

# Palau Manta ID Project 2012-2013



by  
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## Acknowledgements

Funding for the Palau Manta ID Project 2012-2013 was provided through a Small Scale Funding Agreement (SSFA) between the Republic of France Embassy in Manila and the Etpison Museum in Palau. Local funding was supplied by the Palau Pacific Resort and Shell V-power. The press, educational and social marketing materials and Project coordination were done by the Etpison Museum. All Palau photography copyright by Mrs. Mandy Etpison.

Fieldwork is sponsored by Neco Marine Dive-Tour, and supported by Rock Island helicopters. Public outreach was done with the support of the Palau Conservation Society.

Other support was provided by the Koror State Division of Conservation and Law Enforcement. Pilot Matt Harris from Rock Island Helicopters provided an outstanding level of expertise in sighting manta rays during survey and tourist flights.

Special thanks to the following people who provided valuable contributions to this Project: the Neco Marine staff members who assisted with the surveys, and project Assistant Edwin Maidesil Fabio Esposito-PADI *Palau Manta ID Specialty Course* instructor, Jeanette Denby and the people who contributed manta ID photos to the *mantaidpalau.org* website Koror State, Ngarchelong State, and Ngardmau State governments The French Embassy in Manila Guy Stevens/the Manta Trust for general Manta data and non-Palau photographs



palau pacific resort



This report was prepared by the Coral Reef Research Foundation and the Etpison Museum. Any comments should be directed to:

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## 1.0 Introduction

The Republic of Palau is a small island nation in the western Pacific located approximately 1000 km east of the southern Philippines and 800 km north of the western half of New Guinea island (approximately 7°30'N; 134°24'E). The main Palau island group has one large basaltic island (Babeldaob - 400 km<sup>2</sup> in area) and hundreds of smaller limestone islands, known as the "rock islands", forming a complicated archipelago inside a surrounding barrier and fringing reef. The area inside the reefs (lagoon) covers close to 1,000 km<sup>2</sup>. The country has 16 political states of which 10 are on Babeldaob; an 11th, Koror, is the commercial and population center of the country and three others are island entities within or close to the main island/reef complex. The final two states are oceanic islands located up to 500 km southwest of the main group. Total human population is just over 20,000 people with 80% of those residing in Koror State.

Palau has highly diverse shallow water marine communities (Colin 2009). The main island group is surrounded by a barrier reef system on the north, west and south with a fringing reef system on the east. Inside the barrier reef is an extensive lagoon that covers twice the area of land and is no deeper than 50 m. The climate of Palau is tropical with high air and water temperatures and high humidity throughout the year. The average annual rainfall is 375 cm, with the dry months being February through April.

### 1.1 Rays of the World and Palau

The fishes commonly known as "rays" (class Chondrichthys, subclass Elasmobranchii, superorder Rajiformes) are found world-wide in marine and fresh waters. Their diversity includes several groups of the following types with approximate worldwide species numbers: Skates - (260 species - none found in Palau), electric rays (70 spp), guitarfishes - 45 species (2 species confirmed in Palau), eagle rays (2 spp), stingrays (180 spp), manta rays (2 spp), and mobula rays (9 spp). In Palau there are 16 species of rajiform fishes, and these are indicated in Table 1.

**Table 1. Rajiform fishes known from the Republic of Palau.**

#### Rhynchobatidae

- Rhynchobatus djiddensis* - White spotted guitarfish (giant guitarfish)
- Rhina ancylostoma* - bowmouth guitarfish

#### Torpedinidae

- Torpedo* sp. - Electric ray

#### Dasyatidae

- Dasyastis kuhlii* - Blue-spotted stingray
- Himantura fai* - Pink whipray
- H. granulata* - Mangrove whipray
- H. uarnak* - Reticulate whipray
- Pastinachus sephen* - Cowtail stingray

*Taeniura meyeni* - Blotched fantail ray  
*Urogymnus africanus* - Thorny ray

### **Myliobatidae**

*Aerobatis narinari* - Spotted eagle ray  
*Aetomylaeus vespertilio* - Ornate eagle ray

### **Mobulidae**

*Manta birostris* - Oceanic manta  
*M. kuhlii* - Shortfin pygmy devil ray  
*M. japonica* - Spine tail devil ray  
*M. tarapacana* - Sicklefins devil ray

The majority of rays are bottom dwellers with broad, flattened bodies, but a few species live above the bottom near reefs or in the open ocean. These "free-swimming" rays are represented in Palau by the pelagic stingray (*Pteroplatytrygon violacea*), the mobula rays (at least three species in Palau) and manta rays (one species confirmed).

The pelagic stingray almost exclusively inhabits the open ocean and is not found near reefs, hence is hardly ever seen by divers. While a member of the family Dasyatidae, it is the only species within its (monotypic) genus. It is typically found in surface waters down to a depth of 100 m (330 ft). Dozens are caught by longline fisheries vessels on every trip they make in Palau. To avoid losing their hooks or being stung, the rays are either slapped against the hull until dead and thrown back, or kept and eaten. They are reported as general by-catch by fisheries observers (SPC/FAA Palau fisheries observer, personal com).

The mobula and manta rays are both members of the family Mobulidae. The mobula rays are particularly poorly known in Palau and are believed to be mostly pelagic. They are generally shy towards divers and with their mostly pelagic habits, make it hard for humans to observe their behavior in the wild. Myers (1999) indicates *Mobula tarapacana*, the sicklefin devil ray, has been seen along outer reef slopes, occasionally in large groups, in Palau.

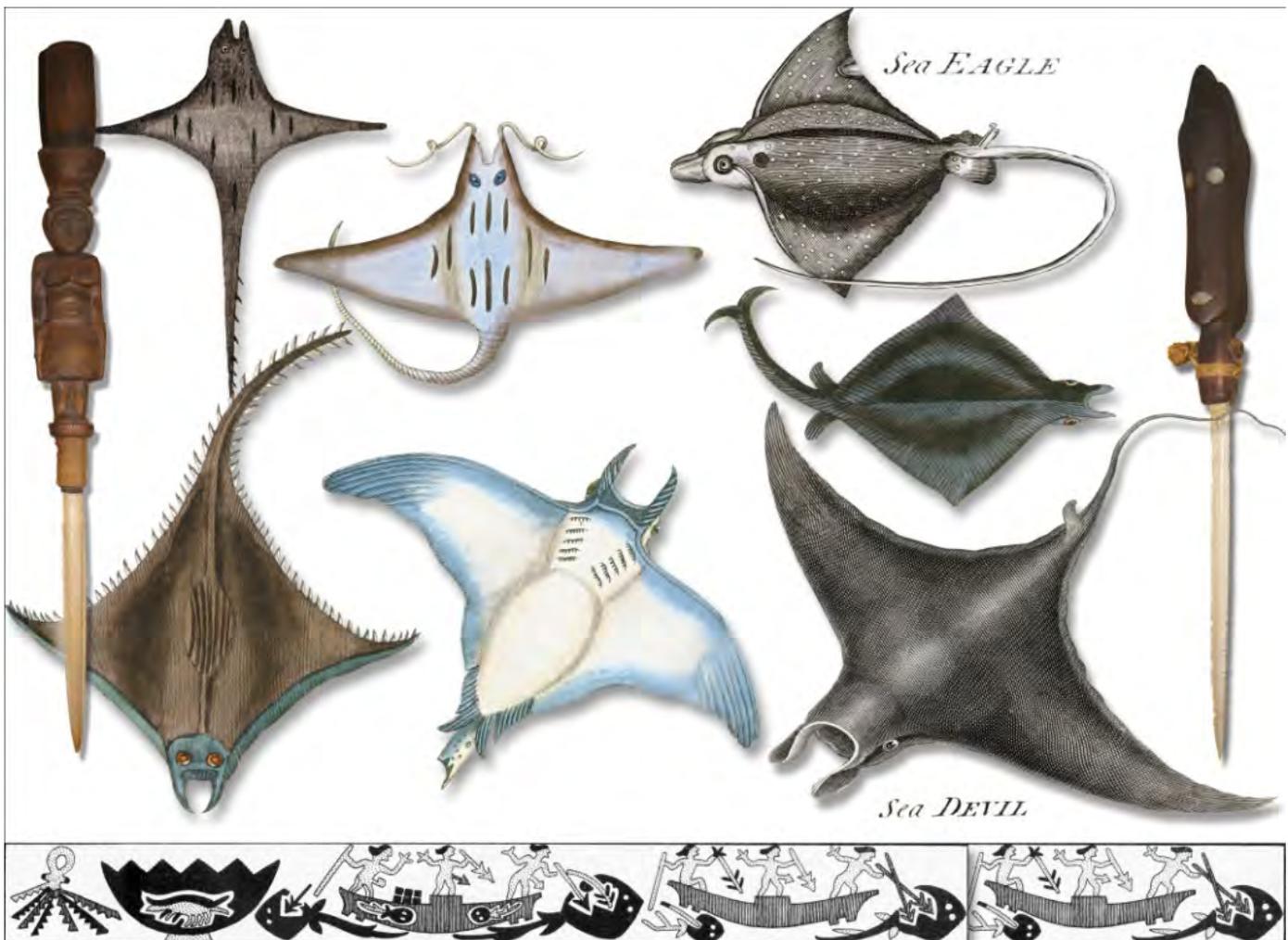
Only in 2009 (Marshall et al. 2009) were the two separate *Manta* species confirmed, based on external characters including color, teeth, denticles and spine morphology as well as size. Research on a possible third, Caribbean Manta species is underway. Scientists know that the *Mobula* rays took to the open water around 20 million years ago, with Mantas evolving more recently around 5 million years ago. The taxonomy of the poorly known Mobula rays, with 9 species identified to date, is likely to change in the next few years also with the recent advances in genetic studies.

There is little information on manta rays from Palau in the scientific or popular literature, but recent work, including what is present in this report, indicates a vibrant and abundant population of the manta ray, *Manta alfredi*, around Palau. Interestingly, the oceanic manta ray, *Manta birostris*, is not yet known from Palau, although its presence is highly likely.

Mobula and manta rays are occasionally caught by Palau longline vessels, and again reported as general by-catch. Since observers are only present on about 5% of the fishing trips, no accurate records exists of the actual ray and shark by-catch in Palau. With the recent increased demand for gill rakers from *Mobula* and *Manta* species in China, Palau needs to make sure they are not targeted by any fisheries operating in Palauan waters (SPC/FAA Palau fisheries observer, personal com.)

Palauans traditionally do not hunt or eat *Manta* or *Mobula* species, although the meat of most stingray species is considered a delicacy by older Palauans. Traditionally Palauans made daggers from the sharp barbs on the ray tail stingers (Fig. 1). Eagle rays, locally called *Ochaieu* are considered Gods in Palau, and anyone who hurts or kills one of these rays can expect sickness or death in the family according to legend.

Figure 1. Historical representations of manta rays are shown in this figure flanked by examples of daggers made from sting ray barbs.



## Rajiform fishes of Palau and their habitats

The following figures (Figs. 2-9) show the different species of rays found to date in Palauan waters. Several more species may occur in Palau which local fishermen say they have seen, including sawfishes (Pristidae) and other whiptail stingray species (Dasyatidae), that have not been photographed or positively recorded yet.

### Guitarfishes

2 species confirmed in Palau



Giant guitarfish  
New Drop-off- Nov 2012  
Photo Tang Yiu Tin



Bowmouth guitarfish  
Ulong- March 2013 Video Jade Rechelluul

Figure 2. The guitarfishes from Palau includes 2 species, the giant guitarfish, *Rhynchobatus djiddensis*, and the bowmouth guitarfish. They are not seen very often, but are distinctive, *Rhina ancylostoma*.



## 180 Stingrays

At least 6 species known from Palau

Blue spotted stingray  
*Dasyatis kuhlii*



Figure 3. At least 6 species of stingrays are known from Palau, with the blue spotted stingray, *Dasyatis kuhlii* the most common. The larger species can reach close to 2 m across the disk.



Mangrove whipray  
*Himantura granulata*



Figure 4. The mangrove whipray, *Himantura granulata*, is distinctive with its white tail.

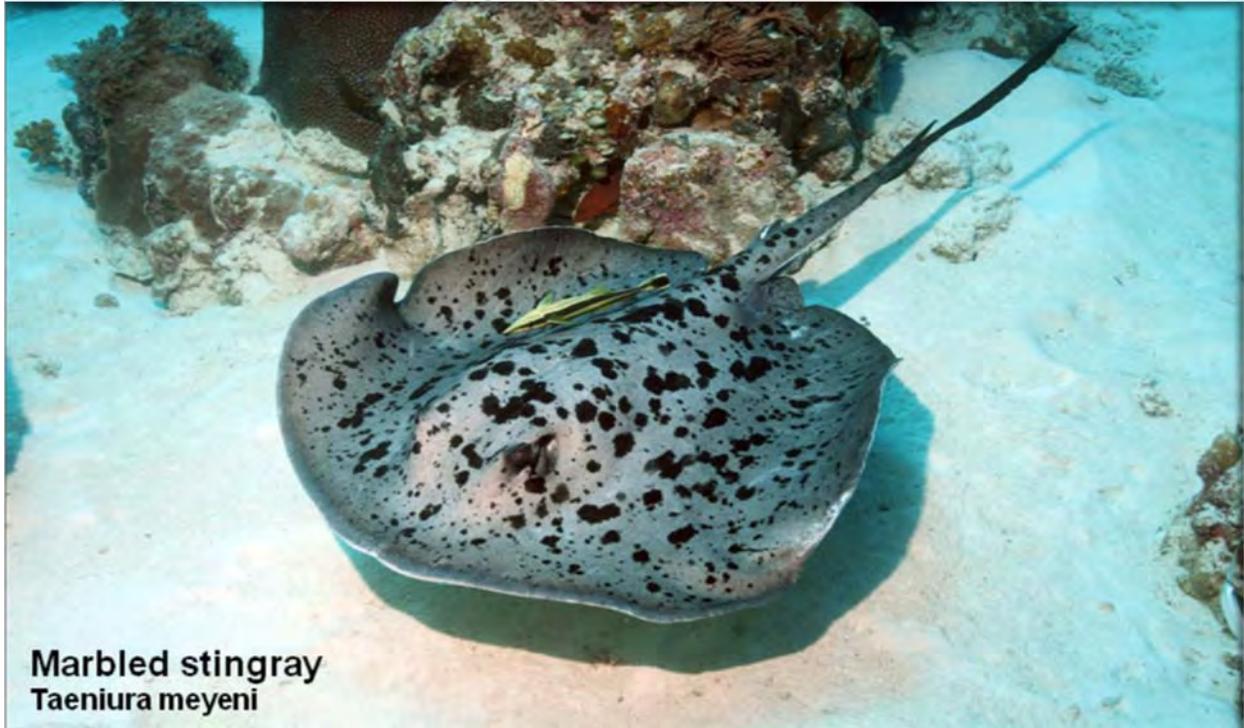


Figure 5. The marbled stingray, *Taeniura meyeni*, is occasionally found in outer reef areas.

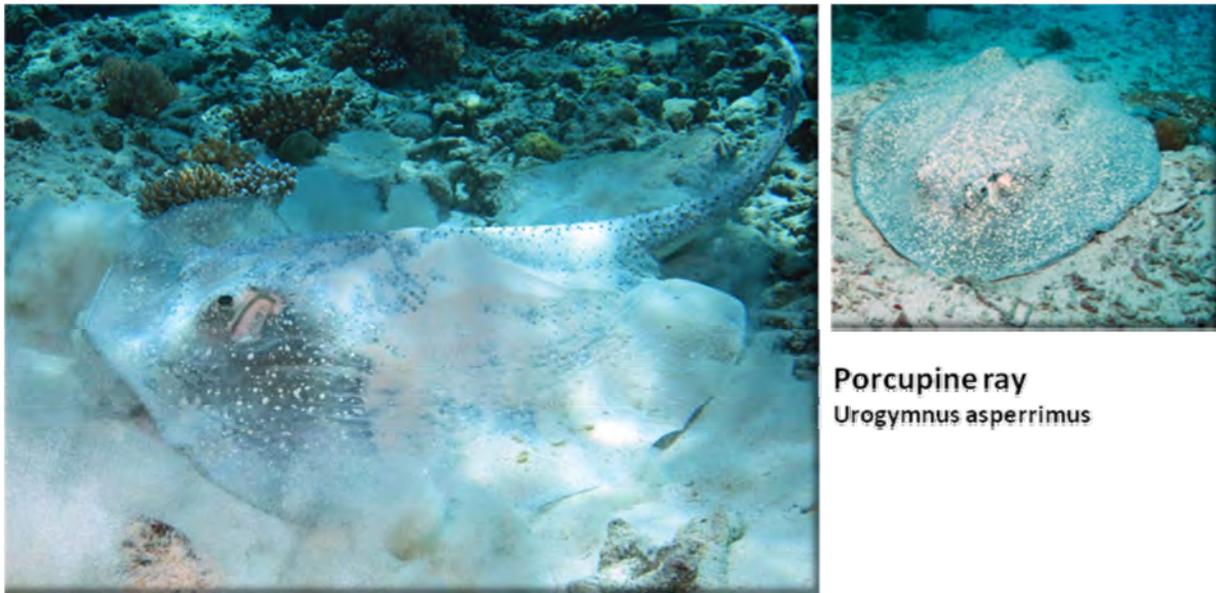
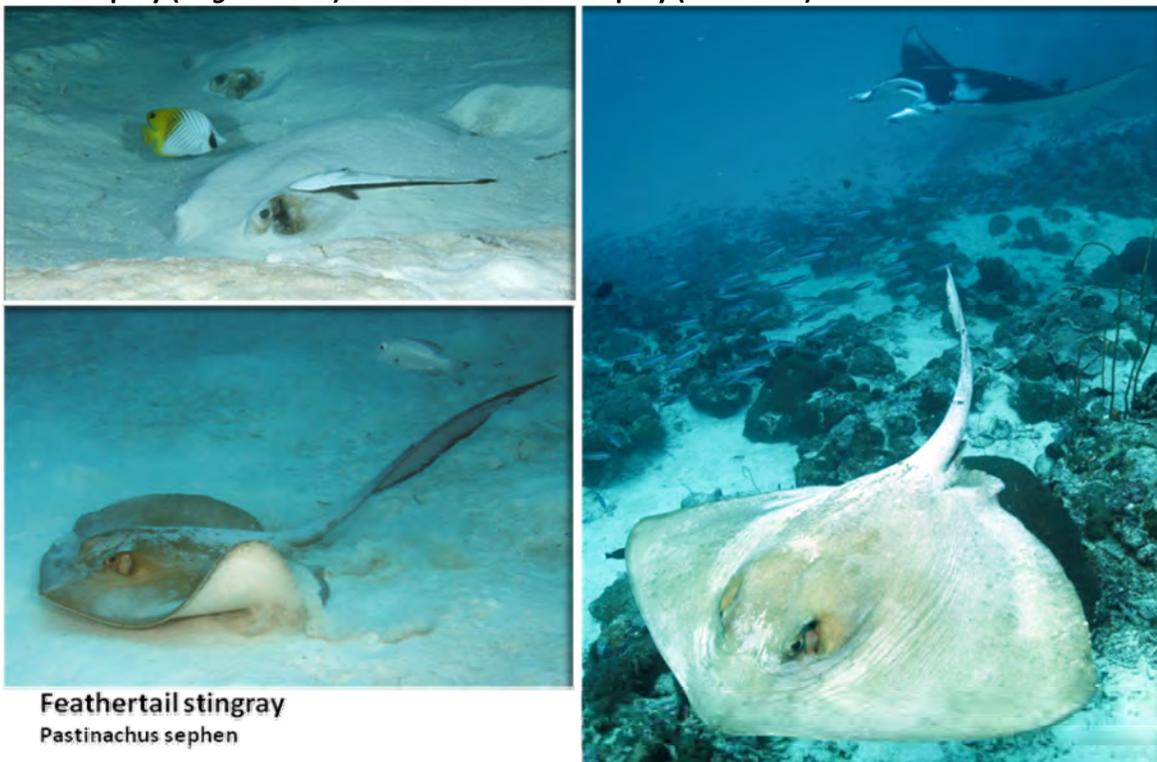


Figure 6. The porcupine ray, *Urogymnus asperrimus*, is so-called because its dorsal surface is covered with small sharp spines.



**Whiptail stingrays**  
*Himantura fai* and other sp.

**Figure 7.** The whiptail stingrays of Palau include the pink whipray (*Himantura fai*), the mangrove whipray (*H. granulata*) and the reticulate whipray (*H. uarnak*).



**Feathertail stingray**  
*Pastinachus sephen*

**Figure 8.** The feathertail stingray is so named because to the broad feather-like ridge on its caudal whip.

## Eagle rays

2 species confirmed in Palau



Ornate eagle ray  
*Aetomylaeus vesperilio*

Spotted eagle ray  
*Aetobatus narinari*

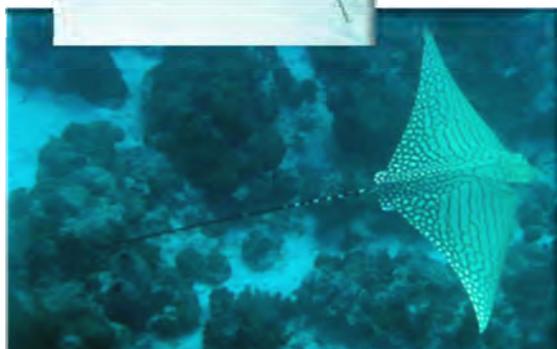


Figure 9. The rarely seen ornate eagle ray, left, is a beautiful but elusive ray. Juveniles are seen around mangrove areas and shallow sandy channels inside the reef, while the adults are found on outer sandy reef slopes and channel mouths from intertidal zone to over 150 feet deep.

The spotted eagle ray, right, is common both inside the lagoon and on outer reef slopes. They are often seen foraging on top of shallow reefs on incoming tides. This ray is considered sacred in Palau, called "*Ochaieu*", and feared by local people even today. It is believed that harming an eagle ray will bring death to one's family members. There may be more than one sub-species of these poorly studied rays, and the pattern on the wings can vary from almost plain bluish-black to intricate mazes of white spots and eye-rings.

All eagle rays probe the sand with their snout which they can curl up when swimming, and they use to locate invertebrates and fishes under the sand.

## Mobula devil rays

at least 3 of the 9 species known are found in Palau waters



Sicklefin devil ray *Mobula tartapanaca*  
Blue Fagner



Japanese devil ray *Mobula japonica*  
German Channel

Figure 10. The mobula devil rays are represented in Palau by at least 3 species, including the sicklefin devil ray, *Mobula tarapacana*, the spine-tail devil ray, *M. japonica*, and the shortfin pygmy devil ray, *M. kuhlii*.

### The Mobulidae - Worldwide and Palau.

Worldwide there are 11 species in the family Mobulidae, consisting of 2 species of manta rays, and 9 species of mobula rays (Table 2). All are filter feeders with forward facing mouths that first appeared in the fossil record only 20 million years ago. Reef mantas are more commonly encountered by divers and tend to be highly social. The name "Manta" comes from the Spanish word "Mantilla" or cloak, with the type species of the genus, *Manta birostris*, described in 1798 by Donndorff. The name "devil ray" comes from the Mantas' cephalic lobes, or mouth flaps, which they use to funnel food into their mouths. When they are cruising, they roll up these flaps, which then look like a devil's horns.

**Table 2. List of manta and mobula rays (Mobulidae), including species known from the Palau Islands.**

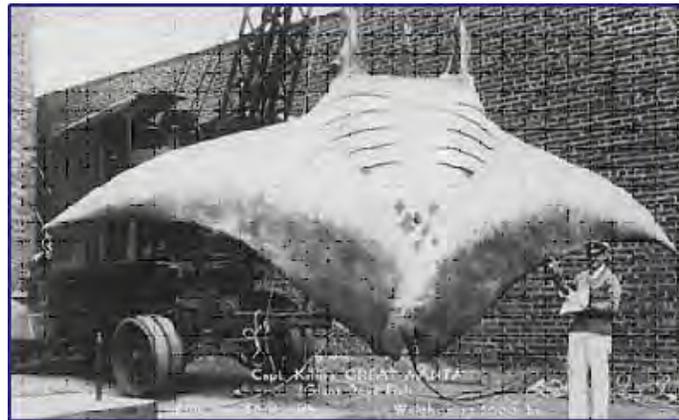
*Manta birostris* - Oceanic manta  
*M. alfredi* - Reef manta, (Palau)

*Mobula eregoodootenkee* - Long-horn pygmy devil ray  
*M. kuhlii* - Shortfin pygmy devil ray, (Palau)  
*M. munkiana* - Pygmy devil ray

- M. japonica* - Spine tail devil ray, (Palau)
- M. tarapacana* - Sicklefin devil ray, (Palau)
- M. hypostoma* - Atlantic devil ray
- M. rochebrunei* - Lesser Guinean devil ray
- M. mobulr* - Giant devil ray
- M. thurstoni* - Bentfin devil ray

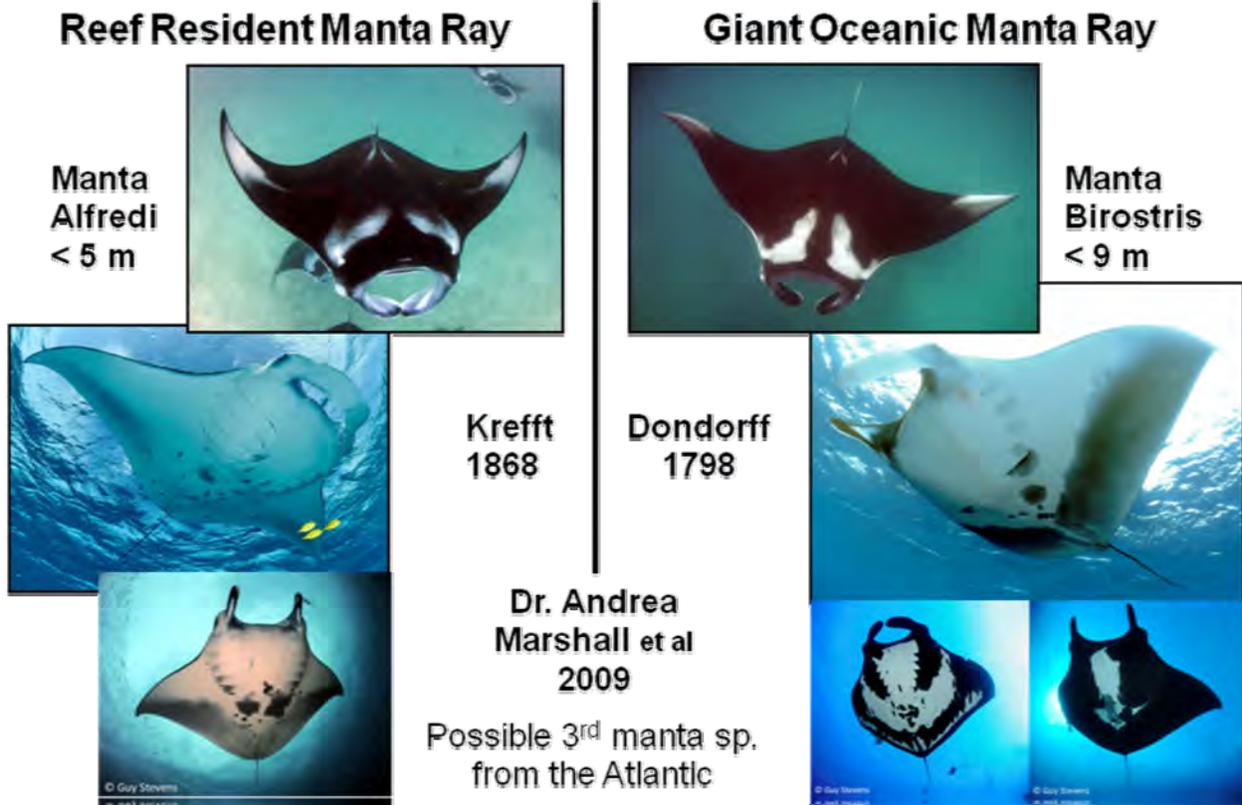
It was only recently confirmed that there are two, perhaps even three, species of *Manta* (Marshall et al. 2009) since little is still known about these mostly pelagic creatures, even though manta rays are some of the largest fishes known. Due to their size, it is hard to preserve specimens for scientific study, which makes comparative study of individuals difficult and has sown confusion as to their taxonomic status. Also due to their size, taking accurate measurements of body parts for comparison is similarly difficult and since they do not possess a hard bony skeleton or a stinger/tail barb, these structure, commonly used for distinguishing elasmobranch species, are not available. Interestingly although mantas swallow their food whole, they still have around 4,000 tiny teeth on their lower jaw. These are believed to be used only by the males during mating, when they grab onto the female's wingtip.

The giant manta (*M. birostris*) has a circum-global distributions, are more oceanic and migratory, and are found in tropical and temperate waters (Fig. 10). The smaller reef manta (*M. alfredi*) prefers warmer, inshore environments, and are found in tropical and sub-tropical waters. Giant manta are estimated to live at least 20 years old, while reef mantas are estimated to reach at least 40 years of age. It is not always easy to tell the two species apart, but with practice this can be reliably done by experienced observers, using a variety of characters (Fig. 11).



**Figure 11. The largest Oceanic manta, *Manta birostris*, ever caught was 6.8m (22ft) and weighed 2,000kg (6,600 lbs). The photo shows a 5,000 lbs Oceanic manta that got entangled in an anchor rope in 1933 off New Jersey, USA. The man is holding an 18 inch stillborn fetus aborted by the distressed pregnant female before she died.**

### Species Identification



**Figure 12.** The differences between the reef manta ray, *Manta alfredi*, and the giant oceanic manta, *Manta birostris*, are fairly subtle. There is a possible third species of *Manta* occurring the Caribbean region. Oceanic manta photographs taken in the Philippines.

At present there are only a few places where both species of manta rays occur together, principally the Philippines, Thailand and Mozambique. In Palau, only Reef manta rays have been seen to date, but the presence of the oceanic manta is highly likely, given the proximity of Palau to the Philippines and the wide geographic ranges of both species. In Palau the reef mantas were well known to in traditional culture and are called "*Ouklemedaol*" locally. Palau has become a manta "hotspots" for tourists, with the prime sites for them inundated with divers at prime times for manta viewing. In the respect Palau has joined other manta dive sites, including the Maldives, Mexico, Mozambique, Australia, Kona-Hawaii, Indonesia, Thailand, and Yap, known for manta ray concentrations. Overall mantas dive sites are extremely important economically as visiting them at such sites is rated high by most tourist divers; a level of economic benefit which might be similar to that derived from sharks.

To further complicate matters, the reef manta has two different color forms, what are known as the "black" and "chevron" patterns (Fig 12). It is not well known what the two different color patterns represent, although individual mantas are consistent in their color over time.



**Figure 13. Reef mantas with the black and chevron patterns are usually not found together, although this photo shows the two types on a reef in Ngardmau State, Palau.**

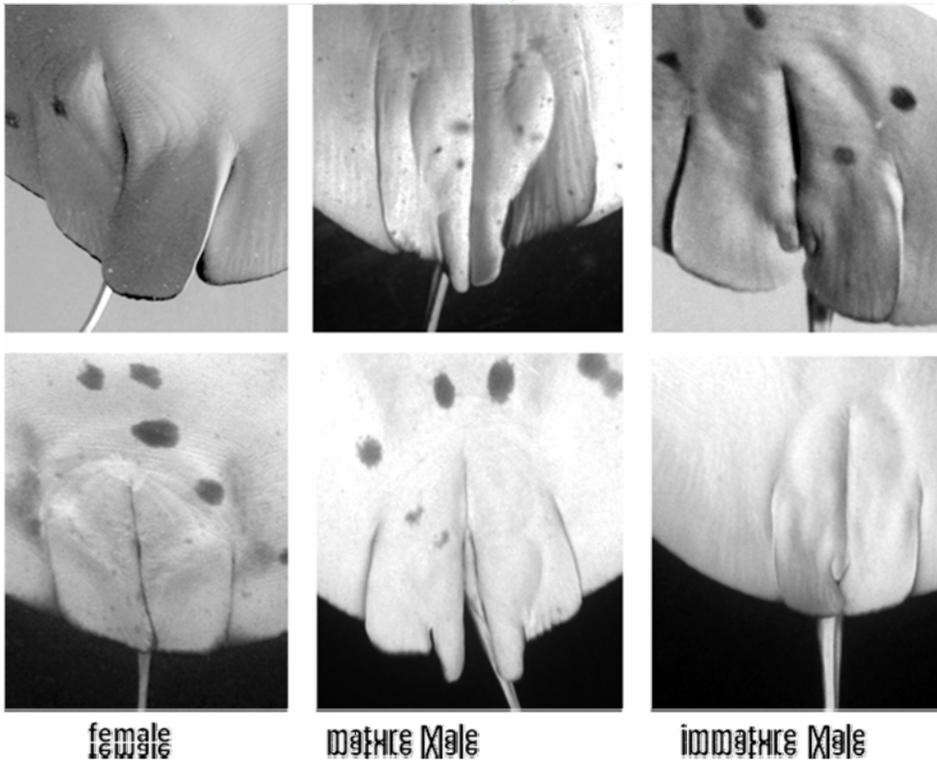
Reef manta rays are resident within limited geographic areas, migrating around a specific home range and appear to follow changes in the seasonal abundances of planktonic food, or to mate and give birth in certain areas. Site fidelity in reef mantas is now known to last multiple decades, allowing researchers to gather in-depth data on the population as a whole and follow the lives of specific individuals as they grow and reproduce.

Mantas also have surprising social interactions. Their large brains and curiosity towards people suggests they may be much more intelligent than scientists previously presumed, given the general intelligence level of fishes. They have the largest brain found in any fish, and one of the highest brain-to-body mass ratios of all fishes with their brains disproportionately large compared to their body size. The overall weight of a manta's brain is comparable to that of a similar sized mammal. Their cerebrum is relatively large, a brain region for many higher functions, including increased sensory functions.

Manta rays must swim their entire lives to survive, constantly in motion without resting for any lengthy period. They feed on tiny planktonic organisms that are filtered from the water as they swim with their mouths open, either by themselves or in groups reaching hundreds of individuals. Their pectoral fins have evolved into wings, and their skin is covered with a mucus to defend against infection. At the base of their long and narrow tail they have a small dorsal fin and lack a spine or stinger on the tail. They visit cleaning stations on the reefs to get their skin, gills and teeth cleaned of parasites, particularly parasitic copepods, by small cleaner wrasses and other fishes. Individual mantas may spend hours every day getting cleaned, often waiting in line at the more popular cleaning stations.

The sex of a manta can be determined by the presence of two claspers visible on the inside of male pelvic fins, which are lacking in females (Fig. 13). Sexual maturity can be confirmed in females if they have mating scars on their left wingtips, and in males is believed to be when their claspers extend well beyond the pelvic fins, and are completely calcified.

