

THE EARTH INSTITUTE COLUMBIA UNIVERSITY



GERMAN CHANNEL

Market & Management

David Prieto

Palau Project Manager, Manta Trust

MSc Sustainability Management, Columbia University

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The historical origin and purpose of German Channel make this site one of Palau's most important maritime assets due to its importance for local market dynamics. Paradoxically, the ecological disaster German Channel was in the 1900's has become an ecological wonder that attracts a particularly charismatic plankton-eating fish species – *Manta alfredi*.

Current market dynamics at German Channel rely on the sustainability of its commercial utility as a passage and biological utility as a manta ray area; yet the lack of any legislation protecting manta rays nor enforcement of sustainable management practices make current site use at German Channel akin to a *Tragedy of the Commons*. Despite the inclusion of German Channel in the Ngemelis Island Conservation Zone (State of Koror, K9-229-10) and Rock Island Management & Conservation Act (State of Koror, K8-207-2009), current legislation and governance mechanisms remain insufficient. Facing a burgeoning tourism market, rapid precautionary measures need to take place in order to avoid situations such as Yap and Maldives where manta rays seem to avoid popular sites.

The 2015 manta ray watching season was very poor. Visitors' success rate of encountering a manta ray was 40% with an average of 2, whilst 12 boats commonly used the site daily. Yet under conservative parameters, the estimated *high season* value of an individual reef manta from German Channel was approximately US\$ 34,096. Manta rays are the most desired marine species to watch by visitors of Palau, whom are willing to pay US\$246.57 under a management scenario that ensures the species sustainability. If manta rays were to be protected by law and proper sustainable management practices enforced; the 50 year lifetime *high season* value of one resident manta ray at German Channel is estimated to be at least US\$ 622,447.

In response to current site use pressure and taking into account the perceptions of key stakeholders, the following recommendations should be followed in order to avoid a tragedy of German Channel's commons.

1. No-Boat Zone

Imposing a no-boat zone by law at German Channel to rapidly address pertinent site use pressure, create accountability for dangerous behaviour and ensure the safety of both tourists and manta rays.

2. Boat Moorings & Capacity

Boat mooring redistribution to avoid vessels floating above divers and mantas under certain conditions, likewise large vessel allocation to the furthest buoys. Installation of protective PVC pipes on all mooring lines.

3. On-Site Ranger

Visible presence of the rangers to all stakeholder in order to deter illegal behaviour. Enacting of proper legislation in order to make dangerous behaviour accountable to ranger enforcement.

4. Compulsory Training

Establish further credential mechanisms to make guides accountable to misconduct and distinguish guides based on experience managing activities at popular sites like Jellyfish Lake, Blue Corner and German Channel.

5. Awareness & Scientific Research

A government-sponsored app that enables any stakeholder to quickly compare a manta ray belly photograph with a centralized database. Develop an obligatory video on manta ray watching that explains best-in-class practices for both diving and snorkelling to visitors whom want to partake in these activities.

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1.1. A Large Ocean State

The Republic of Palau – *Belau* – is a small island developing state (SIDS) in the western Pacific Ocean located on the northeastern fringe of the *Coral Triangle* comprised by the Philippines, Indonesia, Malaysian Borneo and Papua New Guinea (Figure 1.1). The westernmost archipelago of the Caroline Island chain, the main island group of the country - centred approximately at 7° N and 134° E - has one large [400 km²] volcanic island named *Babeldaob* as well as a group of smaller limestone islands popularly known as the *Rock Islands*. *Babeldaob* is the largest island in Palau, yet the commercial and population centre of the country is in *Koror*, where 80% of the roughly 20,000 population of the country resides. The entire archipelago also includes two atolls, one oceanic island and a submerged reef bank referred to as the *Southwest Islands*.¹ Excluding the Southwest Islands, Palau stands on a single shallow platform surrounded by a barrier reef system. The shallow-water area (<50 m) of the platform within the barrier reef - known as a lagoon - is larger than the total area of the islands within it.² With nearly as much shallow water marine habitats found in the Coral Triangle, Palau has become a world-famous destination for maritime activities such as diving, snorkelling and fishing. The rich marine biodiversity of Palau is reflected on an economy heavily dependent on tourism and fishing worth US\$ 259 million.³ Considering these characteristics, rather than a small island developing state Palau should be described as a *large ocean state*.

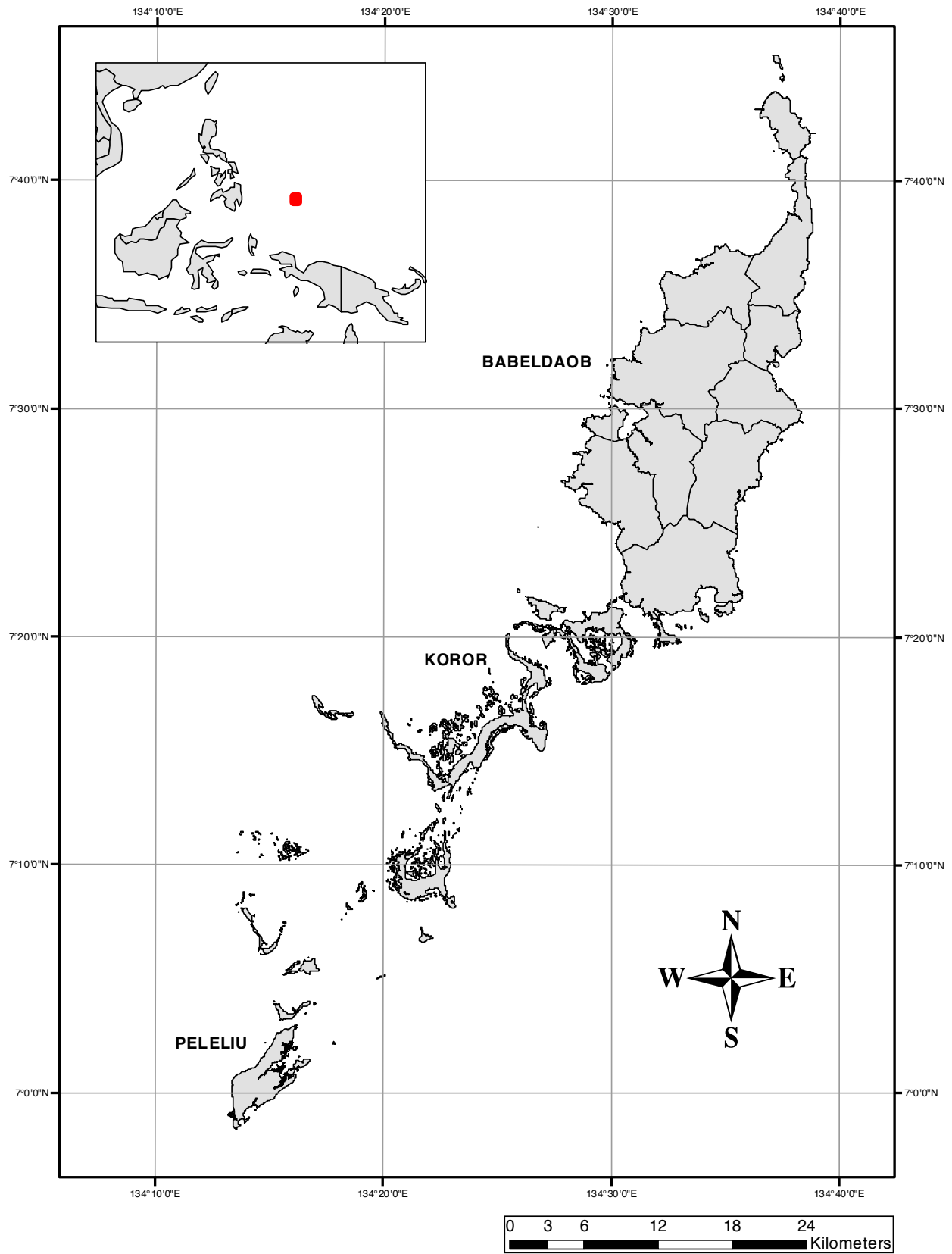


Figure 1.1. The Republic of Palau, excluding the Southwest Islands⁴

1.2. Problems in Paradise

Considered one of the “Seven Wonders of the Underwater World,” the international profile of Palau has drastically increased since the turn of the century. Reflective of this trend is the 313% increase in tourist arrivals between 2000 and 2014.⁵ The vibrant reefs and beautiful landscapes such as *Ngerukeuid Seventy Islands Wildlife Preserve* make Palau a “*destination of a lifetime*” and one of the “*last great places on earth*” according to National Geographic.⁶ Since 2012, the Rock Islands of Palau have been inscribed on the UNESCO World Heritage List. The surge of new capital from a bustling tourist sector is good for the economy of Palau, although it also places substantial pressure on the islands’ fragile ecosystem and scarce resources.

As traditional seafarers, locals are well acquainted with their unique heritage and inextricably linked to the health of Palau’s marine environment. However, this is not the case of tourists whom spend an average length of 5 nights on the islands.⁷ Tourists seek a “*wilderness experience*” as the choice of Palau presents a holiday destination driven by four factors: beaches [69%], diving [56%], scenery [55%] and marine activities [49%].⁸ The increase in tourists seeking a wilderness experience paradoxically diminishes the possibility of experiencing such wilderness. As Hundloe explains: “*it is surely not possible for the ever increasing number of nature seekers to venture into the remaining wilderness or near natural areas without changing the nature of the satisfaction sought.*”⁹

Complicating matters further are the rapidly shifting market dynamics in Palau. Albeit known as a world-class diving destination, the main activity for 44% of tourists in 2014 was snorkelling, slightly surpassing diving at 42%.¹⁰ Diving remains the most popular activity amongst American and European markets, whereas snorkelling was the most popular activity amongst all the key Asian markets. This market shift has important implications for the sustainability of Palau’s marine resources as 87% of all tourist arrivals in Palau during 2014 where from China [28%], Taiwan [27%], Japan [22%]

and Korea [10%]. During the period of this study, visitors from the People’s Republic of China accounted for 54% of total arrivals to Palau, accounting for 62% of arrivals just for the month of February and 28% of total arrivals from PRC China the previous year.¹¹ A stark omen of current market dynamics many Palauans see daily is the Chinese cruise ship “Xian Ni” - abandoned by its owner and crew in Malakal harbour (Figure 1.2.).



Figure 1.2. Chinese cruise ship “Xian Ni” abandoned in Malakal harbour.¹²

1.3. Ouklemedaol

Sharks have long been the flagship species for Palau, however the Palau Tourist Survey shows that tourism focused on manta rays – *Ouklemedaol* in Palauan – is becoming increasingly popular.¹³ 6.88% of dive specific comments in the survey mentioned “manta” or “german channel,” slightly surpassing the 6.42% that mention “shark” or “blue corner.” Koike *et al.* discovered that manta rays ranked first amongst marine species of interest for people that came to Palau, surpassing turtles, sharks, dolphins and napoleon fish.¹⁴

The name *manta* comes from the Spanish word “*mantilla*” or cloak, in reference to their appearance and movement underwater. Manta rays were considered a single species until 2009, when they were re-categorized into two – reef *Manta alfredi* and oceanic *Manta birostris* [see Appendix 1.1.].¹⁵ The resemblance of their cephalic lobes to horns has garnered mantas the common name of “*devilfish*” - a contradiction to their docile nature (Figure 1.3.). Research suggests that manta rays have the highest brain mass to body mass ratio of all fish species.¹⁶ Reef mantas are thus very social, becoming accustomed to divers and even seeking assistance when harmed by hooks and nets. Their lack of sting and harmless behaviour make these “devils” an enticing tourist attraction.

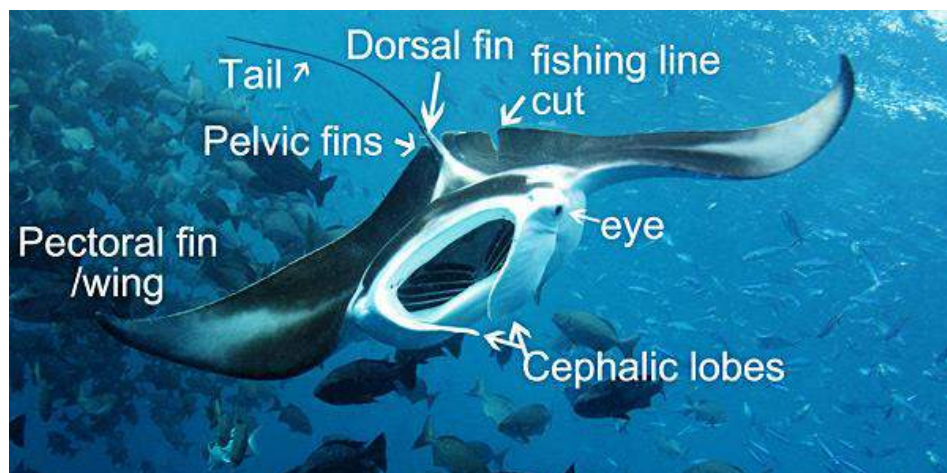


Figure 1.3. Labelled body parts of a manta ray¹⁷

In recent years, Palau became a - “*manta capital of the world*” joining other popular countries like Australia, Indonesia, Kona-Hawaii, Maldives, Mexico, Mozambique, Thailand and Yap.¹⁸ Palau has an identified population of 275 *Manta alfredi* of which 10% has rare black morph coloration [database available at www.mantaidpalau.org].¹⁹ The ventral spots on a manta’s belly are unique to each from birth enabling their identification (Figure 1.4.). The giant oceanic *Manta birostris* has not yet been recorded in Palau. *Manta alfredi* or reef manta can grow to an average disk width of 3.5 meters and are resident to particular locations, as they do not travel long distances. Most diving and snorkelling encounters are with reef manta due to their site fidelity, thereby representing a steady source of economic revenue. Globally generating US\$ 140 million each year, manta ray watching tourism contributed US\$ 6.8 million to the economy of Palau in 2013.²⁰ There are approximately 13 known manta ray areas in Palau (Figure 1.5.). Manta ray watching in Palau predominantly occurs at only one site – German Channel – as exact locations and occurrences at other sites are not completely understood. The resident population of reef manta at German Channel is estimated between 10 and 30 individuals [see Appendix 1.2.].²¹

