such as International NGOs (e.g. Wildlife Conservation Society, Conservation International, World Wildlife Fund).

Project results are being applied to promote conservation by providing recommendation guidelines for policy change to the Government. Additionally, coordination meetings have and are expected to take place to identify further research steps to inform policy through collaboration with the Ministry of Fisheries and the compilation of available data from Government enumerators to be used in further research. New research proposals aiming to test direct solutions for mobula landing reductions have been submitted by team members (e.g. bycatch reduction in artisanal fisheries).

Fig. 16: Diving mobula ID-guide and photo database announcement hanging on the wall of a dive center in Labuan Bajo, Komodo amongst manta rays photo-ID shots, which are much more frequent in the area.

Fig. 17: Workshops with governmental and nongovernmental institution representatives at the Ministry of Marine Affairs and Fisheries in Jakarta (upper: April 2016, middle and lower: January 2017).

Monitoring and Evaluation

Quantitative measures were used to monitor the impact that our project was having on raising awareness in local communities and with stakeholders at a national level, such as the number of fishermen who participated in interviews (and hence mobula ID training), the number of people who attended workshops at the Ministry of Marine Affairs and Fisheries, and the number of institutions present at workshops (as seen on **fig. 14**). It is important to note, however that the number of participants was limited at workshops due to availability of officials and expense restrictions. The success of the education outreach activities was assessed through an oral quiz conducted with school children at the end of the session. Additionally, informal evaluation of the usefulness of our project results was discussed with governmental stakeholders, who acknowledged the need for such a study given the lack of research generally available on mobula rays in Indonesia. Ultimately, the true effectiveness of the project will eventually be assessed on the long term through driving policy change at a national level.

Achievements and Impacts

Mobula ray life history parameters provided

Life history parameter estimation is of crucial importance to understand the basic biology of a species, and they are further necessary to understand how a population will deal with a given threat. We provided preliminary information on the growth of *Mobula japanica* and *Mobula thurstoni*, which suggests that these species are vulnerable to fishing pressure due to slow growth, and late maturity, to government officials during workshops and meetings. The results were positively received and have in general prompted concern for mobula rays from policy makers which were, for the majority, not previously aware of mobula ray biology and ecology.

Key mobula aggregation sites identified

Spatio-temporal trends in species-specific abundance was collected, and key aggregation sites were identified, gleaned from interviews with fishermen. Additionally, information on the maturity stage of mobulas landed was collected, which has and will be useful to streamline conservation measures on a national level.

Awareness raised in local communities

We were successful at conducting education outreach activities in schools of fishing communities in Tanjung Luar and Labuan Bajo (e.g. **fig. 18**), and of providing information on mobula ray identification to fishermen in Tanjung Luar and Muncar. In Muncar, all fishermen interviewed perceived a decreasing trend in mobula ray fisheries over the past 10 years, while 47% of fishermen interviewed in Tanjung Luar perceived such a trend (although the latter may have not responded accurately due to fears associated with local enforcement of manta ray ban). Contact with fishermen and processors in field locations, especially in Muncar was positive and will provide the basis for working towards mobula conservation on the long term.

Government stakeholders are aware of results

Most governmental stakeholders were not aware of mobula ray biology, ecology and conservation before the first meetings and workshops we conducted, meaning that these were crucial for our results to have an impact on conservation. The project suggests that mobula ray threats from fisheries differ according to the location, and hence that a combination of measures will be necessary to reduce landings, such as: the recent international policy on mobula export (CITES Appendix II), desired policy change at a national level, and work towards bycatch reduction. Awareness has been raised with governmental stakeholders, who are aware of project results, recommendations and are currently working towards better management of mobulas at a national level, through ongoing discussions on policy change.

Fig. 18: Sample of education outreach materials distributed to schools.

Capacity Development and Leadership capabilities

The project training (**fig. 19**) which took place after the CLP training attended by Vidlia was beneficial for all team members, specifically it provided presentation and leadership training for Vidlia, novel information and case studies in leadership development and style for team members, streamlining of project aims and objectives, project planning, and media outreach. Through the project provided an opportunity for Anindita, Vidlia and Gerald to independently lead project activities in Lamakera. Training was also delivered concerning sample preparation and analysis. One of the important learning situations was our first workshop with the Ministry of Fisheries, which provided a novel experience for each of us to present findings to governmental entities to promote conservation. In particular, we learnt how to take into account the opinions and paradigms of different stakeholders to find better ways of conveying our data in an understandable formal for stakeholders with vastly differing backgrounds. Moreover, inter-personal skills were developed throughout the project both between the team members, within the educational program, during interviews, and during workshops. These situations represented encounters with stakeholders of diverse backgrounds. The setbacks during the project, such as delays with research permits and tensions in field locations related to manta rays ban enforcement, provided opportunities to be resourceful by finding new ways to reach our objectives.