### Sexual Dimorphism



**Figure 14. Sexing mature manta rays is relatively straightforward with males having elongate claspers.**

Manta mating has only been observed on a few occasions, and actual giving birth has never been observed in the wild. Manta rays held in captivity since 1988 at the Okinawa Churaumi Aquarium, Japan, had 4 single births in 2007, 2008, 2009, and 2010 from the same female. The first newborn was killed by the adult male, its father, and newborns are now separated for the first year and raised in open ocean pens before being returned to the display tanks with the adult mantas. Mantas are oviparous, giving birth to a live pup that hatches from an egg inside the mother. Gestation is around one year, which was learned from the captive births. A pregnant female close to giving birth has an obvious "hump" on her back as well as a rounded belly. The newborn comes out with its wings folded over its head and once the wings are unfolded spans about a meter across. There is no parental care, being abandoned at birth by the mother, and newborns grow very rapidly the first year. The females usually mate again right after giving birth.

### **Threats to the general population on mantas worldwide from fishing and by catch.**

In recent years trade in the large gill rakers of mantas has developed which provides another threat to their populations in much of the world (Fig 14), paralleling the trade in shark fins. In some areas mantas are also caught for food, the wings being cut off for their meat (Fig. 15). Finally to make things even worse, many types of nets and other fishing gear used in oceanic fisheries pose a general threat to manta populations (Fig. 16).

Figure 15. Like shark fins, the gill rakers of mantas are highly prized and used for soup.

## Gill Rakers

WHY?? New Asian demand for dried manta gill rakers to replace shark fins in traditional medicines & soup



## Manta Fisheries



Figure 16. Manta fisheries occur in many parts of the world and the fins contain a large amount of meat.

## Worldwide threats to Manta Rays

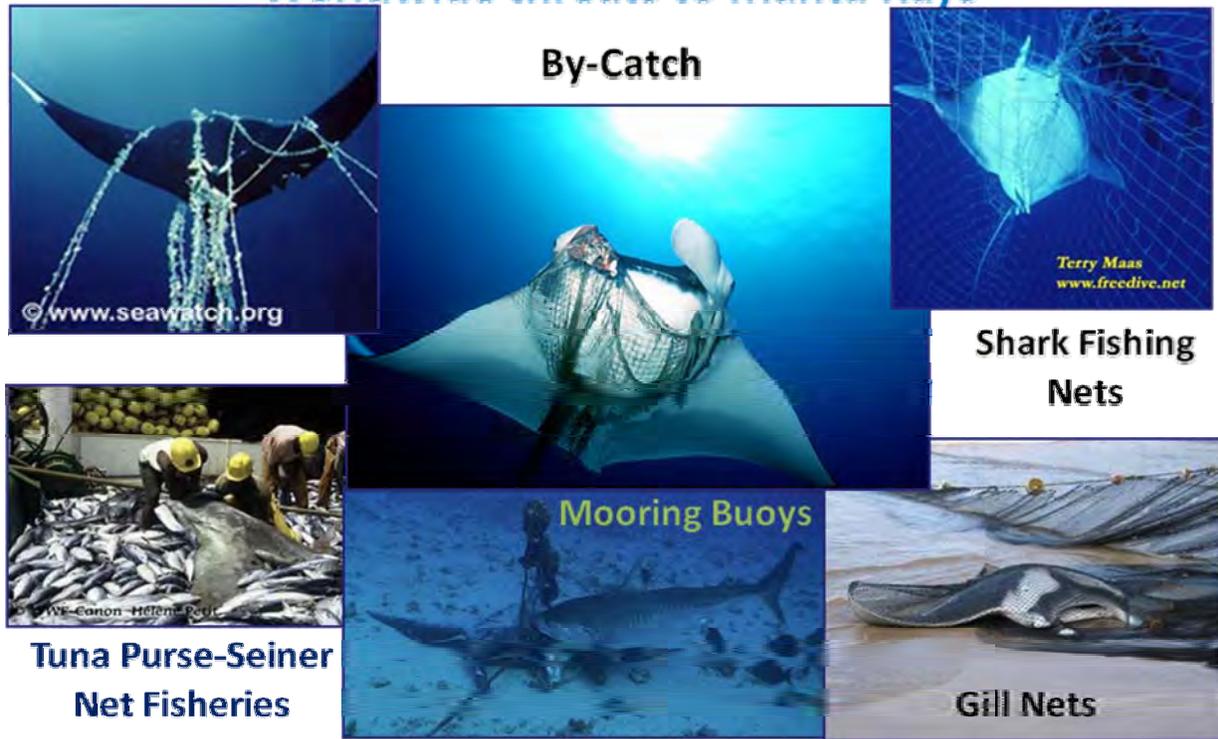


Figure 17. Manta rays are caught by accident in a wide variety of fishing gear and mooring buoys, ending up as by catch.

### CITES - March 2013 - An important step in protection of manta rays under Appendix II of CITES

During the 16th meeting of the Convention on International Trade in Endangered Species (CITES) in Bangkok, Thailand in 2013, both the giant manta ray (*Manta birostris*) and the reef manta ray (*Manta alfredi*) were given protection under Appendix II of CITES, being listed by experts as globally threatened species vulnerable to extinction. These creatures are worth an amazing US\$ 140 million to the global tourism industry annually, but also have commercial value and are being overexploited in international trade of their gills and meat. This move will hopefully help save the mantas worldwide.

In some areas, like Hanifaru Bay in the Maldives, tourism pressure has caused the manta rays to move away from the area. Due to increased tourism pressure after the publication of a National Geographic article in 2009, the Maldives now prohibits scuba and boat entry into the bay as of January, 2013. Some other areas have taken their own steps to protect Manta rays. In Hawaii and Yap, manta rays are protected by state law (H.B.366 2009- no harvest or trade, Yap Manta Ray Sanctuary Protection Act 2008).

### 1.3 Manta ID Palau Project 2010-2013

Very little had been known regarding the occurrence of manta rays and related elasmobranch fishes in Palau. Manta rays, locally called "*Ouklemedaol*" were well known in traditional Palauan culture, but did not play as large a role culturally as other charismatic species such as dugong, fruit bat and crocodiles.

Palauans fished mostly inside the reefs and therefore probably rarely encountered these rays. The diving industry in Palau was aware of the presence of manta rays, but no specific focus was placed upon mantas until relatively recently because encounters could not be guaranteed as in Yap. Years earlier, Yap had become synonymous with manta rays for diving in the 1990s, while this was almost unknown in Palau. However, with extensive observations at a few sites, such as the German Channel manta cleaning station, the Palau tourism industry realized that Yap had no monopoly on manta rays in Micronesia, and that it is just a matter of learning more about predicting their movements around the reefs to locate them.

At present a visit to the manta site at German Channel is considered virtually a "must do" for diving and snorkeling tourists, to the point the site is overwhelmed with people who are potentially disrupting normal behavior and causing the mantas to go elsewhere. Manta are endangered by diving practices, such as divers touching the mantas or sending up surface buoys up in which they can become entangled, and the presence of so many boats passing through the manta dive areas at high speed. Dive shops have also been searching for new manta locations so they can take their customers to areas that are not already overrun with other tourists, so the pressure from the tourism industry on mantas in Palau is now being expanded out to other areas that were either unknown or rarely visited in past time. Careful consideration is needed for management of manta sites, and the question of whether some sites should be made off limits to divers deserves special attention.

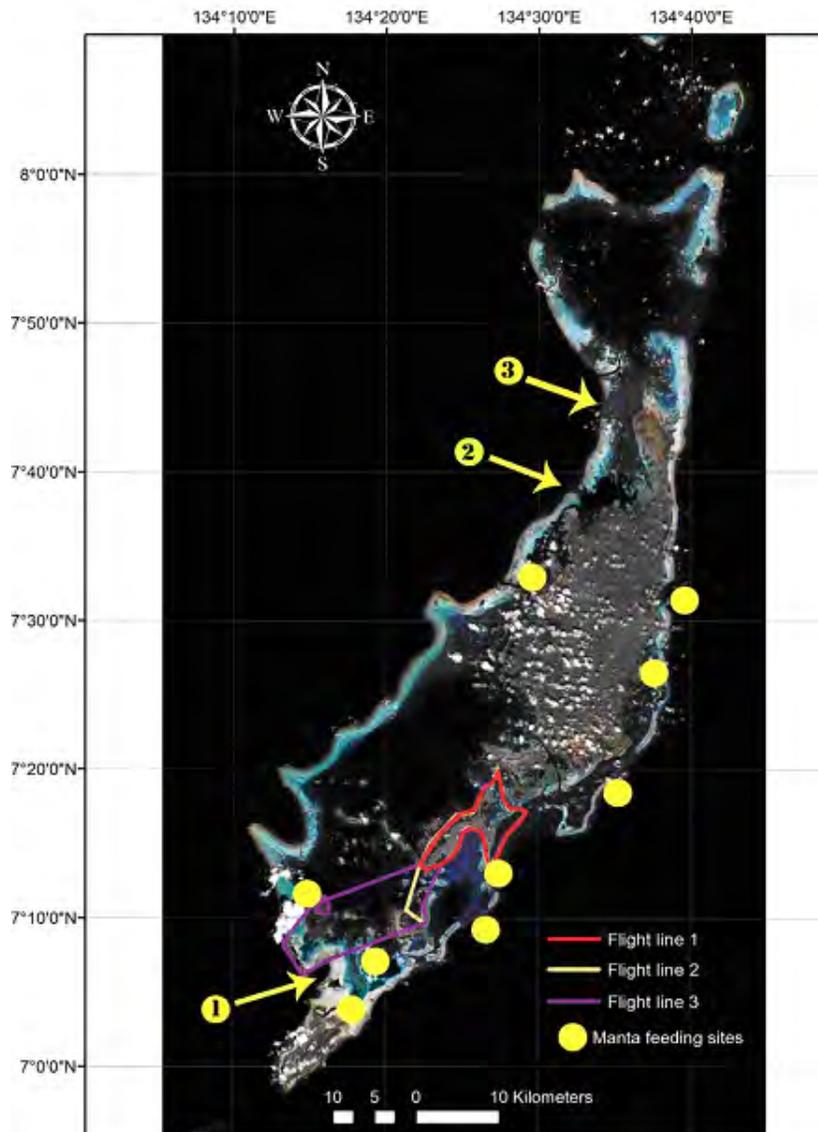
In the consideration of these needs and our general lack of knowledge, it was decided in 2010 to start focusing some attention on mantas and the occurrence in Palau, hence the initiation of "Manta ID project". The project has gathered a vast amount of new information on manta rays in Palau and been able to estimate minimum population size through photo identification of individuals from their color patterns and other identifying marks.

## **2.0 Methods**

### **2.1 Surveys**

Over one hundred dive and snorkel surveys were conducted for Manta rays between October 2010 and July 2013 at different moon phases, at the known manta sites of German Channel, Devilfish City, and Ngarchelong cleaning stations, as well as at new sites located with the aerial surveys. Each Manta ray is born with a belly spot pattern and back pattern that is unique, like a finger print so they are easy to identify with photographs of the belly spots. Such photos can be taken while snorkeling when they are feeding, looping over so the normal underside is visible from the surface, or by using scuba at the cleaning stations and photographing upward from below the mantas. These photographic surveys have resulted in identification of over half of the 235 Manta individuals known from Palau.

Sixteen aerial surveys using a helicopter were conducted to try to locate previously unknown Manta feeding sites during strong incoming tides before and around the full and new moon phases. This resulted in discovery of several new sites which we will be monitoring in upcoming seasons. At present there are approximately 13 known sites for manta feeding in Palau (Fig. 17), the occurrence and exact location of some of these are considered sensitive information which is not shared or publicized yet to give us a chance to study the areas first before tourist boats visit these sites. We hope that someday some of these sites can be designated as "manta protected areas" that are, in essence, no boat entry or scuba diving zones, so that there will be manta snorkeling sites that have minimal disruption to their normal behavior.



**Figure 18.** This satellite image of Palau shows the three normal tourist helicopter flight routes (purple, yellow, red lines) and the locations of manta feeding sites (yellow circles). The three principal feeding sites studied are German Channel - Koror State (1), Devilfish City or Eregoll Iwekakou - Ngardmau State (2) and Yengl Channel - Ngarchelong State (3). The yellow circles show an additional 10 manta feeding sites that are now known. Others certainly remain to be discovered.

Up to 10 time-lapse still cameras were set out at the new Ngarchelong cleaning stations during the months of February- April, 2013 on each moon phase. The camera systems use a GoPro Hero 2 camera in water proof housing with a large external battery pack allowing multiple days of photography. The cameras were set to take photo every 30 seconds for up to five days, and is aimed at the area where the manta rays would pass by or be cleaned. These were set out at a newly discovered Manta cleaning station site for several months during different moon phases. The time lapse cameras were able to photograph dozens of mantas previously unknown in the individual photo data base, helping to expand the known population.



Figure 19. Manta ray seen using a Remote Operating Vehicle (ROV) at 408 foot depths, Short Drop Off, Palau, 19 March 2013. The badly scarred manta just swam by the ROV without missing a beat of its wings.

Incidental observations of mantas were also gathered from divers and researchers who saw or photographed mantas outside of our surveys. The most exciting of these individual observations was the documentation of a large manta swimming past a remote operating vehicle (ROV) at 400 foot depth on 19 March 2013 off Short Drop Off (Fig. 18). Unfortunately this manta swam below the camera on the ROV, so we could not see its spot pattern from the video, otherwise might well have been able to identify it as a given individual. This is the deepest record for a manta ray in Palau, but is not particularly deep for manta rays.

## **2.2 Awareness, education, data sharing and website - Engagement and outreach.**

Incidental observations of mantas were also gathered from divers and researchers who saw or photographed mantas outside of our surveys. The most exciting of these individual observations was the documentation of a large manta swimming past a remote operating vehicle (ROV) at 400 foot depth on 19 March 2013 off Short Drop Off (Fig. 18). Unfortunately this manta swam below the camera on the ROV, so we could not see its spot pattern from the video, otherwise might well have been able to identify it as a given individual. This is the deepest record for a manta ray in Palau, but is not particularly deep for manta rays.

The website for the Manta ID project describes the ongoing education efforts and research activities of the program ([www.mantaidpalau.org](http://www.mantaidpalau.org)). The front page for the website is shown in Figure 20 below. A PDF of the 2013 dugong and manta "Kid's Activity Book" can be downloaded from the website. This booklet was published in January, 2013 and distributed to all local elementary schools in Palau for free to raise local awareness of these two unique but poorly known species with current information on their biology and behaviour in Palau, and with games, stickers and quizzes.

Photos of mantas taken by visitors to Palau, who nearly all come to scuba dive and consider a manta site a "must do" on their vacation, can be uploaded to the site to increase knowledge of manta occurrence in Palau, and help identify new individuals. If a new manta ray individual is found, the person submitting the photo ID can name the manta ray. The main project activity for the last two years has been to see how many manta rays Palau has, which has resulted in 235 identifications. Existing sites were surveyed and monitored, and several new sites are under observation and will be surveyed more in the coming season. The project started working with three of the local range states, Koror, Ngardmau and Ngarchelong, to learn more about the sites there and the movement of manta rays around Palau and the varying seasons, which is important to local tour operators and for future site management. Surveys will continue for several seasons in these three survey sites to be able to pinpoint the exact months and moon cycles when the manta rays show up to feed and/or clean there.

Upcoming activities will include posters of Palau's most often seen/popular manta rays at German Channel for distribution to local tour operators and hotels, and a new edition of the "Ouklemedaol" booklet on Palau manta rays which will be for sale in local stores to help fund the fieldwork for this project.

**Figure 20. The front page of the Palau manta ID website shows the range of activities and provides for downloading items and uploading photographs of manta for inclusion in the photo database.**



### MANTA ID PROJECT

Manta rays have become a major attraction for snorkelers and divers visiting Palau, but little is known about these beautiful creatures because they spend most of their time in open ocean. The only times we get to see them is when they come close to the reefs to feed or get cleaned at coral cleaning stations.

Mantas are vulnerable to boat and tourism pressure, and wrong behavior by groups of divers and snorkelers may cause the mantas to move away from their traditional mating and birthing sites in Palau which they return to each season. Popular and crowded manta sites such as German Channel need to be managed more carefully by the stakeholders to ensure that both mantas and visitors can safely enjoy these encounters.

We started this web database to collect information on Palau's individual mantas, and share with you what we have learned from observing and photographing them in Palau for the last 25 years.

[www.etpisonmuseum.org](http://www.etpisonmuseum.org)

[View our Project Sponsors & Local Partners](#)

### GOALS & FIELDWORK

Read the [latest news](#) available.

- Study manta movements around Palau and find new sites using boat/snorkel/dive and helicopter surveys
- Make recommendations to National and State governments on site management and demonstrate the ability to observe and study the mantas around the tourist sites without using invasive tagging methods
- Collect manta ID's, monitor resident manta behavior using time-lapse camera surveys and underwater photography
- Maintain and seasonally update the Manta ID Palau website and Palau database



### KIDS ACTIVITY BOOK

As part of our awareness campaigns, we published a 2013 kid's activity book on dugongs and manta rays. During their visit to Palau in March 2013, Prince Albert and Princess Charlene of Monaco gave the first copies to 7th and 8th grade students in Palau. All elementary schools on Palau received free copies of the booklets. [Download a PDF copy for yourself.](#)



### MANTA TRUST

Follow Us:



Our Palau Project has teamed up with the Manta Trust Organization to be involved with and learn from worldwide manta research and conservation efforts. Learn more about the Manta Trust Organization and manta rays worldwide.

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### 3.0 Results of Program 2012-2013

Activities and results since we started monitoring Palau's Manta rays in 2010 can be summarized as follows:

- **Started and maintain a public Palau Manta website/ database with seasonal updates**  
*www.mantaDpalau.org*
- **Identified 235 individual manta rays in Palau**
- **Continue to use photo-identification to identify and track known and new more individuals for updating the population estimate**
- **Initiated a PADI Palau Manta ID Specialty dive course teaching divers how to interact with Mantas**
- **Continue to use helicopter surveys to monitor Manta movements around Palau**
- **Published a free Kid's Activity book on dugongs and manta rays for all Palau 7 & 8<sup>th</sup> graders**
- **Published a 45-page information booklet "Ouklemedaol" on Palau manta rays**
- **Started to work with local states on site management and legislation to protect manta rays**

#### 3.1 Aerial and Underwater Surveys

Helicopter surveys for manta rays have proven very effective to locate new feeding areas (Fig. 17). Surveys have to be done around the full, half, and new moon, on incoming tides, which is when the Mantas come up to the surface to feed around reef passes and channels. Since two of the Manta feeding sites/survey sites of Ngardmau and Ngarchelong State are well outside the regular tourist sightseeing helicopter flight routes, there are not many incidental sightings of feeding manta aggregations outside the Rock Island lagoon area. During the 16 charter flights we collected data on manta feeding, which can be identified by the mantas looping vertically in patches of plankton, along the east and west reefs of Palau between Peleliu and Ngarchelong State with GPS coordinates to follow up with boat surveys. The challenge with monitoring feeding manta rays is that they change location based on where the plankton is thickest, which depends on the wind direction, current and tides. There are some feeding areas believed to be locations where stable circulation, and perhaps upwelling, concentrates zooplankton. The German Channel area, which is shaped like a bottle-neck and is the terminal end of a large submarine canyon, is believed to be one area where plankton gets "trapped" or concentrated much of the time, hence has reliable occurrence of mantas. At other sites, the conditions may change on a daily basis based on wind and tides, and is difficult to predict when feeding by mantas will occur there.

**Figure 21. Next page. From April-July, 2013, weekly aerial surveys were done using Rock Island Helicopters (top). In 2011- 2012 there was no helicopter operating on Palau, so aerial surveys for mantas were done by Ms. Etpison whenever possible using helicopters from visiting private yachts, Alucia (Jan, 2013), Plan B (Jan, 2011), and the Veldemiare French military vessel helicopter (Feb, 2012).**



Boat and snorkel/scuba surveys provide important insight into their behavior, while photography is important to collect identification data. The slower speed of a helicopter, relative to fixed wing aircraft, allows more careful inspection of areas, and a helicopter's ability to stop, hover, and turn sharply are all positive factors in obtaining high quality data and photographs. Helicopter surveys were conducted only on a few occasions between February 2011 and April 2013, when no helicopter operation was available and we had to rely on donated airtime from visiting yachts with helicopters. However, the 16 aerial surveys conducted between April, 2013 and July, 2013, for both Dugongs and manta rays, were possible because Rock Island Helicopters started operations again, with pilot Matt Harris, who has flown aerial surveys by plane and helicopter in Palau since 1999. It seems likely we will have the capability of doing helicopter surveys for the immediate future, although such businesses rely largely on tourist flights, during which additional observations are often made, to form their core of revenue.

Over 100 boat, snorkel and scuba surveys were conducted regularly on the days before every moon from October 2012 through July, 2013, and resulted in location of several new sites and the 235 individual manta identifications we have to date.

### **Manta survey sites 2012-2013:**

- 1) German Channel (Koror State)
- 2) Devilfish City- Eregoll Iwekakou (Ngardmau State)
- 3) Yengl Channel (Ngarchelong State)

The satellite image (Fig. 17) shows the three normal flight lines of the regular tourist helicopter flight routes. Aside from the German Channel area, most of the manta feeding areas found so far are outside the regular flight routes, making gathering data on these sites somewhat intermittent. The yellow dots without numbers show new feeding sites found by helicopter during the surveys, which will be monitored further by boat during the next season (Fig. 17).

For the time lapse camera deployments, the best result obtained from one 5-day period during which 44 different manta individuals were identified. Some individual manta are known only from the time-lapse camera photos and have never been seen at any of the dive sites or by diver elsewhere (Fig. 21). This non-invasive survey method is particularly useful since it not only collects data on new identifications, but also records times of the day/tides that the mantas show up to get cleaned there, as well as the times they are not present. Such continuous information on presence/absence at a given site is important in understanding the behavior of the mantas, and for tourism is useful to identifying the best time to see mantas at a given site for local dive operators and for future site management planning.

**Figure 22. Next page. Upper left and right - Time lapse GoPro camera systems used in doing time-lapse photographs of manta rays. Middle left - a diver swims the systems to the locations for deployment on the reef. Middle right and lower - time lapse cameras in place on reef photographing the manta without any human presence (once the photographer that took the photos is gone!).**



As indicated previously it is believed manta are highly intelligent fishes and from the examination of photographs, we noticed was that the mantas seemed very aware of the cameras being there present at the sites. While the cameras are small and tied low to the reef (Fig. 22), but the animals appeared to know immediately that something was different and possibly "out of place" at their cleaning station, judging from the many photographs of manta eyeballs and close-ups of them approaching the cameras with their cephalic sensory flaps opening and closing. (Fig 22). While anecdotal and qualitative, such observations provide us with a fresh perspective on these remarkable fishes which undoubtedly hold many mysteries with regard to their biology and social interactions.

**Figure 23. Manta behavior photographed with the unattended time-lapse GoPro cameras. The cameras are left out for several days, taking photos at 30 second intervals, to track the presence of mantas at cleaning stations and feeding sites.**

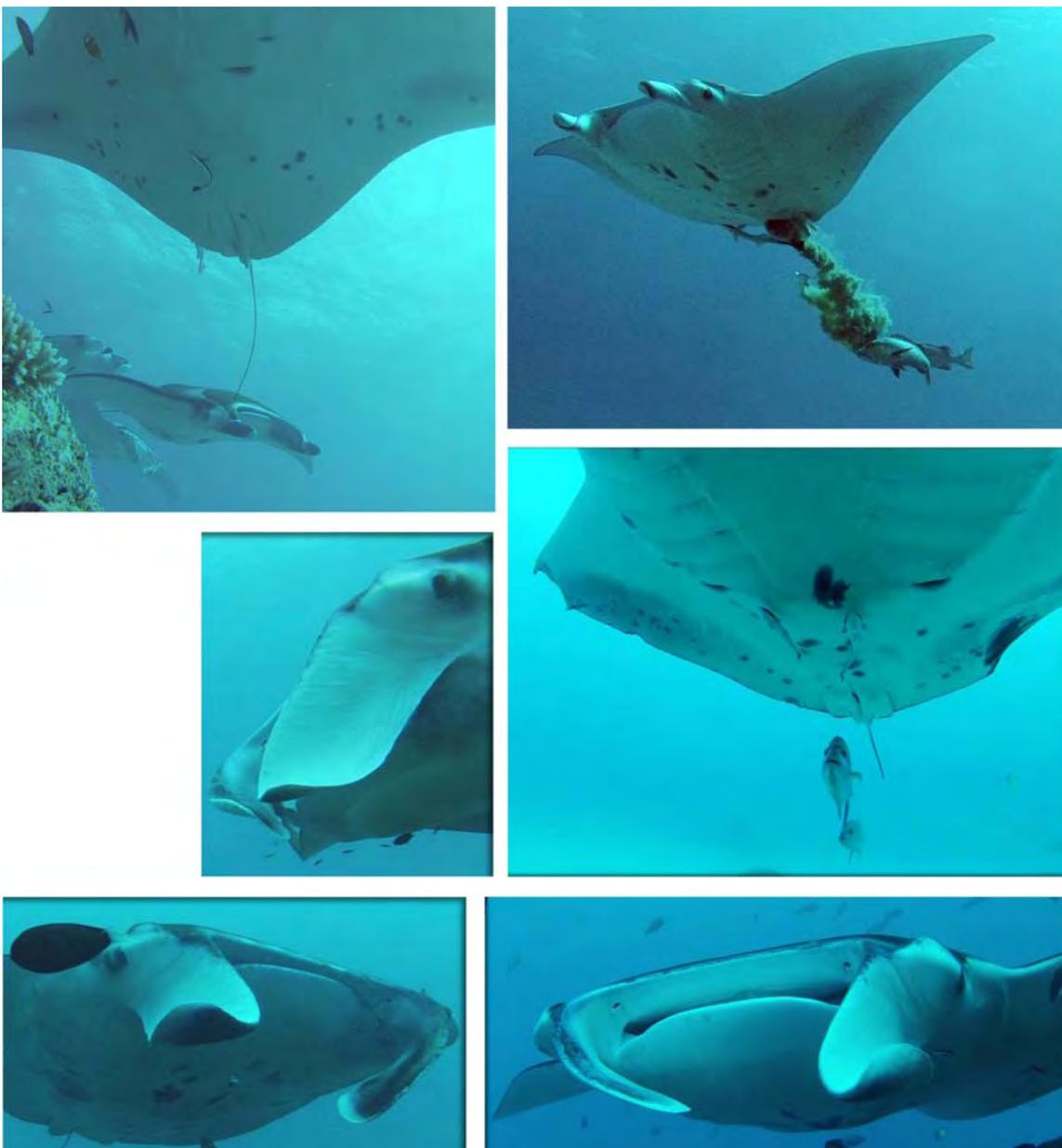


Figure 24. Plankton nets are used during the surveys to collect, examine and photograph the tiny creatures mantas feed on, most the size of a pin-head, only a few mm across.



Manta rays can be seen feeding close to the surface, alone or in aggregations. They feed on tiny planktonic organisms (Fig. 23) and occasionally small fish that are filtered from the water as they swim with their mouths open (Fig. 24). When the incoming current is strong, they come close to the surface and unfold their cephalic fins to funnel food into their wide-open mouths. They sometimes feed in "trains", one manta closely following another. When the current is less strong, they often start "barrel-rolling", doing backflips to push the plankton into their mouths (Fig. 25). On days after the strongest incoming tides, mantas are often seen rolling around far inside the lagoon in shallow pockets where the plankton has been carried.



**Figure 25.** When a manta ray swims with its mouth open, water entering the mouth exits through the gill rakers which filter out small creatures in the water.



**Figure 26.** In areas where plankton is somewhat concentrated, manta rays will do vertical loops ("backflips") to keep filtering the plankton from areas of high concentration. If the plankton is concentrated in patches, otherwise they would have to turn and pass back through the plankton patch, a much less efficient method.

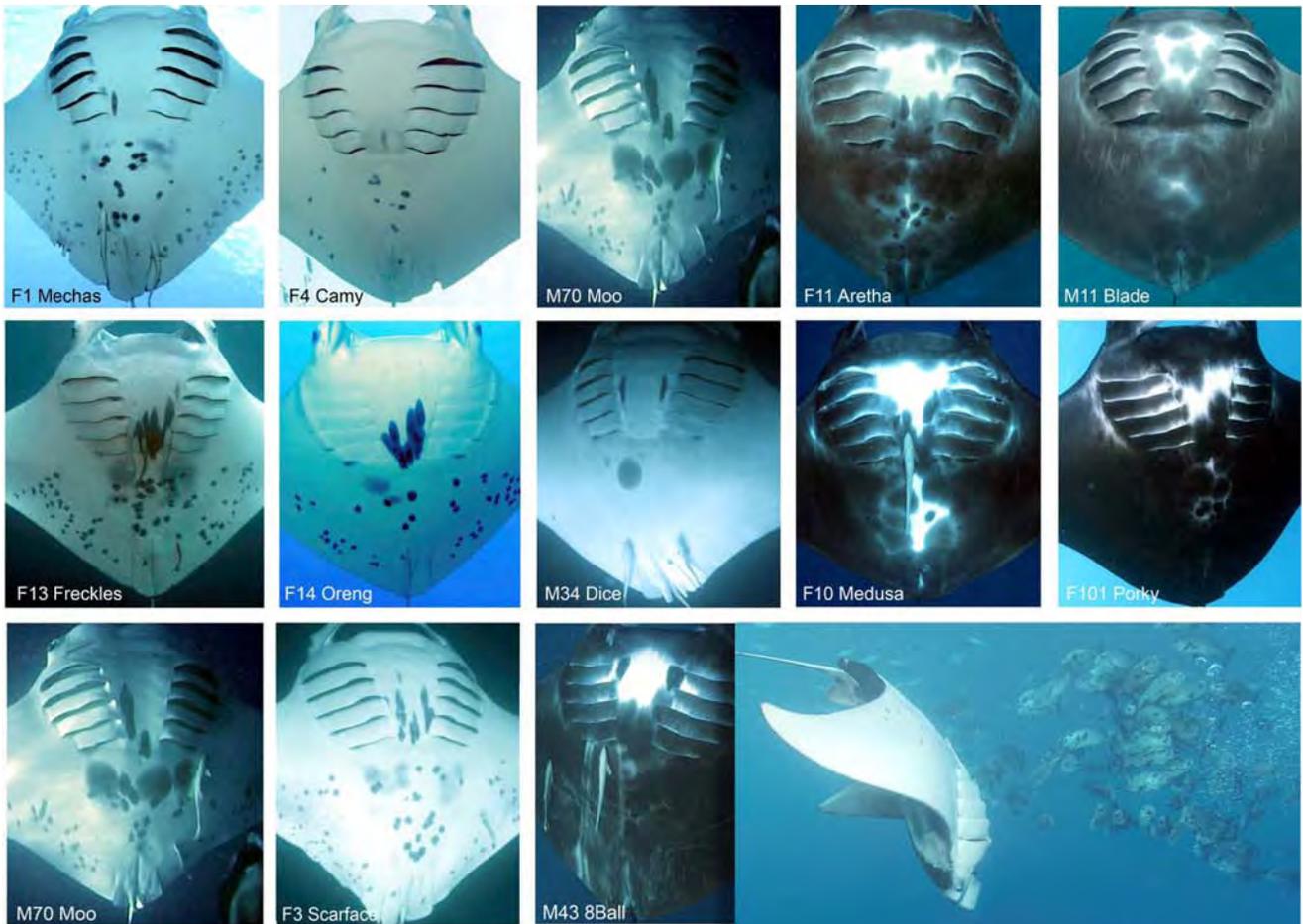
During the 2012-2013 Project we started collecting plankton at manta feeding sites to qualitatively examine the plankton mantas feed on in more detail (Fig. 23). Cephalic fins/flaps are used to funnel food into their mouths, and are also used as sensory organs (Fig. 22). The gill rakers, shaped like large combs, filter out planktonic animals from water passing through the mouth, while oxygen is also absorbed from the water as it flows through the gills (Fig. 24). Manta rays have to stay in constant motion to get enough oxygen by keeping water moving over their gills. Although plankton identification and density research has been done all over the world, it will be useful to find out which species the Palau mantas prefer and are present in the water when large Manta aggregations take place. Also, in other locations mantas are known to feed on certain species of freshly spawned fish eggs, something not yet recorded from Palau, but likely. We will continue to do simple plankton collections in the coming years to find out more details on the food preferences of Manta rays in Palau. Such information, in combination with increasing knowledge of oceanic circulation and bathymetry around Palau, will help us locate new manta feeding sites in the future once the search criteria are refined. The stage is also set for a detailed quantitative study of the relationship of zooplankton and manta rays in Palau's waters. Such would be a major undertaking, but important in understanding this fish so important for the tourist trade.

### 3.2 Palau Manta ray database

During our 2010-2013 surveys we identified a total of 235 different Reef Manta rays (*Manta alfredi*) from belly photographs (Fig. 26). All of these are clearly identified by belly pattern and gender, and given a Female/male designation and number. The unusual or melanistic black morph Manta variation is almost completely dark brown above and below, but still has clear white and black belly spots, making it possible to identify them just as easily as the regular Mantas. The 235 mantas documented in Palau comprise 127 females and 108 males. Fourteen have been born since 2009, 5 females and 9 males. There are 12 known sideways feeders (6 females and 6 males) as well as 16 black morph individuals (7 females and 9 males). The even rarer white morph variation has not been seen in Palau as of yet. Some Manta individuals are lighter than others, and one Palau Manta has been observed "losing color" over the years. The database of 235 belly photographs shown in **Appendix II**, is also available to the public and posted on the [www.mantaIDpalau.org](http://www.mantaIDpalau.org) website, which will be updated every summer after each annual manta season (October-June).

Most individuals were encountered and photographed on more than one occasion, and sometimes at several different sites around Palau over the years. Several dozen more manta belly identifications await second sightings or better photographs to confirm their gender before they will be entered into the database. While some individuals are residents at the German Channel site, staying there almost year-round, we have learned from observations during the last season that other mantas move around a lot, and individuals identified in Ngarchelong State showed up at Devilfish City, and also inside the lagoon of Ngemelis area one month later. German Channel residents such as F2 Romana, F4 Camy, and F1 Mechas, are some of the most photographed mantas in Palau, and Mechas has been seen and photographed there for over 20 years, and was observed pregnant several times in recent years.

**Figure 27. Next page. Examples of manta photo ID pictures.**



Palau's Manta rays were identified using photos of the bellies clear enough to show important individual markings and gender. new feeding sites were identified using helicopter surveys. These were followed by boat, snorkel, scuba and time-lapse camera surveys with fieldwork support provided by Neco Marine from 2010-2013.