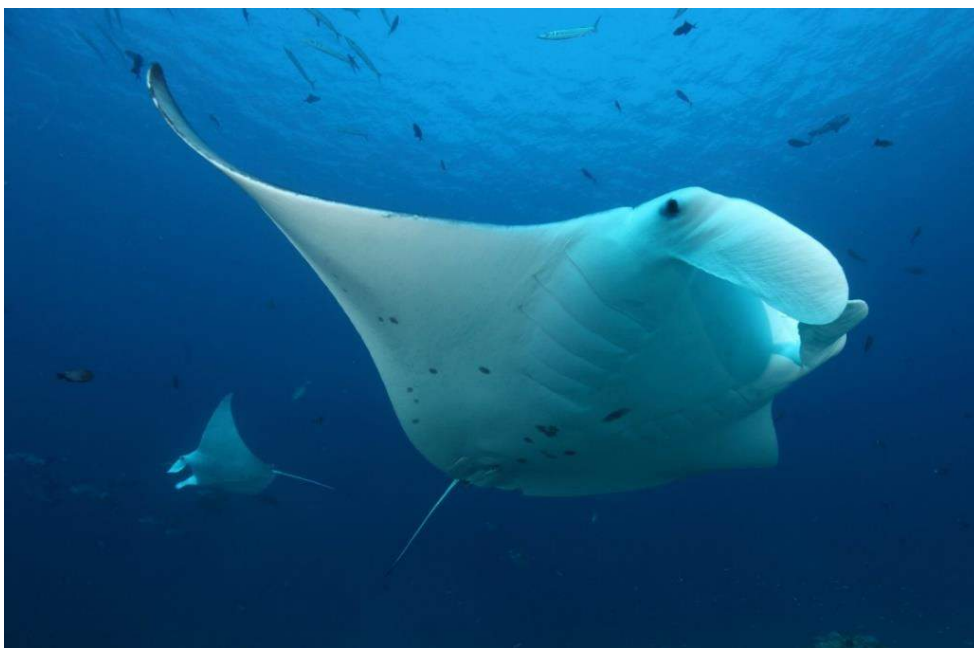


Figure 1.4. M125 Begeray²²



Figure 1.5. Known manta ray areas in Palau²³

As the primary industry, tourism will remain an important source of revenue for the foreseeable future challenging the sustainability of marine resources such as the resident reef manta rays of Palau. As Davis & Tisdell outline, conflicts between recreation and conservation occur in multi-use marine protected areas (MPAs) such as the *Ngemelis Island Complex* German Channel is part of.²⁴ Wildlife tourism occurring in German Channel with the manta rays is prone to unmitigated development to promote visitor satisfaction in expense of ecological integrity according to Semeniuk *et al.*²⁵

The recurring presence of manta rays but lack of management results in overexploitation at German Channel which could extinguish the manta rays as a resource by driving them away. This has been the case in Yap and the Maldives, the most popular sites for manta ray watching in the world. According to the Yap Visitor Bureau, the resident population of manta rays are the most popular natural resource of Yap. However mantas abandoned the Mi'il channel dive site - possibly due to growing tourism pressure - resulting in one year without seeing mantas on dives that generated US\$7.8 million for Yap in 2013.²⁶ Manta rays generate approximately US\$8.1 million per annum for the Maldivian economy, yet media exposure in 2009 and resulting influx of tourists seem to have caused mantas to move away from popular manta watching sites as well.²⁷ Paradoxically, tourist pressure degrades the attraction that drew tourists to the Maldives and Yap in the first place. Photographic evidence of harmed manta rays (Figure 1.6.) suggests that Palau may tell a similar story if German Channel is not managed sustainably.

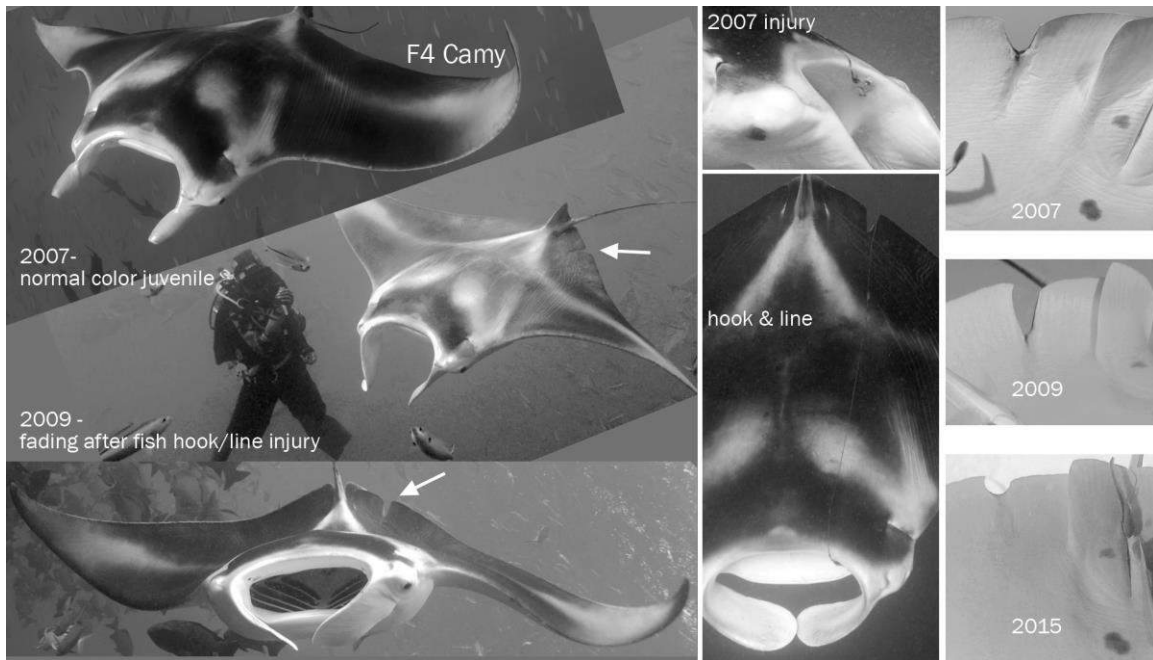


Figure 1.6. Timeline of injuries on resident manta F4 Camy²⁸

Acknowledging their value as commercial and biological assets, manta rays have been protected by various international and domestic laws, including regional competitors such as Indonesia and Yap [see Appendix 1.3.].²⁹ Considering the economics behind manta ray watching and the market potential for their conservation it is surprising that Palau does not have any legislation protecting this majestic species. The findings in this report might garner Ouklemedaol a similar respect as the sacred *Ochaieu* – spotted eagle rays *Aerobatus narinari* believed to bring death to one’s family member if harmed.

1.4. Objective

Although German Channel is just one site of many in Palauan waters, the implications of its sustainable management are a lot larger. Sustainable Development Goal No.14 codified in the post-2015 United Nations development agenda is to “*conserve and promote the sustainable use of the oceans, seas and marine resources.*”³⁰ Such goal is analogous to the traditional ethos of *Bul* – codified in Article 6 of Palau’s Constitution to conserve “*a beautiful, healthful and resourceful natural environment.*”³¹ German Channel is a key maritime asset for Palau because it is the only direct passage to the southern lagoon as well as the most reliable location for manta ray watching. Palau’s ambition to protect 80% of its waters as a National Marine Sanctuary passes first by sustainably managing its most important maritime assets like German Channel. Learning to sustainably manage its small-scale maritime assets first will enable Palau to successfully enforce macro-scale legislation such as a National Marine Sanctuary. Koror State is currently at the forefront of ocean governance in Palau, listing the *Ngerukewid Islands National Wildlife Preserve* in the Rock Islands Southern Lagoon as a UNESCO natural world heritage site.³² Sustainably managing German Channel will maintain Koror State as the leader in ocean governance domestically as well as bolster its reputation abroad.

As the first study of its kind in Palau, the objective of this report is to substantiate anecdotal evidence of the reduced amenity value of German Channel with concrete data in order to ensure its sustainability. By investigating the market potential of manta ray conservation and developing sustainable management recommendations for German Channel, this report aims to inform legislation regarding ocean governance to ensure the sustainability of the marine resources in the Republic of Palau.

2.1. Survey Area

German Channel (latitude 7° 7' N, longitude 134° 16' E) is located in the *Ngemelis* Rock Island Complex, southwest of the Republic of Palau. Administered by Koror State, the passage is 37 kilometres [23 miles] southwest of Koror roughly 45 minutes by speedboat. German Channel spans 2 kilometres in length and 50 meters in width, with a maximum depth of 33 meters during high tide and minimum of 1.5 meters during low tide. As the name of this channel implies, during the German Administration of Palau in the early 20th century a man-made channel was dredged across the shallow flats of Ngemelis (Figure 2.1.). Naturally incomplete, the channel was artificially modified by connecting the natural channel with the lagoon thereby creating a boat passage with a width-depth ratio of 16.6:1.³³



Figure 2.1. Southwest aerial view of German Channel³⁴

The purpose of this new “*German*” passage was to allow vessels mining for Phosphate in the southern island of *Peleliu* to save time by traversing through the reef. Without this new channel German vessels would have to circulate around the barrier reef and enter the lagoon through the West or Ngerechong Channels – both long distances away from *Peleliu*.³⁵ The dredged passage therefore saved substantial amount of time and money for the German Administration. German Channel has remained the sole route of access to Palau’s southern lagoon, becoming a key historical asset to the commercial endeavours of Germans, Japanese, Americans and now Palauans. The historical origin and purpose of German Channel make this site one of Palau’s most important maritime assets due to its importance for local market dynamics. Ironically, the human-caused ecological disaster German Channel was in the 1900’s has become - a century later - into an ecological wonder. Although the spoil banks have prevented establishment of reefs on the edges of the artificial passage, the natural incomplete channel is abundant in reef growth.³⁶

Palau’s barrier reef is broken by a total of 23 channels and passages connecting ocean and lagoon.³⁷ These geological formations transport materials such as oxygen, plankton and sediment with the exchange of water attracting abundant marine biodiversity. Lunar phases drive the directional flow of the tide as rising or *flood* tide cause an incoming current to the lagoon, whereas falling or *ebb* tides cause an outgoing current seaward (Figure 2.2.). Deep channels enable strong currents to develop, where the rapid movement of water produces an ideal environment for filter-feeding invertebrates.³⁸ This encourages the aggregation of organisms that passively filter feed on this constant stream of nutrients. The abundance and diversity of coral and fish species reliant on a regular source of food make the reef channels of Palau very popular sites for recreational scuba diving.

Spring Tides

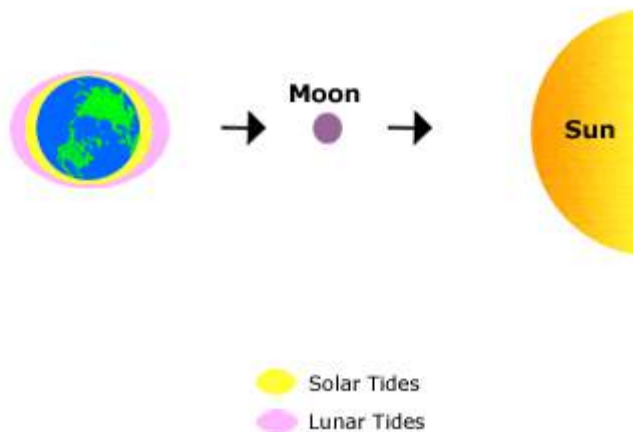


Figure 2.2. “Together, the gravitational pull of the moon and the sun affect the Earth’s tides on a monthly basis. When the sun, moon, and Earth are in alignment (at the time of the new or full moon), the solar tide has an additive effect on the lunar tide, creating extra-high high tides, and very low, low tides — both commonly called spring tides. One week later, when the sun and moon are at right angles to each other, the solar tide partially cancels out the lunar tide and produces moderate tides known as neap tides. During each lunar month, two sets of spring and two sets of neap tides occur.”³⁹

The cyclical pattern between incoming and outgoing lunar tides bring oceanic as well as lagoon waters rich in nutrients like oxygen and plankton through German Channel. The dredged passage at German Channel triggers a bottleneck effect during incoming lunar tide as the cold nutrient-rich waters from the ocean congest at the mouth of the channel (Figure 2.3.). The resulting high concentration of plankton attracts large aggregations of plankton-eating fish species such as scissor-tailed fusiliers *Caesio caerulea*, black snappers *Macolor niger*, and humpack unicornfish *Naso brachycentron*.⁴⁰ In a chain-like fashion, these feeding aggregations commonly known as “bait balls” further attract larger species, of which one is particularly charismatic – Reef Manta Rays. Strong tidal exchanges appear to intensify the size of feeding events, as the greatest intensity of feeding is seen close to high tide time.⁴¹



Figure 2.3. Northeast aerial view of the mouth of German Channel⁴²

What makes the dive site at the mouth of German Channel so remarkable is that in addition to large feeding aggregations, manta rays have recurrently cleaned at three reefs identified as “*cleaning stations*” for 20 years.⁴³ Furthermore, courtship behaviour and juvenile manta rays are witnessed at German Channel every season between November and April, making the site unique for scientific research of this majestic species.⁴⁴ The dive site itself is a sandy slope in the shape of an amphitheatre with three cleaning stations. The majority of dive guides usually swim from the west side in Koror State to the east side in Peleliu State, stopping at Cleaning Station 1 at 18 meters depth and then either drift north into the channel or swim south into the blue depending on the current (Figure 2.4.). Currently, five mooring buoys are in place at the site: four on the west side and one on the east side. Manta rays have also been seen using the dredged passage to move between the open ocean and the lagoon as boats do (Figure 2.5.).