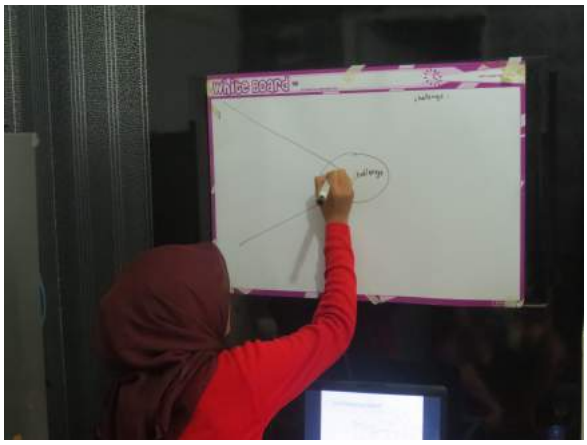


Fig. 19: Team training in Jakarta lead by Vidlia Putri Rosady (pictured here).

SECTION 3

Conclusion

The project confirmed that mobula rays are targeted in Lamakera, and shows that they are also targeted as 'secondary target' and bycatch in Tanjung Luar and Muncar, leading to catches of juveniles, adults and pregnant females of the species *Mobula thurstoni* and *Mobula japanica* and juveniles/ adults of the specie *Mobula tarapacana*. Preliminary life-history parameter estimates suggest that *M. japanica* have slow growth, that female growth is slower than male growth, and that maturity is attained relatively late, which means that they are unlikely to sustain high fishing pressure. We successfully interviewed 37 fishermen in two fishing communities in East Java and Lombok, providing insight into perceived spatio-temporal trends in mobula fisheries, respondent background and information useful to identify alternative solutions to reduce mobula fisheries. The project identified potential solutions to reduce mobula ray landings in Indonesia, which were presented to stakeholders to induce adequate policy implementation. The education outreach program for schools and encounters with fishermen put in place the first steps to support the rise of favorable outlooks towards mobula conservation within local communities. Policy change should be implemented in Indonesia to protect mobula rays nationally urgently, due to conservative life-history and fishery trends, furthermore research into mobula ray populations inhabiting Indonesian waters is necessary to better understand how current fishing pressure is impacting populations and to monitor the evolution of populations in the face of potentially changing anthropogenic threat intensity.

Problems encountered and lessons learnt

This project succeeded in providing preliminary life history parameters for *Mobula japanica* and in part, *Mobula thurstoni* in Indonesia, however we could not estimate parameters for *Mobula tarapacana* due to the morphology of their vertebra centra, which did not show clear growth bands. The project provided information on the species-specific abundance of mobula rays at three main fishing grounds in Indonesia, including evidence of pregnant *Mobula thurstoni* and *Mobula japanica* landed in Muncar, and spatio-temporal trends gleaned from interviews with fishermen. The education outreach program reached our target number of students, and was successful in raising the knowledge of young members of the fishing community concerning mobula biology, ecology and conservation. Moreover, the project identified avenues to reduce mobula ray landings in Indonesia, through compiling information gleaned from interviews, market surveys, and discussions with governmental and non-governmental institutions. The main limitations of our project were firstly, the delays encountered to acquire research permits for our foreign team member, which significantly impacted the start of the project date, and the date of return to the field for the second part of the project. Second, recent enforcement actions for the national ban on manta rays, although crucially important, meant that fishermen were not as open to cooperation in Lamakera in 2015, and that most of the mobula landings in Tanjung Luar were not brought to the auction terminal, and likely trafficked, which meant we could not monitor efficiently in those locations. However, bringing the focus of the project to a location were manta rays are not usually landed and were mobula rays are landed frequently, enabled us to continue the project (in Muncar). Third, the development of our photo-database did not meet our expectations in terms of photo inputs by divers, although it may provide results over a longer term, especially due to the scarcity of close mobula encounters at dive sites. Fourth, interviewing fishermen which are part of the pelagic fishery in Tanjung Luar proved challenging due to the extent of fishing trips and the reduced rest time, so that not all fishermen could be interviewed, although