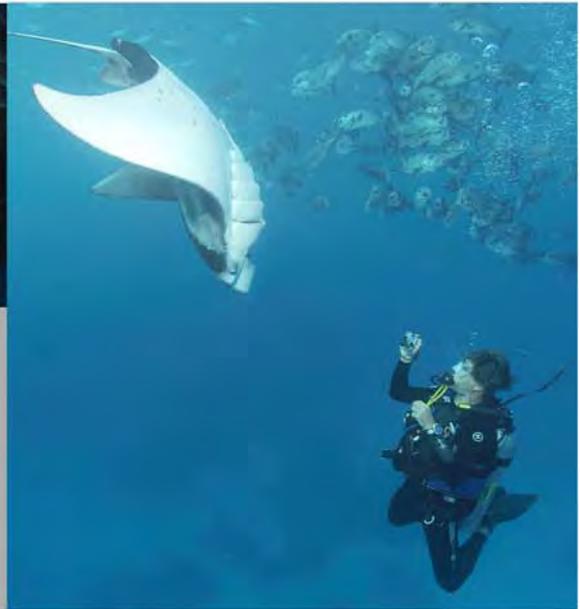
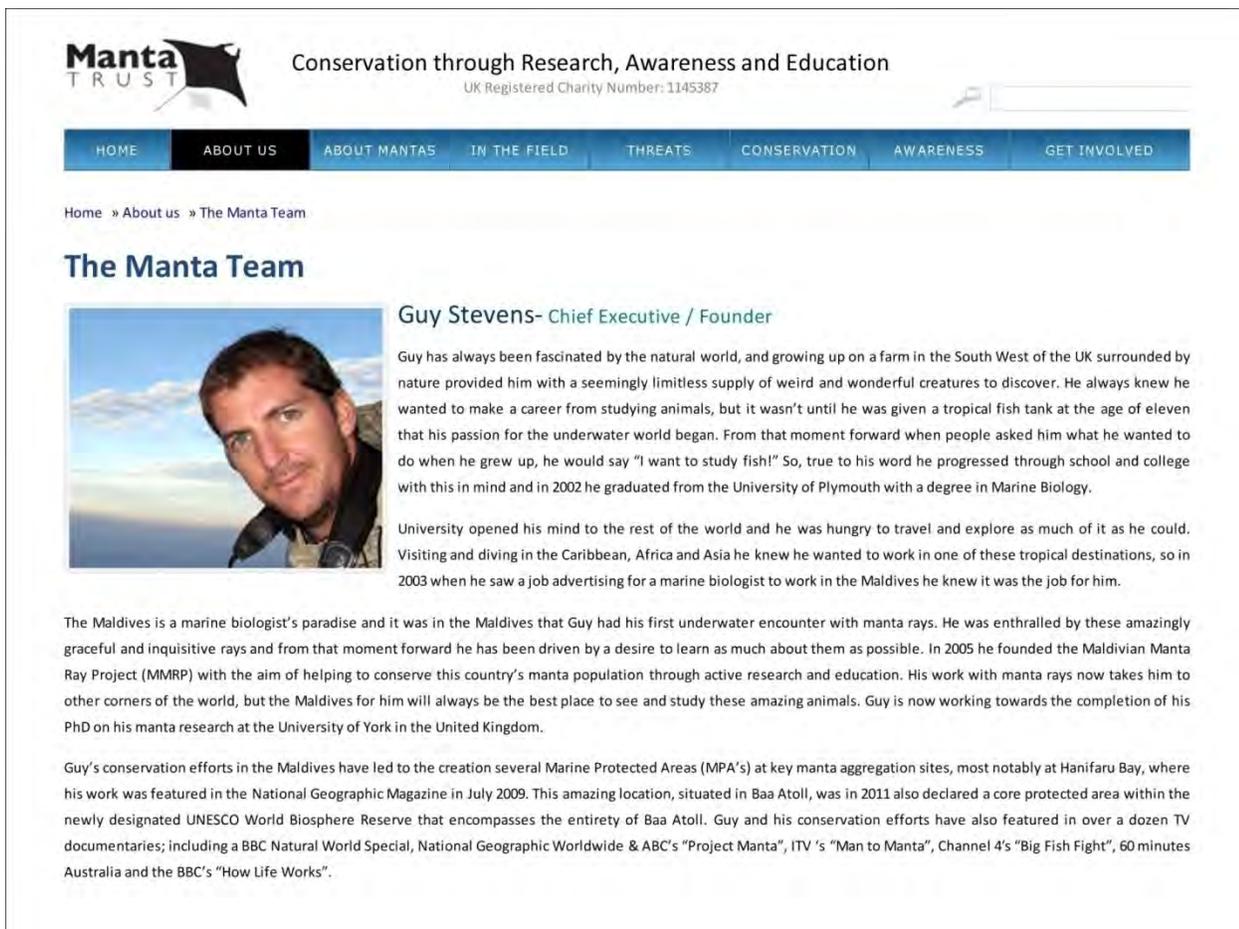


photo by Niall McCarty

### 3.3 Collaboration with the Manta Trust on data and research

In May, 2013, the Manta ID Palau Project teamed up with the global organization **Manta Trust** to assist Palau in exchanging data and research with other manta range countries and experts around the world (Fig. 27). Instead of starting from scratch, Palau will be able to learn from other countries' experiences with manta research, fisheries, tourism, and management. Yap is also a part of the Manta Trust team effort.



**Manta TRUST** Conservation through Research, Awareness and Education  
UK Registered Charity Number: 1145387

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## The Manta Team

**Guy Stevens- Chief Executive / Founder**

Guy has always been fascinated by the natural world, and growing up on a farm in the South West of the UK surrounded by nature provided him with a seemingly limitless supply of weird and wonderful creatures to discover. He always knew he wanted to make a career from studying animals, but it wasn't until he was given a tropical fish tank at the age of eleven that his passion for the underwater world began. From that moment forward when people asked him what he wanted to do when he grew up, he would say "I want to study fish!" So, true to his word he progressed through school and college with this in mind and in 2002 he graduated from the University of Plymouth with a degree in Marine Biology.

University opened his mind to the rest of the world and he was hungry to travel and explore as much of it as he could. Visiting and diving in the Caribbean, Africa and Asia he knew he wanted to work in one of these tropical destinations, so in 2003 when he saw a job advertising for a marine biologist to work in the Maldives he knew it was the job for him.

The Maldives is a marine biologist's paradise and it was in the Maldives that Guy had his first underwater encounter with manta rays. He was enthralled by these amazingly graceful and inquisitive rays and from that moment forward he has been driven by a desire to learn as much about them as possible. In 2005 he founded the Maldivian Manta Ray Project (MMRP) with the aim of helping to conserve this country's manta population through active research and education. His work with manta rays now takes him to other corners of the world, but the Maldives for him will always be the best place to see and study these amazing animals. Guy is now working towards the completion of his PhD on his manta research at the University of York in the United Kingdom.

Guy's conservation efforts in the Maldives have led to the creation several Marine Protected Areas (MPA's) at key manta aggregation sites, most notably at Hanifaru Bay, where his work was featured in the National Geographic Magazine in July 2009. This amazing location, situated in Baa Atoll, was in 2011 also declared a core protected area within the newly designated UNESCO World Biosphere Reserve that encompasses the entirety of Baa Atoll. Guy and his conservation efforts have also featured in over a dozen TV documentaries; including a BBC Natural World Special, National Geographic Worldwide & ABC's "Project Manta", ITV's "Man to Manta", Channel 4's "Big Fish Fight", 60 minutes Australia and the BBC's "How Life Works".

**Figure 28. The Manta Trust website has basic information on manta ray biology and conservation.**

The Manta Trust has the vision of "A world where manta rays thrive within a globally healthy marine ecosystems". Their mission is to advance the worldwide conservation of manta rays and their habitat through robust science and research, raising awareness, providing education, influence and action. They currently work with regional projects in the Maldives, Sri Lanka, India, Indonesia, Mexico, Costa Rica, Hawaii, Fiji, and the Philippines. In Micronesia they have teamed up with projects in Guam and the Mariana Islands, Yap and the Federated States of Micronesia, and our project in Palau. This will enable Palau to have the latest information and data on worldwide manta research, legislation, and advise from scientists.



### Seasons of Change

Lying close to the equator and within the doldrums, the Maldives rarely experiences any severe weather events. However, the Maldives has two distinct Monsoons (Seasons) a year which shape the prevailing weather patterns and drive the ocean currents. This year in the Maldives the winds of change did not blow as expected, reducing productivity and significantly affecting the feeding aggregations and reproductive success of the resident population of manta rays... [\(more\)](#)

1 2 3 4 5

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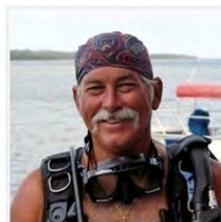
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Photo Stories



**Bill Acker- Project Leader (Federated States of Micronesia)**  
Nick-named "The Manta Man" Bill Acker is legendary throughout the scuba diving community as the pioneer of dive industry in Yap and for identifying one of the first manta dive spots in the waters of this island. For thirty years now Bill has been diving with the Yap mantas and knows most of the individuals by sight!  
Originally from Texas, Bill grew up fascinated with the South Pacific and after graduating from The University of Texas with a degree in Marketing he joined the Peace Corps and found himself volunteering on the island of Yap... the rest as they say is history!  
Bill's personal observations of the manta population of Yap over three decades are vital to scientists and as year round tourist destination and an ideal place for scuba diving photographers, Yap is a perfect location for a long-term manta photo ID project. In addition Yap, with the endorsement of Governor Sebastian Anefal have created an MPA for manta rays that extends across 8,234 square miles and covers 16 islands and 145 atolls and islets. The island of Yap and the insights of Bill Acker are central to improving knowledge of manta rays and implementing effective conservation in the South Pacific.



**Mandy Etipson- Project Leader (Palau)**  
Originally from the Netherlands, Mandy started diving in the North Sea when she was 16, and became a PADI Open Water Instructor at 18 while living in the Philippines. She started working as the first PADI dive instructor on Palau when the Palau Pacific Resort opened in 1985, and still finds herself in Palau to this day helping her husband Shallum manage Neco Marine, one of the largest tour & dive operators on the island. In addition she is also the Honorary Consul of France to the Republic of Palau, and curator and co-founder of the non-profit Etipson Museum, which showcases Palauan culture, history and nature to the public.  
Mandy is at the forefront of conservation efforts in Palau. In 2010, the Etipson Museum started an awareness campaign with local and foreign partners to educate people about Palau's most threatened marine species, the dugong sea cow, which is still hunted and eaten locally. In 2010, Mandy also started the Palau Manta ray photo ID project ([www.mantalDpalau.org](http://www.mantalDpalau.org)) and in just two years she has been able to identify over 200 mantas in Palau. Mandy has been fascinated with the behaviour of the resident manta rays around divers and snorkelers, and would like to learn more about these amazing animals to be able to protect them from increased tourism pressure at the Palau dive sites.

Fig 29. The Manta Trust works with regional projects, including Palau and Yap in Micronesia.

### 3.4 Observations on Manta ray behavior in Palau

From years of interacting with the same individuals at German Channel, it is obvious that they are highly social creatures, who recognize each other, as well as divers. They show individual behavior and character, and some of the resident females at German Channel have been seen with the same male partners year after year during mating season. Some individuals are shy towards people and avoid getting close to divers and snorkelers, even after years of regular contact. Others will often seek out and interact with divers and snorkelers when they are not feeding, show curiosity and playfulness, and even try to look at their own reflection in camera domes. They seem to have cognitive abilities, an ability for self-recognition that humans and only a few large-brained animal species have. Dive guides around the world as well as in Palau cite examples of injured Manta rays that seem to seek assistance from divers to remove nets or fish hooks.

As with all wild animals, it is very important how to approach and interact with them. Experience has shown that a few common sense guidelines enhance the chance of meaningful encounters of divers with manta rays. These guidelines are taught in the manta interaction course taught at NECO Marine in Palau and are summarized here. At a cleaning station divers should stay on the bottom. The mantas will often come closer to check divers out between cleaning, or even hover over their head, and stay around for a whole dive. Swimming too close to, or over a cleaning station, will cause any cleaning mantas to leave. Trying to sneak up on a manta from behind can easily spook them. Sharks attack mantas from behind judging from the position of most shark bite injuries, and because of the positioning of their eyes, they cannot see well straight behind or in front of them. So divers should stay slightly to the side of a manta, so they can see the person coming. If a diver swims alongside them instead of straight at them they will let the diver get much closer. Small groups of divers and snorkelers can have amazing close encounters if they give the animals space, and wait for the animals to come to them. When the mantas are feeding, divers should observe from a distance first to figure out their feeding route. If they position themselves slightly to the side, they will return over and over to the same spot and pass by really close to the divers, sometimes feeding in a "train", following each other closely, which is amazing to watch. Divers putting themselves straight in the line of the feeding mantas cause a bubble curtain, forcing the mantas to maneuver around them and at the same time breaking up any feeding trains.

In Palau, gatherings of other plankton-eating fish species such as fuseliers, rudder fish, mouth mackerels and black snappers on the surface have proven to be good indicators for where manta rays will show up to feed. When the currents are just right, these fish will form large feeding balls on the surface where the plankton is thickest, and often mantas will join them and circle the fish balls while feeding alongside the other fish, sometimes for several hours at a time until the current dies down. When the Mantas finish feeding, they will roll up their cephalic flaps and swim down and out into the blue. If there is not a strong enough current, the mantas will start barrel-rolling, doing back-flips to scoop up as much plankton as possible. The documentation of these remarkable feeding locations by so many planktivores indicate scientists need to devote careful attention to examining why plankton concentrates in such locations and the relationship of the oceanography of such regions to the occurrence of plankton feeding fishes.

### 3.5 Threats, Natural versus Unnatural, and Injuries to Manta rays in Palau

Manta rays are open to natural dangers and predation. They are known to be preyed upon by large sharks (Figs. 30 and 31) and killer whales (Orcas). Since 1993, Orcas have been spotted offshore of Palau during the local manta mating season, between November- May each year (Fig. 31). Usually they are small groups of females with juvenile Orcas, but in March 2013 a large pod, including males, was spotted off Ngarchelong State. Ten days before that Orcas had been spotted in Yap. It is possible that these whales specifically hunt manta rays as a seasonal snack when migrating through Micronesia, so keeping records of Orca sightings is important for future manta research.

**Figure 30. Tiger sharks are found all around Palau, sometimes crossing shallow reefs, but usually in deep water away from the reef. Tiger and Hammerhead sharks are rarely seen by divers in Palau.**



**Great hammerheads, German Channel- May 2011**  
photo Amornthep Chimpleenapanont



**Orcas, Ngemelis Dec 1993**  
photo Becky Dawson

Orcas seen:  
**Ngarchelong**  
**Siaes**  
**Blue Corner**  
**Peleliu Corner**  
**Dec-March**

**Orcas seen in Yap**  
 Yap Divers, March 11, 2013



**Orcas seen Ngarchelong**  
 March 21, 2013  
 photo Kenneth West

**Figure 31. Orcas and sharks prey on manta rays.**

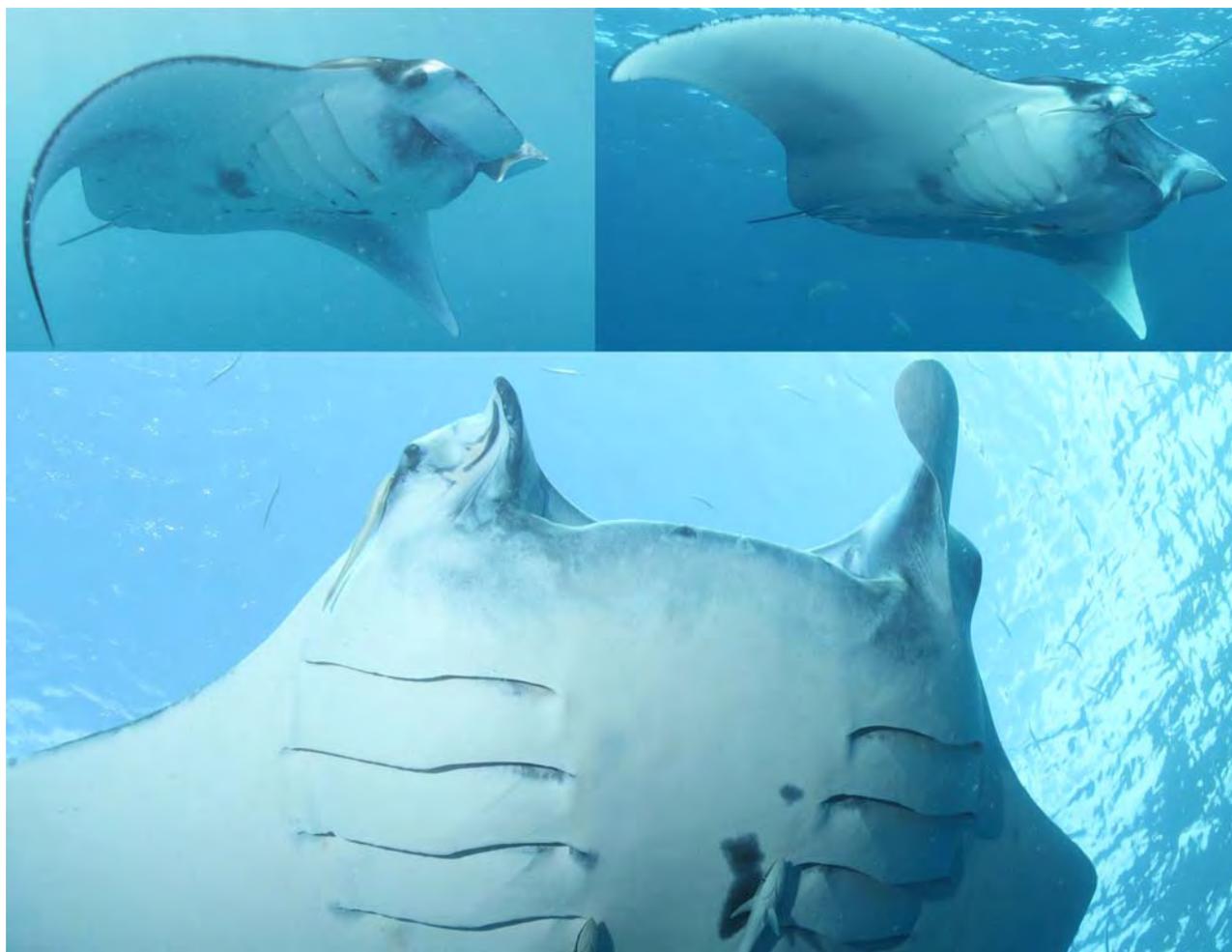
From observing the manta rays over many years here, we have learned that they can recover from terrible shark bites, but this often takes several years. Their skin is like a soft rubber, covered with a mucus to defend against infection. It is easily sliced by fishing lines, nets and propellers.

Whether physical events, like typhoons, pose a danger to island manta ray populations has not been explored previously. In December 2013 Palau was hit by Typhoon Bopha and we were able to make some observations regarding the occurrence and behavior of manta rays in the months following the storm, which are detailed subsequently, however there were no indications that the typhoon had a major effect on manta ray populations in Palau.

Human and man-made threats to mantas are more worrisome in Palau, and most other locations in the world where they occur. There is fortunately no specific fishery for manta rays in Palau, although the potential is there, due to the demand for manta ray products in the Asian market, and lack of legislation to protect manta and mobula rays. Palau has over 75 longline vessels operating in its waters, aside from the illegal Asian vessels caught on a regular basis, and they have long fished for shark fins illegally here. There are other threats to mantas, largely from the interactions of people and mantas on and in the water. Specific man-made threats to manta rays in Palau that we have observed in the last three years include:

- Mooring buoy line entanglement
- Casting fishing by tour boat operators at manta feeding sites
- Boat/propeller strikes
- Tourism pressure
- Purseiner and gill nets
- Longline fishing hooks

Injuries to resident manta are often seen at dive sites (Figs. 32 and 33). When the same individuals have been monitored over long periods, often many years, any new injuries are particularly distressing to dive professionals who see these animals often and get to know them as something other than "just a fish" (Figs. 34 and 35). Mooring buoy problems for mantas are particularly ironic, since the moorings are usually installed to protect the reef, by making it unnecessary to anchor, yet the presence of this mooring can result in the death of a manta ray (Fig. 36). Placing PVC pipes over the mid-water rope section of a mooring can greatly reduce the chance of a manta hitting and becoming entangled in these lines, and this is an easy and cheap method every manta range state in Palau should adopt when placing mooring buoys around manta feeding and cleaning sites (Fig. 37).



**Figure 32. Above: Female manta F17 Gypsy returns every season to German Channel. Top left, Gypsy in 2011. When she showed up in October 2012 she was missing her right sensory flap, which is also used for feeding. The cleanly sliced cut indicates a possible propeller injury.**



**Figure 33. M68 photographed in Ngardmau State in 2012, with injuries from net entanglement. A piece of net was deeply imbedded in the skin behind the left eye, and the left back wing showed deep cuts from where the net had sliced through the skin.**



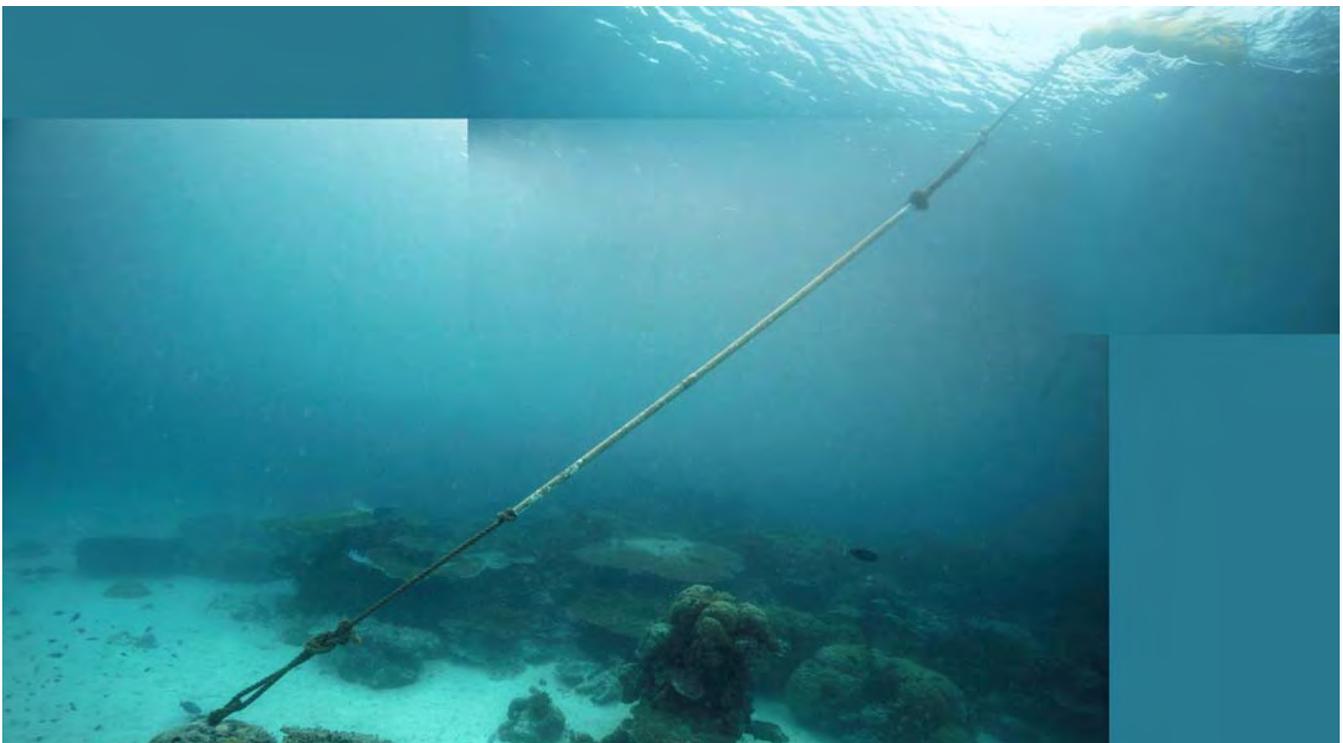
**Figure 34.** Above; F64 photographed with a broken right cephalic flap in 2011 and 2012 in Ngardmau State. These type of injuries are usually caused by line or net entanglement.



**Figure 35.** M2 Silverback, a seasonal male visitor to German Channel since 2005, and several other mantas showed injuries around their mouths in January, 2012, likely from swimming into new mooring buoy lines placed around German Channel. After Koror State placed PVC pipes on the main mooring lines, no such injuries were seen again.



**Figure 36. A dead manta at Blue Corner, 2010, entangled in a mooring buoy line at the dive site. This manta had been photographed at German Channel before. Because their eyes are located on the side of their head, mantas do not see well what is straight in front of them (photo by Yoko Hidashide).**



**Figure 37. PVC pipes placed around mooring lines at German Channel by Koror State prevent mantas from getting entangled when swimming into these lines. This simple method if implemented by all states for mooring buoys placed around manta sites can prevent future Manta deaths and injuries.**

### 3.6 Managements considerations and recommendations for individual manta sites

#### Koror State- German Channel



- One of Palau's Top 5 spots
- Increased # of tourists & boats
- Estimated 80-200 pax/day divers and snorkelers
- Casting by tourboat drivers
- Channel trolling by state boat
- Lack of site management



**Figure 38. German Channel manta ray cleaning and feeding site area from the air.**

German Channel (Fig. 38) is the most visited manta site in Palau. Located 23 miles southwest of Koror, it is only about 45 minutes by speedboat from the town and base of most hotels, tour and dive operators. In the last few years, because of the likelihood of seeing a manta, and with its shallow depth a perfect location as a third dive site for tourists on boats around the Ngemelis reefs, German Channel has become one of the top three most visited dive sites in Palau. After typhoon Bopha hit last December this is even more so, since the eastern reefs are still badly damaged with limited visibility, which severely limits the options for diving sites in the summer when the wind shifts and starts coming from the west.

German Channel is often the most sheltered spot around Ngemelis when the weather conditions are bad or the winds are from the west (Fig. 39). Consequently the location and its mantas are under a lot of pressure from visitors and their activities, this year more so than ever. Most of the large live-aboard vessels now park almost permanently on the inside or outside of the German Channel, to save fuel and out of convenience, and their groups do several dives a day at this site alone. While a few resident female manta rays and young mantas can be found year-round here at this site, larger numbers of manta rays come in for feeding, mating and giving birth between October-May each year, when up to twenty animals can be seen at a time when the incoming current is strong before the new and full moons.



**Figure 39. (top) German Channel from the air looking towards deep ocean in a southwesterly direction. (lower) German Channel from its eastern side from the air.**

German Channel is an important site for learning about the behavior and biology of mantas. There are resident mantas there that have been in that area for over 20 years. The older female manta, F1 Mechas, can usually be found here year-round. She does move around to other areas, having been photographed inside the lagoon and as far northeast as Ngeremdiu reef, but basically lives around German Channel area. By getting to know the individual manta rays, we can monitor their movements around Palau as well as their pregnancies, and the mates they chose every season. Courtship behavior, mating trains, and mantas ready to give birth are observed at German Channel each season (Fig. 42), and although we have not observed actual manta mating or giving birth in the wild in Palau, it is likely to take place somewhere near this site. Courtship behavior and females being shadowed by the smaller males can be observed during the winter months. (Fig. 44).

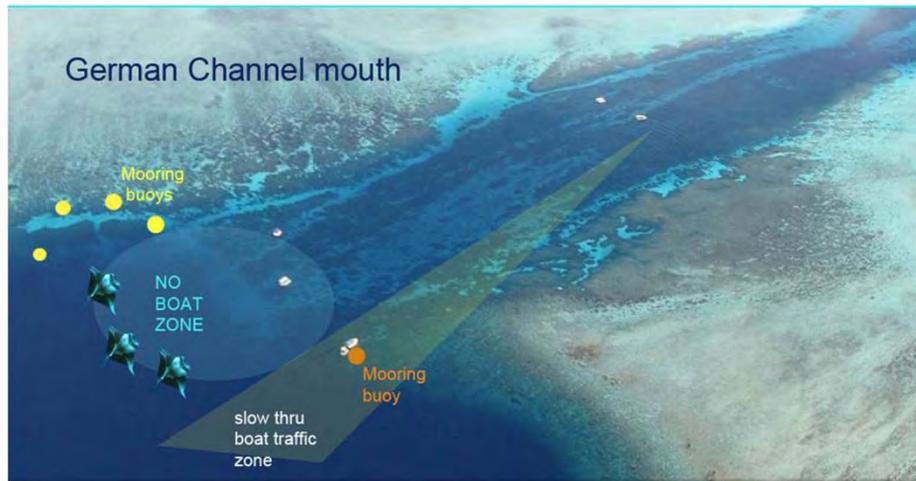


Figure 40 Aerial view of German Channel showing the "no-boat zone" proposed to Koror State since tourism pressure started to become a problem in 2011.



Figure 41. Tourists divers swimming too close over the German Channel cleaning station, crowding the mantas which caused them to leave right after this photograph was taken.

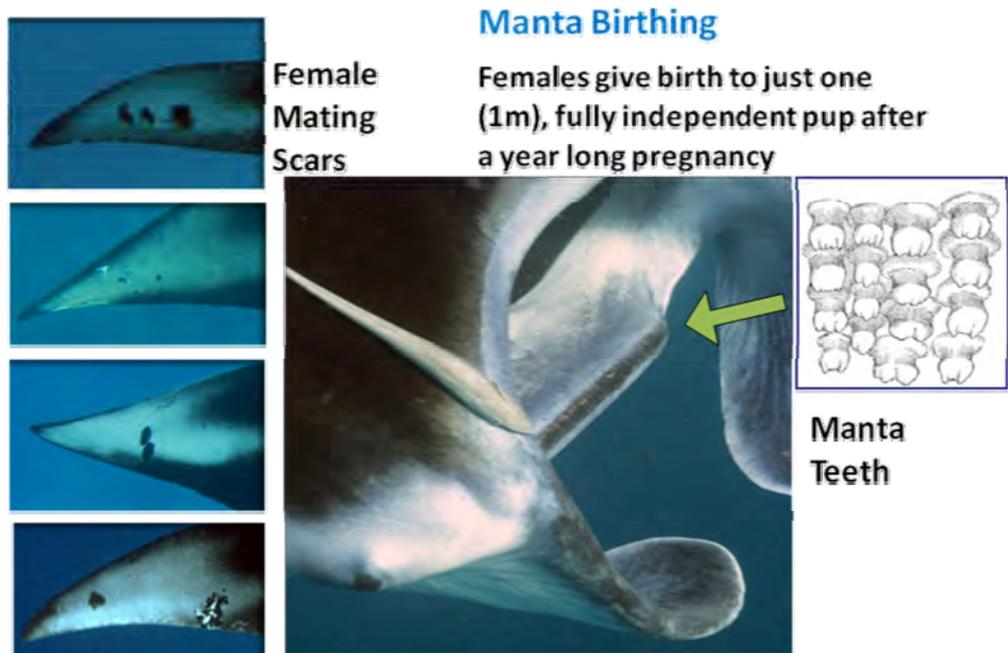


Figure 42. Manta F1 Mechas shown in different stages of pregnancy, in 2010 and in 2013 at German Channel.



Figure 43. Boats driving over the site come dangerously close to feeding mantas, snorkelers and divers watching the mantas. Propeller injuries are now observed more and more on the resident mantas.

German Channel is the only site in Palau so far where newborn and very young Mantas are seen every season between November and April (Fig. 44). Mantas are about a meter across when born, and like most young animals, less cautious than the adults and very playful. Divers can approach them closely (Fig. 45), and the young mantas will often swim upside down to check out the strange "bubble creatures". From observing and recording the newborn mantas seen since 2009, we know they grow very fast the first year, and rarely interact with adult Mantas, although they seem eager to copy their every move. We have seen small young Mantas being deliberately slapped aside by adult Mantas when getting too close, especially during feeding, and young Mantas are never seen in the feeding "trains".



**Figure 44. Mating scars are seen near the tips of fins on female manta rays. Shown are some examples from Palau.**

On the other hand, some of the older resident females at German Channel like F1 Mechas and F4 Camy seem very tolerant of the youngsters, and sometimes even seem to be guiding them when feeding. Newborn Mantas practicing their barrel rolling are like wind-up toys, often back-flipping very fast without stopping or looking, causing them to bump into other Mantas or divers, this is very entertaining to watch.

We have provided Koror State with copies of the management plan done for Hanifaru Bay in the Maldives as an example and reference for possible management of German Channel. We have included additional recommendations specifically for German Channel site management along with this. Hanifaru Bay, although it has a much larger Manta population, faced similar problems with tourism and boat pressure in a small Manta feeding area. Scuba diving and boat entry is now prohibited there as of January, 2013, and a management plan was implemented. Fieldtrips to the German Channel site were conducted on April 11, 2012, as well as on June 5, 2013, with Koror State policy makers and State Rangers. A proposed legislation for the No-boat zone was drafted and introduced in February, 2012, but is still being considered by the State legislature.



**Figure 45. Project Assistant Edwin Madesil with a newborn Manta at German Channel, November 2012.**

To date no site management is in place at German Channel aside from a number of new mooring buoys placed for boats and PVC piping installed on the mooring lines. Since larger Manta aggregations have been found in other States in Palau, and they probably move across state borders, we are now considering to draft a national legislation instead of trying to do this for each separate Manta range state in Palau.

**The main recommendations for management of the German Channel Site provided to Koror State are:**

- 1) Put PVC pipes on any new mooring buoy lines being installed, and make sure there is no loose rope since manta rays or other marine life can get tangled in lines.
- 2) Implement a No-boat zone for the safety of divers and snorkelers around the site. Divers and snorkelers should swim in and out of the area to avoid injury to Manta rays and people from boats/ propellers.
- 3) Limit the number of boats that can use the site to 5 at any time, on a first come-first served basis, and after divers come up these boats should leave the area immediately, making space at the buoys for the next boat.
- 4) Do not allow any type of fishing at the site. Fishing gear should not be allowed on dive boats.

## Yengl passage-Ngarchelong State

Yengl Passage is located 31 miles northwest of Koror, about an hour and a half by speedboat. Three cleaning stations are located close together in 35-50 feet of water on a reef pass that Mantas seem to use to travel between Ngardmau State and Kossol reef (Fig. 46). Many of the individuals seen being cleaned at the Ngarchelong site are the same individuals that are regularly seen feeding around Ngardmau during the same months, and over 44 individuals regularly seen feeding in Ngardmau State were recorded by our time-lapse cameras here. Mantas were seen here in March, April and May, but we know little beyond that since we have just started monitoring this site since March, 2013. Small groups of manta rays were seen feeding outside the reef pass in deep water on incoming tides also. We will need to monitor this site starting October to see when the manta ray season here starts, but it seems to end in May, no mantas were seen at the cleaning stations after this month. During the months of March, April and May, the manta rays were observed swimming back and forth between Ngarchelong for cleaning and Ngardmau State reefs for feeding.



**Figure 46. Yengl passage in Ngarchelong State is believed to be an major cleaning site and route for manta rays. More monitoring with time-lapse cameras next season is needed to determine the exact months manta rays can be found here and/or are passing through.**



**Figure 47. Mantas at Yengl Passage main cleaning station, Ngarchelong State.**

**Yengl Passage - Site Management Recommendations for Ngarchelong State:**

- 1) Put PVC pipes on any new mooring buoy lines being installed, and make sure there is no loose rope manta rays or other marine life can get tangled in.
- 2) Do not put any mooring buoys too close to the site, if any, they should be at least 150 feet away from the cleaning station.
- 3) Implement a No-boat zone for the safety of divers and snorkelers around the site. Divers and snorkelers should swim in and out of the area to avoid injury to manta rays and people from boats/ propellers.
- 4) Limit the number of boats that can use the site to 3 at any time to avoid scaring the mantas away from the site, and do not allow live-aboard vessels or yachts to anchor on the site.
- 5) Keep the fee as is for tourists. Suggest to increase the fee for yachts and live aboard vessels to be higher than for local dive operators, who will bring you more business in the long run, and have less impact on the site than yachts that stay overnight or longer. there should be no charge for one local dive guide per boat to encourage them to bring tourists to your state.
- 6) Try to develop other dive sites in the area to make it worth the trip from Koror, or offer a state dock lunch BBQ with sightseeing package to dive operators to encourage them to bring customers in between dives.
- 7) Do not allow any type of fishing at the site. Fishing gear should not be allowed on dive boats.
- 8) The season for the cleaning stations is limited to only 3 months a year, so development and surveys for other manta sites in your state is needed to make mantas a year-round attraction. Coordination with Ngardmau State is recommended, since the two states seem to share the same manta population.