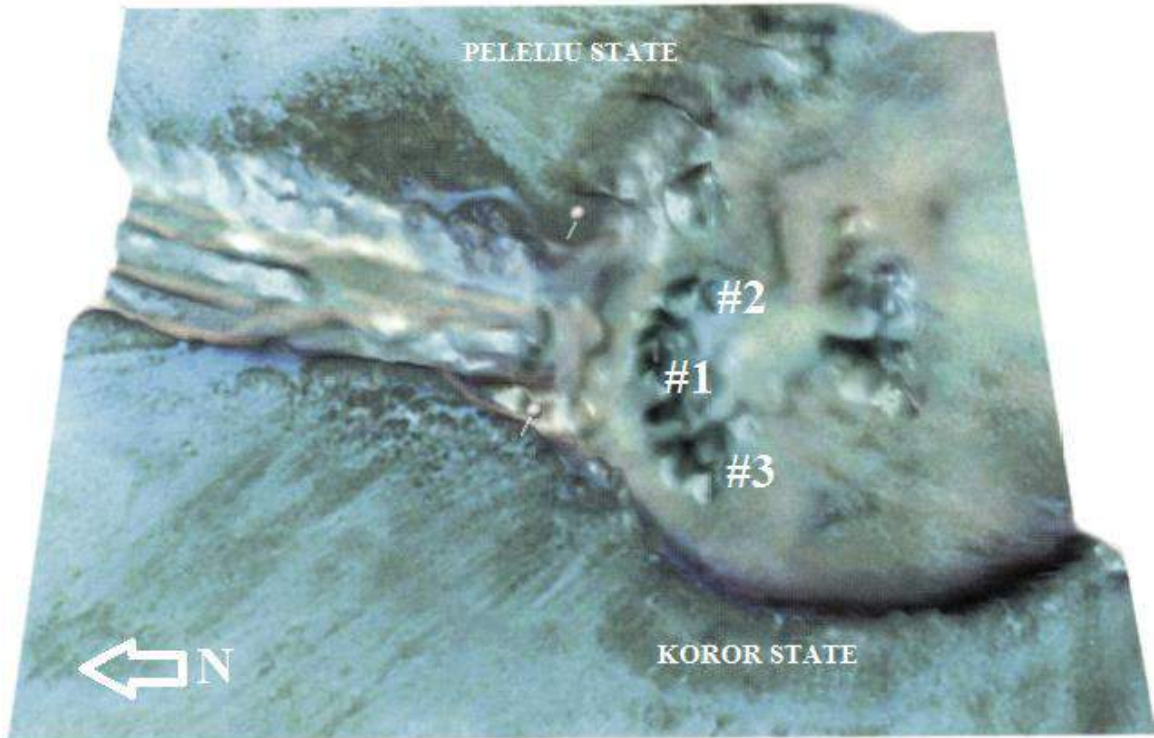


Figure 2.4. Labelled bathymetry map of German Channel Cleaning Stations⁴⁵

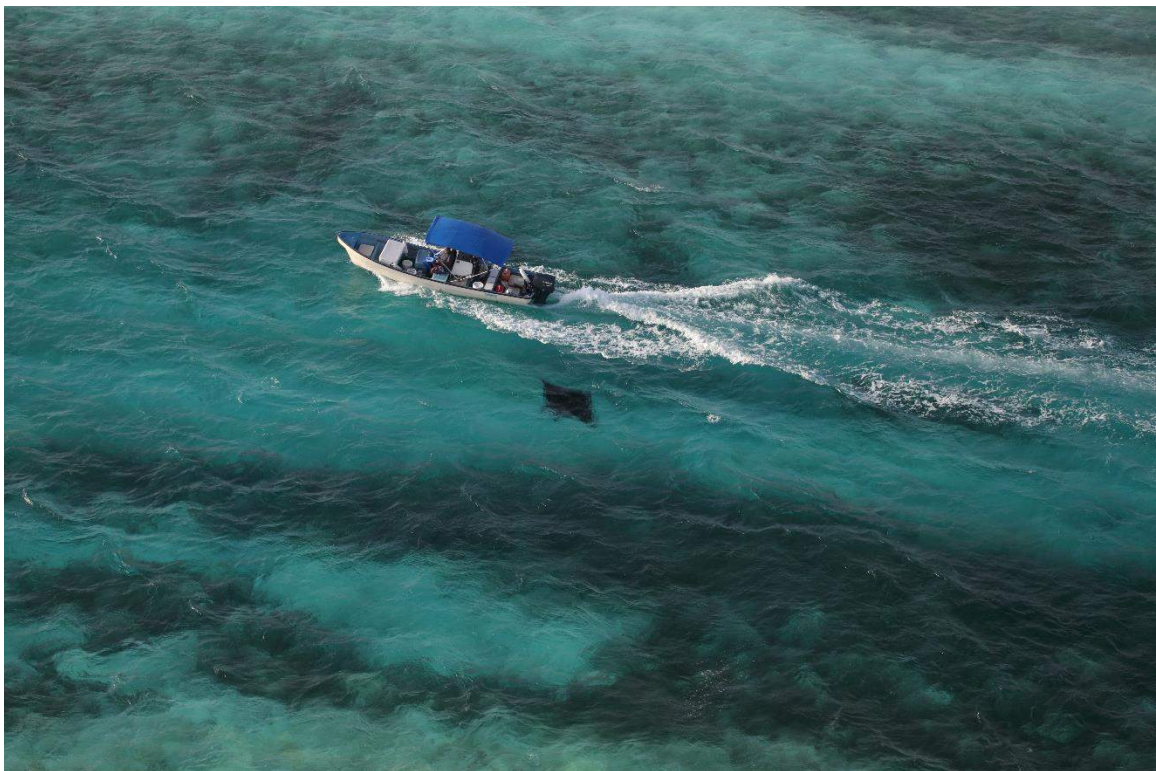


Figure 2.5. Boat dangerously close to manta ray⁴⁶

As the primary thoroughfare of marine transportation between the open ocean and the southern lagoon, the German Channel *passage* has historically been a key maritime asset that has saved resources for many stakeholders in Palau and is thus essential to the local economy. In addition, the predictability of manta encounters at the German Channel *dive site* in recent years coupled with the site's proximity to Koror and other popular dive spots around the Ngemelis reef have further bolstered its importance (Figure 2.6.). Complicating matters further is the fact that German Channel is the most sheltered spot in the Ngemelis Island Complex and its shallow depth [<33 m] make it the "go-to" dive site during inclement weather, with inexperienced divers or as a natural third tank dive.⁴⁷ Current market dynamics are thus reliant on the sustainability of German Channel's commercial and biological assets, regardless of the fact that there seems to be a disjunction in demand between these resources.

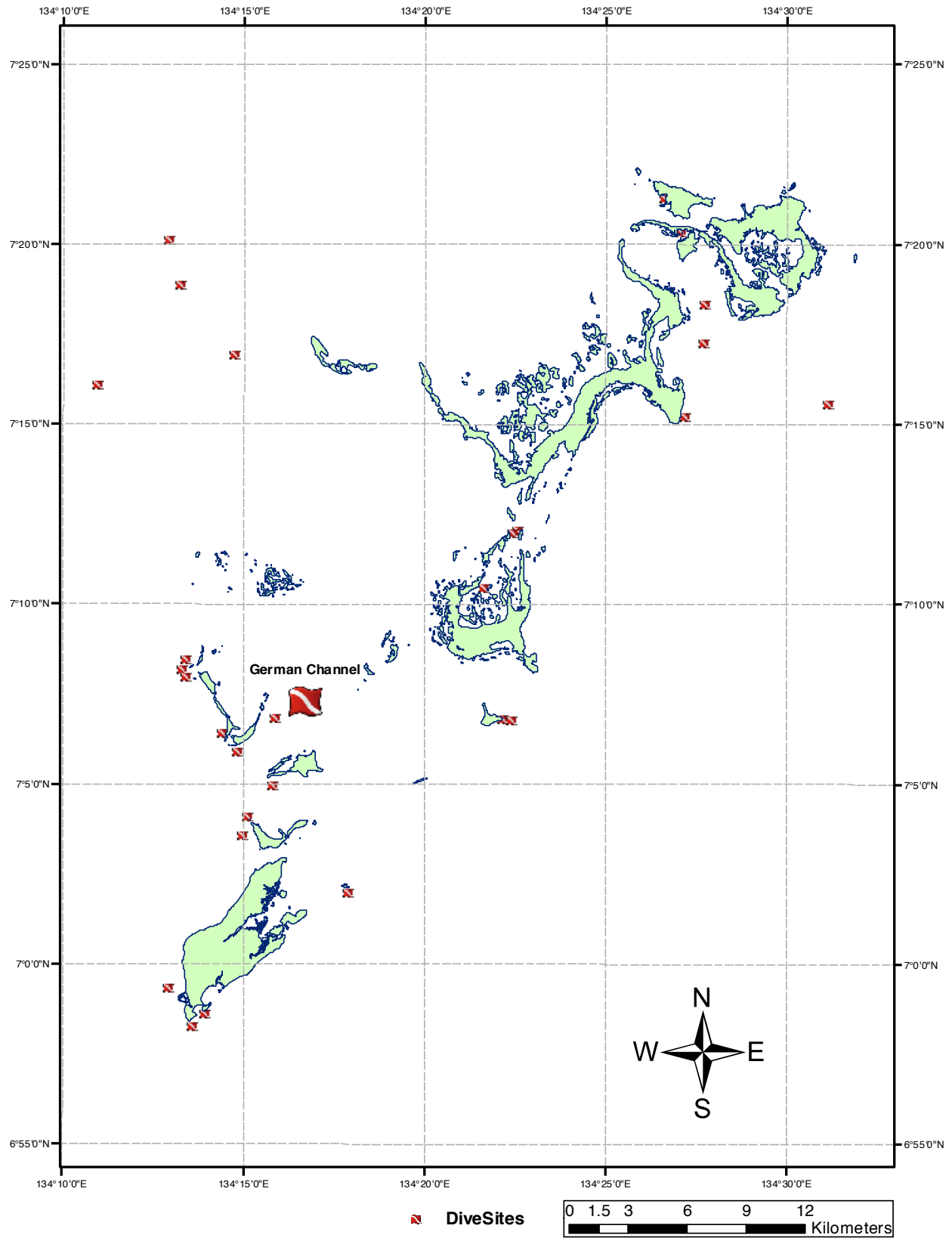


Figure 2.6. Locations of German Channel and other dive sites⁴⁸

2.2. Data Collection

2.2.1. Site Use

The study period was designed to fall within the tourist high season in Palau considered between December and May to assess site use pressure and perceptions at peak demand. Fieldwork was thus carried out from the 14th January until April 13th 2015 on as many days weather conditions permitted. The fieldwork was granted a permit waiver within the territorial water of Koror State by Governor Yositaka Adachi (see Appendix 2.1.). Three modes of transportation to German Channel were employed based on availability of resources from various sponsors. First, using an independent research vessel when the primary sponsor had no prior commitments. Second, going on vessels that were transporting guests to dive the Ngemelis Island Complex. Third, once per week surveys were conducted from a liveaboard safari vessel. The mix in transportation modes enabled the surveying of German Channel between dawn and dusk that could not have been done if surveys were solely conducted by tourist vessels. Survey sessions were recorded and varied in duration depending on the weather, manta ray abundance and other commitments for the research and from the sponsors.

On the surface of German Channel, each vessel moored at the site was recorded and the operator identified. Oceanographic features were also logged including moon cycle, high tide time, cloud cover, Beaufort scale, as well as wind speed and direction. Comments were noted regarding the conduct of other vessels using the site including speed, mooring, movements, and guest behaviour; from which the amount of vessel misconducts were counted.

Underwater of German Channel the behaviour of tourist and guides were observed as well as manta rays video recorded when present. Data regarding manta ray interactions were logged including amount present during dive, duration of

interaction, and peak encounter time. Comments were noted regarding the conduct of tourists and guides underwater such as location around cleaning stations, behaviour during manta ray interactions and surfacing procedures, from which the amount of diver misconducts were counted. In addition, further oceanographic characteristics were logged including visibility, current direction and strength, plankton density, bait ball density, and water temperature. Seldom the case, it must be noted that due to the physiological limitations of scuba diving a maximum amount of 3 dives lasting 60 minutes each were possible in an entire day of fieldwork, thus limiting the underwater observation time at German Channel.

2.2.2. Stakeholder Perceptions

Isabel Ender, the Manta Trust Head of Conservation Strategy gave an introductory presentation (see Appendix 2.2) about the importance of the conducted fieldwork for Palau on Friday, February 6th, 2015 at Koror State Assembly Hall. All stakeholders were invited to this event, which included the Koror State government, representatives from National Government, local research and conservation organisations, dive guide and operators, and dive tourists (see Appendix 2.3.). A key objective of the presentation was to convey the independent character of the study regardless of the local sponsors for the fieldwork. The genuine interest palpable in the audience resulted in further sponsorship by various attendees.

Initially, three questionnaires for dive operators, dive guides and dive tourists were drafted to assess current barriers towards sustainable management at German Channel for key stakeholders. After a two week trial period, the content and amount of questionnaires were changed. Based on feedback from interviewees and quality of responses the dive operator and dive guide questionnaires were merged into one dive professional questionnaire. In addition, the extensive writing required in the first draft was eliminated in favour of option selection. Available options to select were based on the most recurrent answers given during the trial period. The dive

professional survey asked questions regarding: A) Operations in Palau, B) Activities at German Channel and C) Sustainable Management for German Channel. The dive tourist survey asked questions regarding: A) Travelling to Palau, B) General Dive Trip Information, C) Experience at German Channel and D) Demographic Information. The resulting questionnaires after the trial period were more concise albeit covered the same amount of sought information, as well as faster and easier to answer for interviewees (see Appendix 2.4.). The majority of the questionnaires were conducted in-person by surveyors during surface intervals between dives or during closing hours at dive shops.

A key issue gathering stakeholder perceptions was the language barrier. Considering that the key markets for the tourism industry in Palau are Chinese, Taiwanese, Japanese and Korean, it must be acknowledged that the gathered surveys have a bias towards interviewees whom were able to speak English. Acknowledging this limitation and in an attempt to address this bias the dive tourist questionnaire was translated to Japanese (see Appendix 2.5.). Resources were not available to translate the questionnaires in Mandarin, Cantonese or Korean.

In an attempt to gather the perception of all key stakeholders of German Channel the rangers and managers of Koror State Government Department of Conservation and Law Enforcement were interviewed on March 31st, 2015 (see Appendix 2.6). As the principal enforcers of legislation in the Ngemelis Island Complex, their participation in the study was crucial. This enabled a deeper understanding of how the Rock Islands, in particular German Channel and the Ngemelis Island Complex, are supervised, administrated, and gained perspective on current enforcement challenges faced by Koror State.

During the final weeks of fieldwork in Palau, state and national government officials were interviewed. In order to effectively convey the need of sustainable management at German Channel a video summarizing the footage gathered during the course of

the fieldwork was shown [available online at: www.mantatrust.org]. Furthermore, preliminary results from the fieldwork were presented and explained in an effort to argue in favour of legislation that ensures the sustainability of the manta rays at German Channel (see Appendix 2.7.).

2.3. Data Analysis

In order to provide an accurate depiction of the market dynamics and management requirements at German Channel, gathered data during the period of fieldwork was analysed using spreadsheet software. Two main data sets were analysed, site use data obtained during daily expeditions to German Channel and stakeholder perception data obtained through interviews and distribution of questionnaires.

2.3.1. Site Use

Data gathered during expeditions enable a clear understanding of present levels of site use at German Channel through analysis. Data analysis for site use was divided into two areas: boat traffic and manta rays.