we extended the timeframe allocated to the interview process. In the future, life history parameter estimation could be enhanced by increasing the sample size of mobulas used in the study, and by using samples collected during each month of the year to provide better verification of results. Market survey activities could be enhanced by increasing the number of team members to allow permanent monitoring of mobula landings in Muncar and eventually other locations, and by collecting GPS points of mobula landings through collaboration with fishermen. Workshops and discussions on solutions to reduce mobula landings with the Ministries should be carried out more frequently during the year, to maintain a high awareness of stakeholders towards mobula ray conservation on their busy agendas.

In the future

In the future we will aim to focus on the following main areas: (1) policy change and implementation in Indonesia, (2) continued monitoring of abundance from market surveys and in-situ observations, (3) estimation of mobula ray species-specific population size, (4) education outreach, (5) bycatch reduction efforts. Within (1) we will continue leading workshops with the government in collaboration with our partners at Manta Trust to support the government in their policy decisions to sustain mobula ray populations and to provide training in terms of, for example, policy enforcement. Within (2) we will aim to continue market surveys in Muncar and to extend efforts to other places in Indonesia which have not currently benefitted from landing surveys. Within (3) we will aim to obtain funding to conduct a study on population genetics to estimate effective population size for *M. japanica*, *M. thurstoni* and *M. tarapacana*, which would greatly support stock assessments in Indonesia. Within (4) we will aim to perform education outreach activities in local fishing communities and in Universities containing a marine biology program, and (5) we will aim to apply biological and ecological knowledge of mobula rays to reduce bycatch.

Financial Report

Itemized expenses	Total CLP requested (USD)	Total CLP used (USD)	% Difference	Explanation & Proposed Spending**
PHASE I - PROJECT PREPARATION				
Communications (phone, internet, postage)	450.00	362.52	-19%	
Field guide books, maps, journal articles and other printed materials	200.00	158.52	-21%	
Insurance	300.00	0	-100%	Team members had ongoing insurance.
Visas and permits	650.00	506.04	-22%	
Team training	200.00	15.72	-92%	Team training was done at team member's apartment to reduce costs.
Medical supplies/First Aid	300.00	5.05	-98%	Close to no expenses incurred.
Reconnaissance	800.00	832.89	4%	
EQUIPMENT				
Scientific/field equipment and supplies (market survey equipment, sampling equipment and reagents)	550.00	971.31	76.60%	Materials- more scientific equipment was required to return to the field in 2016 (eg. Fridge, ice boxes, vials, dissection kits, reagents, etc.)
Vehicle Hire	340.00	320.60	-5.71%	
PHASE II - IMPLEMENTATION				
Accommodation for team members	2,140.00	2207.55	3.16%	
Food for team members and local guides	950.00	1039.42	9.41%	
Travel (Including fuel costs)	1,880.00	2435.09	29.53%	Local transportation by plane was often necessary due to the large distance between sites. Multiple trips to Jakarta were also needed, for administration, meetings and workshops.
Outreach/education activities and materials (stickers, posters, t-shirts, ID guides, booklet, leaflets)	970.00	749.11	-22.77%	
Workshops (at Ministry of Marine Affairs and Fisheries)	900	1087.40	20.82%	
Other (laboratory compensation LIPI)	800.00	1217.19	52.15%	Laboratory compensation RCO-LIPI, extra lab materials.
PHASE III - POST-PROJECT EXPENSES				
Report production and results dissemination	600.00	591.59	-1.40%	Printing and distribution of reports as booklets.
Other (Please detail: Administration and unexpected expenses)	470.00	0.00	-100.00%	Used for extra field trip travel expenses
Total	**12,500.00**	**12,500.00**	0.00%	

SECTION 4

Appendices

Appendix I: CLP M&E measures.