## Devilfish City- Irengoll Ewekakou, Ngardmau State



**Figure 48. Looking at the Devilfish City area from the south shows the twin opening into the lagoon.**

Devilfish City, locally called Irengoll Ewekakou, is located 24 miles northwest of Koror, and about an hour by speedboat (Figs. 48 to 52). It has long been a site to which dive shops have brought tourists, however, the distance from Koror and lack of other popular dive sites nearby, have limited its appeal to tourists. Local dive operators are not encouraged to take tourists there because of the added fuel cost and permit required even for the guide on the boat.

There are three cleaning station sites along the northern side of the reef pass, but bad visibility and strong currents limit this dive to slack high tide or slow current half moon days. The innermost cleaning station where the white mooring buoy is located is used more as a travel route than as a cleaning station by the mantas on their way in and out of the reef to feed. Manta feeding aggregations are seen here outside the reef during the months of January- May.

### **Site Management Recommendations for Ngardmau State:**

- 1) Put PVC pipes on any new mooring buoy lines being installed, and make sure there is no loose rope Manta rays or other marine life can get tangled in.
- 2) Do not put any mooring buoys too close to the reef corners and cleaning stations. People should swim in and out of the area to avoid the problems observed at German Channel with boats running over the manta rays and people.

- 3) Do not allow live-aboard vessels or yachts to anchor on the site. they should anchor inside the lagoon.
- 4) Do not allow any type of fishing at the site. Dive boats should not be allowed to carry fishing gear.
- 5) Keep the fee as is for tourists. Suggest to increase the fee for yachts and live aboard vessels to be higher than for local dive operators, who will bring you more business in the long run, and have less impact on the site than yachts that stay overnight or longer. There should be no charge for one local dive guide per boat to encourage the guides to bring tourists to your state.
- 6) Try to develop other dive sites in the area to make it worth the trip from Koror, or offer a state dock lunch BBQ with sightseeing package to dive operators to encourage them to bring customers in between dives.
- 7) The season for the manta feeding is limited to only 3 months a year, so development and surveys for other manta and dive/snorkel sites in the State is needed to make Mantas a year-round attraction. Coordination with Ngarchelong State is recommended, since the two states seem to share the same manta population, so site management in one State can affect the tourism and mantas in the other State.



**Figure 49.** The central reef at Devilfish City has three cleaning station sites for mantas, but is mainly a route to the outside reef used for feeding by manta rays visiting from Ngarchelong State area on incoming tides.



**Figure 50.** Tourist boat at the Devilfish city manta ray site. The site is used occasionally by operators from Koror during the months of January- May , but it has a lot more potential once we learn more about the feeding cycle and movements of the manta rays in this area.



**Figure 51.** Some of the largest manta aggregations seen in Palau have been around Ngardmau State reefs. The distance from Koror, strong currents, and uncertainty of encountering any mantas are the reason this unpredictable site has never become as popular a dive site as German Channel. Manta feeding movements here change daily depending on the currents, tides and wind, and cover a large area. This makes it often difficult to locate and stay with the feeding mantas even when large aggregations are at the site.



**Figure 52. A large number of the adult manta rays photographed around Ngarchelong and Ngardmau State have severe shark bite injuries and scars, something rarely observed in the German Channel Manta rays.**

### **3.7 Effects of Typhoon Bopha on manta sites**

On the night of December 2-3, 2012, the eye of Super Typhoon Bopha passed just south of Palau. With at 145 MPH winds at its center Bopha was a very strong typhoon and this was the first time in 45 years that the main islands of Palau were hit directly by a typhoon. One month after the passage of the storm we were able to use a helicopter from the visiting yacht "Alucia", to survey some of the typhoon damage to the reefs and check manta rays (Figs. 53 and 54). During two flights, mantas were seen feeding inside the lagoon behind the "70 Islands" island group. Subsequently they have been seen feeding and cleaning at the known sites in the months after the typhoon, in spite of the bad visibility and silt around the channels as a result of the typhoon. Several new feeding sites have been discovered since the typhoon, some inside the lagoon. In general the typhoon does not seem to have had any negative effects on the manta rays, or their movements around Palau, although the number of animals observed this season overall was less than in the previous two years. As of this report, the visibility, especially around the channel mouths, is still bad because of the destruction to the reef caused by the storm and the sand-silt mobilized into the water column and shallow water environments.



Figure 53. Before and after photos showing changes caused by the impact of typhoon Bopha since December, 2012.



**Figure 54. German Channel in 2010, top, and after the Dec, 2012 typhoon, below. There is talk of dredging the shallow inside entrance to the channel (1) to facilitate larger boats passing through. This could have a major impact on the already stressed Manta dive site located along the outside mouth of the channel (2). Mantas are seen passing through this narrow channel to and from their cleaning stations at the German Channel mouth.**



## 5.0 Conclusions

Despite the fact that mantas are one of the largest fish species, and very popular with tourist divers and snorkelers around the world (Fig. 55), it has only been in the last 10 years that research into these animals' lives has really begun around the world. Global populations of manta and mobula species are currently unknown. In January 2012, the Manta Ray of Hope team released a report that was the first global assessment of what is currently known about manta and mobula biology, the threats they face, the fisheries and trade that target them, current conservation measures. They recommended a number of urgent steps to prevent regional extinctions.



**Figure 55. Manta rays are some of the most engaging and charismatic animals in the ocean, and there is a lot of current public interest in their biology and conservation, making them useful ambassadors for Palau's entire marine environment, conservation efforts and tourism.**

What is known is that these species are slow to mature (8-10+ years), long-lived (40+ years) and reproduce very slowly. A female manta ray will give birth to a single pup every 2-5 years, and to only around 16 pups in her entire lifetime. This makes the mantas and mobulas extremely vulnerable to overfishing and regional depletion. Total global annual documented fisheries landings list 3,400 mantas and 94,000 mobulas, aside from being listed as general bycatch by many other fisheries such as the longline vessels operating in Palau, and undocumented fisheries in Asia. Fishermen in the Philippines and Indonesia report a rapid decline in manta rays and mobula landed in recent years due to the growing market of the last decade for gill rakers in China. This trade, something for which the general public and policy makers seem largely unaware, is similar to the more well known trade in shark fins and should be of equal concern.

We will continue to monitor the manta rays in Palau for the coming years, refining and updating the Manta ID Palau website every season. Equally we will explore for new sites with the aim to discovery and document all major manta sites in Palau and will work with the states and national government on legislation to protect these beautiful creatures. They are an important source of tourism revenue, and there is a lot more we need to learn about their biology and movements around Palau's reefs.

It will take time and effort to explore all the channels around Palau at different moon phases to find new feeding and cleaning sites, and also to learn more about their behavior, especially where they give birth in Palau, which would be important knowledge for proper site management. For the last 30 years, only two Manta sites, German Channel and Devilfish City, have been regularly visited by tourist divers. Our surveys showed that both sites are important for Manta rays in Palau. German Channel has resident female Mantas that have been there for over 20 years, and each season courtship behavior and newborn Manta rays have been observed at this same site. Tourism pressure is becoming a problem at this site due to lack of site management, and too many boats and people crowding the mantas in the relatively small feeding and cleaning area. Devilfish City and the whole Ngardmau reef area has the largest Manta aggregations of over 70 individuals observed so far in Palau, and courtship behavior has been observed there too, although no newborn Mantas have been seen there. There are a lot of other potential sites in other states where mantas have been reported, but these still need to be explored and surveyed more to determine the right time, tide, wind direction and moon phase, which seems to vary between channels.

## **5.1 Tourism pressure**

Manta rays have in recent years become a major attraction for divers and snorkelers visiting Palau, and having an encounter with a Manta ray is an amazing experience for anyone. Briefings by local dive and tour operators, however, often do not address proper behavior so as not to scare off the feeding or cleaning manta rays. While some guides will keep their groups together and sit on the sand to observe the manta rays, others have customers scattered all over the site, and allow them to chase any approaching manta rays out into the blue, ruining the encounter for other groups at the site. Tour boats still run right over the cleaning station and feeding area, even while snorkelers and divers are in the water, and manta rays are feeding on the surface. This has already resulted in propeller injuries to some of the manta rays, and may cause accidents with divers and/or snorkelers getting run over if this issue is not addressed. Although illegal, boat operators still do cast fishing at the site too when their tourist customers are in the water. Several manta rays at the site have shown bad injuries from fishing hooks and lines in recent years.

Little is known about the biology and movements of the amazing manta rays in Palau, but we are learning more every season from observing their behavior. The only time we get to see them is when they come close to the reefs to feed or clean. From other countries' experiences we do know that Manta rays are vulnerable to tourism and boat pressure, and improper behavior by large groups of divers and snorkelers may cause the mantas to move away from their traditional mating and cleaning sites. In Palau they still return to German Channel every season in spite of the increased tourist numbers and boats at this site, however popular and crowded sites like this need to be managed more carefully by the government to ensure that both visitors and Mantas can safely keep enjoying these encounters without accidents and/or injuries to either the Manta rays or the tourists.

No boat zones need to be established to protect feeding Mantas, and diver behavior at the sites needs to be controlled, with the number of divers allowed at one time to be limited. It has become painfully clear in the last few years that this cannot be left to the local dive and tour operators to be managed. It will need government enforcement and regulations for site management if Palau wants to ensure the Manta rays will stay around for future tourists to enjoy.

**Manta Ray tourism generates  
US\$8.1 million in revenue  
annually for the Maldives.**

**Sport Diver magazine  
estimates mantas generate  
US\$6.25 million annual  
revenue for Yap and Palau**



**Figure 56. Manta rays are a very important element of tourism in Palau and elsewhere in Micronesia.**

Manta Tourism is worth an estimated \$140 million each year (O'Malley et al. 2013) with over a million manta ray dives and snorkels per year worldwide. There are several hundred companies that regularly take divers and snorkelers to see manta rays worldwide, and locally in Palau manta rays have become a major attraction for visitors in recent years. The yearly fisheries value of manta and mobula rays in Asia was estimated at only US \$5 million, only 4% of the sustainable tourism value in the same area.

Feeding mantas come close to the surface and can be seen snorkeling (Fig. 57). Most cleaning stations are at least 40 feet deep, so scuba is needed to observe cleaning Mantas, who sometimes will stay around for an entire dive if not disturbed, and come very close to check divers out. However, if divers swim after them, get too close to the cleaning station, or crowd the Manta rays, they will leave. While one or two photographers with strobes do not seem to bother the mantas, a lot of strobes going off all around will spook most mantas, so the number of divers allowed at the site at any one time should be limited.



**Figure 57. Bubbles and large groups of divers can interfere with/block the Mantas from feeding, while snorkelers disturb the Mantas less. Mantas are more comfortable and come closer to snorkelers than divers.**

## **5.2 Manta research- future work in Palau**

We plan to continue to engage in the non-intrusive types of research on manta rays in Palau which have provided significant results to date. These include two areas of focus: aerial surveys with ground truth surveys to identify manta feeding and cleaning areas and expansion of the photographic component to document occurrence of known and new individual mantas at specific sites within Palau. While other types of more intrusive research have been conducted elsewhere, such as acoustic tagging programs and biopsy surveys, at present we feel these types of research are not needed to continue increased knowledge of manta rays in Palau. We also worry that such activities may have a negative effect of manta behavior and their interactions with tourists, which is a major economic benefit to Palau.

While activities such as tagging and biopsies can provide useful information, we have the advantage in Palau of having a number of known manta sites where intensive observational and

photograph data collection can be undertaken, as well as a large number of diver guides and tourists photographing individual mantas at the sites. Technology today allows extensive studies using acoustic tags, implanted in or on target animals, and stationary passive receivers. This type of research is popular in that it can now be done, unlike in the past, and has uses in studies such as fisheries. With all tagging there is an accepted risk of injury and loss of life to the animals and while justifiable for common, short-lived and fast reproducing species of fishes, it is more problematic for long-lived, slow reproducing and threatened species like the Manta. Also given the importance for tourism revenue for Palau, policy makers have to carefully consider the risk of injuring or scaring these animals away from areas they have frequented for years versus the information that they are realistically expected to get from the research.



**Figure 58.** If divers are respectful of the manta rays and do not approach too closely, they will provide an amazing show to the humans watching, and often approach the divers quite closely.

**Recommended websites related to manta rays:**

Palau Manta ID Project: [MantaIDpalau.org](http://MantaIDpalau.org)

Manta Trust: [mantatrust.org](http://mantatrust.org)

The Marine Megafauna Foundation (MMF): [marinemegafauna.org](http://marinemegafauna.org)

Manta Ray of Hope: [mantaryofhope.com/](http://mantaryofhope.com/) [sharksavers.org/mantas](http://sharksavers.org/), [wildaid.org/mantas](http://wildaid.org/mantas)

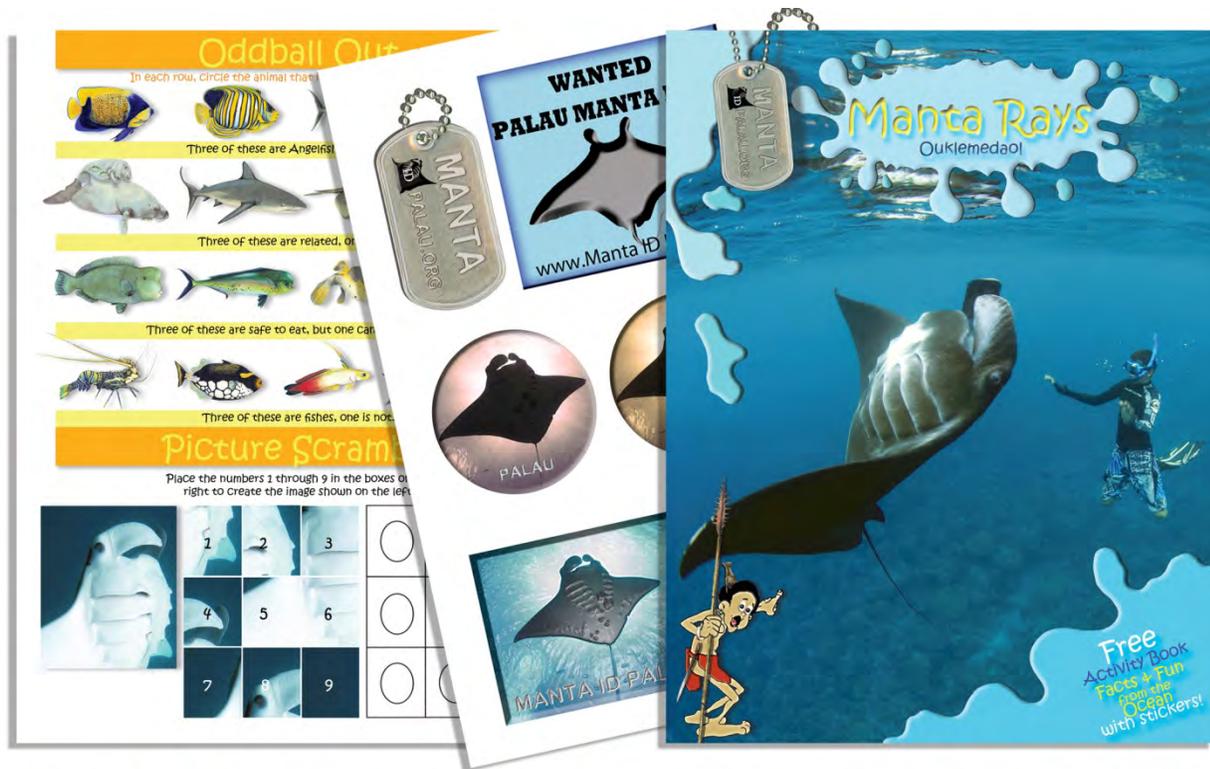
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***Manta rays are some of the most engaging and charismatic animals in the ocean, and because of the current public interest in their biology and conservation, they are great ambassadors for Palau's marine environment, conservation efforts and tourism.***





45 page Kid's Booklet on Dugongs and Manta rays, download available : [www.mantaIdpalau.org](http://www.mantaIdpalau.org)

## 2013 kids activity booklets and posters given to students

Islandtimes, Tuesday, March 26 2013 RICK L. MAGBANUA  
Reporter

After Melekeok Elementary School, 7<sup>th</sup> and 8<sup>th</sup> graders from Seventh Day Adventist Elementary School and Koror Elementary School yesterday received the 2013 kids activity booklets and posters.

The booklets and posters are about Dugongs and Manta Rays. They are activity booklets and posters that tell about facts about Dugongs and Manta Rays with free stickers for kids to enjoy learning. The booklets were given



out by Mandy Etpison and Yalap Yalap of the Palau Conservation

Society.

Aside from facts, the booklets also tells about how important Dugongs and Manta Rays to Palau's economy as tourists come to see them as well in Palau's magnificent waters. It also speaks of how important it is to conserve them for future generations.

According to Mandy Etpison, they will be giving out booklets and posters to other schools within the month and extra copies are available at the Etpison Museum while supply last. The booklets are published by Etpison Museum





# Aquarium After Dark

Lecture Series at  
Palau Aquarium

Guest Lecturer: Mandy Etpison  
Topic: Manta Rays  
Wednesday, June 5th at 7 pm.

Happy Hour from 6-7 pm with a free wine  
tasting sponsored by Palauan Made

\$2 Admission includes aquarium access

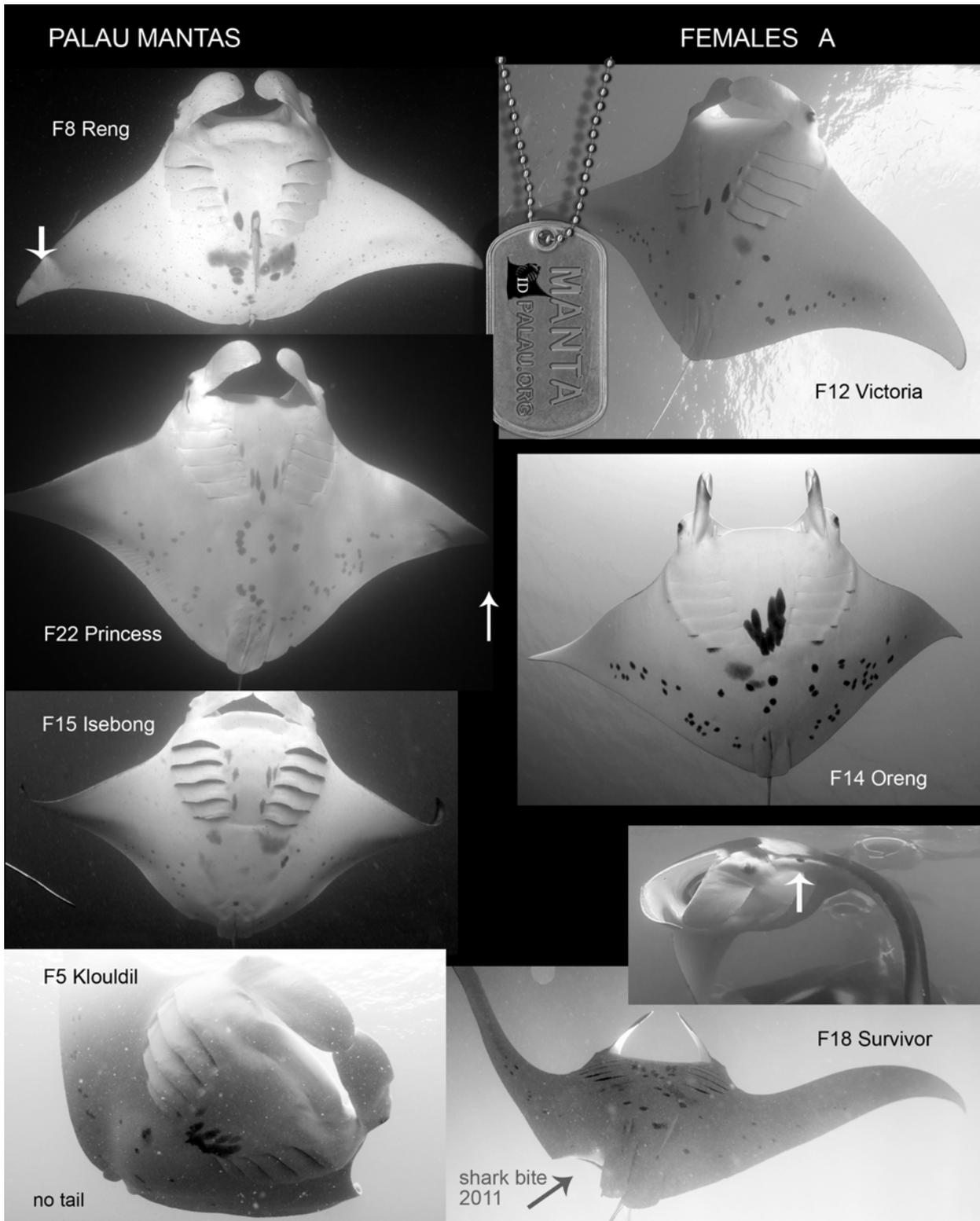


Palau Aquarium is located  
at Palau International Coral  
Reef Center.

From the main road, take  
M-Dock road (next to Palau  
Supreme Court) and con-  
tinue straight.

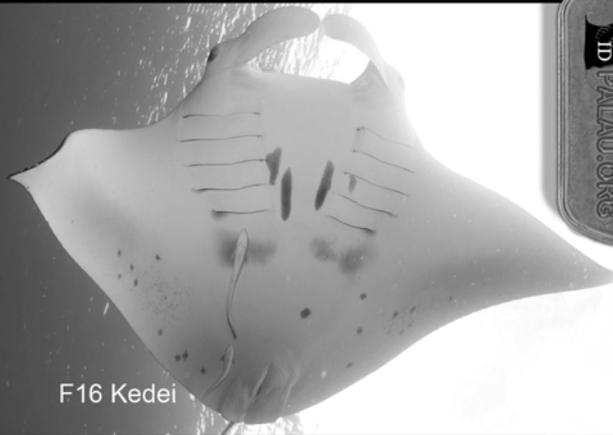


Appendix II: Palau Manta ID Database- 235 Manta rays as of June, 2013.

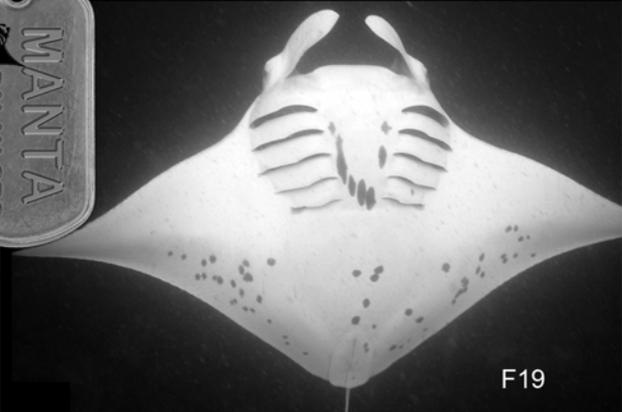


PALAU MANTAS

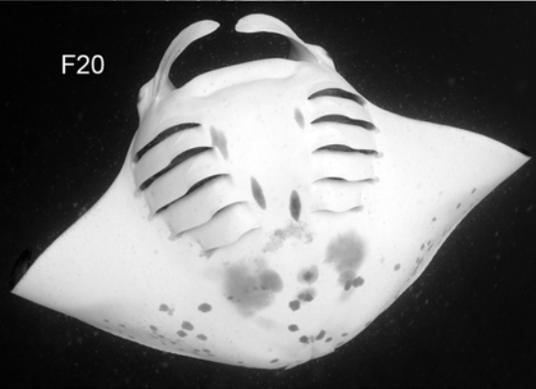
FEMALES B



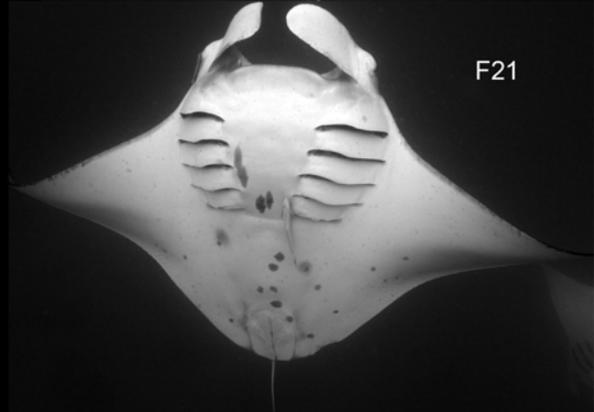
F16 Kedei



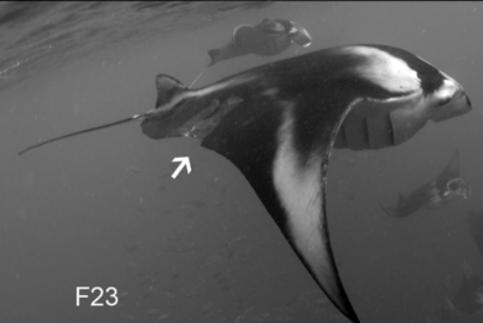
F19



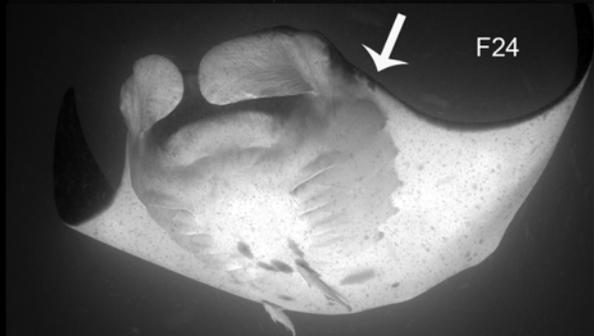
F20



F21



F23



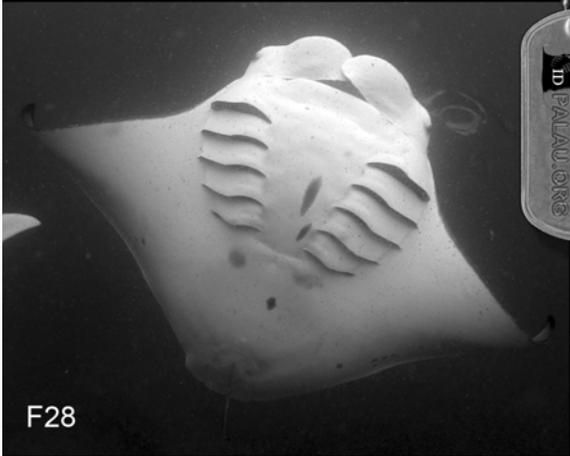
F24



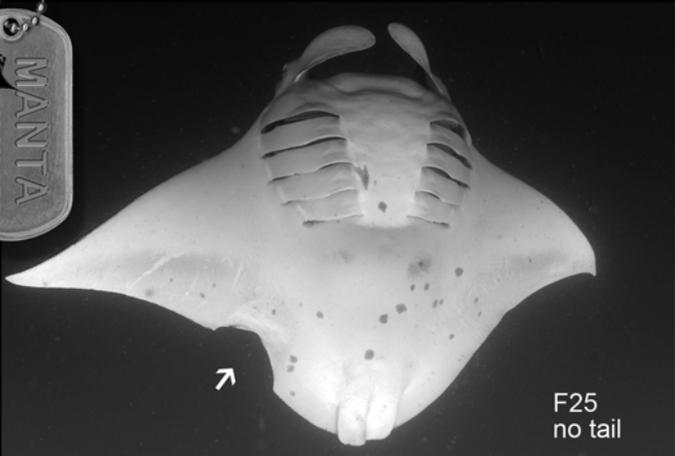
F27  
Metiek

PALAU MANTAS

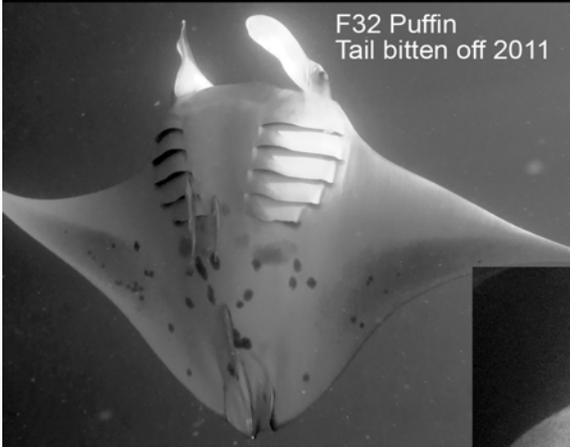
FEMALES C



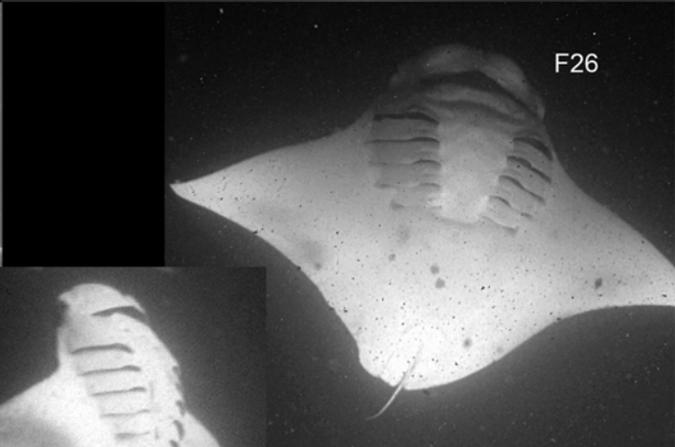
F28



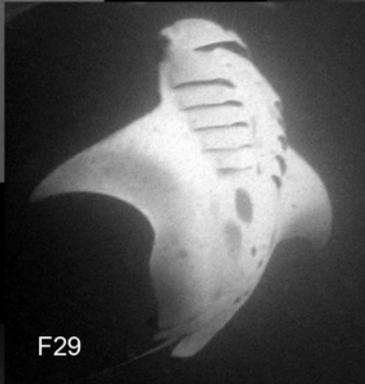
F25  
no tail



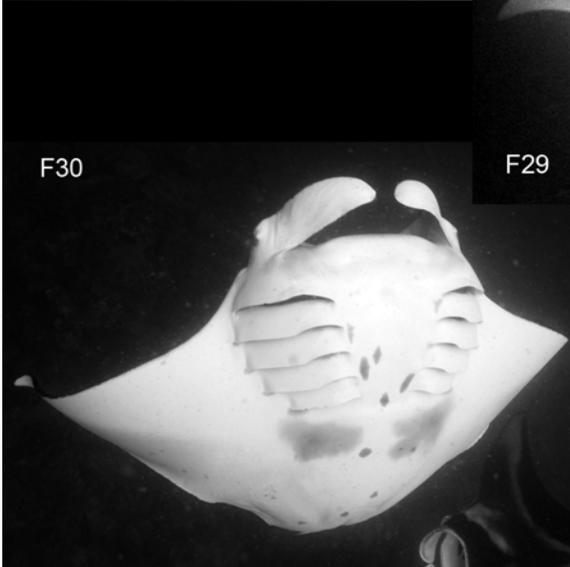
F32 Puffin  
Tail bitten off 2011



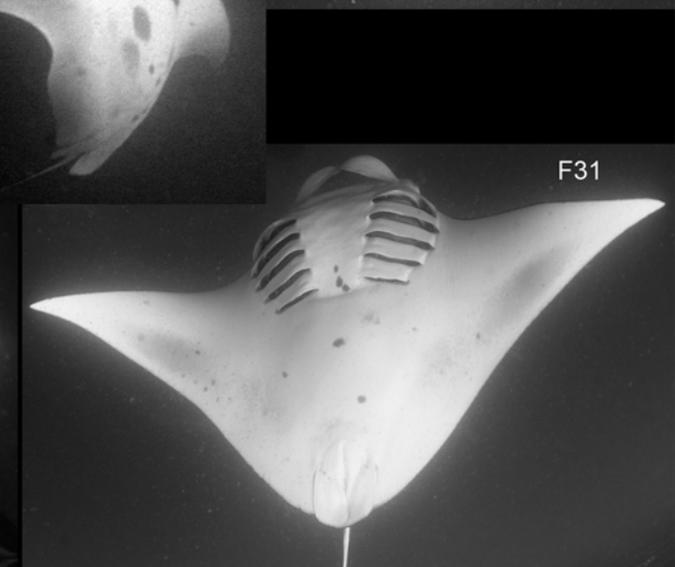
F26



F29



F30



F31

PALAU MANTAS

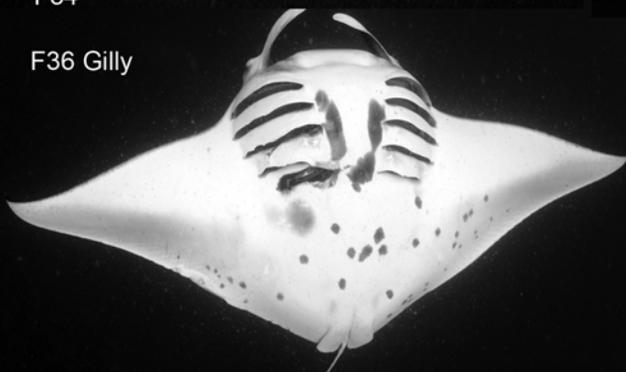
FEMALES D



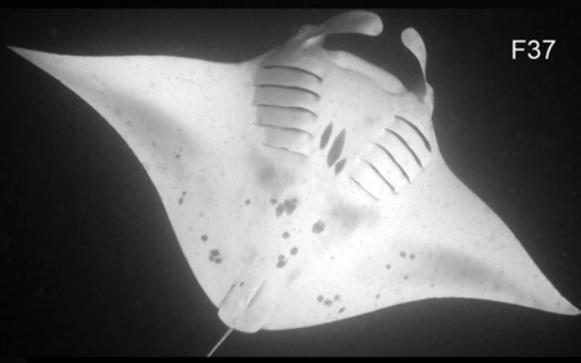
F34



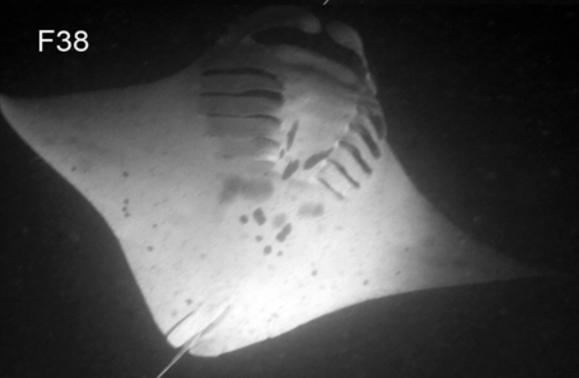
F35 Mesmeang since 2003



F36 Gilly



F37



F38



F39



F40



F41

PALAU MANTAS

FEMALES E



F42



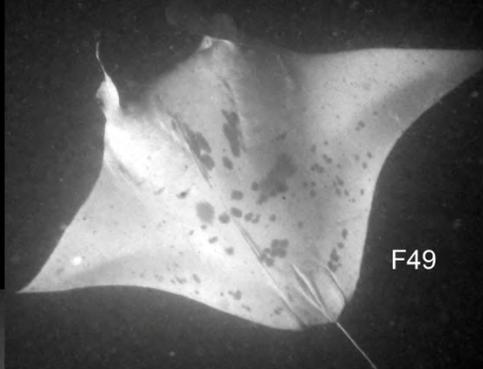
F43



F44



F45 Niall McCarty



F49



F46



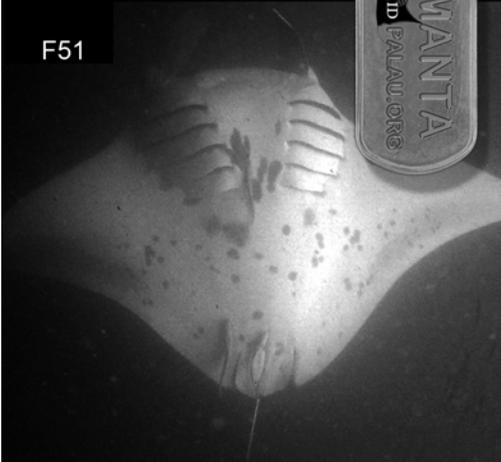
F48

PALAU MANTAS

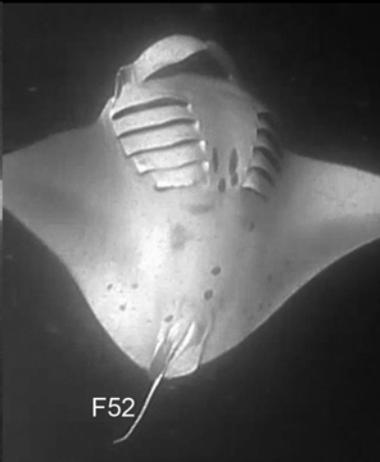
FEMALES F



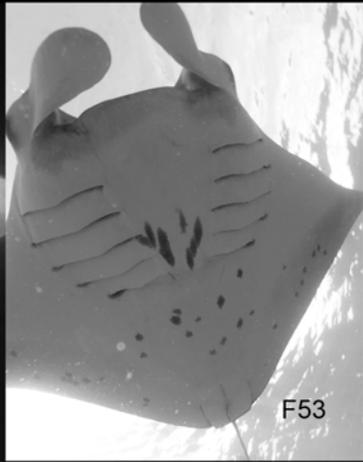
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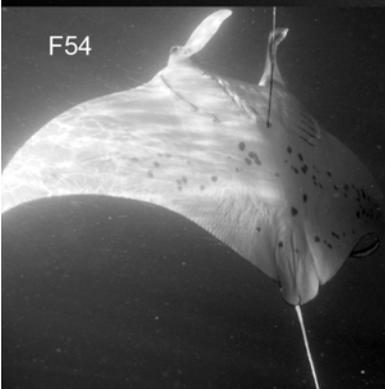
F52