For boat traffic site use, data analysis focused on number of boats and misconducts observed at the site, as well as identification of vessels. The amount of people at the site was not recorded due to limitations on amount of surveyors, observation time, operator activities and distances at the site. Whilst the site vessels were counted each time they dived and/or snorkelled the channel within one day, so if they would return from another site the vessel would be counted a second time. Boats cruising through the site to other destinations were not recorded, making site use data more conservative. Liveboard vessels and their respective speedboats were counted separately. Due to the independent stance of this report, sponsoring vessels were also included throughout the study. From this data it is possible to analyse how many

boats and which operators used the site each day in total, commonly and in average as well as correlate the data with instances of misconduct observed.

Manta rays are also users of the channel, therefore included in the site use data analysis. Analysis focused on underwater count of manta rays encountered during dives at the site, duration of encounters, current flow and diver misconducts. Identification photos known as “*belly shots*” were taken when circumstances permitted in order to identify the observed manta ray and not repeat counts of individuals encountered at the site. Recorded encounter time was aggregated amongst all instances manta rays were watched during a dive. As a key indicator of manta ray presence, current flow was analysed based on dive experience and observations underwater. Diver conduct breaches were counted as well, albeit due to visibility limits underwater figures are very conservative. From observed manta ray records it is possible to estimate how many manta rays used the site each day and duration of encounters. Further analysis provides monthly and seasonal figures of mean, mode, encounter success rate and boat-to-manta ratio. Site use dynamics at German Channel were explored by analysing the relationship between commercial utility (boat abundance and observed misconduct) and biological utility (manta ray abundance and encounter time).

2.3.2. Stakeholder Perceptions

Analysis of survey data provides an aggregate picture of the current market, barriers towards sustainability and opinions on management at German Channel. Surveys focused on the perceptions of dive professionals and dive tourists, acknowledging them as the primary stakeholders affected by any legislation triggered by this study. However, data analysis of surveys is divided into four segments: dive professionals, dive tourists, German Channel and sustainable management.

Dive professional data was analysed to accurately represent the industry and harness the knowledge and experience from the constant use of the site by this constituency. Data analysis results in fundamental percentage values regarding market distribution amongst operators and nationalities as well as general industry and manta ray diving experience. Tourist perceptions analysed in this report represent a *sample* group that dive and thus do not reflect the entirety of tourist perceptions visiting Palau. Yet data analysis still provide important knowledge on key markets for diving, visits to Palau, average figures of stays and day trips whilst in Palau, as well as awareness regarding various imposed environmental fees by the Government of Palau and Koror State.

Data analysis for stakeholder perceptions on German Channel and sustainable management was done by aggregating answers and benchmarking both data sets. This provided a clear and concise understanding of professional and tourist perceptions on essential issues such as site popularity, experiences at the site, as well as site use and management opinions. Analysis of answers regarding German Channel thus bring forth differences in experiences and perceptions from the site as well as highlights complementing observations amongst the key stakeholders. Data analysis of sustainable management responses helps display aggregate stakeholder perceptions regarding management needs and solutions. Benchmarked data analysis therefore illustrates the synergistic and mutual association between both set of stakeholders.

3.1. Site Use

During the length of 89 fieldwork days in Palau a total of 78 hours and 51 minutes with 51 dives during 40 days (accounting for 45% of the entire study period) were spent surveying German Channel; 7 days (20 hours and 23 minutes and 9 dives) in January, 12 days (25 hours and 43 minutes and 14 dives) in February, 23 days (26 hours and 10 minutes and 22 dives) in March and 6 days (6 hours and 35 minutes and 6 dives) in April. The lower number of survey days (and hence data) in January and April is due to the arrival and departure of the project managers mid-way through those months, and therefore do not represent entire month site use.

3.1.1. Boat Traffic

A total of 399 boats were recorded at the site, with a maximum of 23 boats observed in a single day on March 18th (Figure 3.1.). The maximum number of boats simultaneously using the site was 17 on March 18th as well. Site use across each month was fairly even with an average of 9.57 boats in January, 9.92 in February, 10.53 in March, and 8.50 in April; resulting in an aggregate average of 9.98 ± 5.1 S.D. [10th percentile = 4.9; 90th percentile = 17] boats diving or snorkelling German Channel. The mode value of boats recorded at the site per day was 12. Furthermore, a total of 82 conduct breaches - behaviour misconducts - by boats and divers [e.g. driving over cleaning stations, chasing manta rays] with an aggregate average of 2.05 ± 2.5 S.D. [10th percentile = 0; 90th percentile = 4.2] per day were observed during survey hours, accounting for 20% of all operations surveyed during the fieldwork. With a mode value of 0, breach figures are very conservative considering the limitations of only one individual surveying the site and the visibility underwater. Figure 3.2. illustrates a positive correlation of 0.34 between amount of boats and observed breaches.

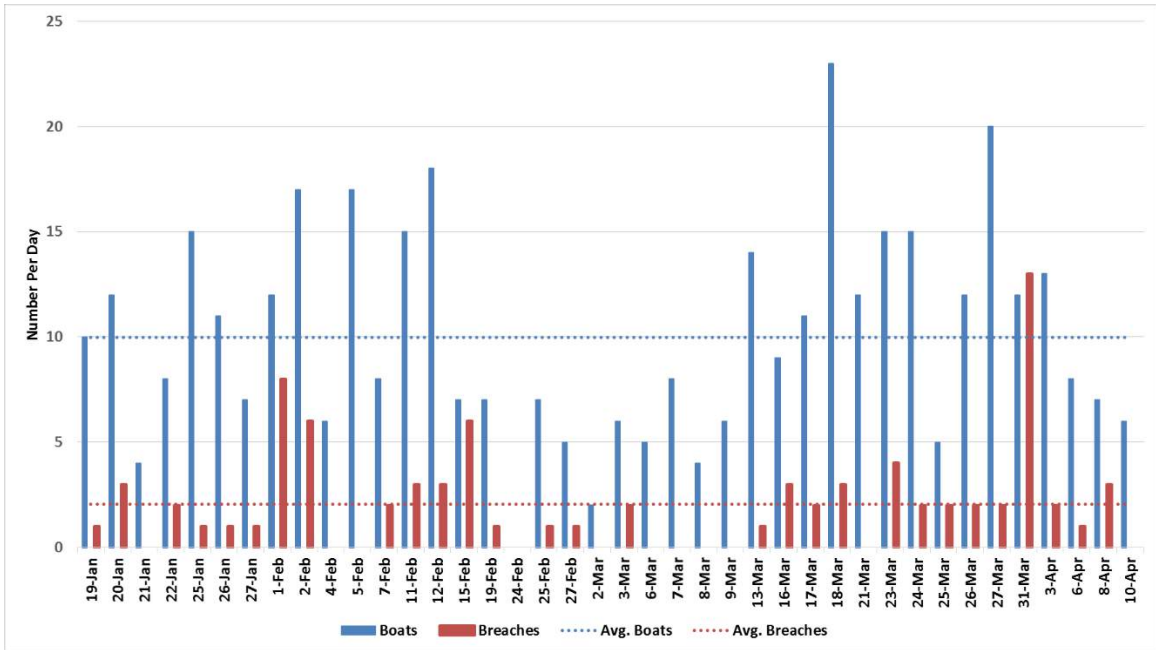


Figure 3.1. Site use & behaviour at German Channel between January and April

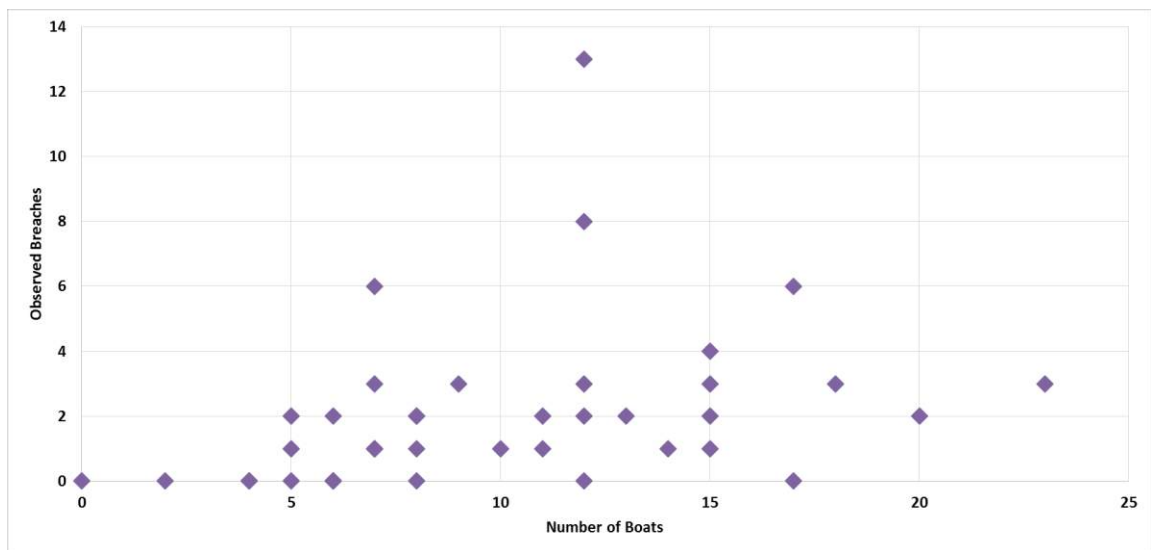


Figure 3.2. Correlation between boats and breaches

The boat operators in German Channel are dive shops mostly from Koror State and liveaboard vessels that safari across the Rock Islands. From a total of 297 *identified* vessels in German Channel (74% of total recorded), site use is dominated by dive shops accounting for 67% and liveaboards with 25% (Figure 3.3.). The remaining 8% of other vessels included unidentifiable or unknown operators, private vessels and ranger boats. On average 12 ± 8.3 S.D. [10th percentile = 5; 90th percentile = 22.9] dive shop and 8 ± 4.8 S.D. [10th percentile = 2; 90th percentile = 13.3] liveaboard vessels (including their speedboats and private yachts) were identified at the site each day during fieldwork. The most common amount of vessels per operator type observed at the site was 5 for dive shops and 2 for liveaboards.

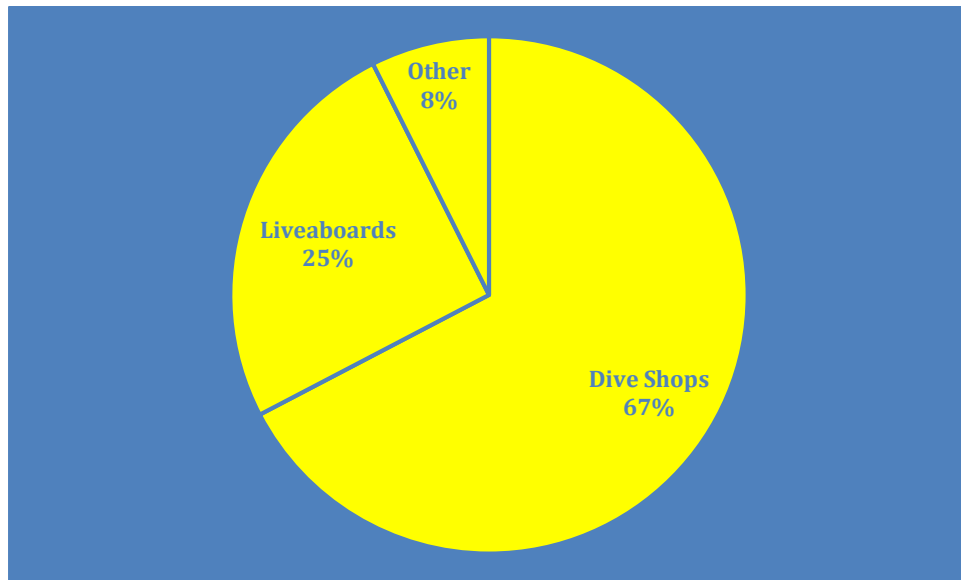


Figure 3.3. Site use by operator type

A total of 17 dive shops (Figure 3.4.) and 10 liveaboards (Figure 3.5.) were identified through the period of study. In regards to dive shops, Fish’N Fins and Daydream Palau accounted for the largest proportion of site use at German Channel with 15% and 11% respectively. Of the operating liveaboards, the Palau Sports and Ocean Hunter III correspondingly accounted for 21% and 17% of total observed site use.