Output	Number	Additional Information
Number of CLP Partner Staff involved in mentoring the Project	2	Charlotte Klinting, Kiragu Mwangi.
Number of species assessments contributed to (E.g. IUCN assessments)	0	
Number of site assessments contributed to (E.g. IBA assessments)	0	
Number of NGOs established	0	Mobula Project in beginning of process for being registered as an NGO.
Amount of extra funding leveraged ($)	1	Current project concluded on CLP funds alone. Funds (7000 USD, Rufford Foundation) gathered for side project on feeding ecology.
Number of species discovered/rediscovered	0	
Number of sites designated as important for biodiversity (e.g. IBA/Ramsar designation)	0	
Number of species/sites legally protected for biodiversity	5	Mobula rays added to App. II of CITES at CoP17 regulating international trade from April 2017 onwards.
Number of stakeholders actively engaged in species/site conservation management	5	Ministry of Fisheries, National Institute of Sciences (LIPI), Ministry of Forestry (CITES Management Authority), Customs Officials representative, International NGOs (Manta Trust, WCS, WWF, CI)
Number of species/site management plans/strategies developed	1	In development through National Shark and Ray group through ongoing workshops with the Government including recommendations from the study
Number of stakeholders reached	8	Local fishermen (Tanjung Luar, Muncar), Local schools (Tanjung Luar, Komodo

		Labuan Bajo), Dive centers, Ministry of Fisheries, National Institute of Sciences (LIPI), Ministry of Forestry (CITES Management Authority), Customs Officials representative, International NGOs (Manta Trust, WCS, WWF, CI)
Examples of stakeholder behaviour change brought about by the project.	1	Addition of mobula rays to National Plan of Action for shark and rays in Indonesia with ongoing discussions about legislation change at national level.
Examples of policy change brought about by the project	0	Ongoing discussions for policy change due to be decided upon by April 2017.
Number of jobs created	0	
Number of academic papers published	0	Manuscript to be submitted for review in 2017.
Number of conferences where project results have been presented	0	At least 1 conference in 2017.

Appendix 4.1 CLP M&E measures

Appendix II: (A) *Mobula japanica* age estimates, in agreed number of growth bands on caudal vertebrae centra. DW: disc width. Females that are qualified as being 'mature' were landed pregnant.

Date	DW (mm)	Weight (kg)	Maturity	Score	Age (# growth bands)
Females					
12.10.15	1740	*NA*	*NA*	5	*Unreadable*
14.10.15	2260	96	*NA*	3	9
14.10.15	2160	*NA*	*NA*	3	16
17.10.15	2120	94.5	*NA*	2	9
17.10.15	2100	*NA*	*NA*	3	12
18.10.15	2220	99	*NA*	4	13
18.10.15	2280	66	*NA*	4	10
20.10.15	1525	31	*NA*	2	4
20.10.15	*NA*	95	*NA*	3	19
22.10.15	2750	83	Mature	3	15
22.10.15	2290	103	Mature	4	12
22.10.15	1880	49	*NA*	2	3
23.10.15	1620	*NA*	*NA*	4	5
31.10.15	1900	45	*NA*	5	*NA*
03.11.15	1980	40	*NA*	5	*NA*
03.11.15	1390	15	*NA*	2	2
04.11.15	*NA*	37	*NA*	2	3
06.11.15	2340	100	*NA*	3	17
06.11.15	2200	80	*NA*	3	11
06.11.15	2140	71	*NA*	3	11
Males					
14.10.15	*NA*	*NA*	Juvenile	5	*Unreadable*
18.10.15	1430	22	Juvenile	2	2
20.10.15	2110	82	Mature	2	7
20.10.15	2250	70	Mature	4	10
21.10.15	2170	79	Mature	2	6
21.10.15	1940	53	Juvenile	2	4
21.10.15	2070	68	Mature	5	*Unreadable*
22.10.15	*NA*	10	*Fetus*	2	0
22.10.15	*NA*	11	*Fetus*	3	0
22.10.15	2160	65	Juvenile	3	7
22.10.15	2240	95	Mature	4	12
05.11.15	1820	*NA*	*NA*	3	5
26.10.15	2090	65	Mature	3	8
06.11.15	1140	*NA*	Juvenile	2	0
Unknown sex					
12.10.15	*NA*	*NA*	*NA*	5	*Unreadable*
14.10.15	*NA*	*NA*	*NA*	5	*Unreadable*
19.10.15	*NA*	90	*NA*	4	10
19.10.15	*NA*	77	*NA*	3	13

19.10.15	*NA*	75	*NA*	4	6
21.10.15	*NA*	*NA*	*NA*	2	3
21.10.15	*NA*	*NA*	*NA*	3	15
24.10.15	*NA*	*NA*	*NA*	5	*Unreadable*
25.10.15	*NA*	*NA*	*NA*	5	*Unreadable*
01.11.15	*NA*	*NA*	*NA*	2	1

(B) *Mobula thurstoni* age estimates, in agreed number of growth bands on caudal vertebrae centra. DW: disc width. Females that are qualified as being 'mature' were landed pregnant.