F53



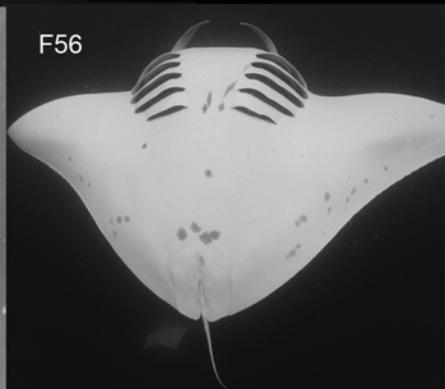
F54



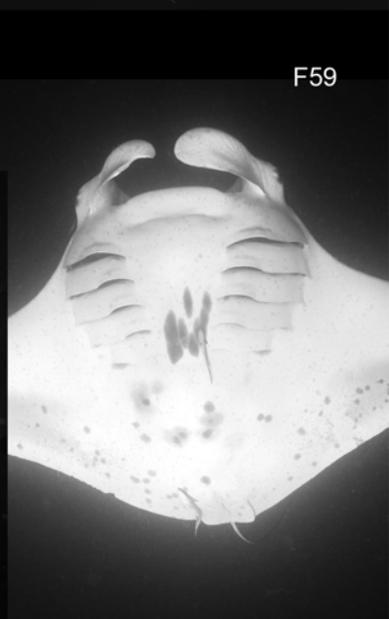
F55



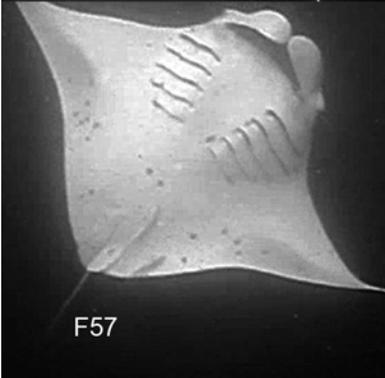
F56



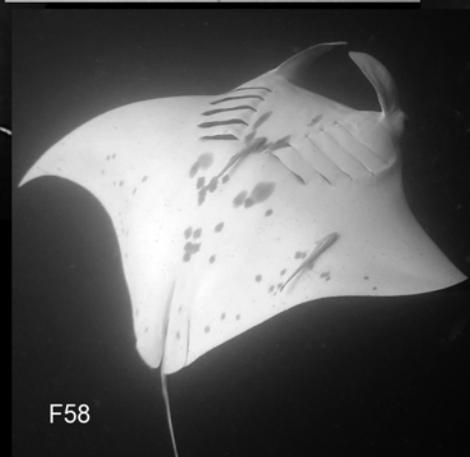
F59



F57



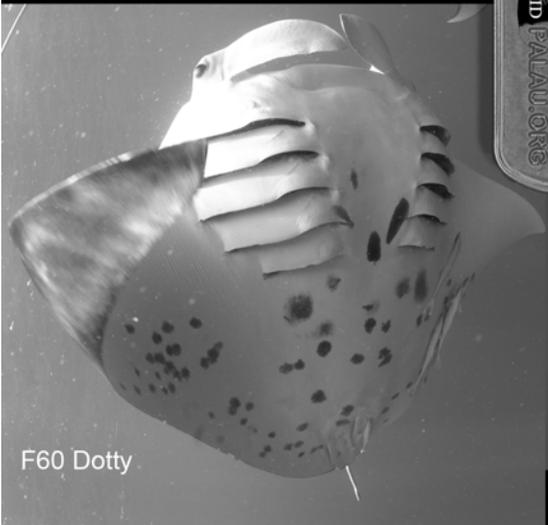
F58



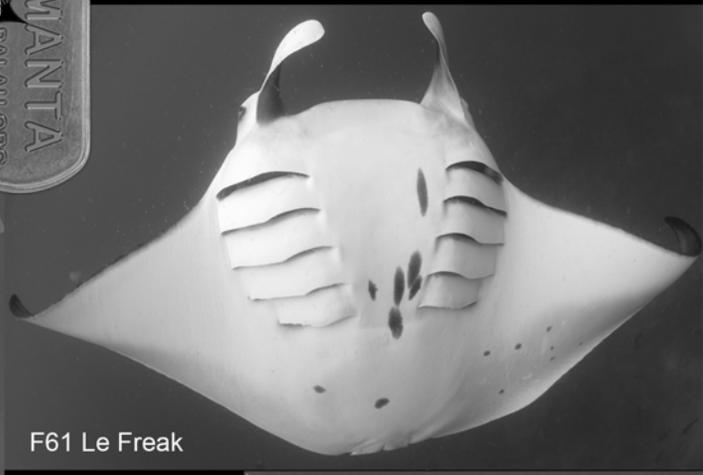
PALAU MANTAS

FEMALES

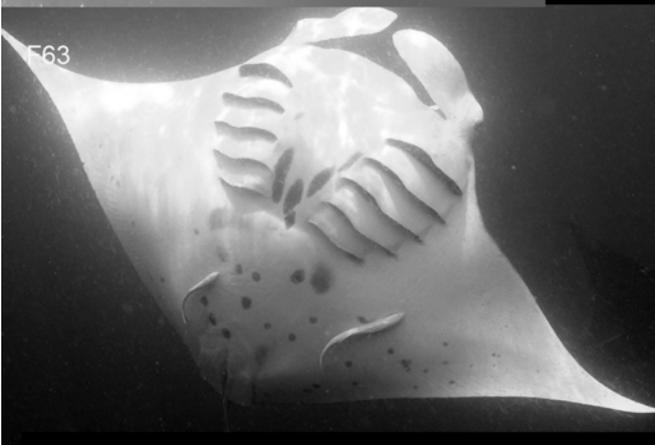
G



F60 Dotty



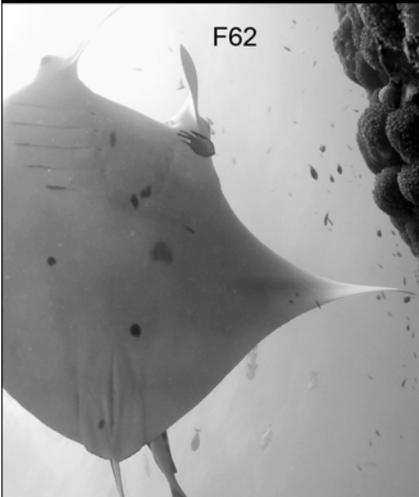
F61 Le Freak



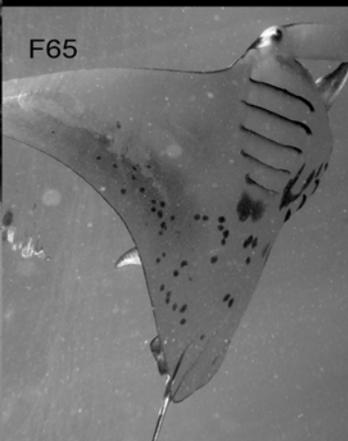
F63



F64 Broken lobe



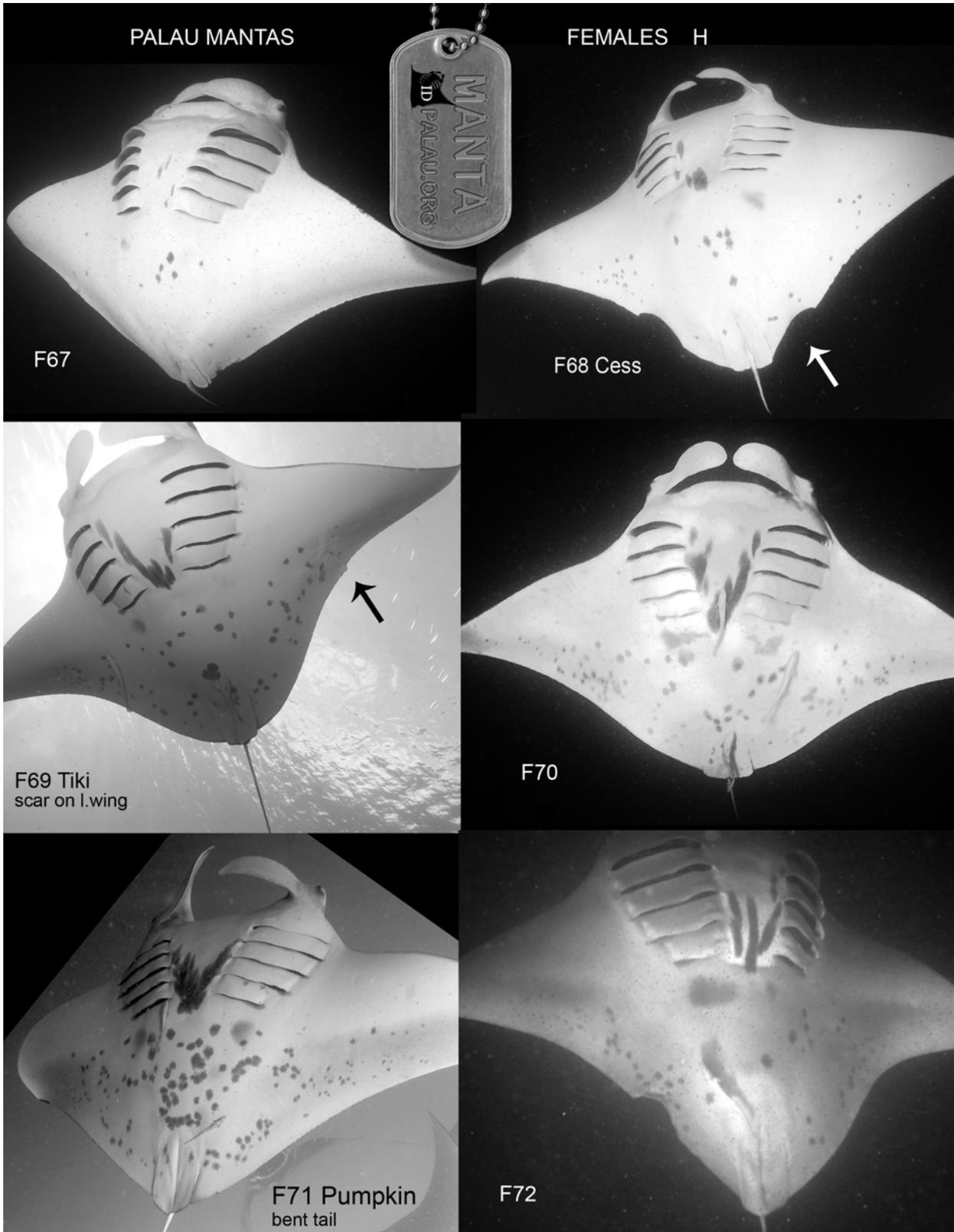
F62



F65

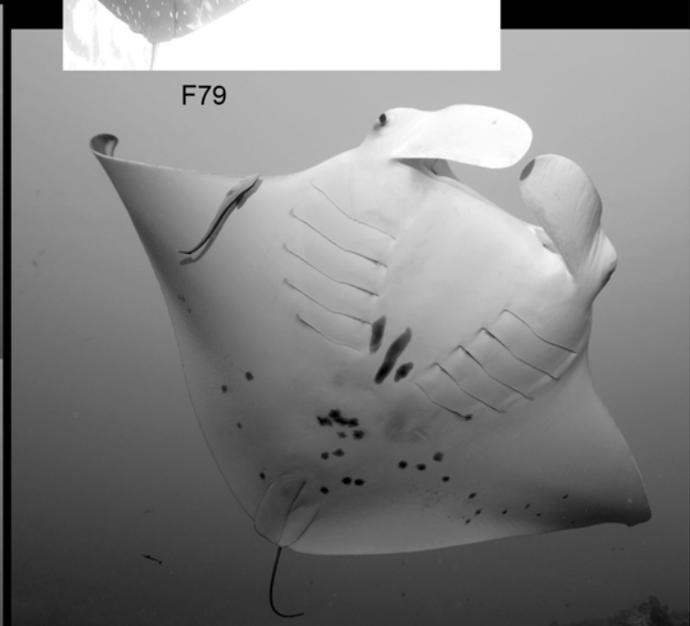
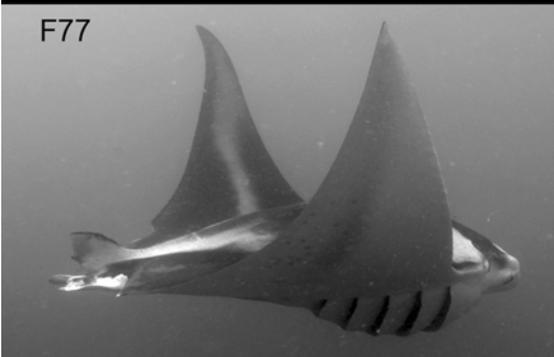
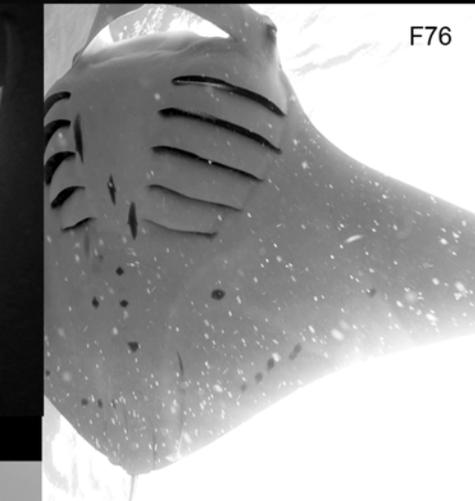
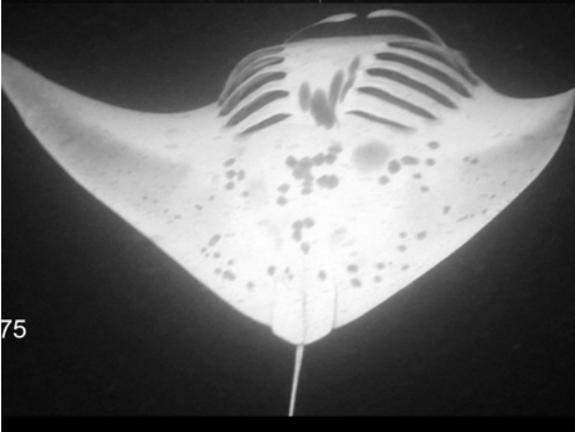
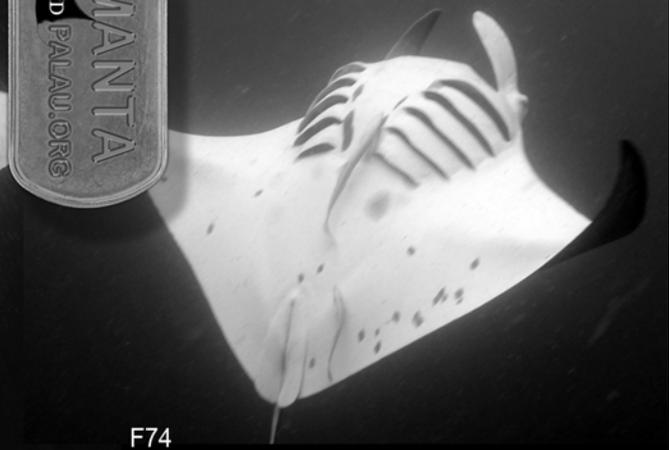
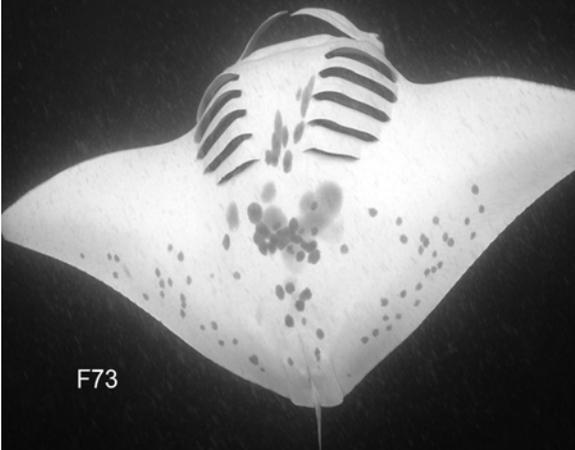


F66 Vspot



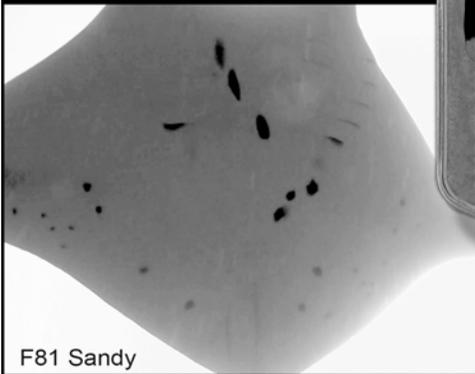
PALAU Mantas

Females I

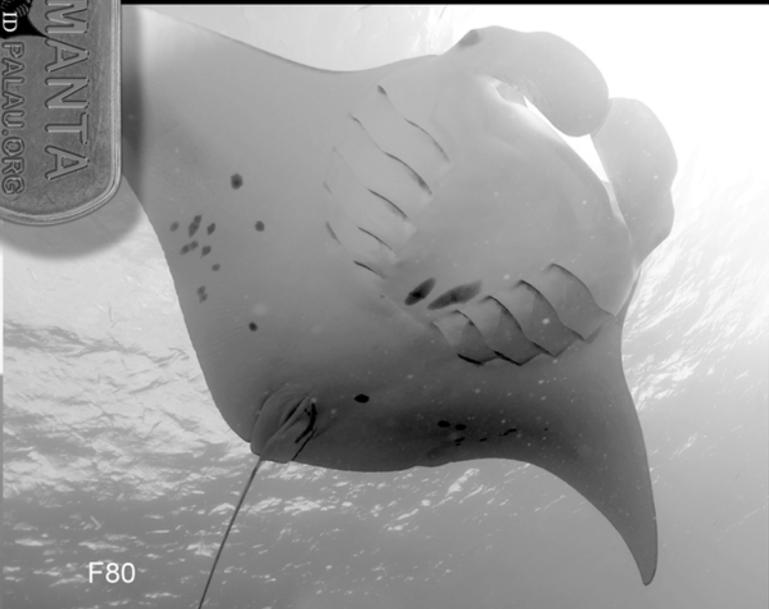


PALAU MANTAS

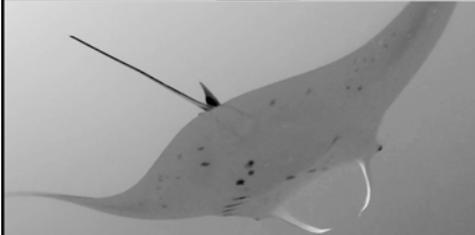
FEMALES J



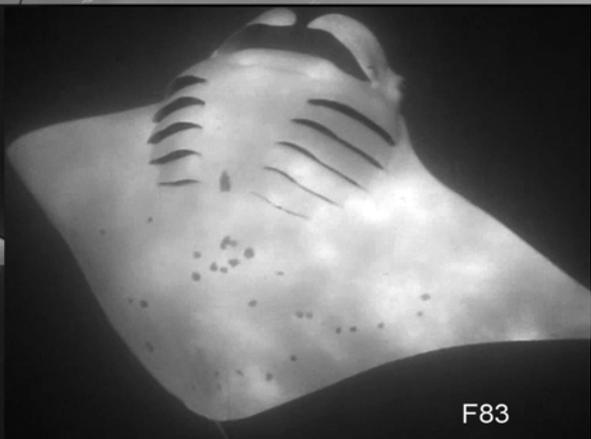
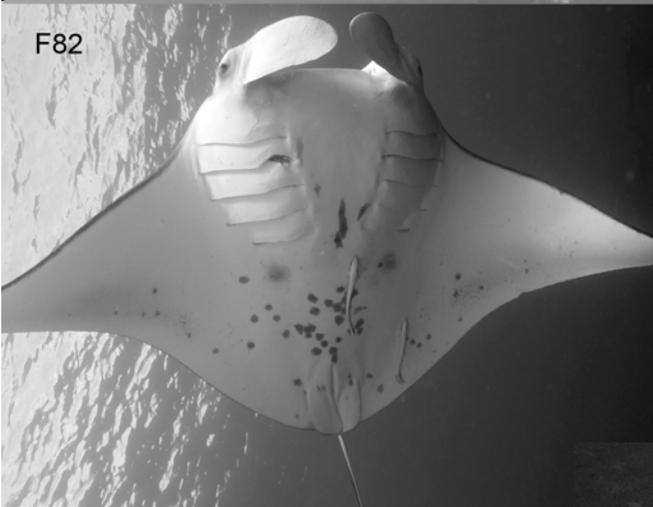
F81 Sandy