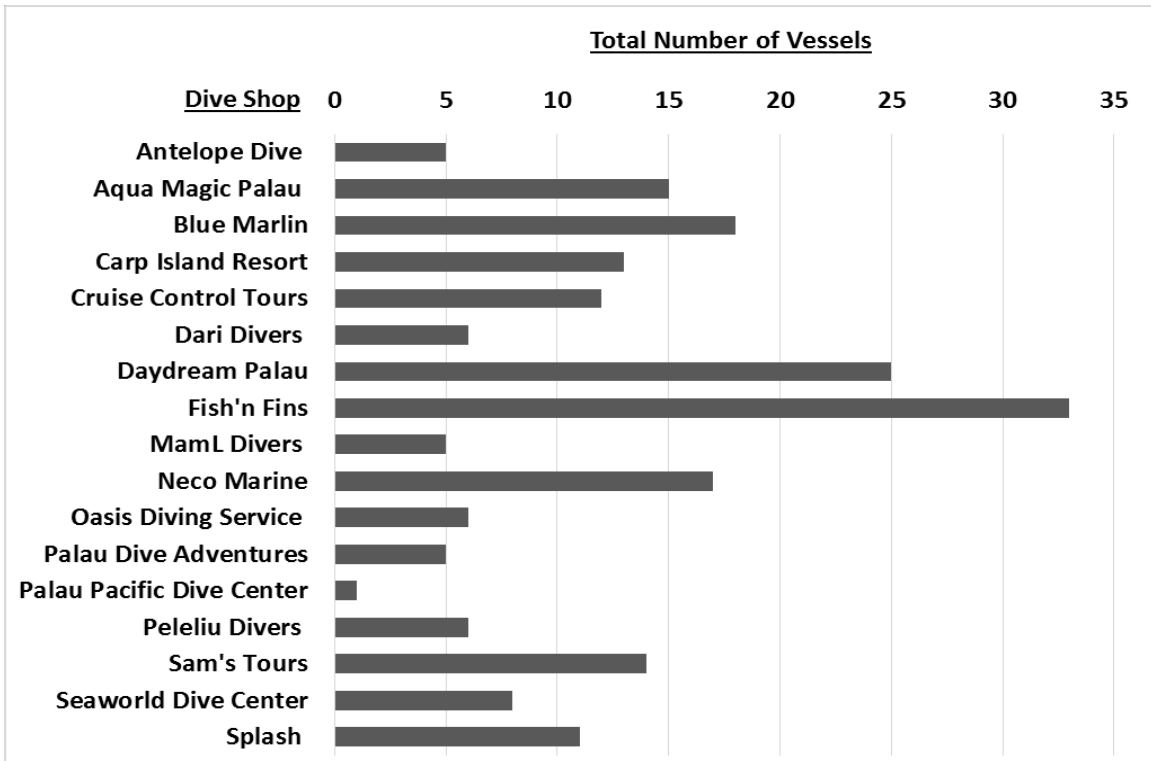


Figure 3.4. Identified dive shop vessels between January and April

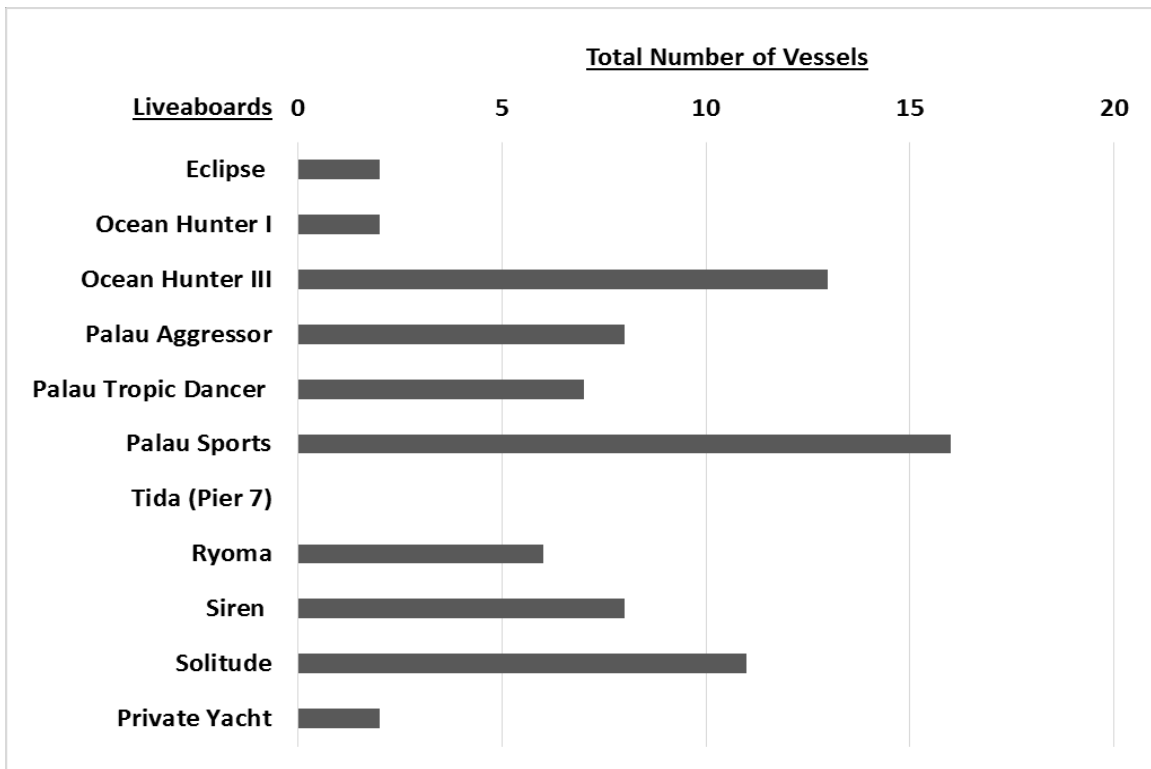


Figure 3.5. Identified liveboard vessels between January and April

3.1.2. Manta Rays

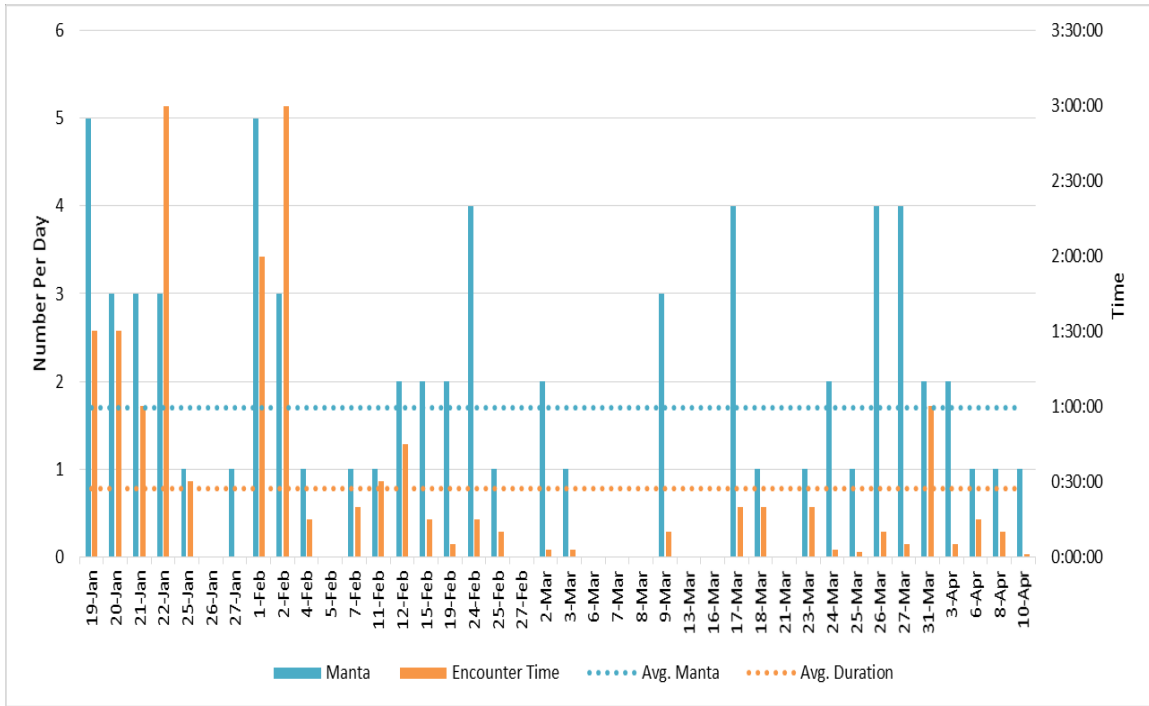


Figure 3.6. Manta ray sightings & encounter time at German Channel between January and April

A total of 68 manta rays were observed at German Channel, with a maximum of 5 individuals witnessed during one same dive on January 19th and February 1st (Figure 3.6.). Average number of mantas encountered decreased each month as 2.29 were seen in January, 1.83 in February, 1.47 in March and 1.25 in April; resulting in an aggregate average of 1.7 ± 1.47 S.D. [10th percentile = 0; 90th percentile = 4] mantas witnessed at German Channel during the 2015 season. Furthermore, the average manta encounter duration through the study period was 27 minutes ± 45 S.D. [10th percentile = 0; 90th percentile = 90]; yet month-by-month display a gradual decrease too with 64 minutes in January, 38 minutes in February, 9 minutes in March and 8 minutes in April (Figure 3.7.). The manta encounters of longest duration were January 22nd and February 2nd for an estimated time of 3 hours. Figure 3.8. illustrates a positive correlation of 0.54 between amount of mantas and encounter periods.

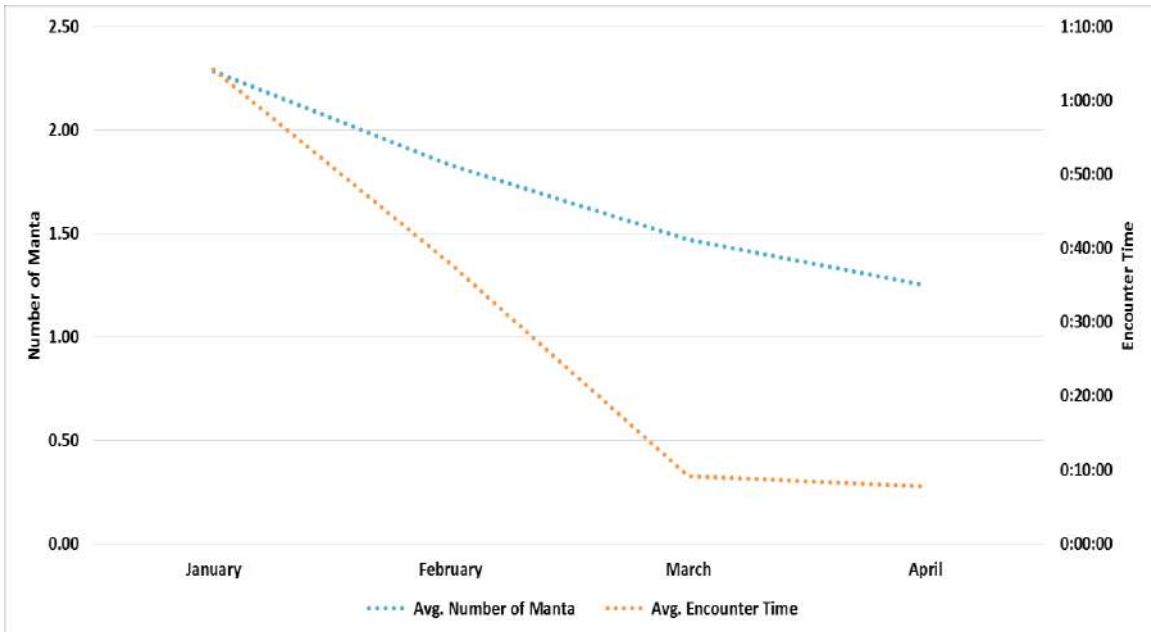


Figure 3.7. Seasonality of manta rays at German Channel

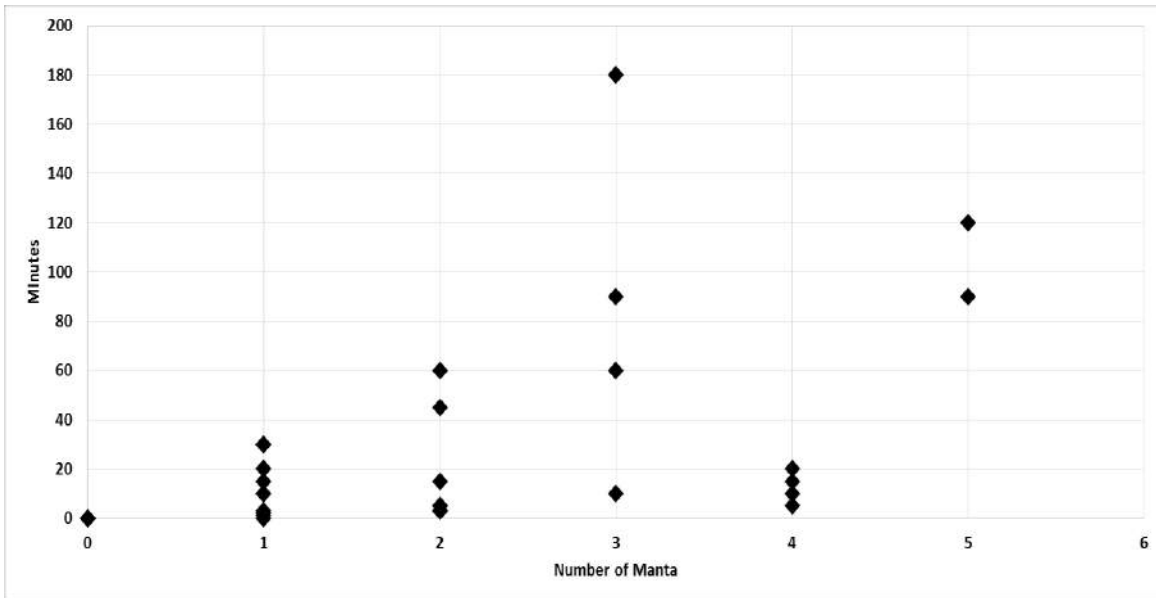


Figure 3.8. Correlation between manta rays and encounter periods

With mode values of 1 manta and 0 minutes, the manta ray watching season in 2015 was very poor (Figure 3.9.). Yet the success rate of seeing a manta ray at the site remained high at 78%, having a 0.46 positive correlation with current flow as 90% of dives and 99% of witnessed manta ray at the site observed incoming or switching currents (Figure 3.10.). Out of the 10% of outgoing current dives, only one manta [1%] was observed with an encounter duration of 2 minutes. Albeit manta ray watching is the major attraction of diving German Channel, there is only a 0.07 correlation between abundance of manta rays and abundance of boats (Figure 3.11.). Consequentially, the relationship between manta and boat abundance at German Channel is likely nonlinear, based on oceanographic and socio-economic variables respectively. Regarding boat-to-manta ratios through the period of study; there were 4.19 boats per manta during January, 5.41 during February, 7.16 during March, and 6.18 during April, resulting in an aggregate 5.87:1 boat-to-manta ratio between January and April 2015.