Date	**DW (mm)**	**Weight (kg)**	**Maturity**	**Age (# growth bands)**	**Score**
Female					
21.10.15	1050	*NA*	*NA*	2	2
31.10.15	*NA*	75	Mature	*NA*	5
31.10.15	1750	48	Mature	8	3
31.10.15	1720		Mature	*NA*	5
03.11.15	1890	56	Mature	8	4
03.11.15	1870	*NA*	Mature	7	4
Males					
16.10.15	910	*NA*	Juvenile	1	3
04.11.15	1720	45	*NA*	9	3
Unknown sex					
27.10.15	*NA*	*NA*	*NA*	6	3

Appendix III: Mobula-ID guide used for workshops and distributed to dive centers, also available in Bahasa Indonesia.

MOBULA RAYS of Indonesia
Diving ID-guide

Common species

Mobula japanica

Spinetail mobula

IUCN status: Near Threatened (Vulnerable in South-East Asia)
Distribution: Found globally in temperate, tropics and sub-tropics
Disc width: 3.1m (males mature at ~2m)
Colour: dark gray with dark band below head on back (not visible when dead), white on ventral side.

Characteristics:
- **Tip of dorsal fin is white**
- **White colour extends above eye when viewed from lateral and top view**
- **Tail is longer than disc width**

Mobula tarapacana

Sicklefin mobula

IUCN status: Data Deficient
Distribution: Found globally in tropical, sub-tropical and temperate waters
Disc width: 3.3m (males mature at ~2.5m/ females at ~2.7m)
Colour: uniform brown on back, white on ventral side with a gray area at the lower edge of pectoral fins.

Characteristics:
- **The pectoral fins form a crescent shape**
- **Dorsal fin is plane**
- **Eyes are located well ahead of pectoral fins**

Mobula thurstoni

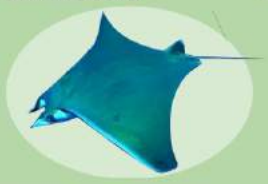
Bentfin mobula

IUCN status: Near Threatened (Vulnerable in South-East Asia)
Distribution: Found globally in tropics and sub-tropics
Disc width: 2.2 m (males mature at ~1.5m)
Colour: dark gray with dark band below head on back (not visible when dead), white on ventral side, with light grey toward pectoral fin tips.
Characteristics:
- **Bend is visible on front edge of pectoral fins (distinct curve)**
- **Short neck appearence**
- **Tip of dorsal fin is white**
- **Tail half length to full length of disc width**

Uncommon species

Mobula kuhlii

Shortfin mobula



IUCN status: Data Deficient
Distribution: Indo-West Pacific
Disc width: 1.2m (males mature at ~1.1m)
Colour: dark gray with dark band below head on back, white on ventral side, and grey pectoral fin tips.

Characteristics:
- **Dorsal fin is white tipped (but not on all specimens)**
- **Short neck appearance**
- **Tail is shorter than disc width**

Mobula eregoodootenkee

Pygmy mobula

IUCN status: Near Threatened
Distribution: Indo-West Pacific
Disc width: 1m
Colour: gray-brown on dorsal side, white on ventral side, with darker markings located at bend of pectoral fins (on ventral side)

Characteristics:
- **Long cephalic fins giving long neck appearance**
- **Dorsal fin is white tipped**
- **Pectoral fins have a dark brown groove along the edge**
- **Tail is shorter than disc width**

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References: White et al., 2006; MantaTrust, Couturier et al., 2012, KKP 2014.
Photo copyrights: Guy Stevens, J. Yonover, J. Fontes, SFTEP 2002, CSIRO, Marine Megafauna Foundation, and The Mobula Project Indonesia.

Appendix IV: Information poster distributed to dive centers for the photo-database.

HELP US STUDY MOBULAS!

PARNAHKAH ANDA MELIHAT MOBULA ?