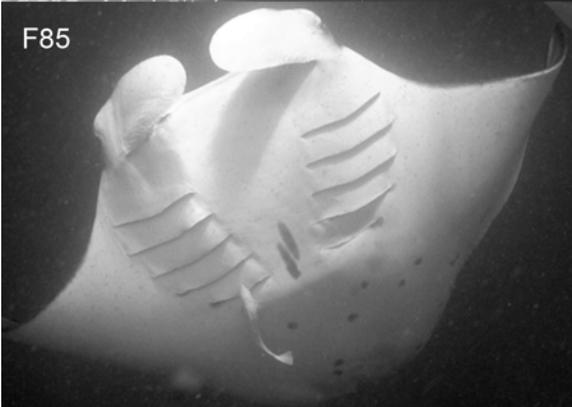
F80



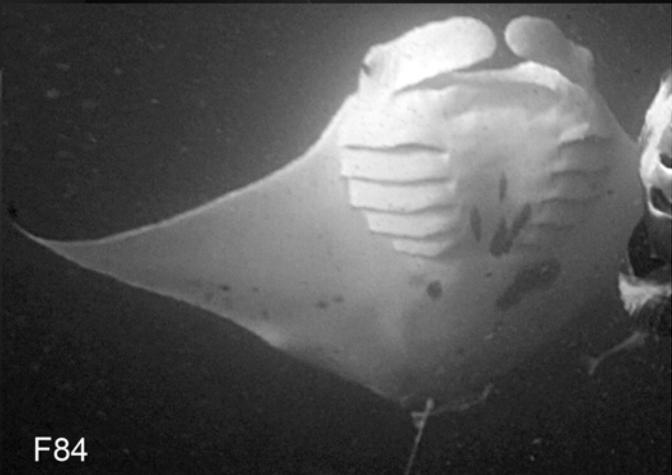
F82



F83



F85



F84

PALAU MANTAS

FEMALES K



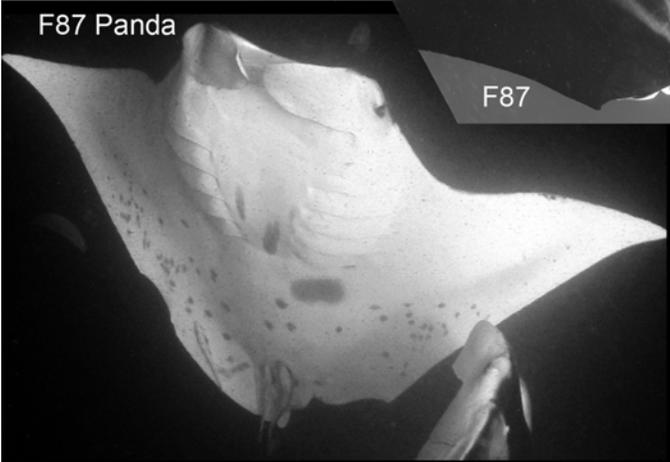
F86



F91

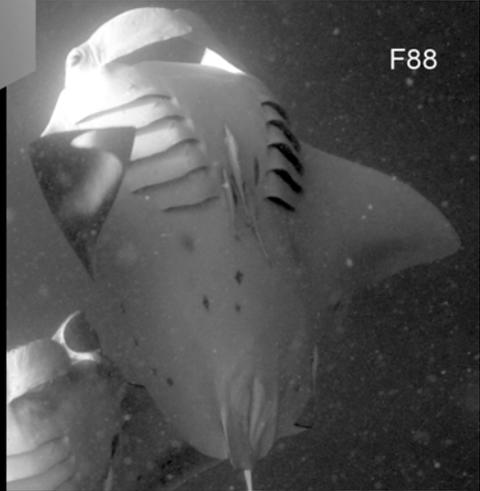


F87 Panda

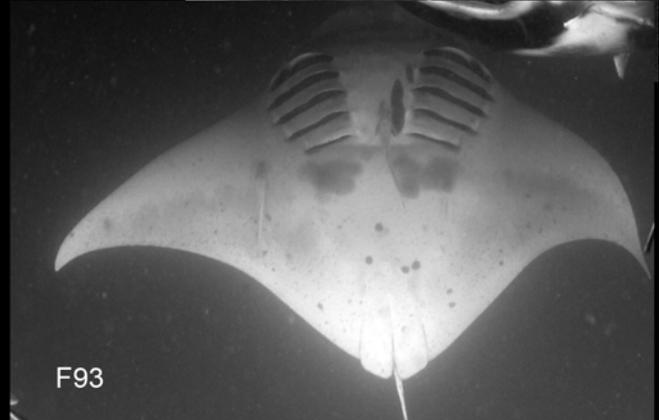


F87

F88



F92



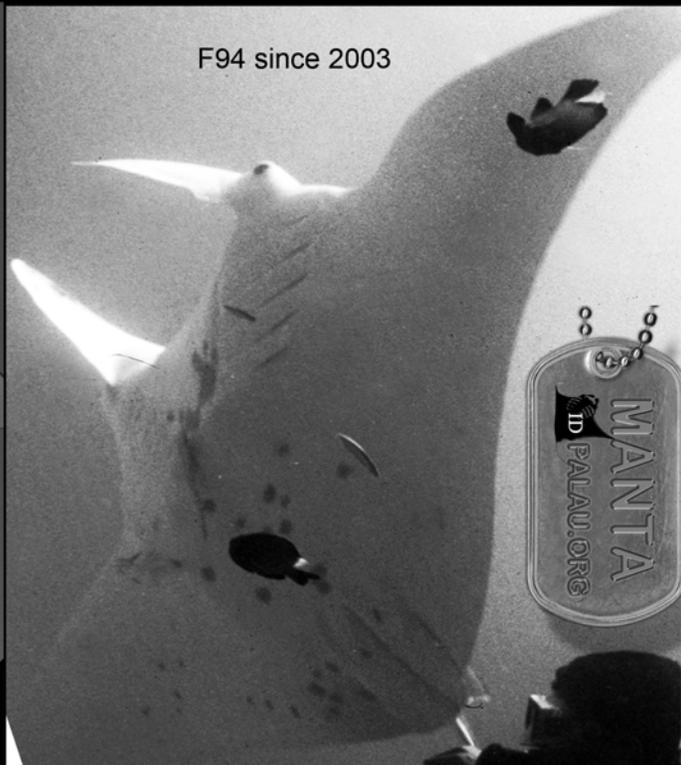
F93

PALAU MANTAS

FEMALES L



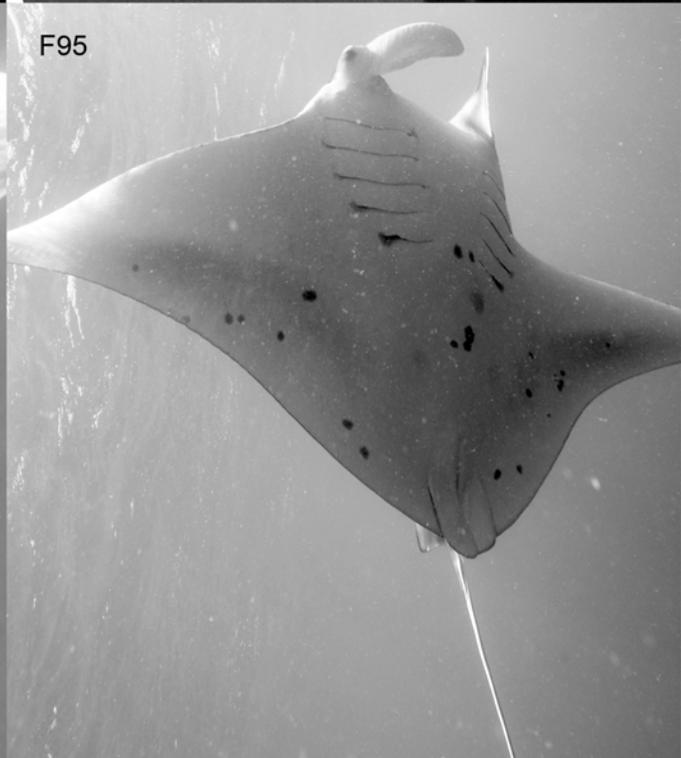
F98  
cracked tail



F94 since 2003



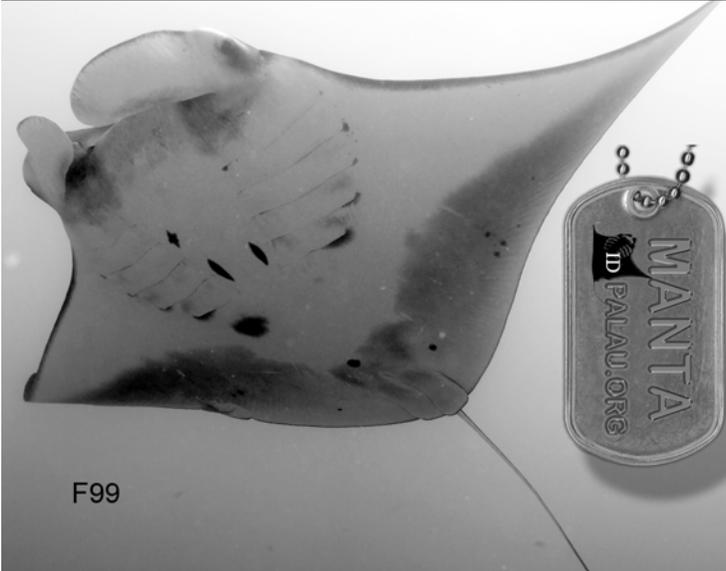
F96



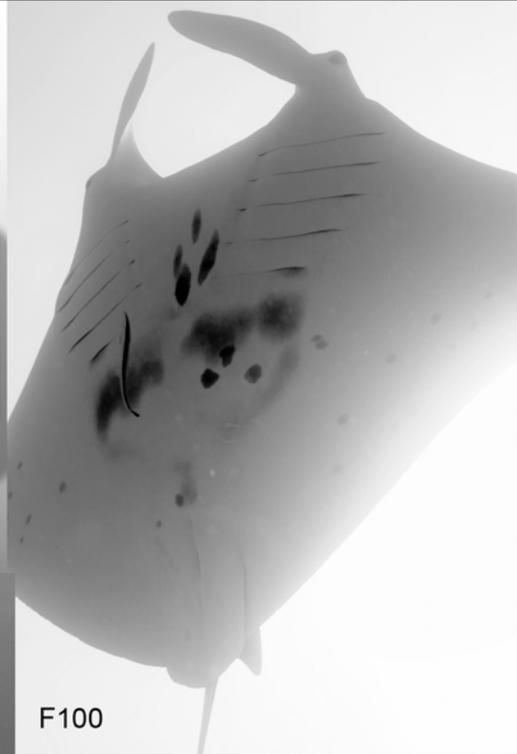
F95

PALAU MANTAS

FEMALES M



F99



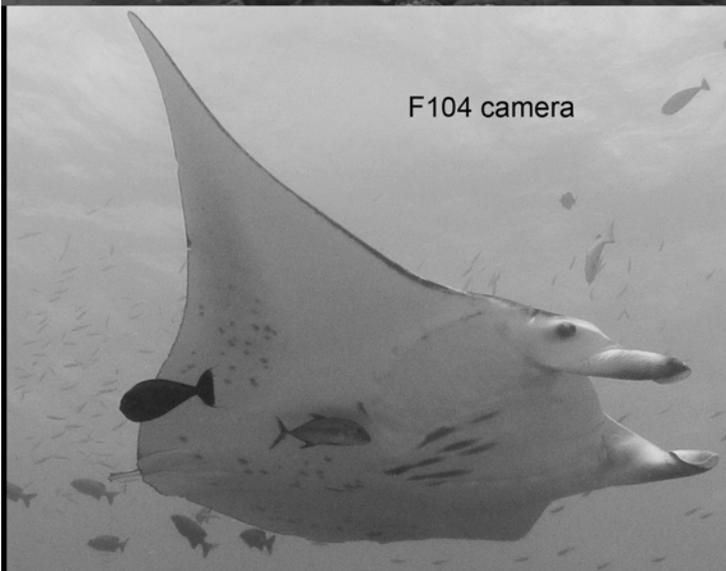
F100



F104



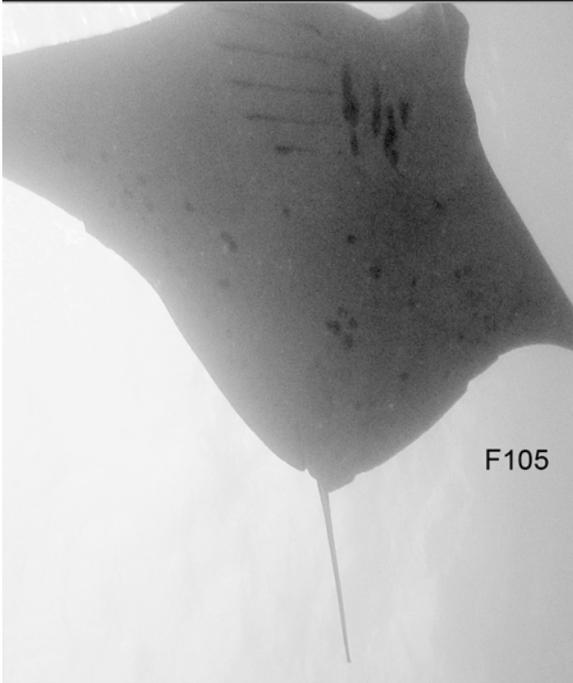
F103 camera



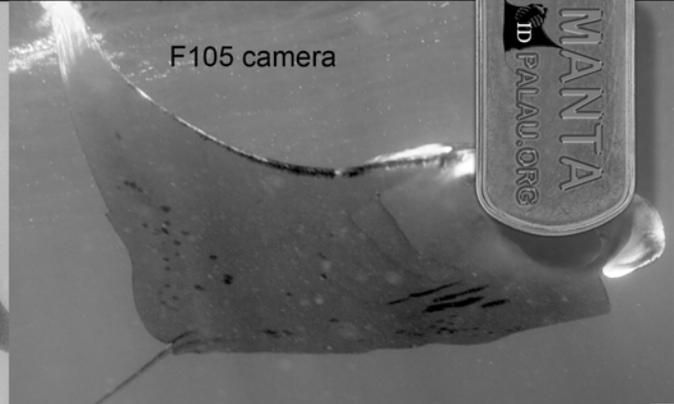
F104 camera

PALAU MANTAS

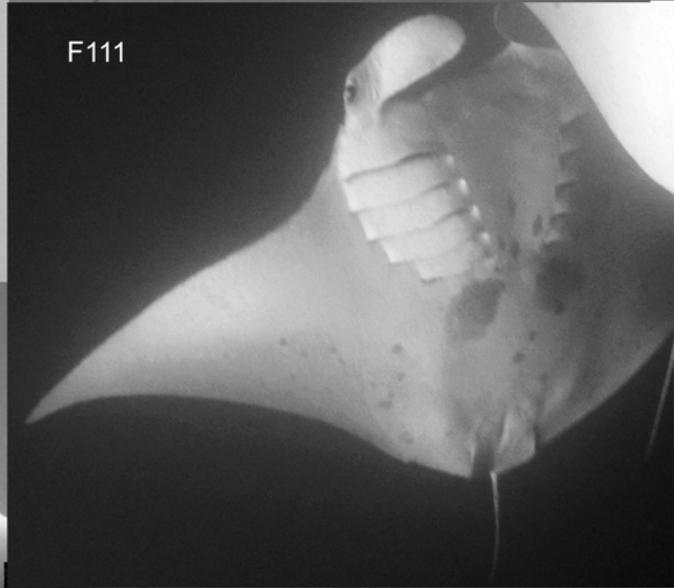
FEMALES N



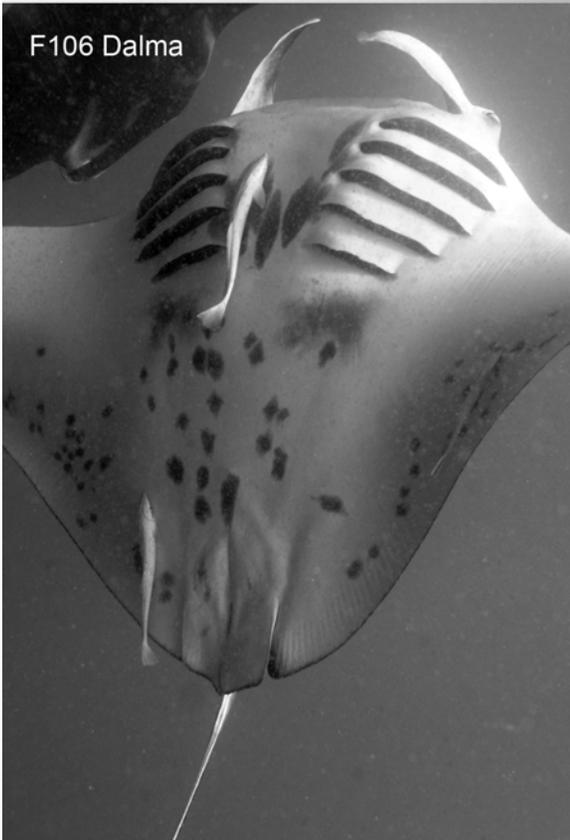
F105



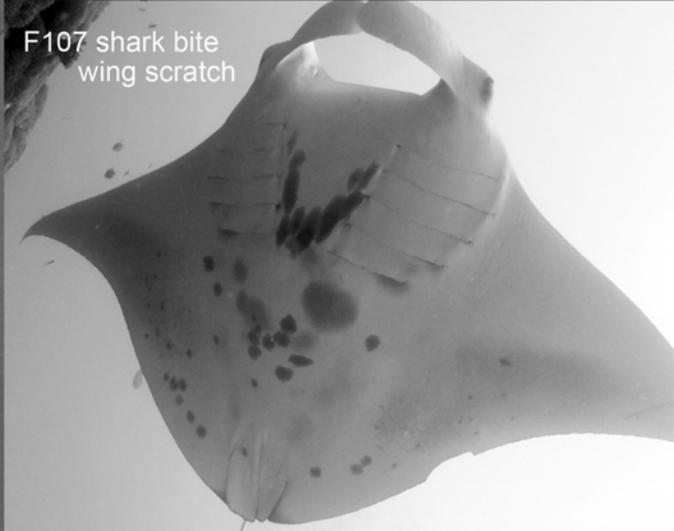
F105 camera



F111



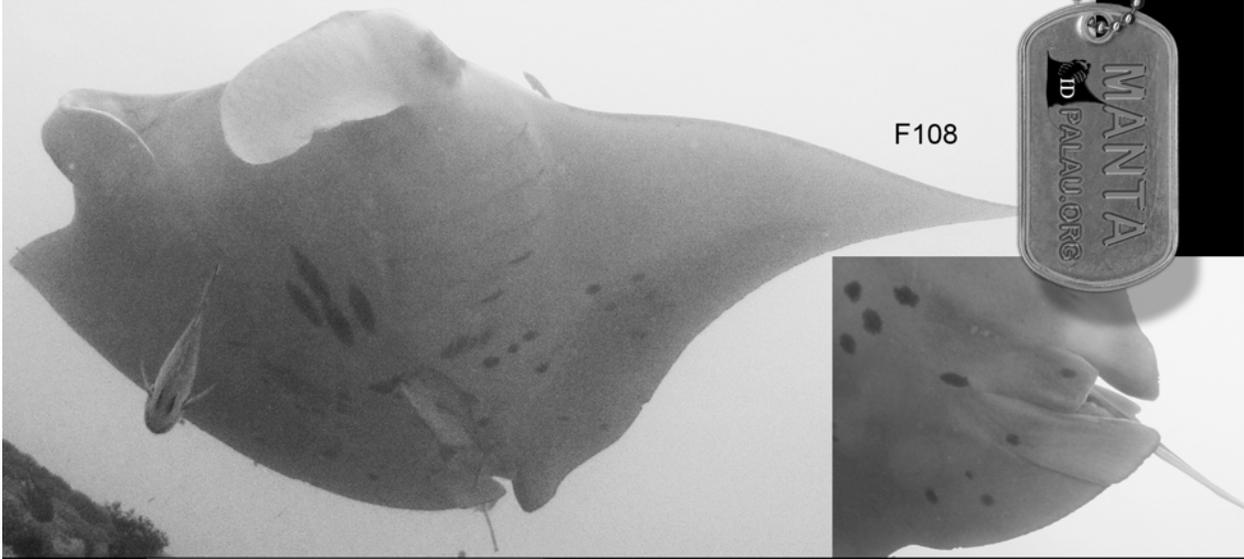
F106 Dalma



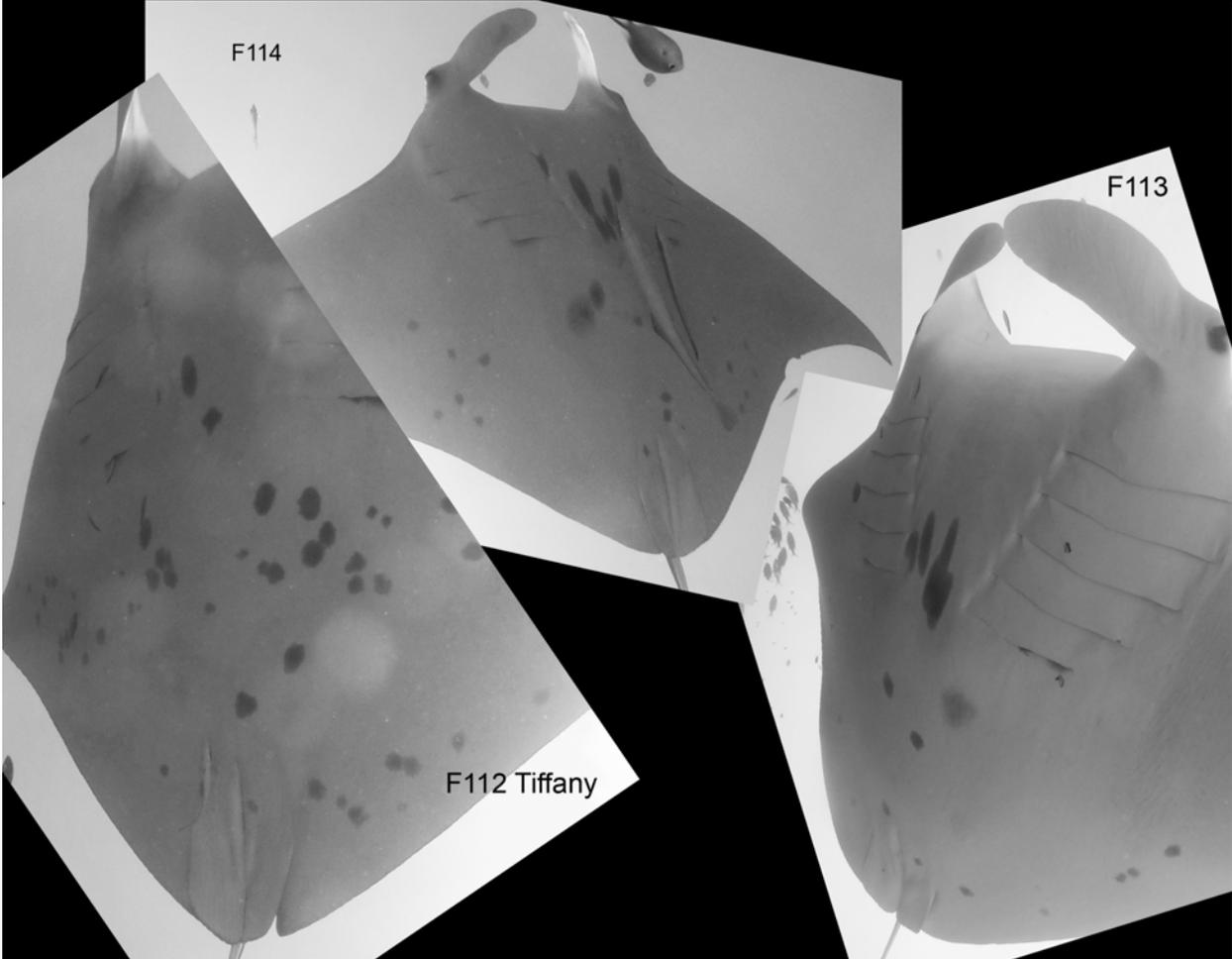
F107 shark bite  
wing scratch

PALAU MANTAS

FEMALES O



F108



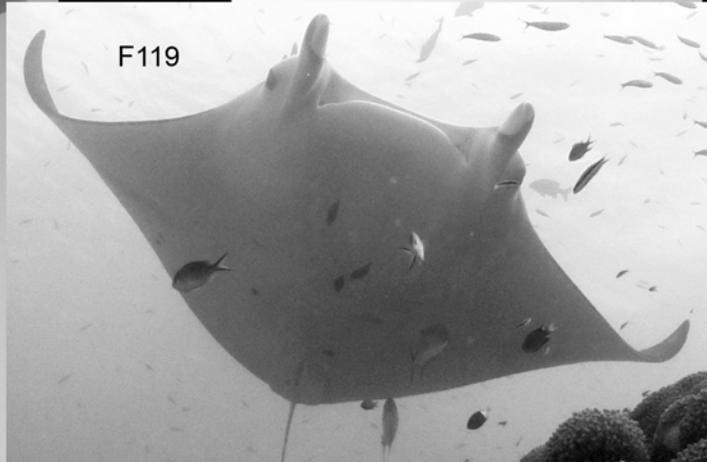
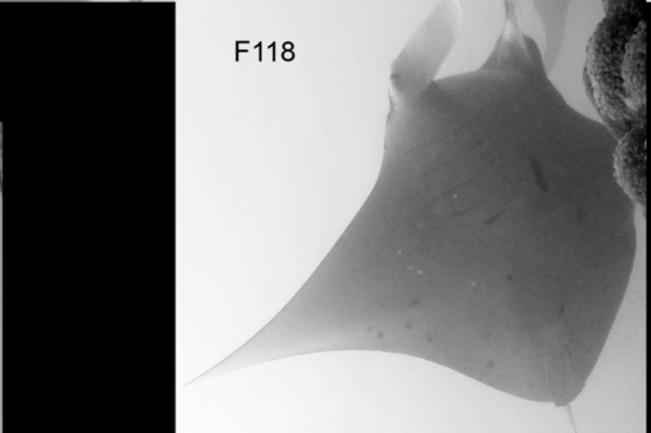
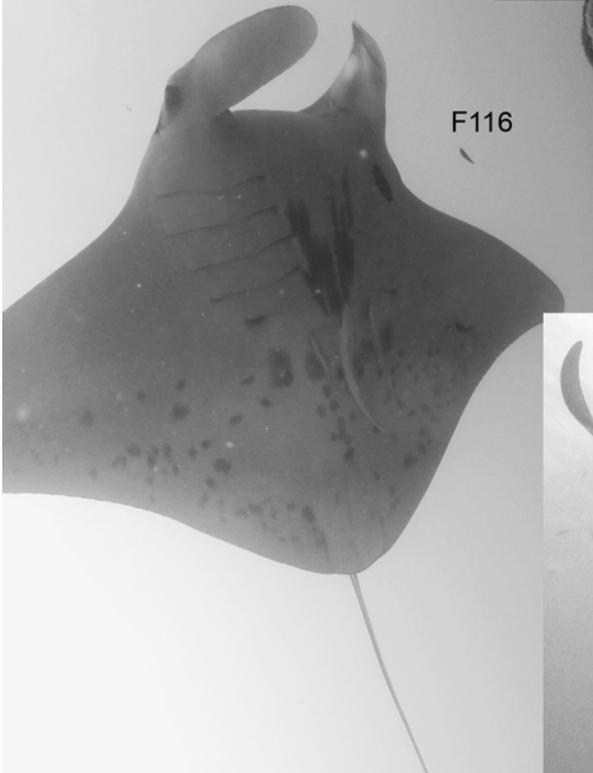
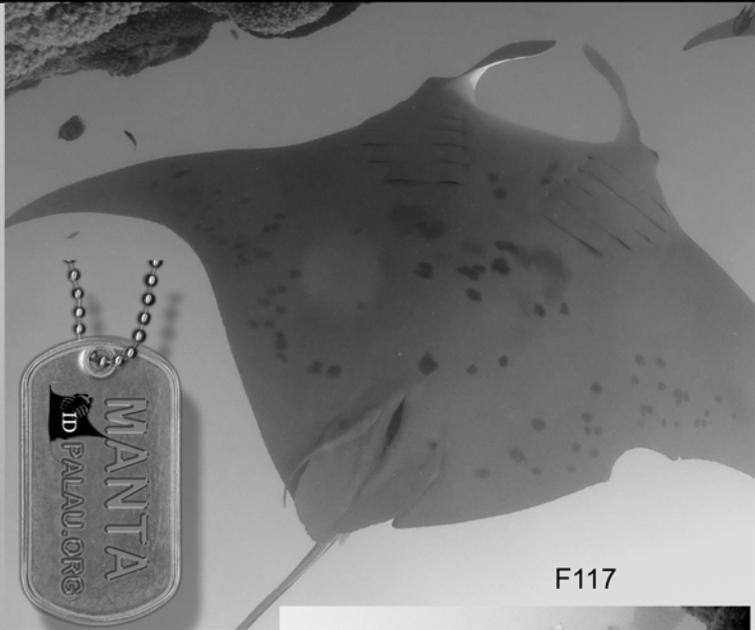
F114