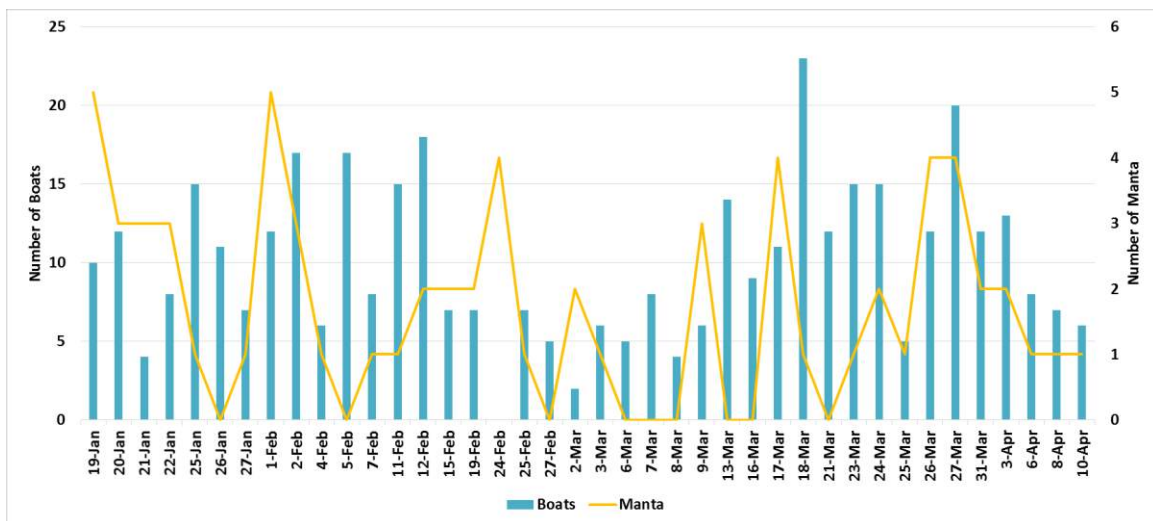


Figure 3.9. Manta ray abundance and boat site use at German Channel between January and April

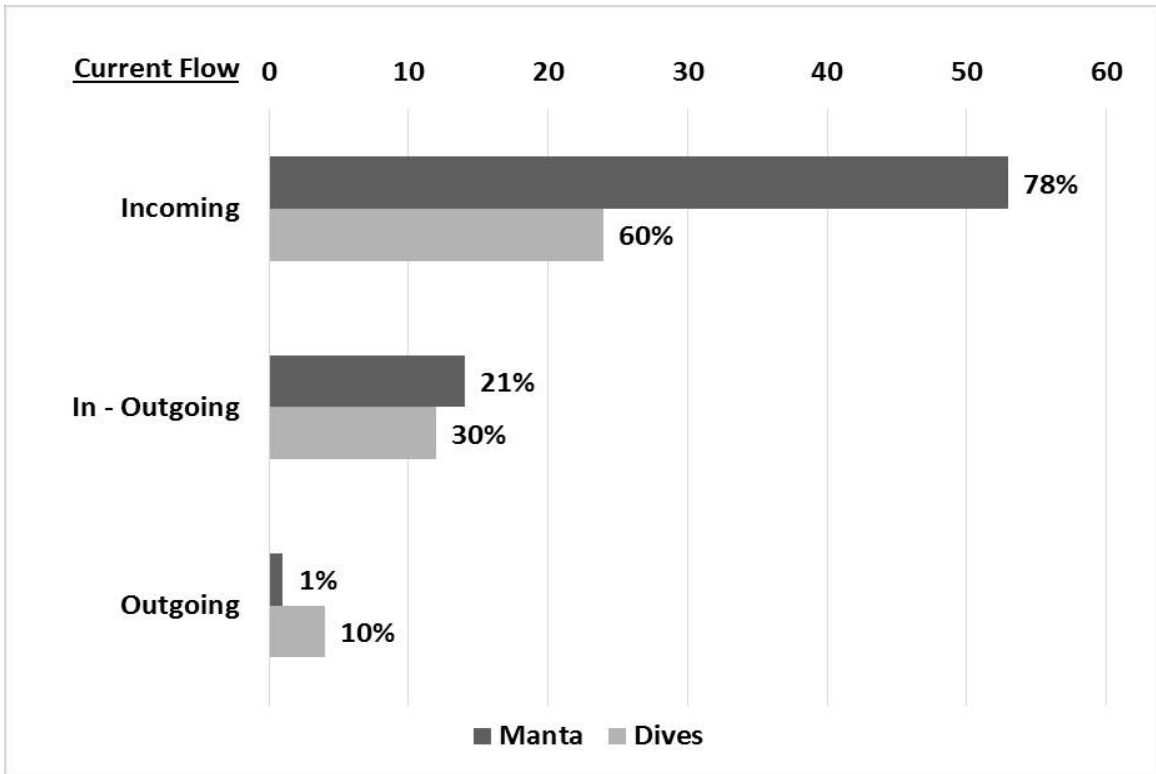


Figure 3.10. Distribution of dives and observed manta ray with current flows

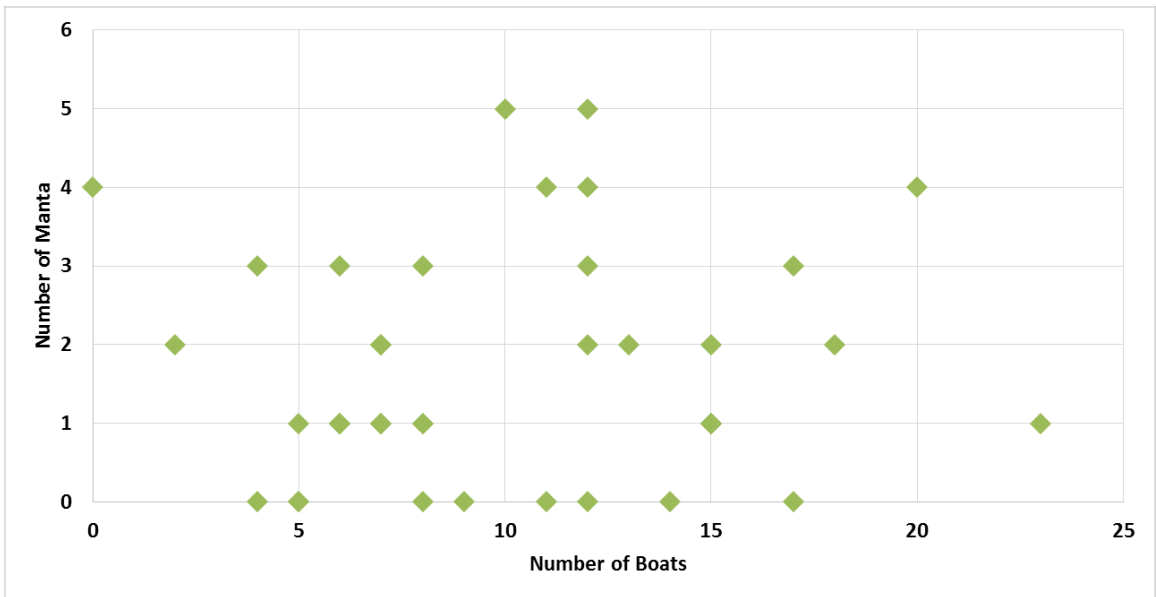


Figure 3.11. Correlation between manta ray abundance and boat abundance

3.2. Stakeholder Perceptions

In order to assess the current market at German Channel and barriers towards sustainable management, a total of 182 surveys were conducted to dive professionals ($n = 78$) and dive tourists ($n = 104$) during 89 days [approximately 1068 hours] of fieldwork. Albeit snorkelling is the largest tourist activity in Palau, questionnaires focused on the diving industry because German Channel is categorized as a *dive site* and site use remains predominant amongst divers. One must acknowledge that not all questionnaires were completed in their entirety.

3.2.1. Dive Professionals

The majority of dive professionals interviewed were dive guides as well as some experienced dive shop managers and boat drivers. A total of 18 dive shops (whose key revenue stream is from diving not snorkelling) were identified comprising the diving market in Palau. The identified market thus includes: Antelope Dive, Aqua Magic Palau, Blue Marlin, Carp Island Resort, Cruise Control Tours, Dari Divers, Daydream Palau, Fish'n Fins, MamL Divers, Neco Marine, Oasis Diving Service, Palau Dive Adventures, Palau Pacific Dive Center, Peleliu Divers, Sam's Tours, Seaworld Dive Center, and Splash. Furthermore, an additional 10 liveaboard vessels were identified as well in the dive market which are: Eclipse, Ocean Hunter I, Ocean Hunter III, Palau Aggressor, Palau Tropic Dancer, Palau Sports, Tida, Ryoma, Siren and Solitude. From the 78 interviews conducted to dive professionals with at least one professional from each operator interviewed; 100% of identified dive shops and 90% of identified liveaboard vessels were included in this study.

Figure 3.12 illustrates the distribution of nationalities amongst dive professionals within the market. Palauan and Asian are the dominant nationalities in the dive market accounting for 36% of interviewed professionals each. The prevalence of Asian dive

professionals is reflective of a tourism market that is majorly Chinese, Taiwanese, Japanese and Korean customers.

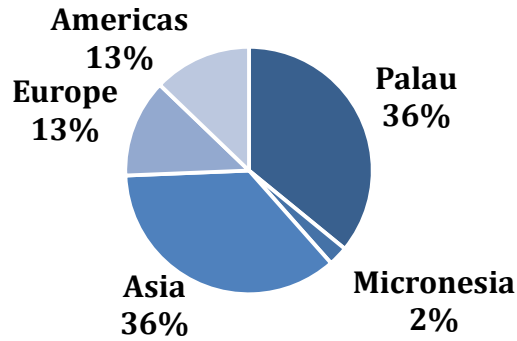


Figure 3.12. Distribution of dive professional nationality

40% of professionals interviewed had “*divemaster*” qualification, whereas 58% had a higher “*instructor*” qualification. In view of that 94% of professionals worked full time in the industry. Yet results indicate that 71% of Palauans have more than 5 years of experience working in the dive industry in contrast to 37% of non-Palauans. (Figure 3.13.). Moreover, 58% of dive professionals received information on how to dive with manta rays at German Channel, none of which was attributed to the Government of Palau or Koror State.

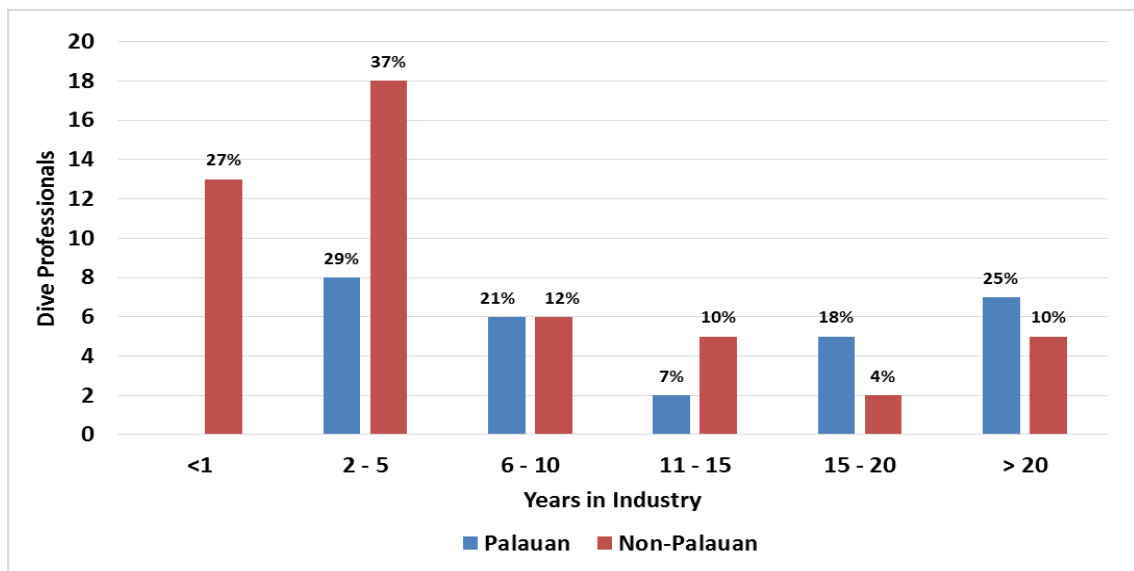


Figure 3.13. Experience in dive industry based on nationality

3.2.2. Dive Tourists

American and European tourists accounted for 51% and 15% respectively of total dive tourist surveys, reflecting how diving is the primary reason for visiting Palau amongst these markets. Yet Asian respondents accounted for 32%, a low value considering their markets' importance. 50% of participating dive tourist were over 50 years of age, whilst the remaining age groups between 21 and 50 were evenly distributed [14%, 18%, and 18%]. Regarding travel to Palau, 58% of tourists had never been to Palau before whereas 36% had visited Palau between 1 and 5 other times. A clear 68% majority of dive tourists reported a duration of stay in Palau of around one week, followed by 12% staying two weeks, 10% less than a week and the remaining 10% for more than two weeks or an undecided period of time. The majority of dive tourist completed between 2 to 5 [36%] and more than 20 [26%] day trips, reflecting a market dominated by dive shops and liveaboard operators. Day trips are defined as: "trips on speedboat with the purpose of completing at least one open water dive during the course of a working day".

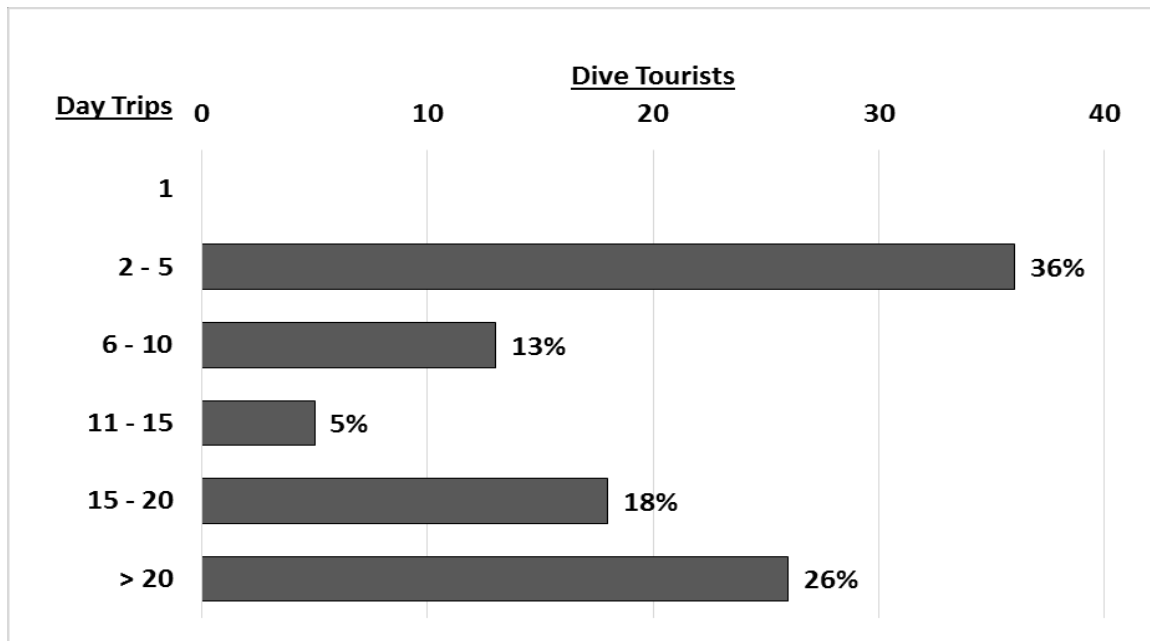


Figure 3.14. Total amount of day trips whilst in Palau

Figure 3.15 displays dive tourist awareness on the use by Palau Government and Koror State of the Green Fee Departure Tax and Dive Permit Fee respectively. Poor awareness on how environmental fees are used is the norm in the sample, with 57% unaware how the government and 78% the state use their respective environmental fee.