Anda dapat membantu kami mempelajari kelimpahan dan distribusi Mobula di perairan Indonesia untuk membantu mengetahui biologi dan ekologi Mobula. Kami menerima foto lama dan foto baru dari Mobula yang anda lihat Semua yang kamu butuhkan hanya mengirim data pengamatan atau foto. (lokasi, tanggal dan perkiraan jumlah mobula yang terlihat) ke **info@mobulaproject.com**

TELL US ABOUT YOUR SIGHTINGS AND SEND PHOTOS!

You can help us study their abundance and distribution in Indonesian waters by reporting your sighting (with location, date, time, and estimated number of individuals) and sending eventual photos! We welcome recent and old photos and sightings.

Send to: info@mobulaproject.com

MORE INFO at www.mobulaproject.com

MOBULA VS MANTA?

MOBULA	MANTA
Mulut di bawah. Mouth below body.	**Mulut di depan.** Terminal mouth.

Di atas

Abu-abu, coklat sampai hitam di atas. Putih di bawah (bisa abu-abu).	**Putih dan hitam di atas. Putih dan biasanya bintik-bintik hitam di bawah.**
Dark grey, brownish or black on back. White on ventral side (can have light grey markings).	Black and white above. Usually white with black spots on ventral side. Occasionally black.

Di bawah

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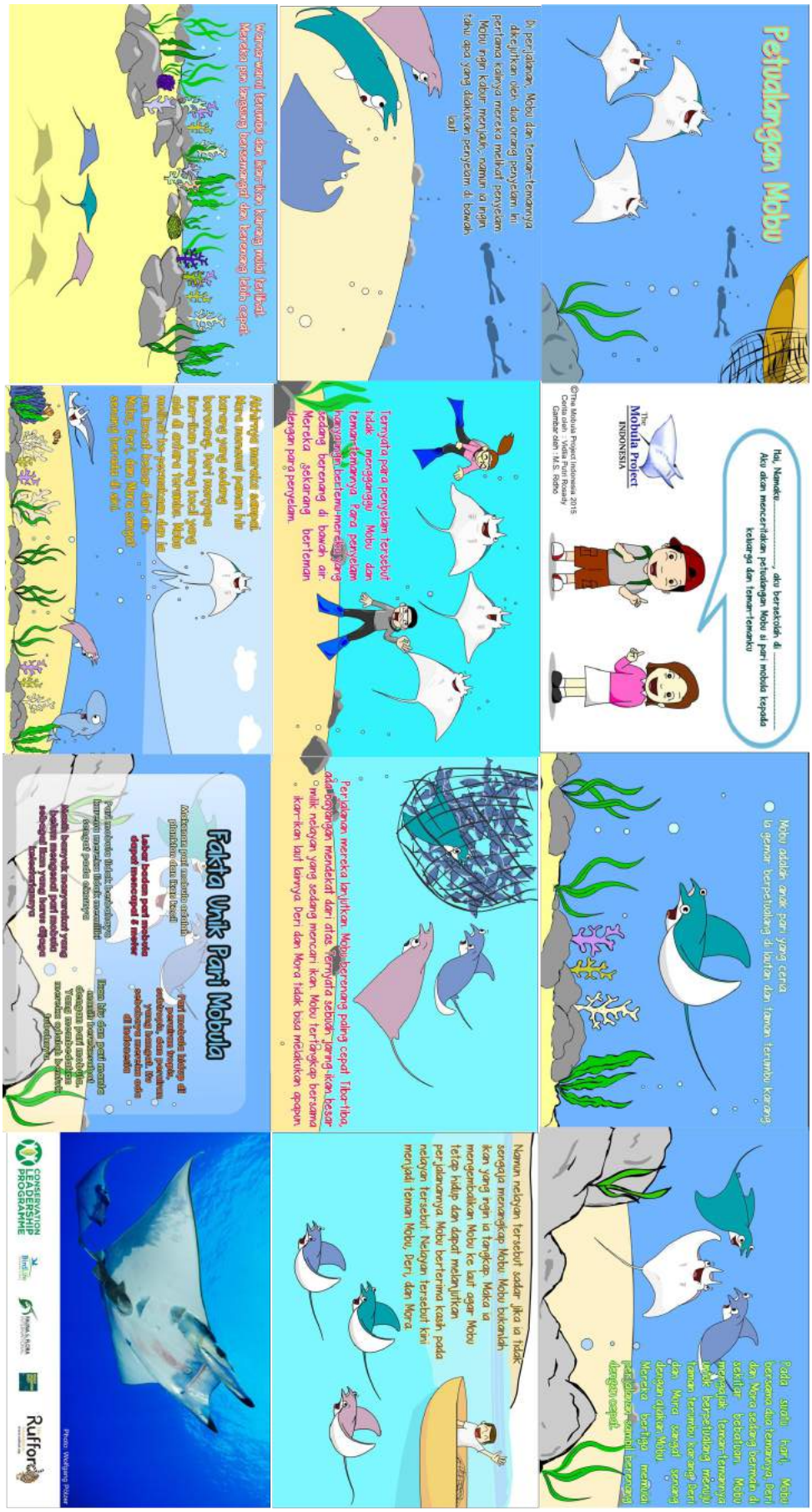
Appendix V: Extract from booklet distributed to primary school children during outreach activities.