F113

F112 Tiffany

PALAU MANTAS

FEMALES P



PALAU MANTAS

FEMALES Q

F120



F127

F121

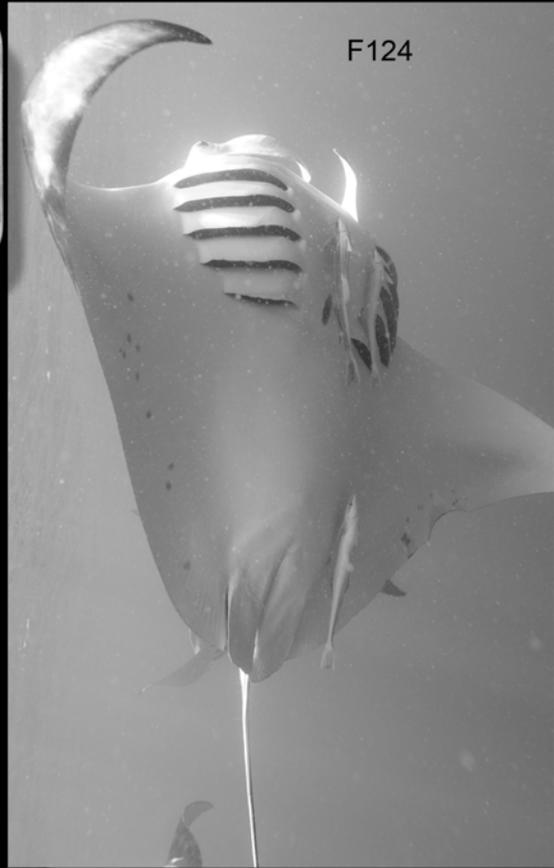
F123

F126

F122

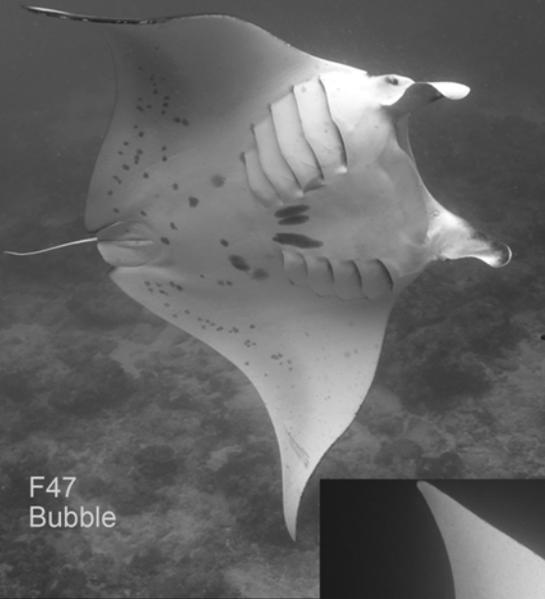
PALAU MANTAS

FEMALES R

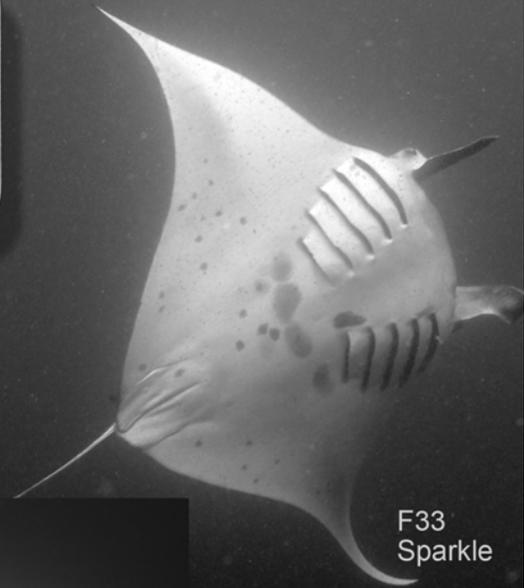


PALAU sideways feeders

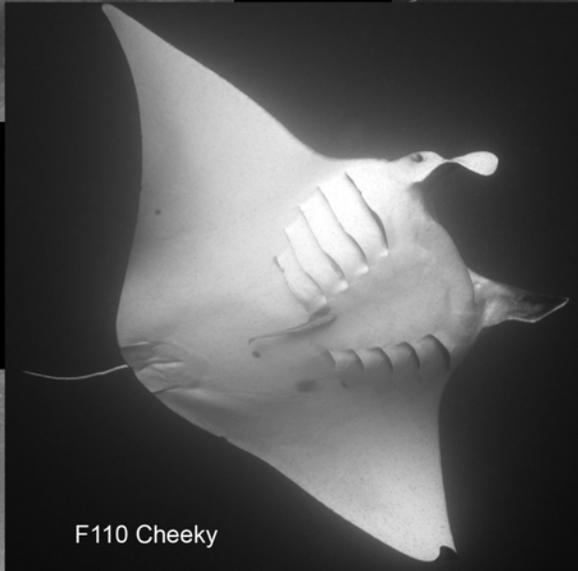
Females



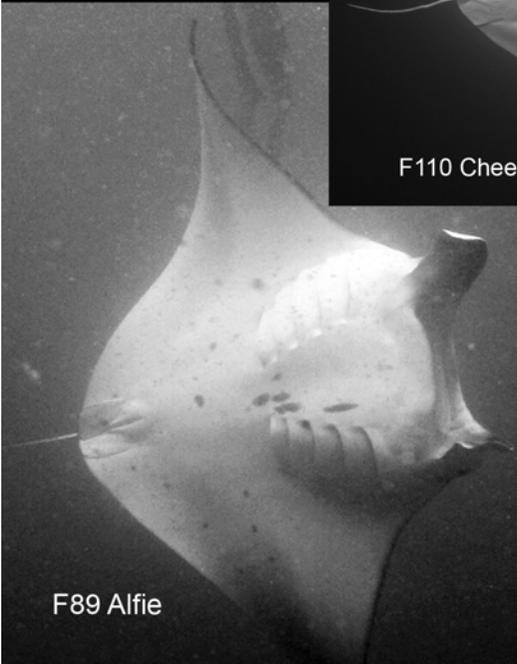
F47  
Bubble



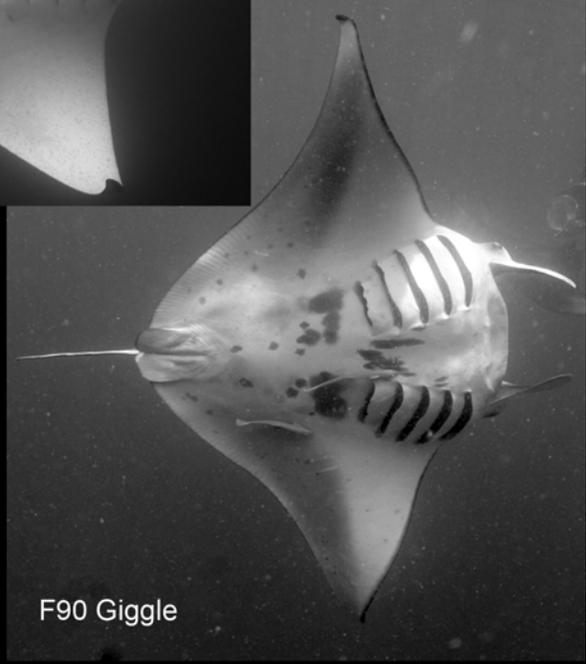
F33  
Sparkle



F110  
Cheeky



F89  
Alfie



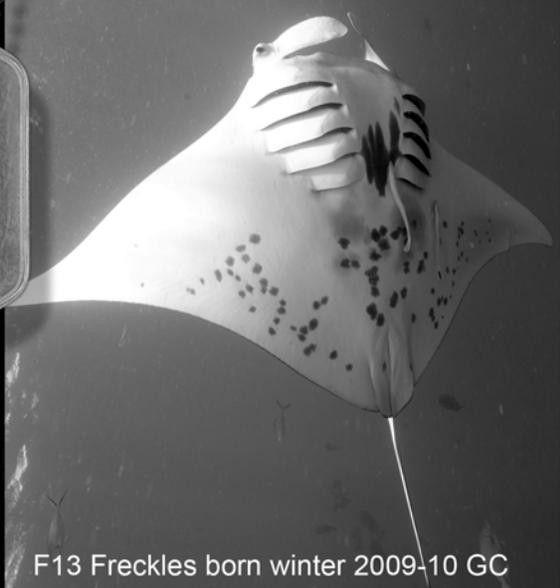
F90  
Giggle

PALAU Young Mantas

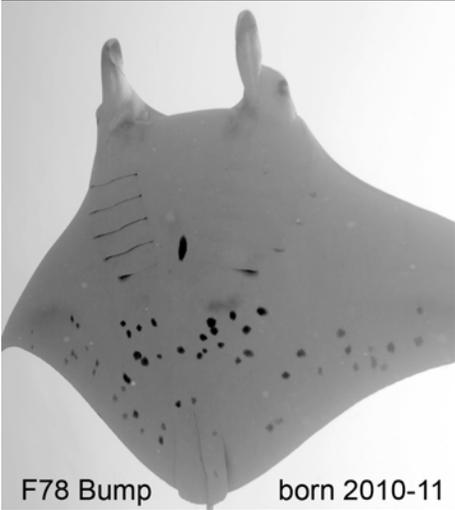
born 2009~ Females A



F6 Missy born winter 2008-09 GC



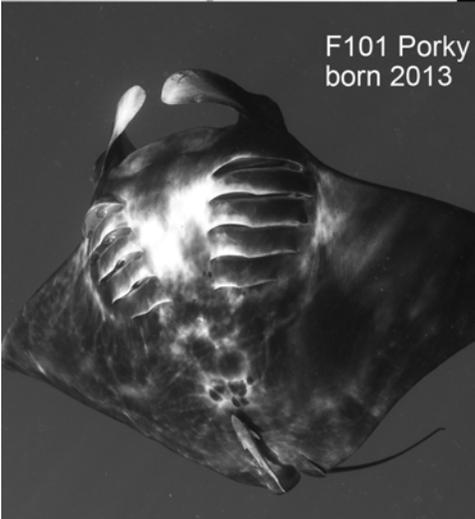
F13 Freckles born winter 2009-10 GC



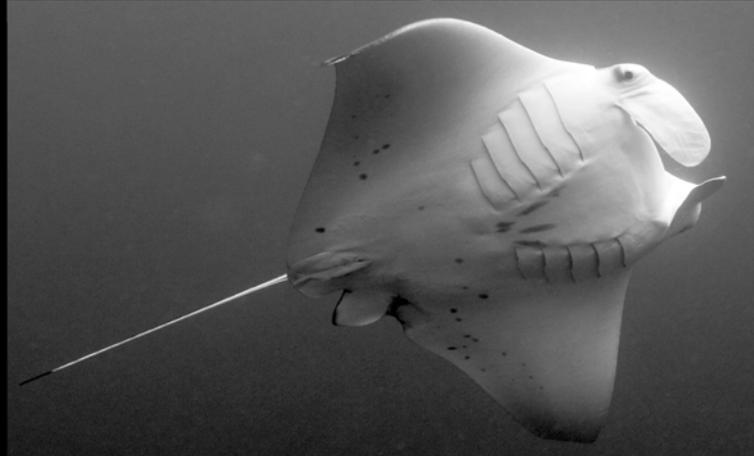
F78 Bump born 2010-11



F109 Sasha juv 2013



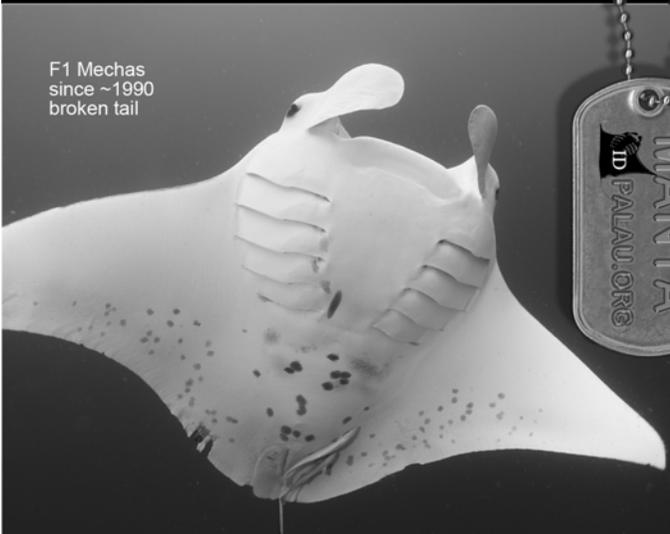
F101 Porky born 2013



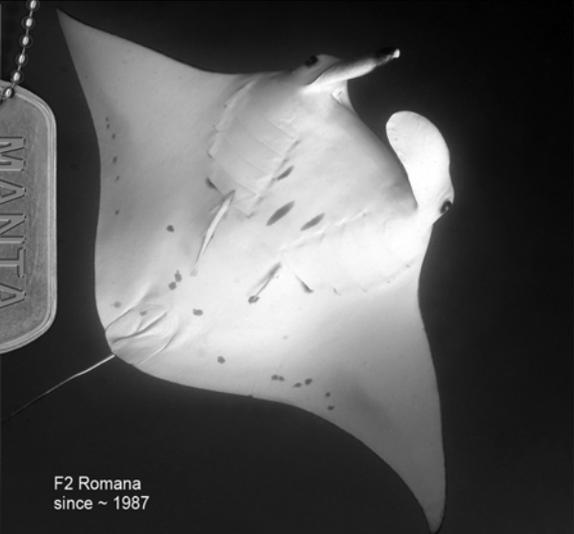
Popular German Channel MANTAS

FEMALES

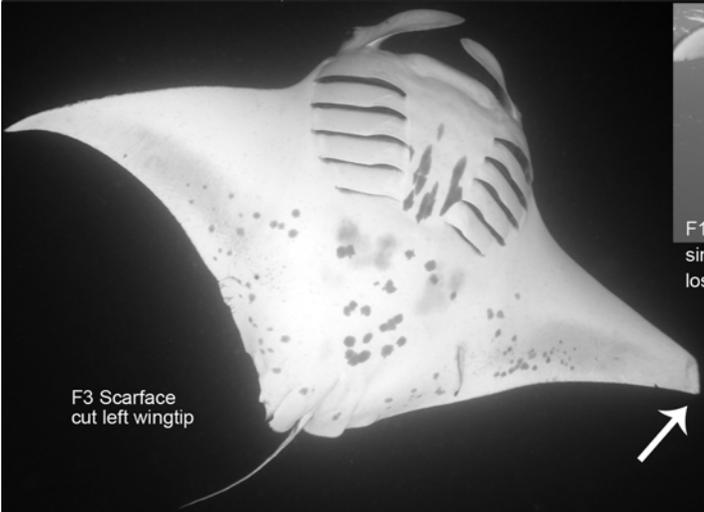
F1 Mechas  
since ~1990  
broken tail



F2 Romana  
since ~1987



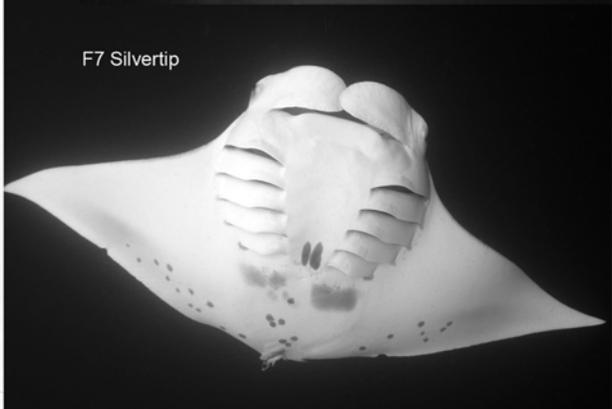
F3 Scarface  
cut left wingtip



F17 Gypsy  
since ~2007  
lost right lobe 2012

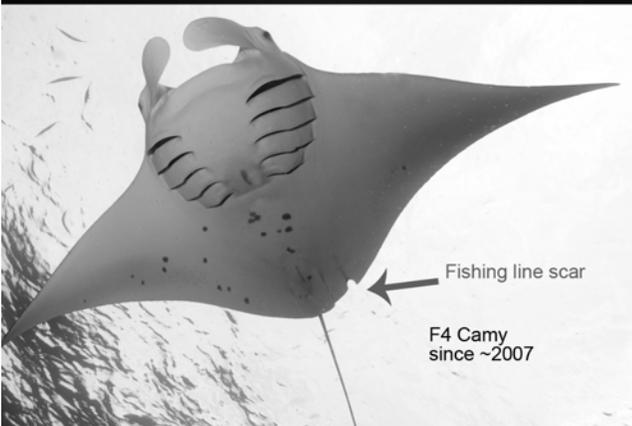


F7 Silvertip



Fishing line scar

F4 Camy  
since ~2007

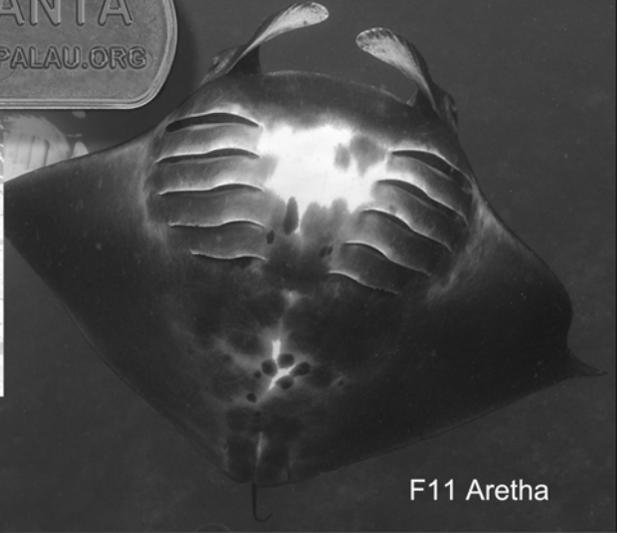


PALAU BLACK

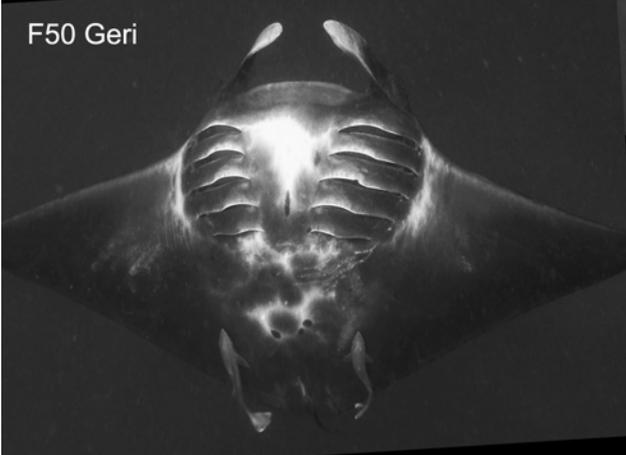
Females A



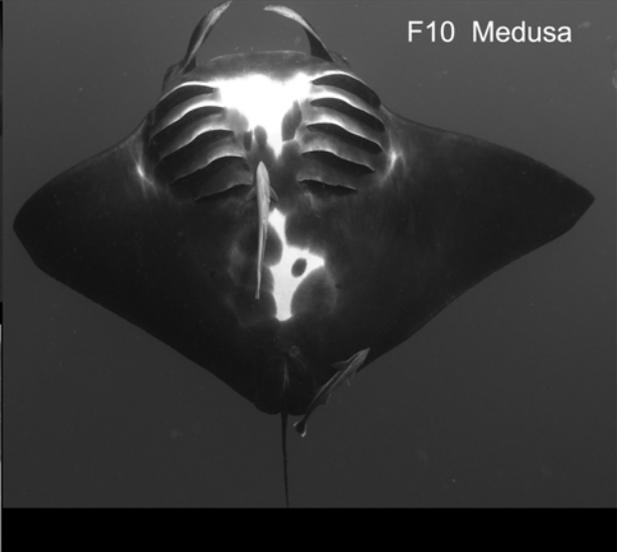
F9 Black Widow



F11 Aretha



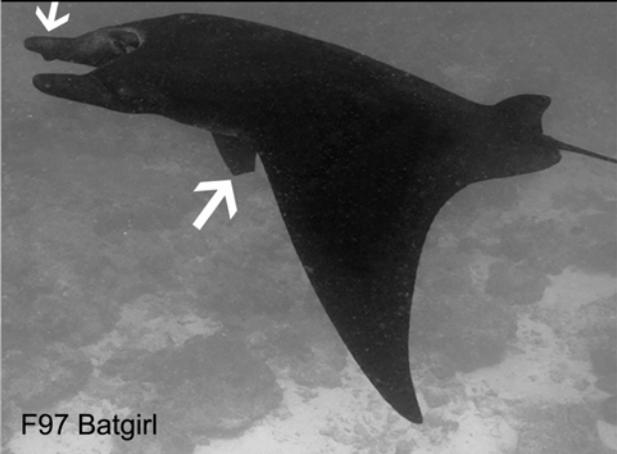
F50 Geri



F10 Medusa

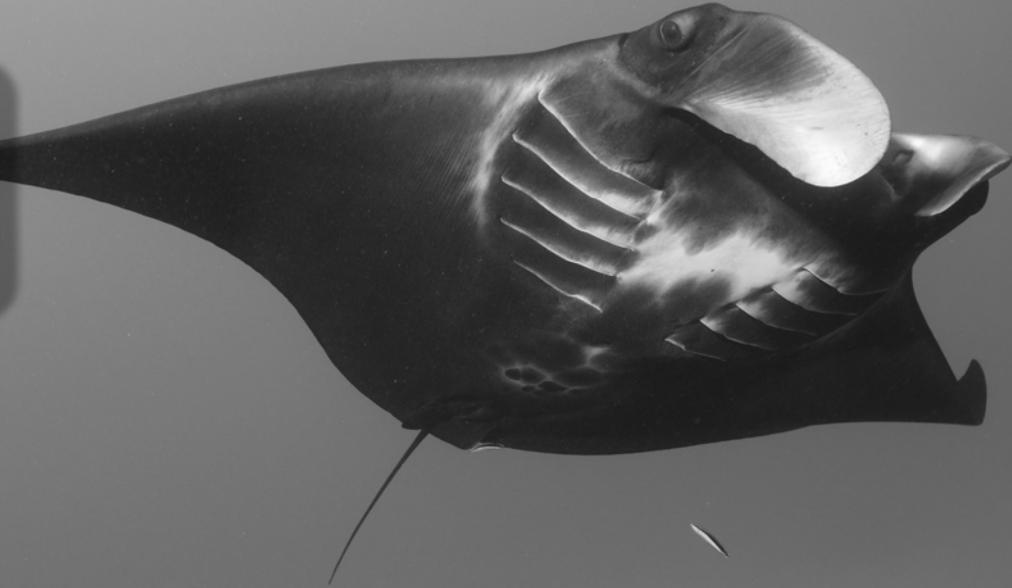


F97 Batgirl



F97 Batgirl

PALAU BLACK Females B



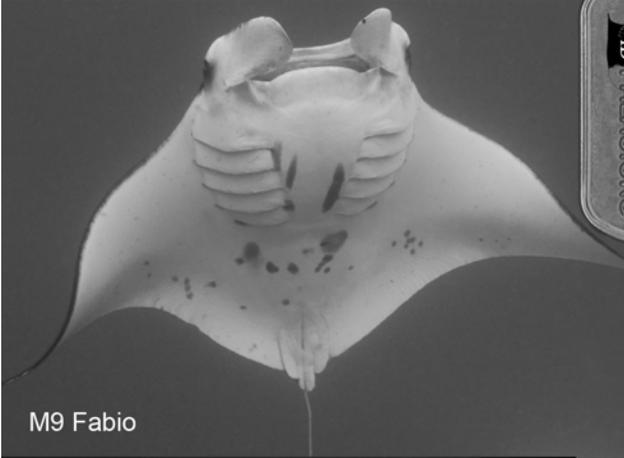
F101 Porky

F102 Phantom GoPro

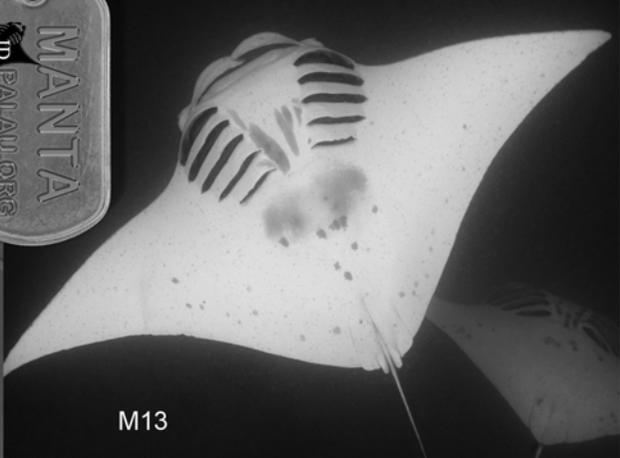


PALAU MANTAS

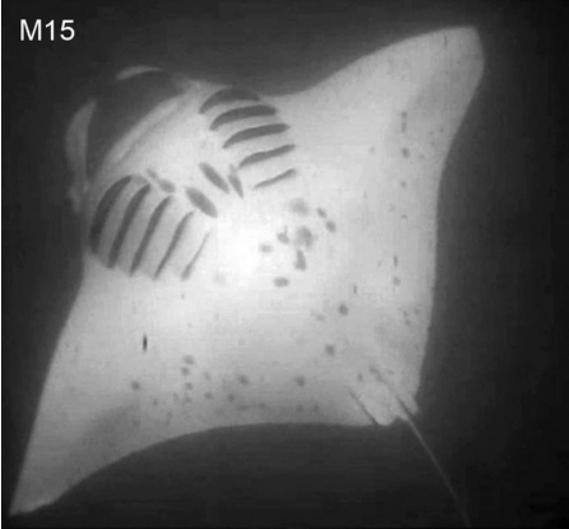
MALES A



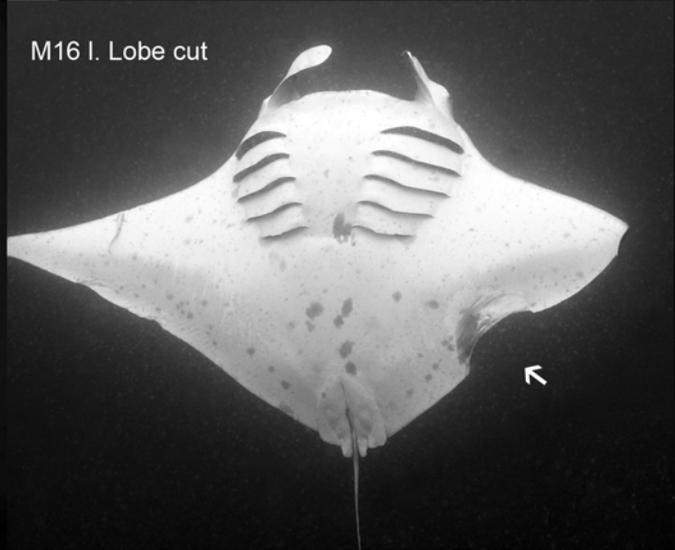
M9 Fabio



M13



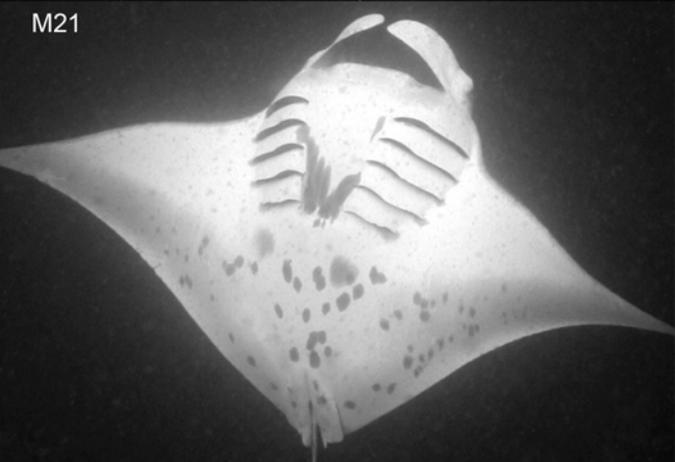
M15



M16 I. Lobe cut



M18

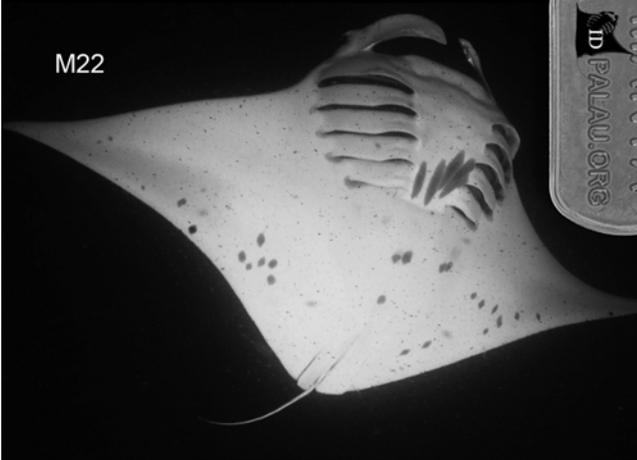


M21

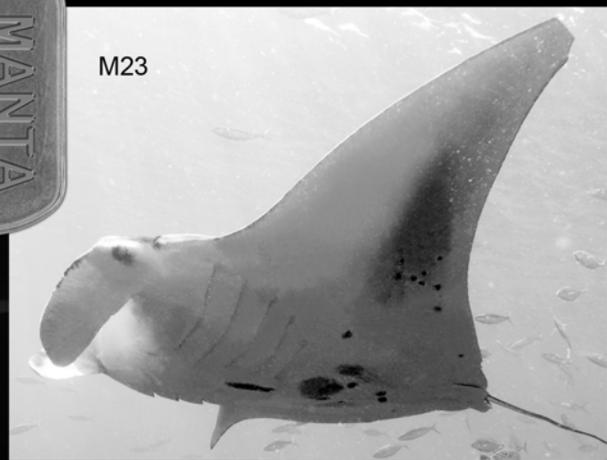
PALAU MANTAS

MALES B

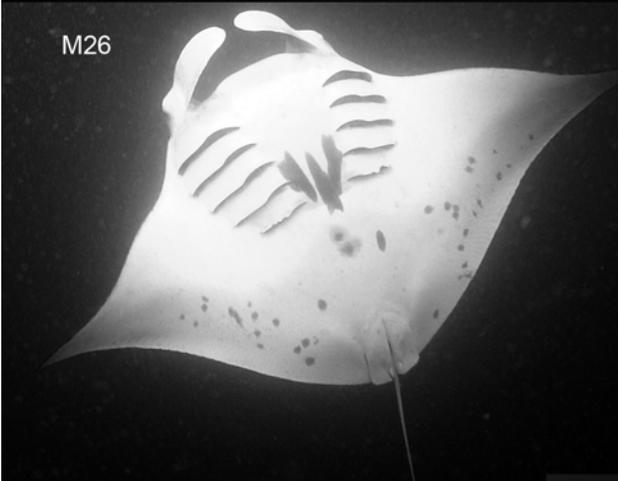
M22



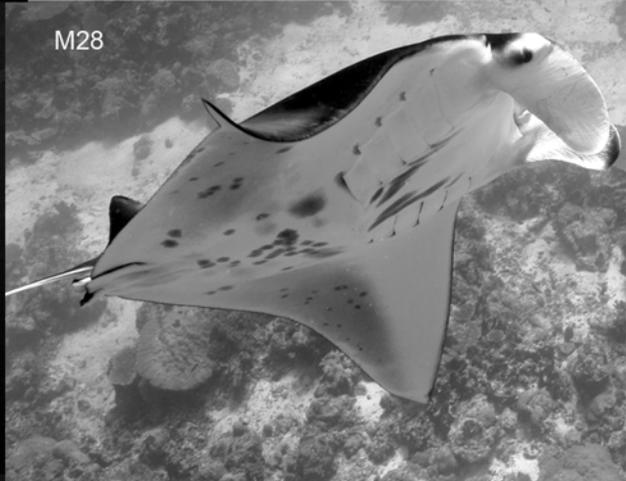
M23



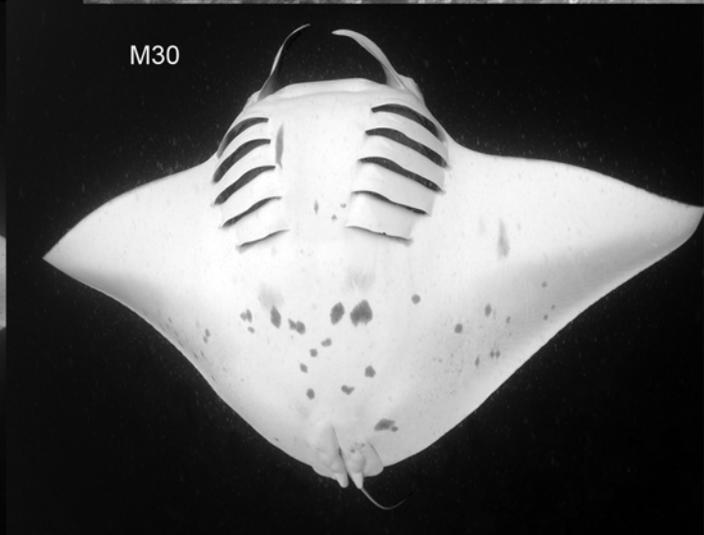
M26



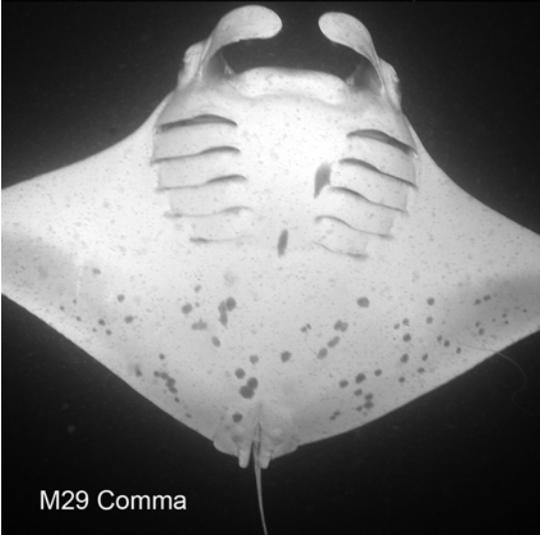
M28



M30

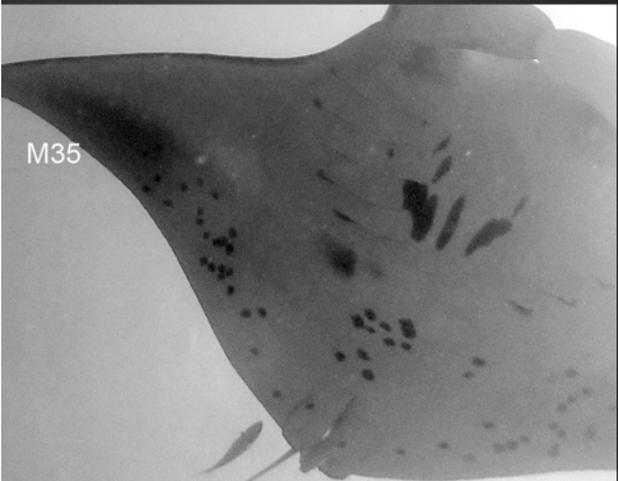
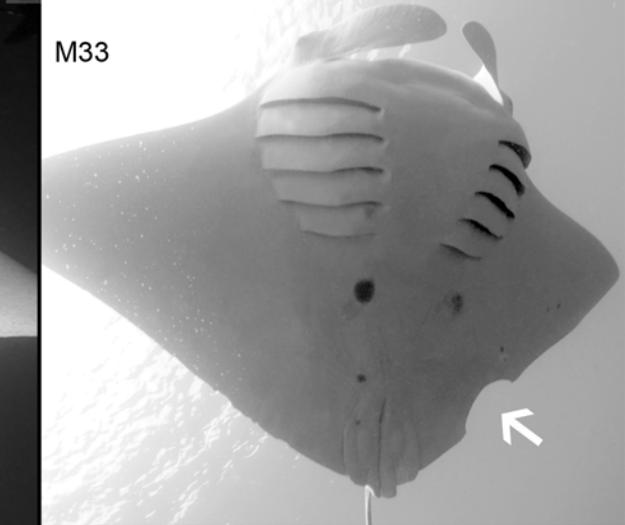
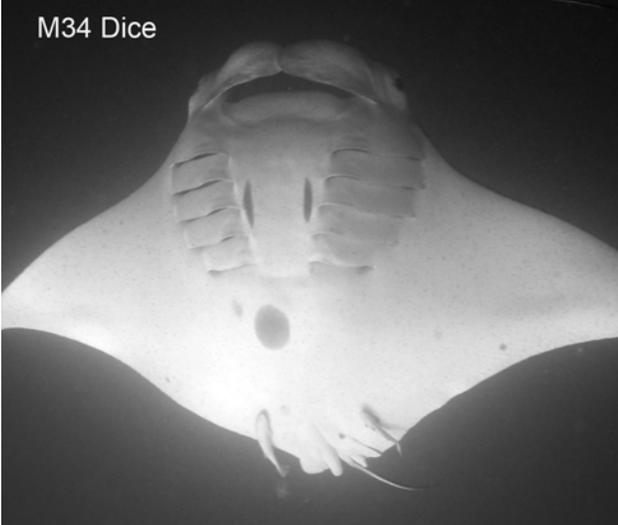