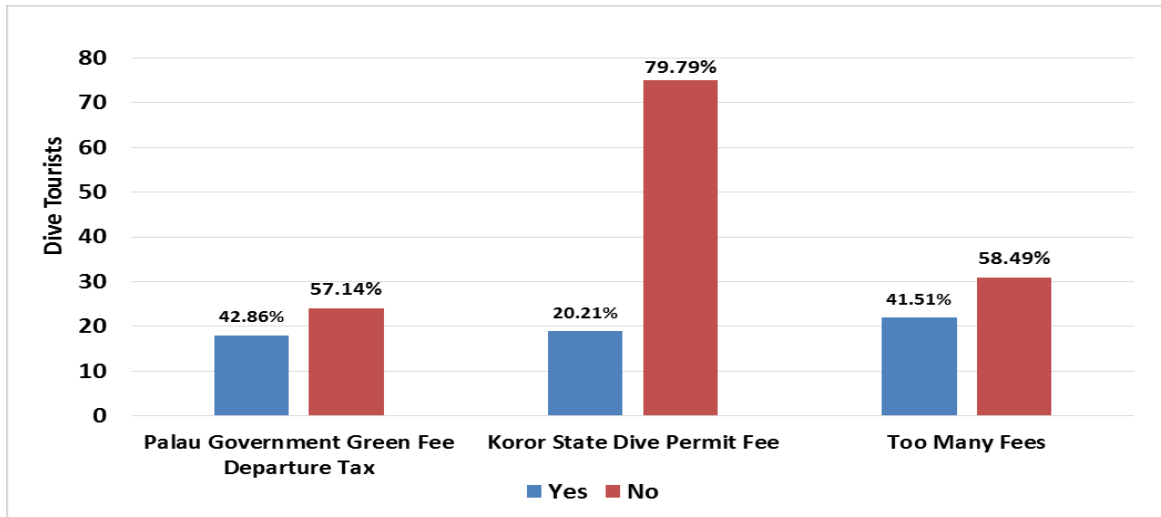


Figure 3.15. Tourist awareness and opinion of environmental fees

3.2.3. German Channel

When inquired to rank the importance of various popular dive sites in Koror State (1 = Most Important; 5 = Least Important), 80% of dive professionals and 51% of tourists ranked German Channel as the 2nd most important dive site (Figure 3.16.). Blue Corner remained the unequivocal top dive spot in Palau with 94% of professionals and 66% of tourists ranking the dive site as the 1st most important. As a result, 77% of dive tourists expressed a “high” level of interest in watching manta rays and 21% “medium” level of interest.

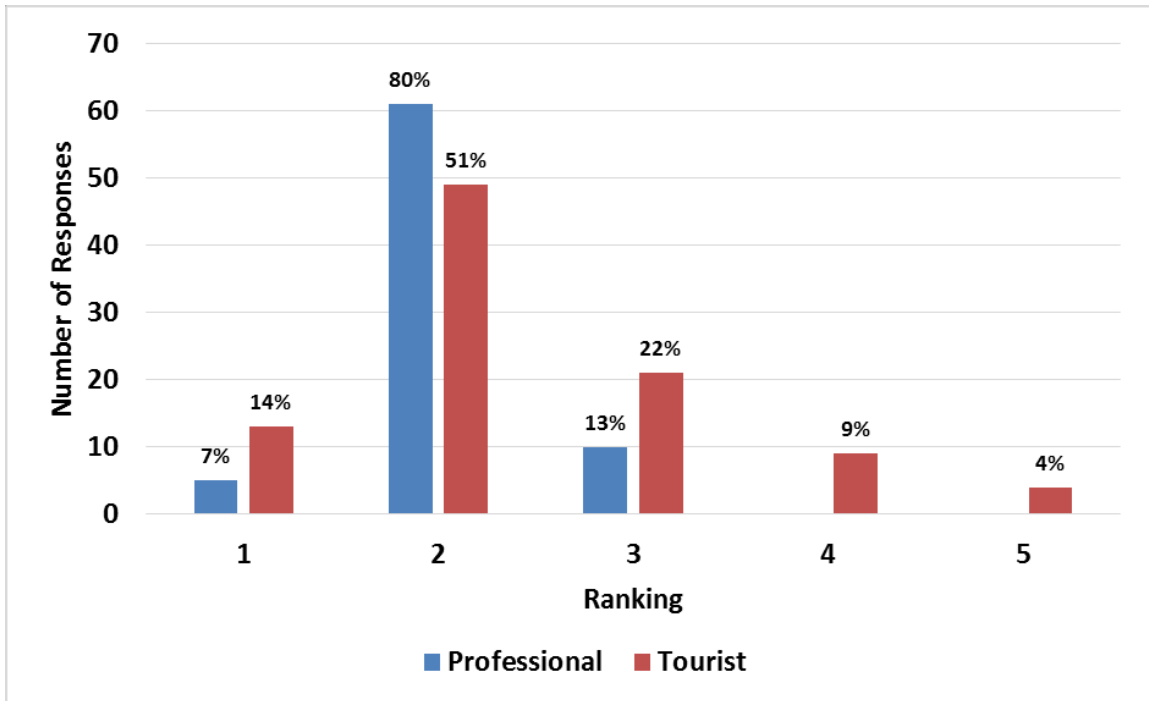


Figure 3.16. Ranking of German Channel amongst dive professionals and tourists

Reported average activity at German Channel shows a disparity of 1 dive per week more amongst professionals [3.03] than tourists [2.03]. As a result of this difference in one unit value in site use per week, average number of manta seen per week was slightly higher for professionals [2.94] than tourists [2.33]. Additionally, the success rate of seeing at least one manta was 40% for tourist and 73% for professionals (Table 3.1.).

	Average Number of Dives	Average Number of Manta	Manta Encounter Success Rate
Professional	3.03	2.94	73%
Tourist	2.03	2.33	40%

Table 3.1. Average weekly site use of German Channel amongst dive professionals and tourists

Focusing on dive professionals with at least 5 years in the industry, 54% reported not having changed how often they go to German Channel since 2010 whereas 29% more often and 15% less often. Yet, 90% of the same group unequivocally agree that

there has been an increase in the total amount of operators using German Channel. Average reported estimates of maximum number of boats seen at German Channel during the 2010, 2014 and 2015 seasons, indicate a 16% 5-year increase in operators at the site from 15.11 to 17.54 (Figure 3.17.).

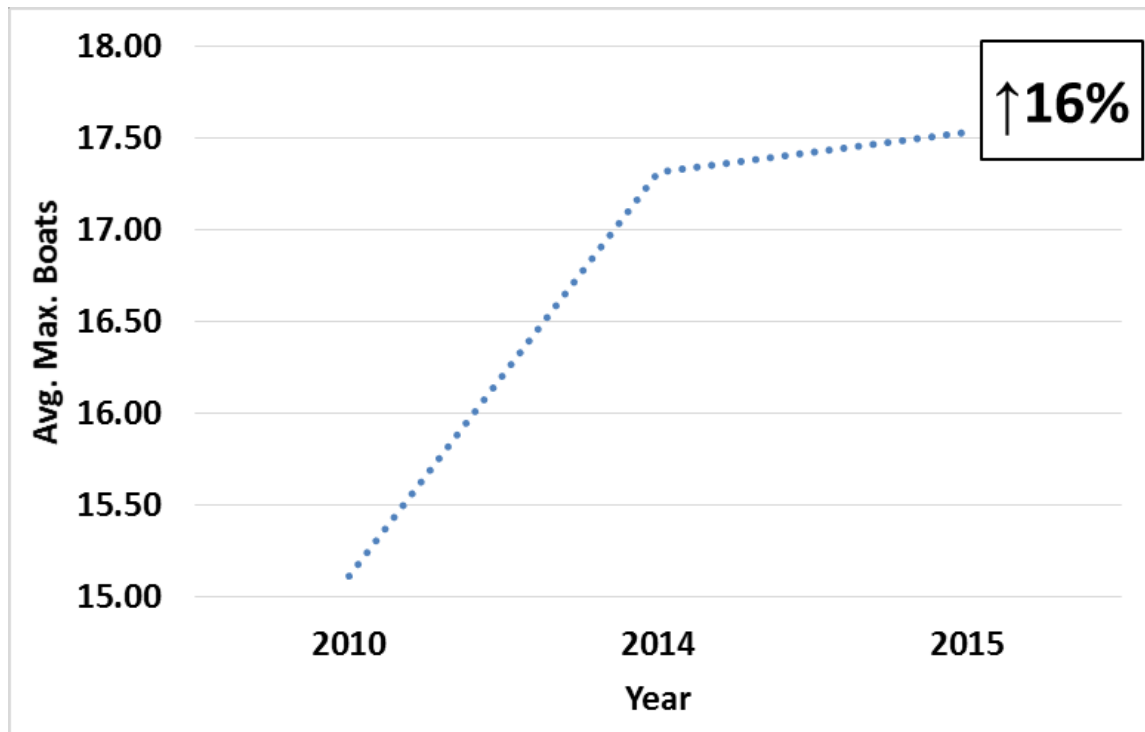


Figure 3.17. Average estimated maximum number of boats at German Channel

In regards to the increase in site use at German Channel, 91% of all dive professionals believed that the amount of boats and divers had an effect on the dive site. Figure 3.18. displays the effects dive professionals quoted in regards to boat site use of which the most common are manta ray safety [33%], coral damage [20%] and tourist experience [17%]. *Other* effects include noise pollution, oil leaks from liveaboards, and inexperienced divers. Still, 50% of dive professionals quote that they have never witnessed any ranger checks at German Channel as well as estimated a 69% aggregate occurrence of fishing at varying frequencies at the site (Figure 3.19.). Dive tourist responses corroborate this pattern as 96% did not see or could not distinguish a ranger at the site.

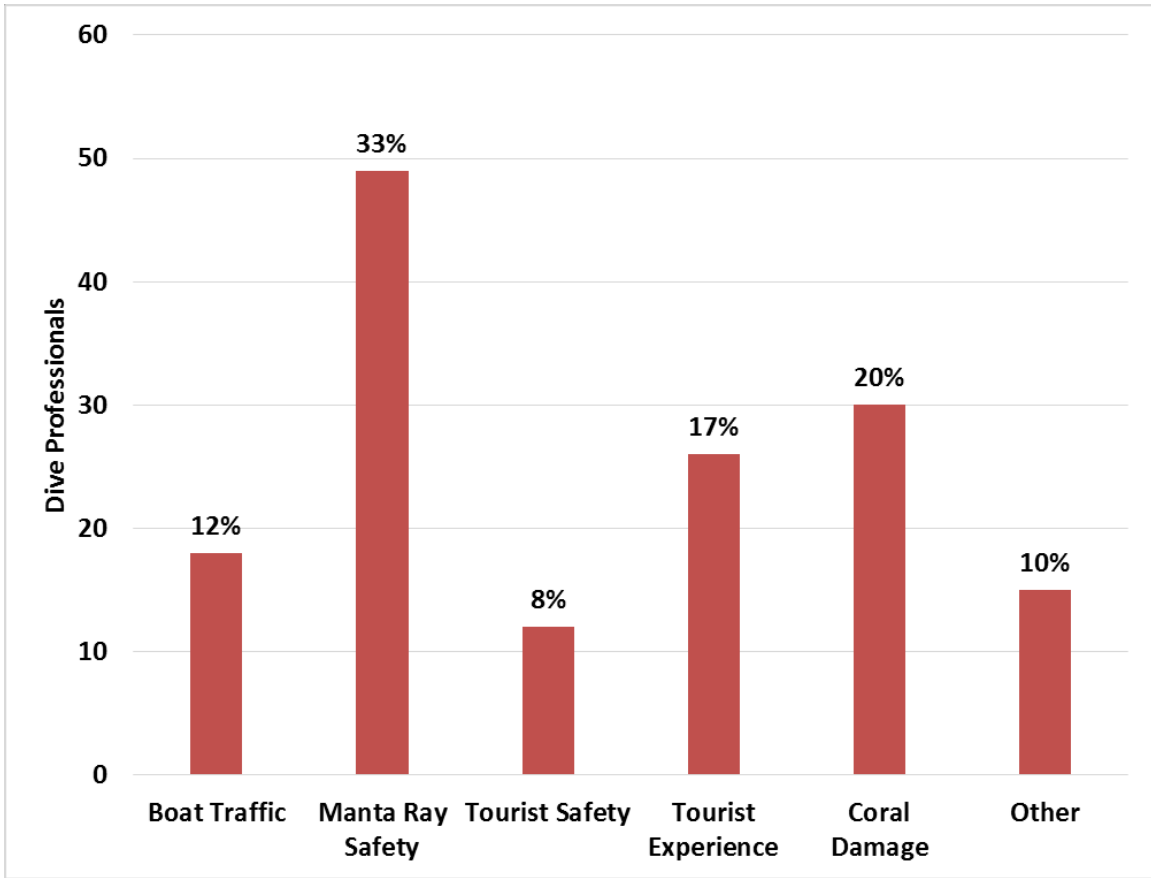


Figure 3.18 Quoted effects of site use pressure

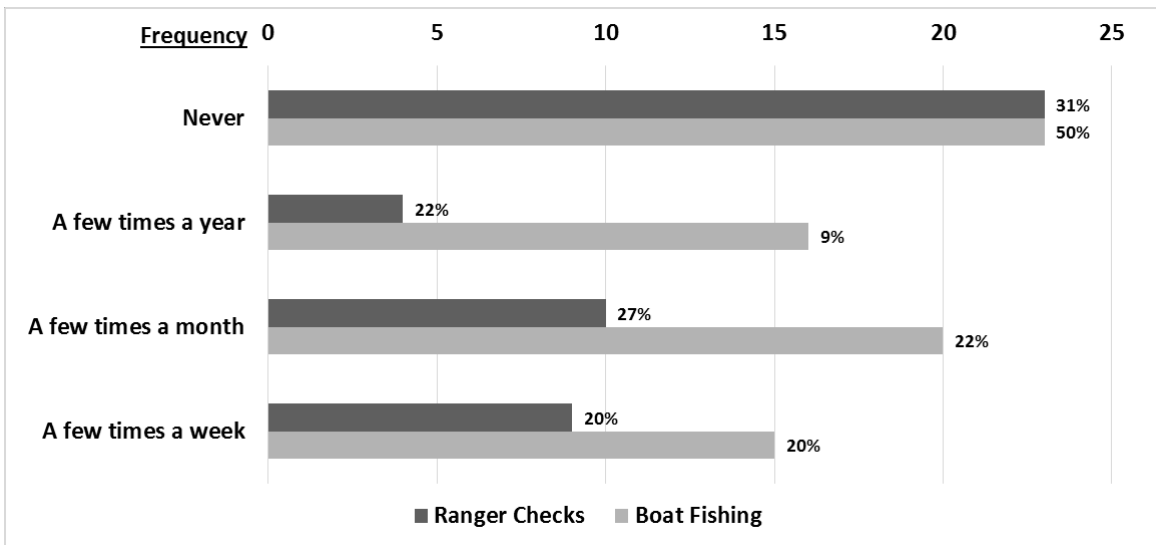


Figure 3.19. Quoted frequency of ranger checks and boat fishing

Figure 3.20 summarizes the reported experience at German Channel amongst the sample of dive tourists. The level of satisfaction was asked by using a rank system where: 1 = Not Satisfied; 2 = Barely Satisfied, 3 = Quite Satisfied, 4 = Satisfied, 5 = Very Satisfied. In terms of amount of manta seen, 27% of dive tourist were “quite satisfied,” 23% “satisfied” and 24% “very satisfied” resulting in an aggregate satisfaction level of 75%. In regards to the quality of the interaction such as duration and proximity, 16% of divers reported being “quite satisfied,” 23% “satisfied” and 31% “very satisfied” resulting in an aggregate satisfaction level of 71%. Aggregate satisfaction levels were even higher when asked about briefing quality [97%] and information on manta rays [80%]. Overall, 79% of dive tourist were “quite satisfied” or more with their experience at German Channel, with the maximum reported satisfaction level being “satisfied” at 30%. In addition, 72% of dive tourists responded that the site was either “crowded” or “too crowded,” from which 45% stated that the level of crowdedness had a negative effect on their experience. 12% of tourists felt unsafe underwater attributed mainly to boat traffic and crowdedness [82%].