Appendix VI: Extract of leaflet created for secondary school students and above.

CONSERVATION LEADERSHIP PROGRAMME

The Mobula Project INDONESIA

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Penjangkauan pendidikan 2015

MEMENUHI PARI MOBULA

Proyek

Proyek ini telah dimulai sejak Juli 2015 dan didanai oleh Conservation Leadership Programme dan The Rufford Foundation. Proyek ini bertujuan untuk memahami dampak, solusi alternatif, dan kesadaran terhadap perikanan pari mobula di Indonesia. Kegiatan kami termasuk survey ke tempat penjualan ikan, 'citizen science', dan wawancara untuk menyediakan informasi mengenai biologi dan ekologi dari pari Mobula spp. dan untuk mengimplementasikan kesadaran komunitas.

Pari Mobula dan Pari Manta

Pari Manta dan Pari Mobula berasal dari famili ikan yang sama, yaitu Mobulidae. Terdapat 5 spesies Pari Mobula dan 2 spesies Pari Manta (Pari Manta oseanik dan Pari Manta terumbu) yang ditemukan di Indonesia. Mereka berenang di kolom air dengan menggerakan sirip pektoral yang berbentuk seperti sayap, membuat mereka mampu berenang cepat (mencapai 6 meter per detik) dan menempuh jarak migrasi yang jauh (hingga 1000 km).

Pari Mobula
(Mobula tarapacana)

Pari Manta
(Manta alfredi)

Mereka mengalirkan air laut melalui insang untuk menyaring plankton dan ikan cekil sebagai makanan. Walaupun begitu biologi dan ekologi pari mobula belum banyak diketahui, mereka mempunyai beberapa karakteristik yang sama dengan Pari Manta: pertumbuhan yang lambat, masa dewasa yang lama, dan fekunditas yang rendah (mereka tidak dapat memproduksi banyak juvenil -kurang dari satu ekor pertahun), yang mana membuat mereka sangat mudah terancam jika ditangkap, karena mereka tidak dapat bereproduksi cukup cepat untuk mengimbangi tekanan penangkapan. Mobula dapat dibedakan dengan Manta dari tiga kareakterist: a) Letak mulutnya b) warna kulitnya, dan c) ukurannya. Manta biasanya lebih besar dari Mobula. Mulut mobula terletak dibawah badannya, dimana manta mempunya mulut yang sejajar.

Website: http://www.mobulaproject.com/
Like us on Facebook: The Mobula Project Indonesia

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Address list and web links

- **The Ministry of Fisheries and Marine Affairs of Indonesia**
  Address: Jalan Medan Merdeka Timur, DKI Jakarta / Website: kkp.go.id/
- **Research Center for Oceanography and Fisheries, Indonesian Institute of Sciences**
  Address: Jalan Pasir Putih I, Ancol Timur, Jakarta / Website: oseanografi.lipi.go.id/
- **The Manta Trust-** Address: Catemwood House, Corscombe, Dorset, UK/ Website: mantatrust.org/
- **MantaWatch-** Website: mantawatch.com/

Distribution list

- KKHL, Ministry of Fisheries and Marine Affairs of Indonesia
- Directorate General of Ecosystem and Natural Resources Conservation, Ministry of Environment and Forestry
- Research Center for Oceanography and Fisheries, Indonesian Institute of Sciences
- International NGOs Indonesian offices (WCS, Conservation International, WWF)