M29 Comma



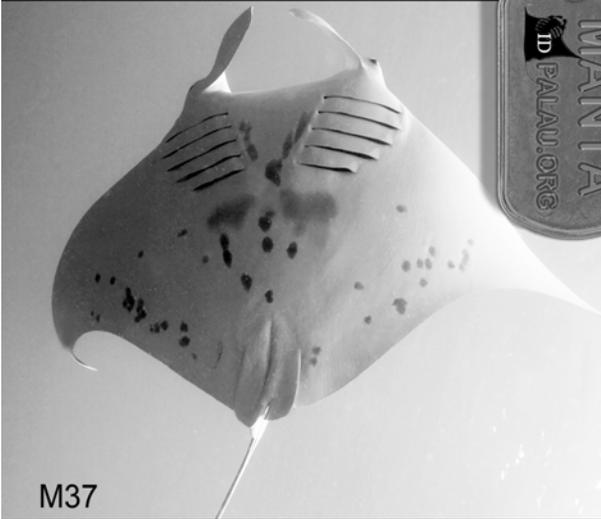
PALAU Mantas

Males C



PALAU MANTAS

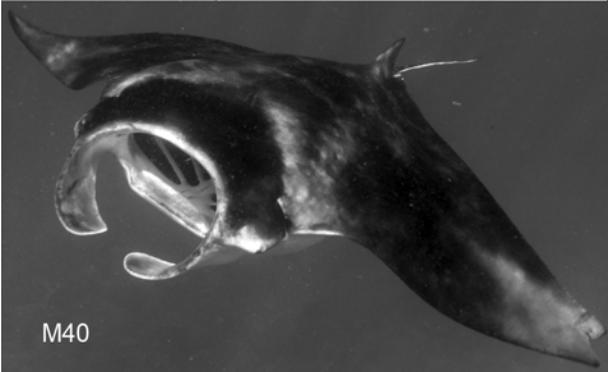
MALES D



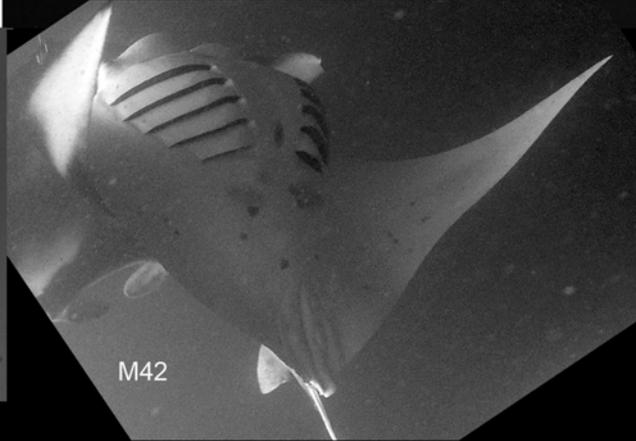
M37



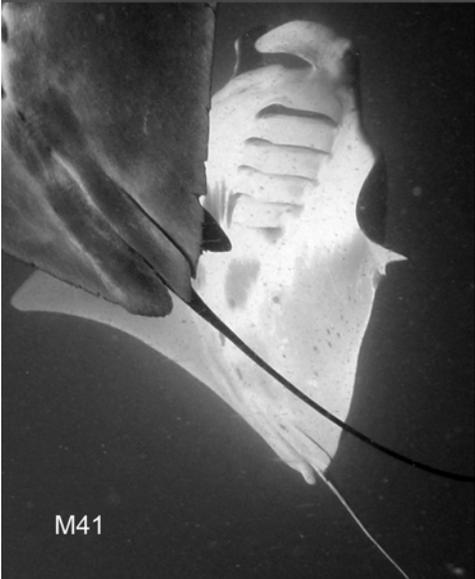
M39



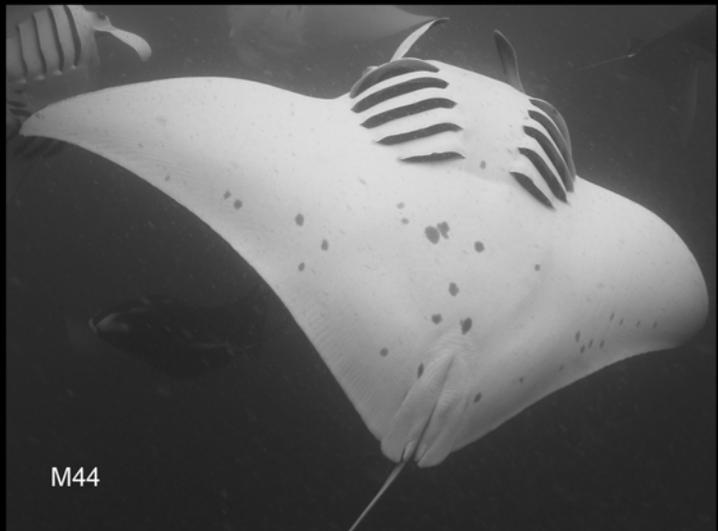
M40



M42



M41

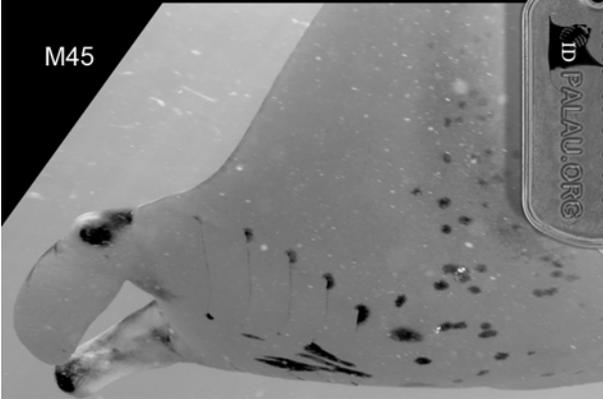


M44

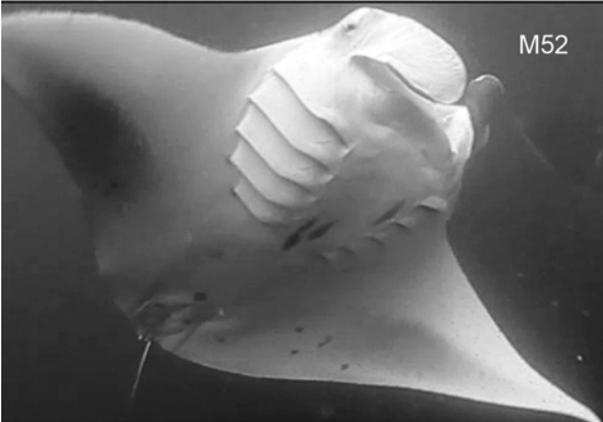
PALAU MANTAS

MALES E

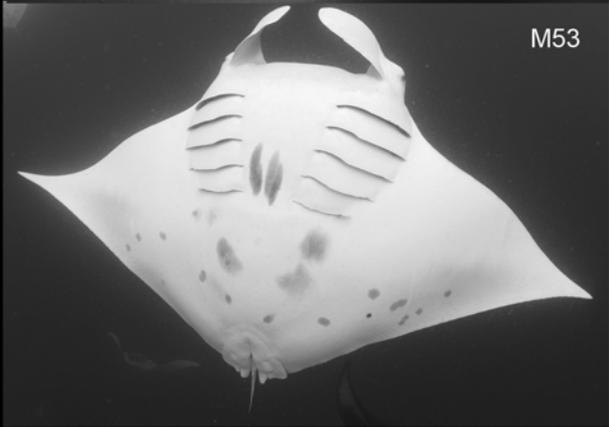
M45



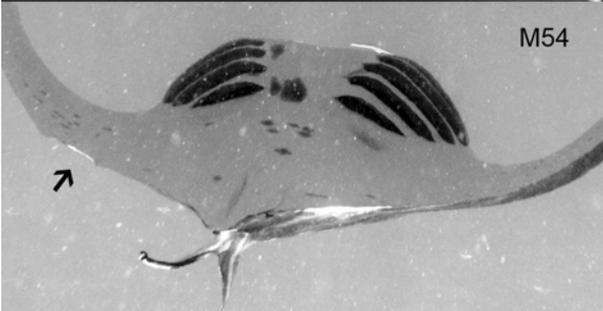
M50



M52



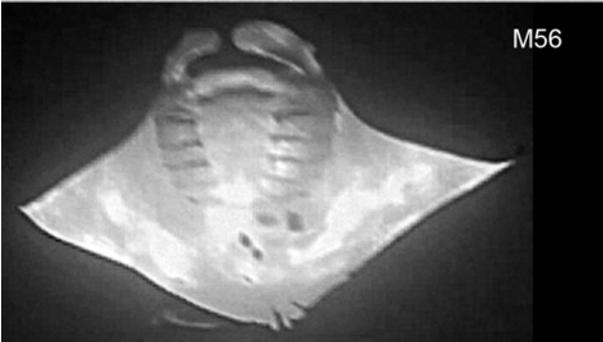
M53



M54



M55

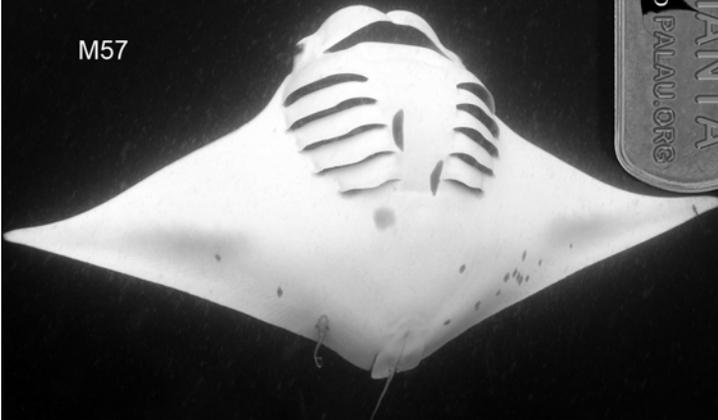


M56

PALAU MANTAS

MALES F

M57



M59 Snow

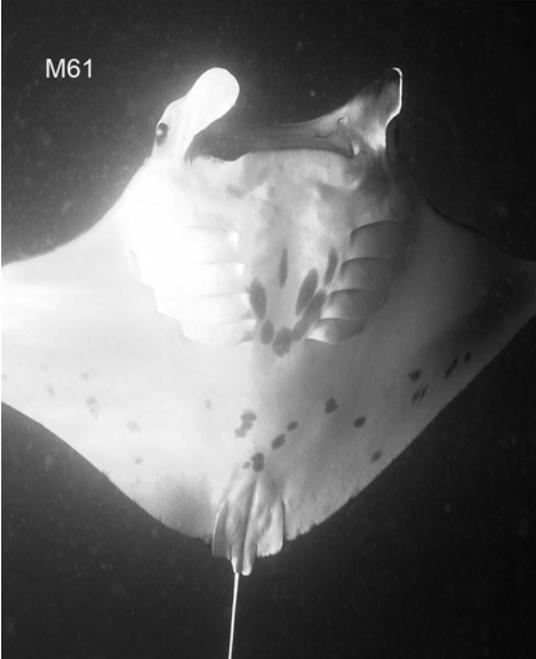
M58 Cut tip



M60



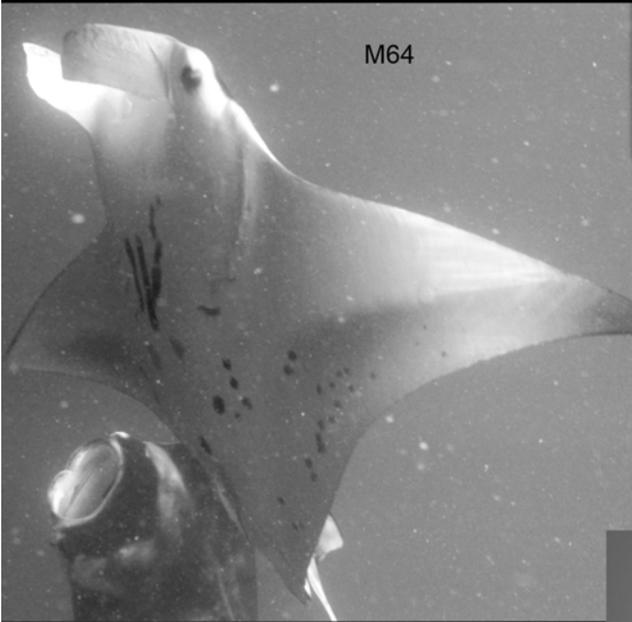
M61



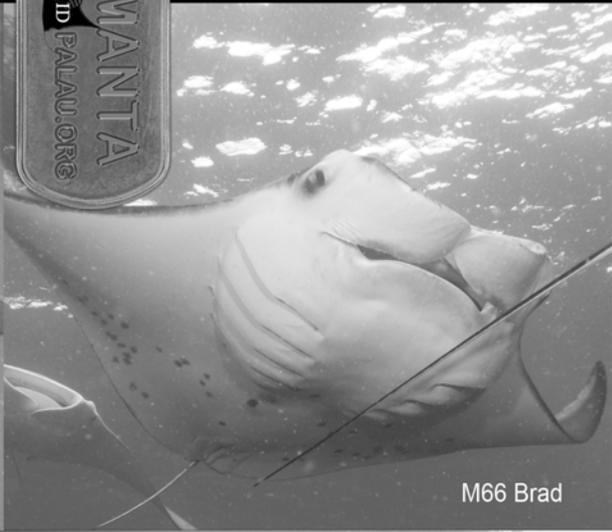
M63 Scorpio

PALAU MANTAS

MALES G



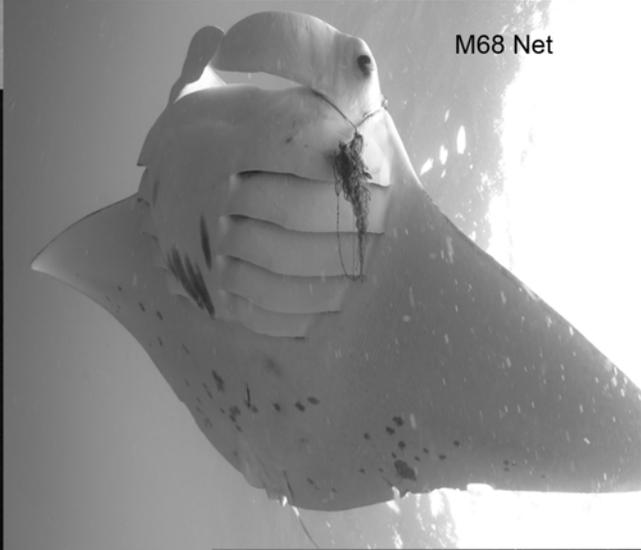
M64



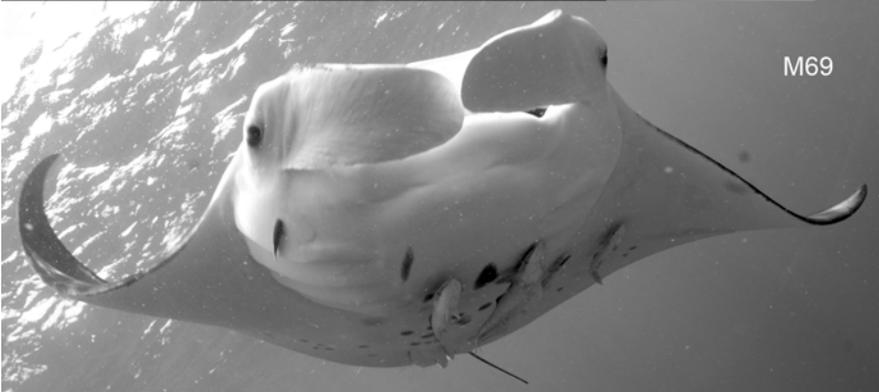
M66 Brad



M70 Moo



M68 Net



M69



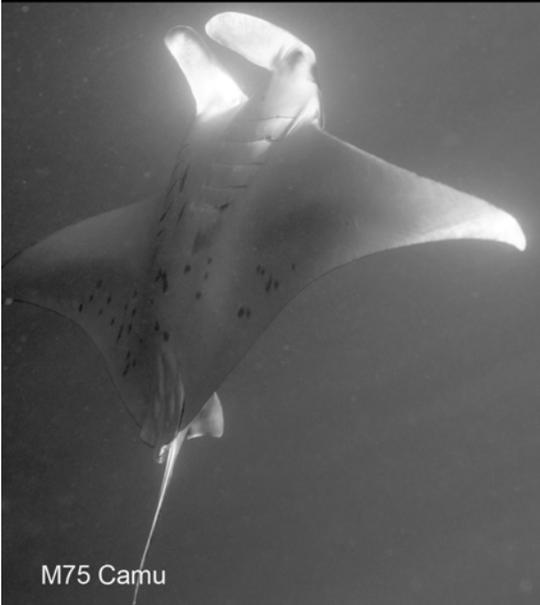
PALAU MANTAS

MALES H

M71



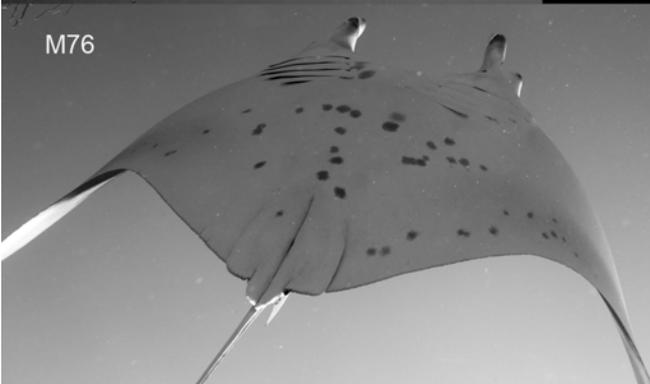
M72



M75 Camu



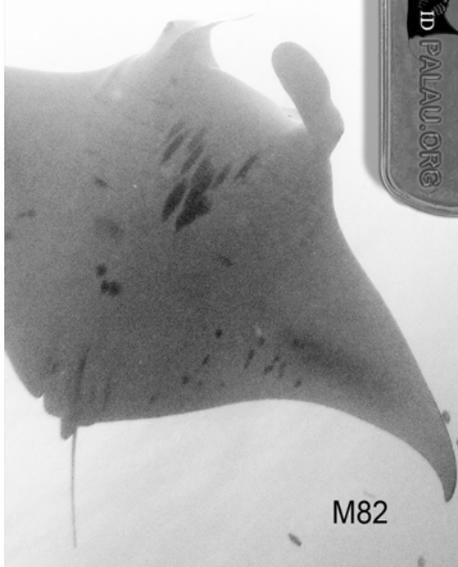
M77 juv



M76



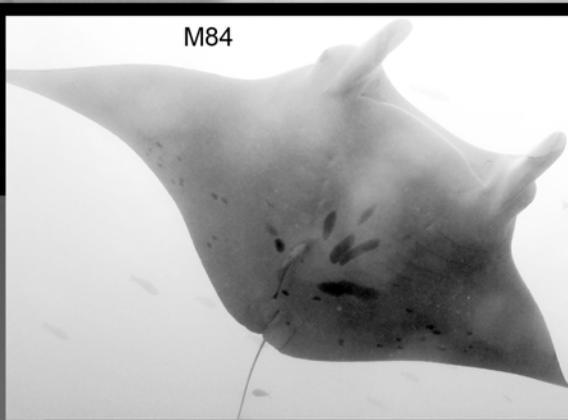
M74



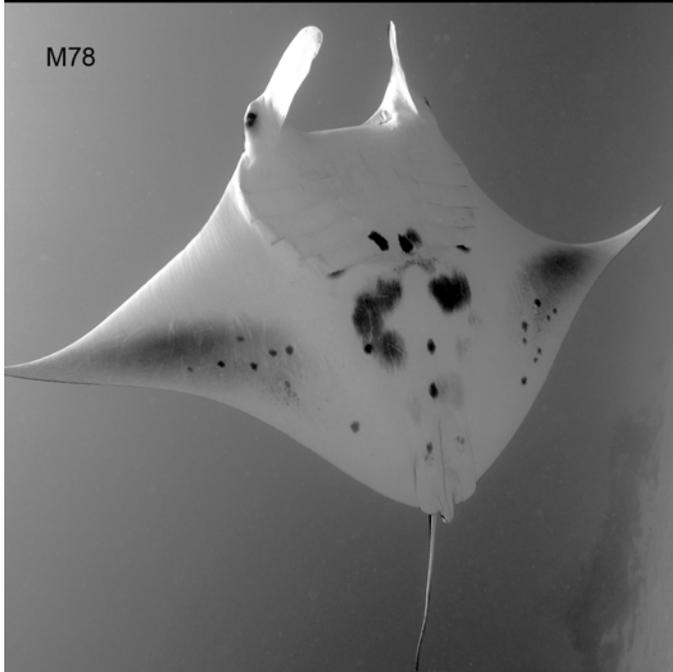
M82



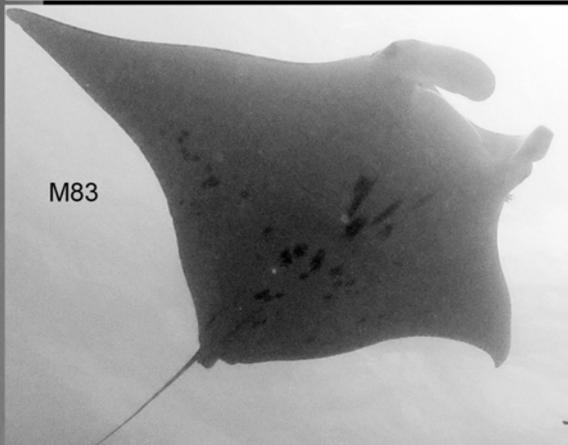
M79 Tomcat camera



M84



M78



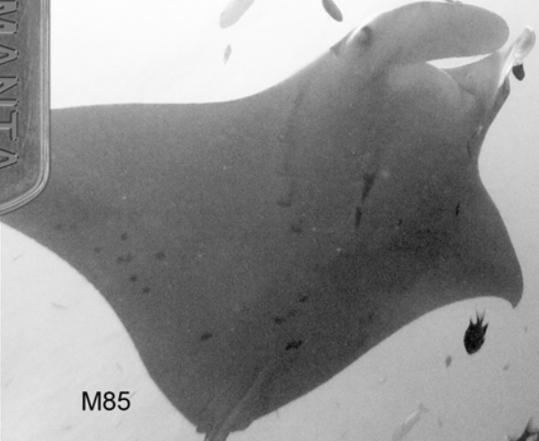
M83

PALAU MANTAS

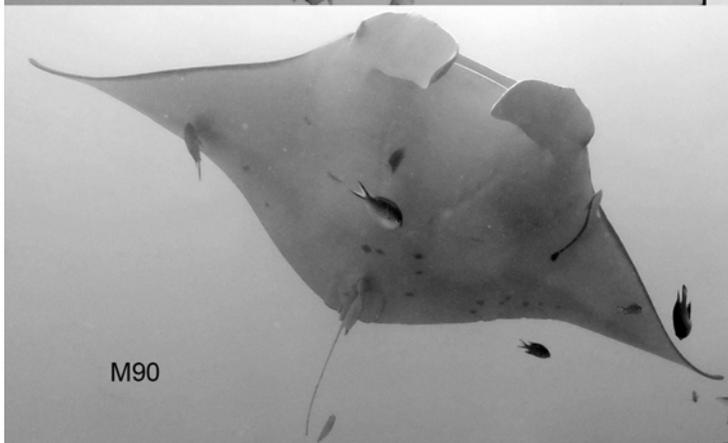
MALES J



M87



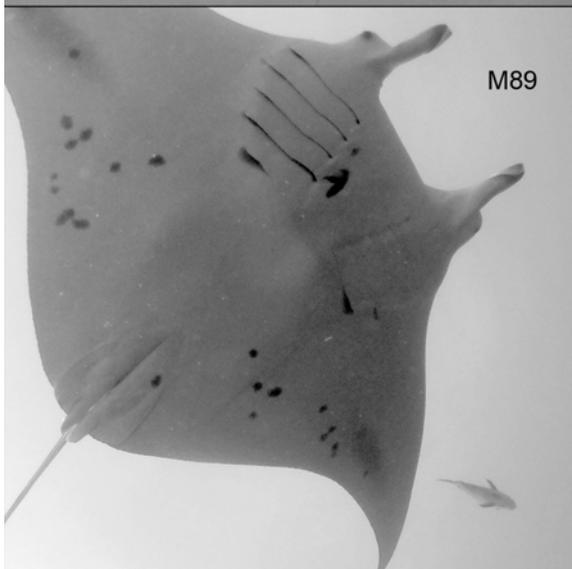
M85



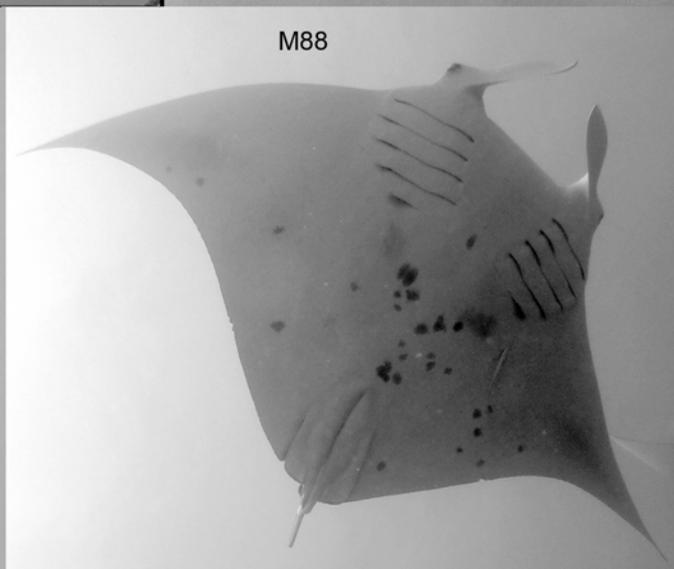
M90



M86



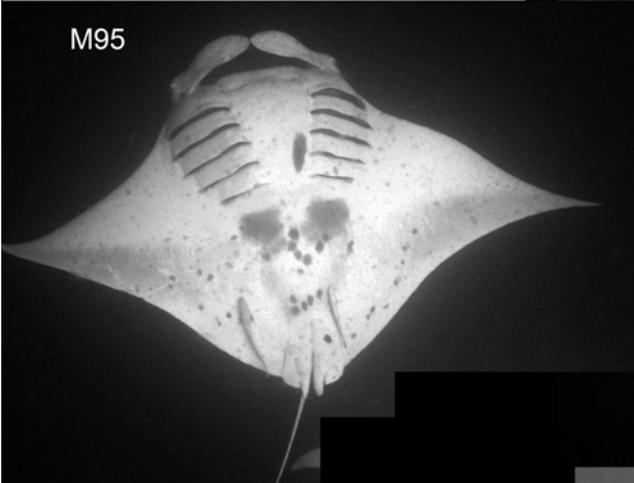
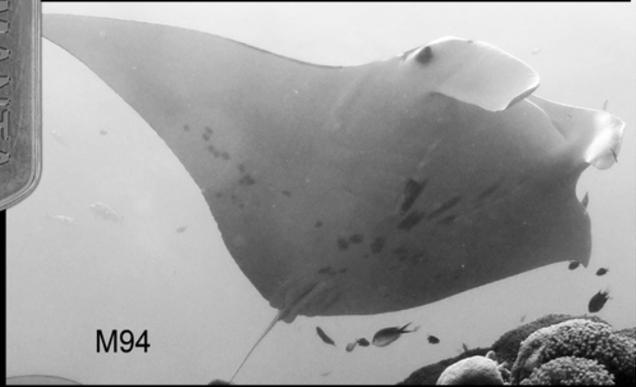
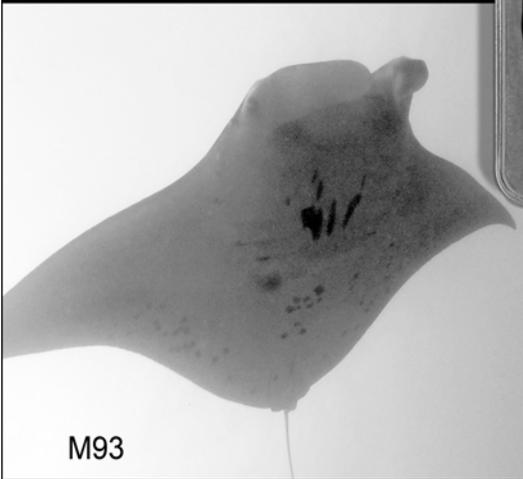
M89



M88

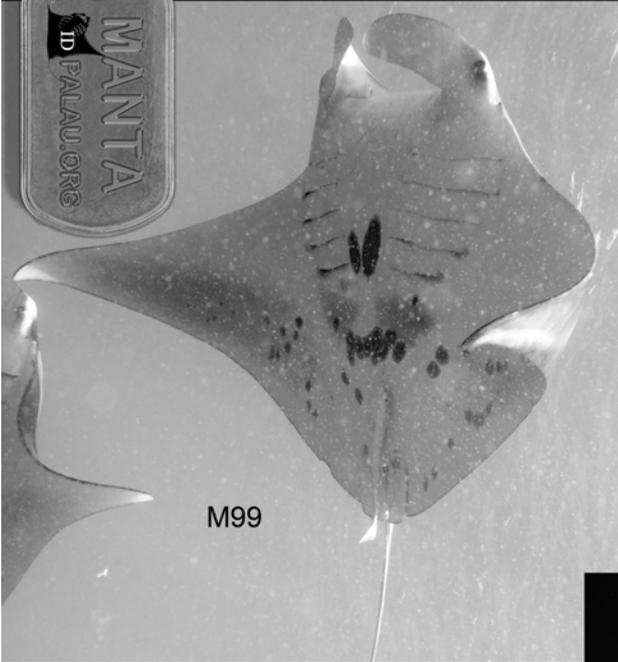
PALAU MANTAS

MALES K



PALAU MANTAS

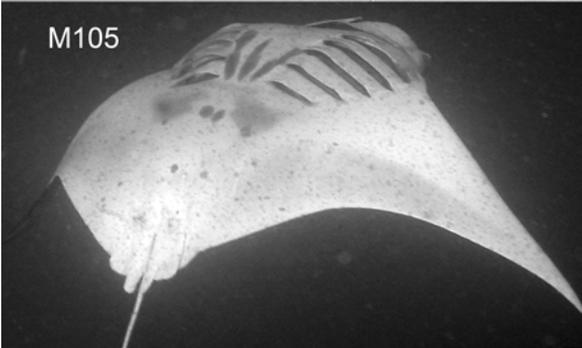
MALES L



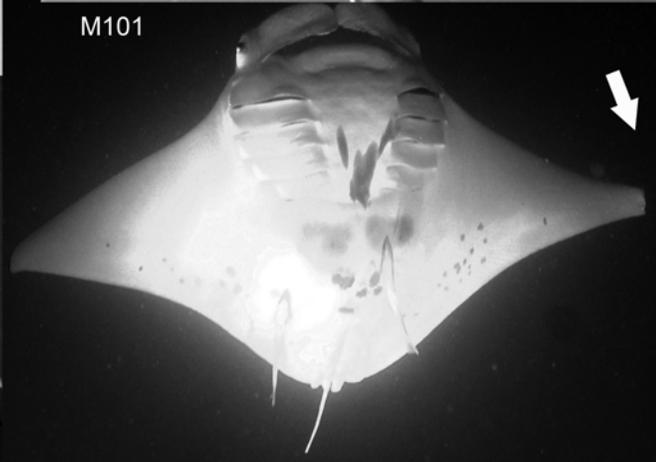
M99



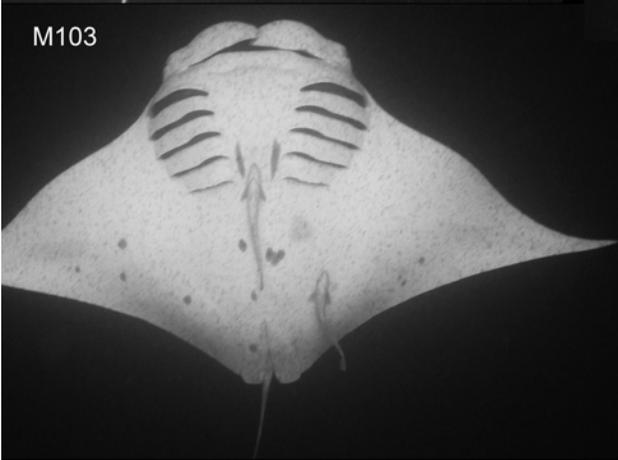
M100 Eskimo



M105



M101



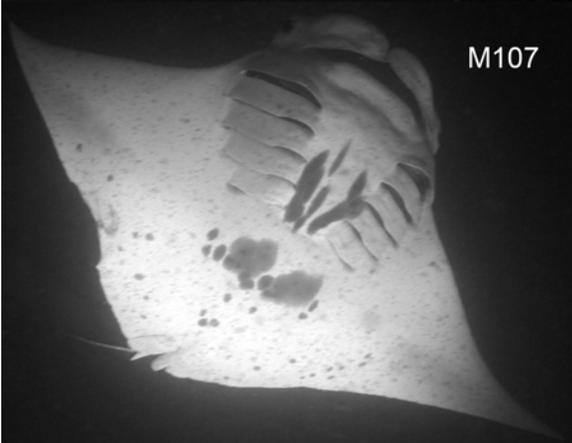
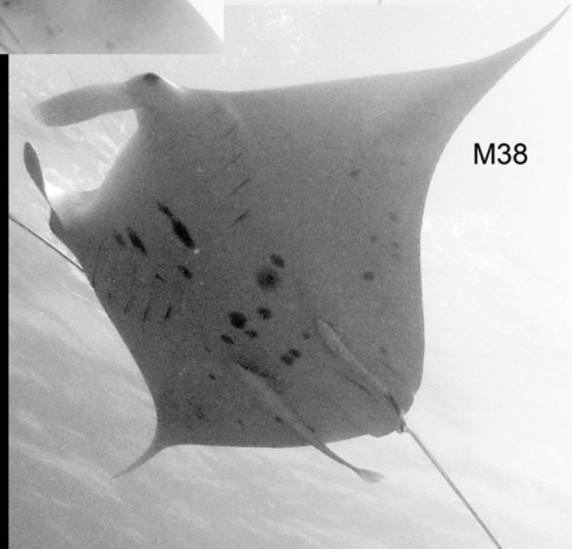
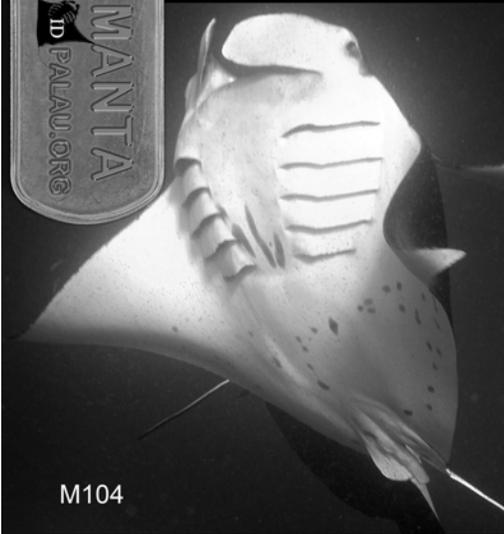
M103



M102

PALAU MANTAS

MALES M



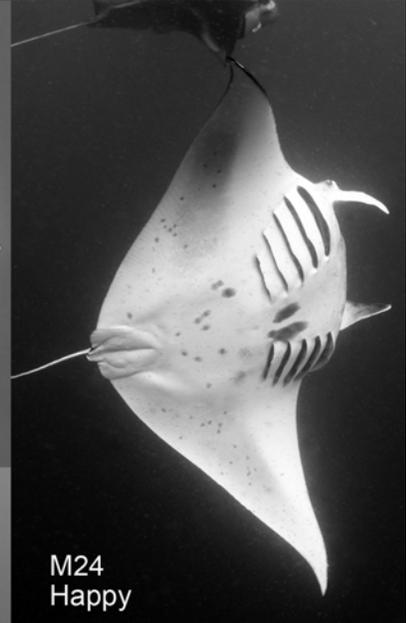
SIDEWAYS FEEDERS Males



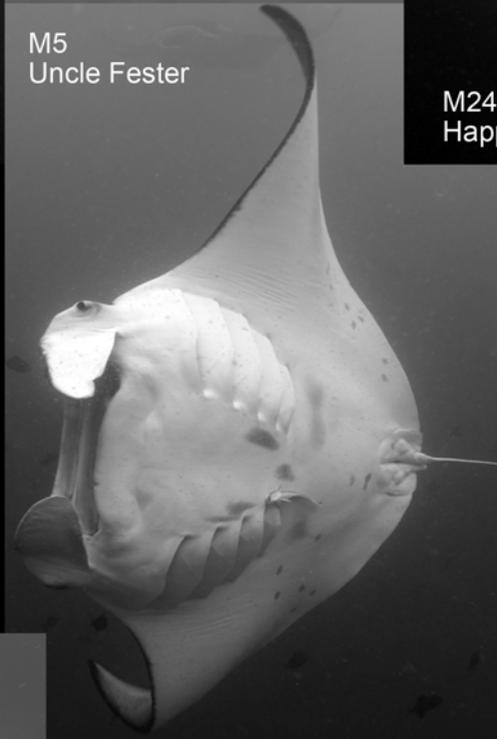
M14  
Rainbow



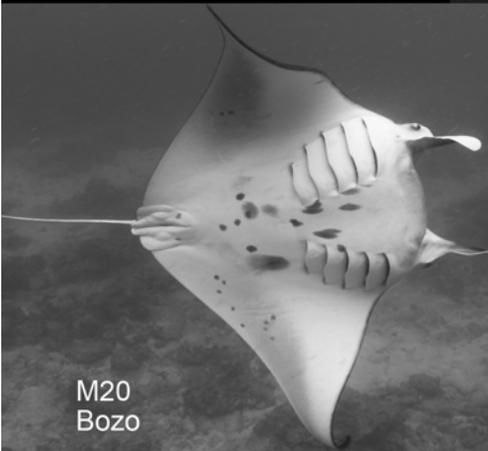
M17  
Joker



M24  
Happy



M5  
Uncle Fester



M20  
Bozo



M49  
Binky

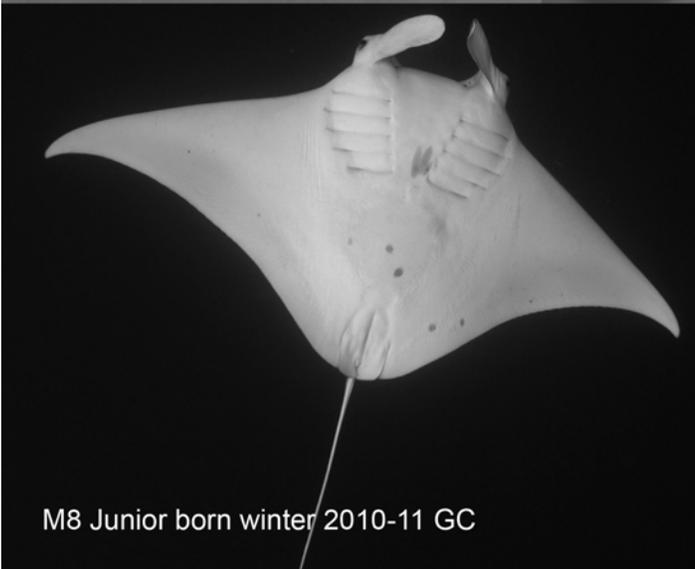
PALAU Young Mantas born 2009~

Males A



M19 Diddy born Nov 2009 LHC

M62 Chico born Nov 2011 GC



M8 Junior born winter 2010-11 GC



M27 Niall born winter 2010-11 GC



M7 Bai born winter 2010-11 GC



M67 Paolo born winter 2011-12 GC

PALAU Young Mantas born 2009~

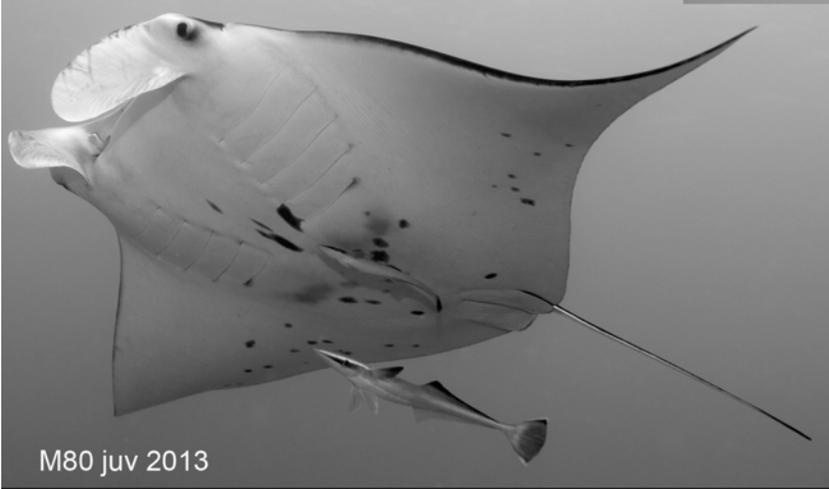
Males B



M73 Eddy born Jan 2013 GC



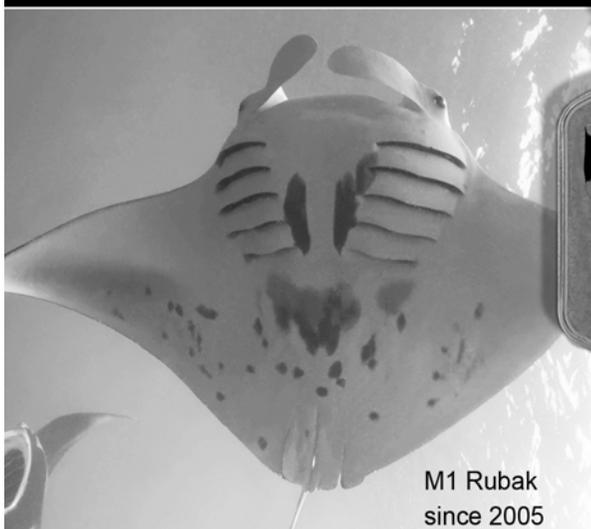
M81 juv 2013



M80 juv 2013

Popular German Channel MANTAS

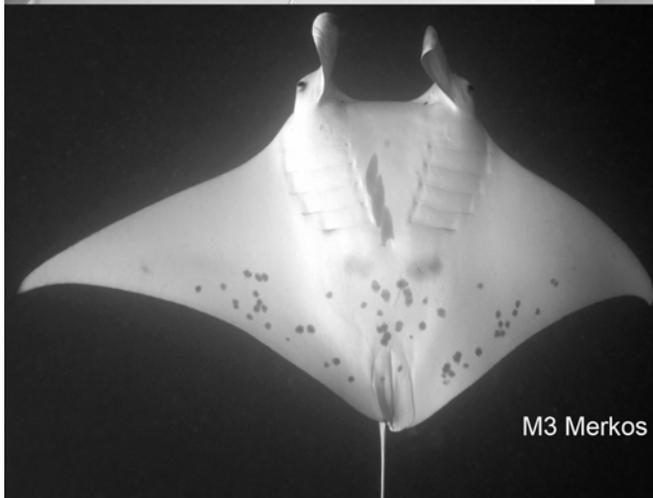
MALES



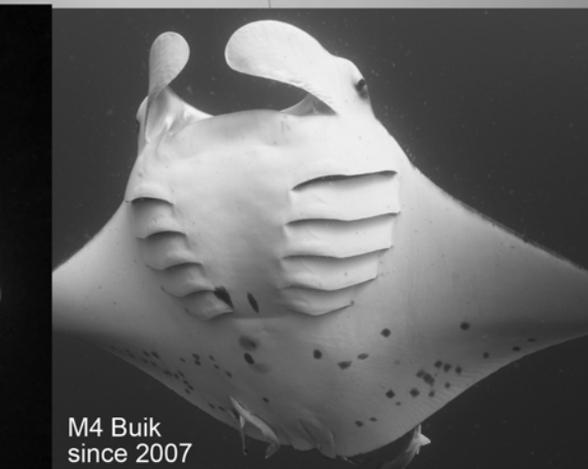
M1 Rubak  
since 2005



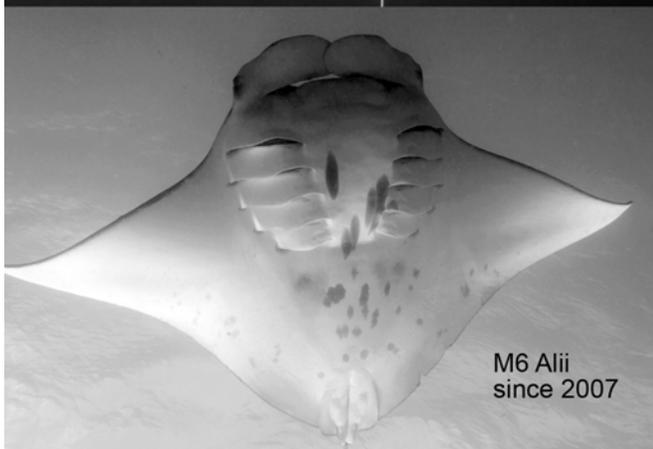
M2 Silverback  
since 2005  
grey back



M3 Merkos



M4 Buik  
since 2007



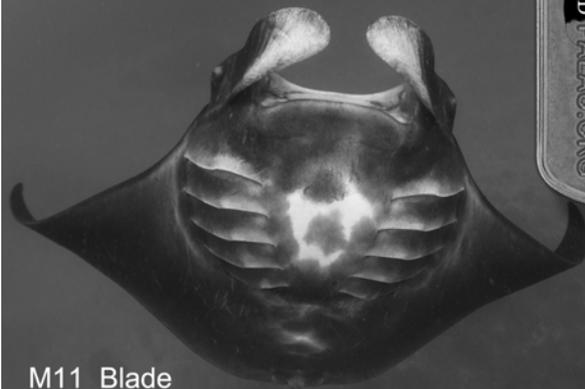
M6 Alii  
since 2007



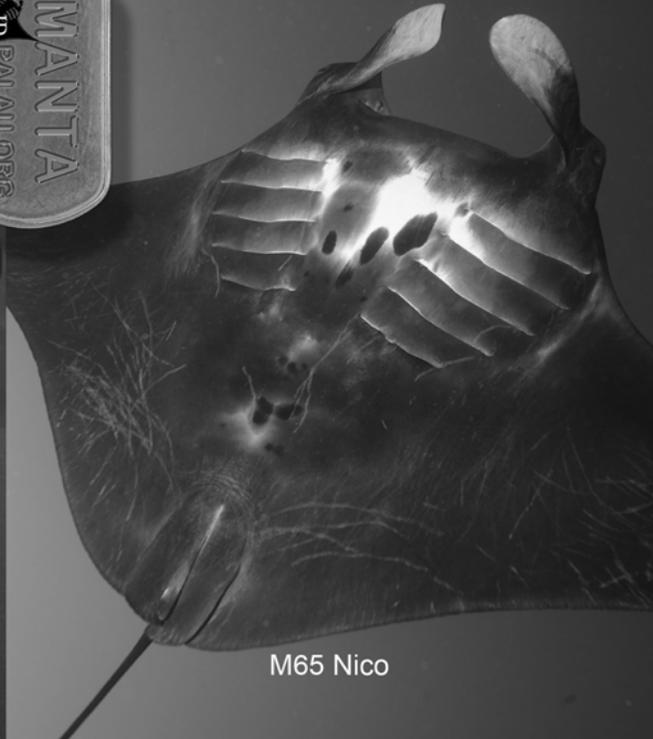
M25 Chief

PALAU BLACK Males

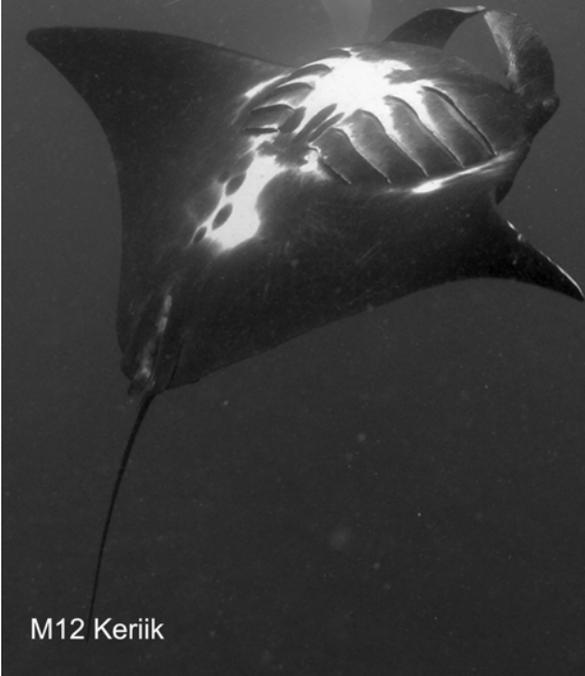
A



M11 Blade



M65 Nico



M12 Kerik



M10 Darth Vader



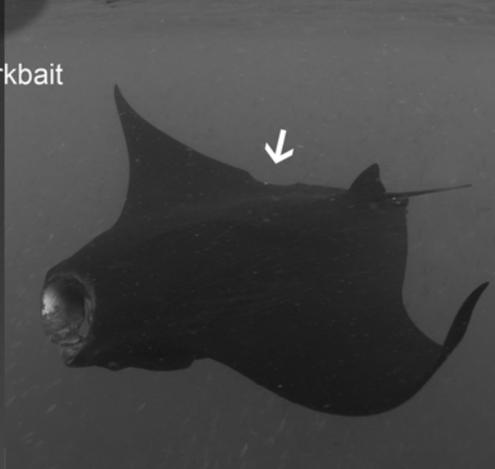
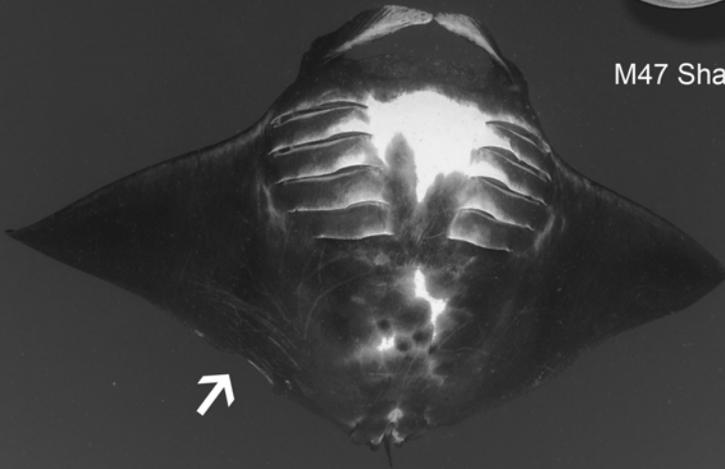
M43 8Ball juv male-broken tail

PALAU BLACK Males B

Obama M46



M47 Sharkbait



M48 Morpheus



M51 BlackJack  
kink left wing