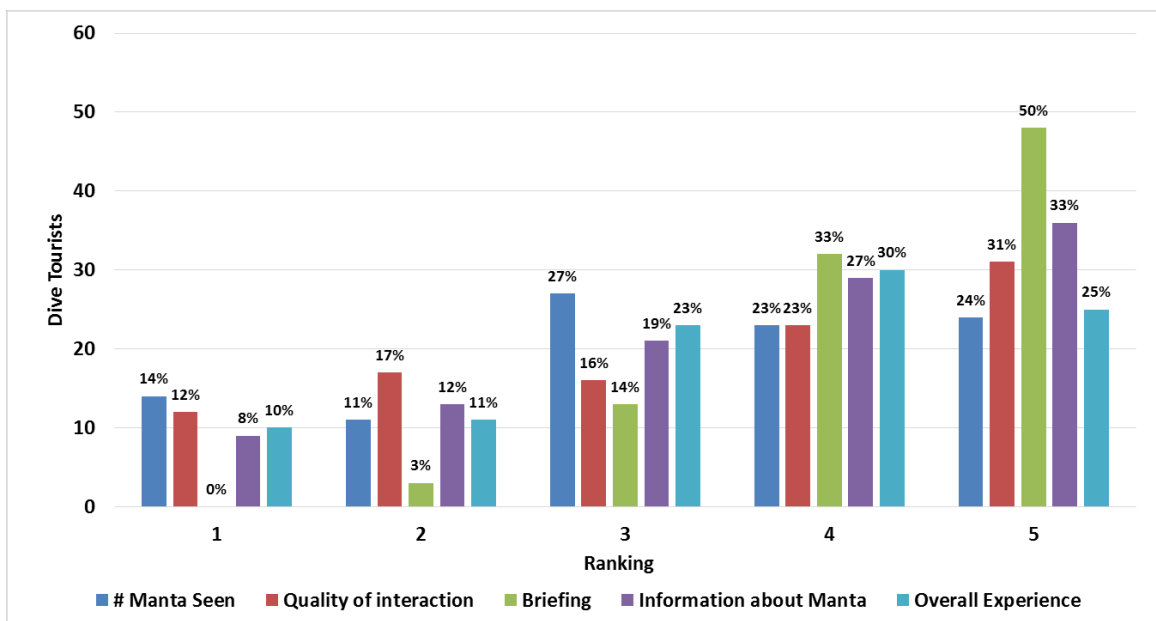


Figure 3.20. Dive tourist satisfaction levels experiencing German Channel

3.2.4. Sustainable Management

In consequence of the perceived site use pressures at German Channel, 82% of dive tourists expressed the need for stricter site management at German Channel, 88% of which believed the environmental permits they pay should be used for site management purposes. On a similar note, 66% of dive professionals expressed their dissatisfaction with the present arrangement of mooring buoys at the site, with a 41% majority citing an insufficient amount of them. In response to present circumstances Figure 3.21. summarizes the most common management suggestions brought up by interviewed dive professionals.

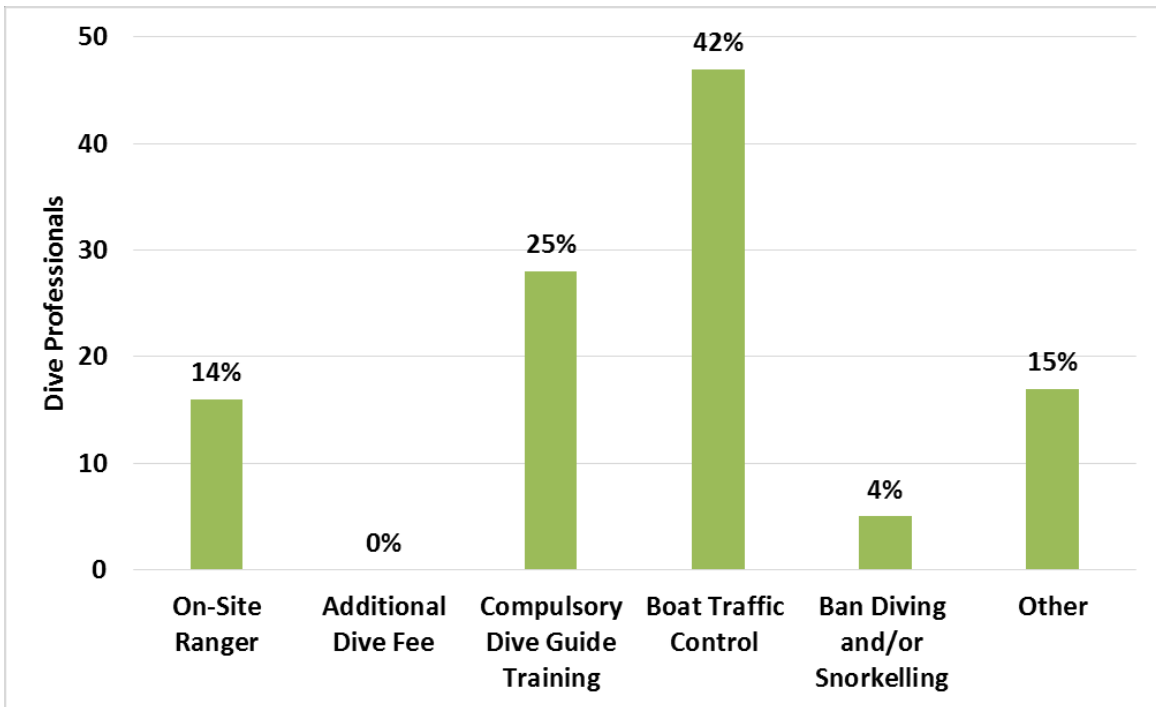


Figure 3.21 Dive industry management suggestions

Boat traffic control including but not limited to: a no-boat zone, boat cap, speed limit, and buoy distribution, was the primary management response to current site use issues accounting for 42% of dive professional suggestions. Subsequently, compulsory dive guide training was the most common with 25% of industry

suggestions, followed then by an on-site ranger [14%] and other suggestions [15%] such as standardized rules, obligatory industry meetings, minimum diver experience, banning gloves and tank bangers or even dredging a new channel.

Salient in the results is the rejection of banning marine activities [4%] and imposing an additional dive fee [0%]. 58% of dive professionals consider there are too many permit fees imposed on tourists, yet 42% of dive tourists did not consider government and state legislations imposed too many fees. Although the option of an on-site ranger only gathered 14% of total suggestions, it must be noted that 64% of respondents considered an on-site ranger *essential* to the implementation of their respective management suggestion. Likewise, 86% of interviewed professionals agreed that if there were to be compulsory training, learning how to dive with manta rays and German Channel should be part of the curriculum.

Analogous to the perceived increase in operators since 2010 in Figure 3.17, 71% of dive professionals with at least 5 years of experience also acknowledge that manta ray tourism in general has increased. What's more, 83% of participating dive tourists expressed their desire to *maybe or definitely* return to Palau to watch manta rays again. In contrast, results display an even division amongst dive professionals whom think manta ray "*should*" [55%] or "*should not*" [45%] be more marketed. The same percentile division also reflects the dive industry's opinion whether manta ray tourism is currently promoted in Palau, 89% of which perceive operators and media as the primary marketers of manta ray tourism in the country.

Current market dynamics at German Channel rely on the sustainability of its commercial utility as a passage and biological utility as a manta ray area; yet results illustrate a tragedy of the commons situation where the lack of management is resulting in a disjunction between the resources of this maritime asset. Despite the inclusion of German Channel in the Ngemelis Island Conservation Zone (State of Koror, K9-229-10) and Rock Island Management & Conservation Act (State of Koror, K8-207-2009), current legislation and governance mechanisms remain insufficient considering the present situation illustrated by the data.⁴⁹ Tourism has grown more than threefold since the year 2000 and is deemed to continue the trend considering the economic growth of key Asian markets. Development promoting visitor satisfaction is being progressed at the cost of ecological integrity. The amenity value of German Channel is thus being reduced, as the wilderness experience visitors seek diminishes with crowdedness that could possibly also trigger a local extinction of the primary resource of economic revenue – manta rays.

4.1. Tragedy of the Commons

German Channel is unequivocally the second most popular dive spot in Palau after Blue Corner, and is either the second or third most important tourist attraction of the republic with Jellyfish Lake and Blue Corner. This is reflected by the data in Figure 3.16 as well as by a study by Noelle Oldiais placing it before Jellyfish Lake and after Blue Corner in frequency of visitors.⁵⁰ German Channel is one of the most important maritime asset in the country as its amenity value is in reality higher than both Blue Corner and Jellyfish Lake considering that in addition to its use as a dive site, it is also the only passage into the southern lagoon.

Geographic Information Systems software shows the centrality of German Channel to present market dynamics as there are a total of 18 dive sites in close proximity to it; including very popular sites like Blue Corner, Big Drop-Off, Blue Holes and New Drop Off that are at an average distance of merely 9.37 kilometres (5.82 miles) [see Appendix 4.1.]. From these 18 dive sites though approximately a third located on the east side of Palau have been damaged by the 2012 Typhoon Bopha, limiting the total amount of dive sites available to operators and placing further stress on them with burgeoning tourism growth (Figure 4.1.). Complicating matters even further is the fact that the majority of the dive industry knows what moon phase, tide and wind direction are ideal to encounter manta rays at German Channel [see Figures 2.2. & 3.10.] thus under specific circumstances all operators want to use the site within a very limited time frame (Figure 4.2.). The unique characteristics of German Channel and present market dynamics are subjecting the site to intensified use concomitant with a quintessential *Tragedy of the Commons*.⁵¹



Figure 4.1. Ngeruchutang Island damaged by Typhoon Bopha⁵²



Figure 4.2. Simultaneous site use under exceptional conditions on March 18th ⁵³

The dive industry is aware of current overexploitation as 90% of dive professionals with at least 5 years of experience unequivocally agree that there has been an increase in the total amount of operators using German Channel, with an estimated increase of 16% since 2010 on the average maximum number of boats observed at the site. Likewise, 91% of the industry further agrees that the present amount of boats has a negative effect on the site. Ironically, the plateau from 2014 to 2015 displayed in Figure 3.17 is a result from increased visitors from Asian markets that predominantly snorkel, driving boat pressure to other more snorkel-friendly sites instead. Oldiais discovered that tourist perception on crowding at site was “moderate” in 2012.⁵⁴ She then warned: “At the rate of number of visitors that Palau is receiving each year, this crowding perception is most likely to shift to a “more” or even “very” crowded side of the scale.”⁵⁵ Current figures display worrying implications for German Channel’s sustainability.

The majority of dive professionals consider a site is crowded when there are 10 or more boats, and results indicate a common sighting of 12, maximum of 23 and average of 9.98 boats.⁵⁶ Conservatively using a ratio of 8 visitors per guide which is considered the industry *minimum* for booking a dive operation, a total of 3591 divers were observed at the site with a mode value of 108 and 90 mean.⁵⁷ Yet the mean number of divers and snorkelers that was accepted by visitors in 2012 was 17.⁵⁸ 72% of dive tourists in this study responded that German Channel was either “crowded” or “too crowded,” 45% of which said the level of crowdedness has a negative effect on their experience [see Appendix 4.2.].

The stress on commercial resources at this maritime asset are palpable. 66% of dive professionals are dissatisfied with the present arrangement of mooring buoys, 41% of which believe there are not enough. 50% of dive professionals and 96% of dive tourists quoted never having seen a ranger check at German Channel. In response to which the Koror State Department of Conservation and Law Enforcement established in February 2015 a ranger fleet specifically for the Ngemelis Island Complex, and plan to commence 24 hour surveillance from Ngemelis Island Post. Regardless of legislative prohibition (State of Koror, K8-191-2007/K8-234-2011), 69% estimated an aggregate occurrence of fishing at the site in varying frequencies, mainly on the east side of the site governed by the State of Peleliu.⁵⁹

In addition to commercial resources, biological resources are equally as impinged by site use. 33% of dive professionals believe manta ray safety is in jeopardy, 20% that coral has been damaged and 17% that their tourist experience has been hindered. Tourist experience is heavily reliant on biological resources of the site as Oldiais discovered that “*biological criteria such as pristine underwater environment, abundance, diversity and size of fish, corals, and good visibility were ranked ‘extremely important’ by majority of tourist.*”⁶⁰ Yet 20% of observed operations partook in forms of misconduct that hindered manta rays.⁶¹ During the period of this study there were various encounters with manta rays harmed by fishing hooks and mooring

lines at German Channel, an alarming fact considering the species is a key source of economic revenue (Figure 4.2.).

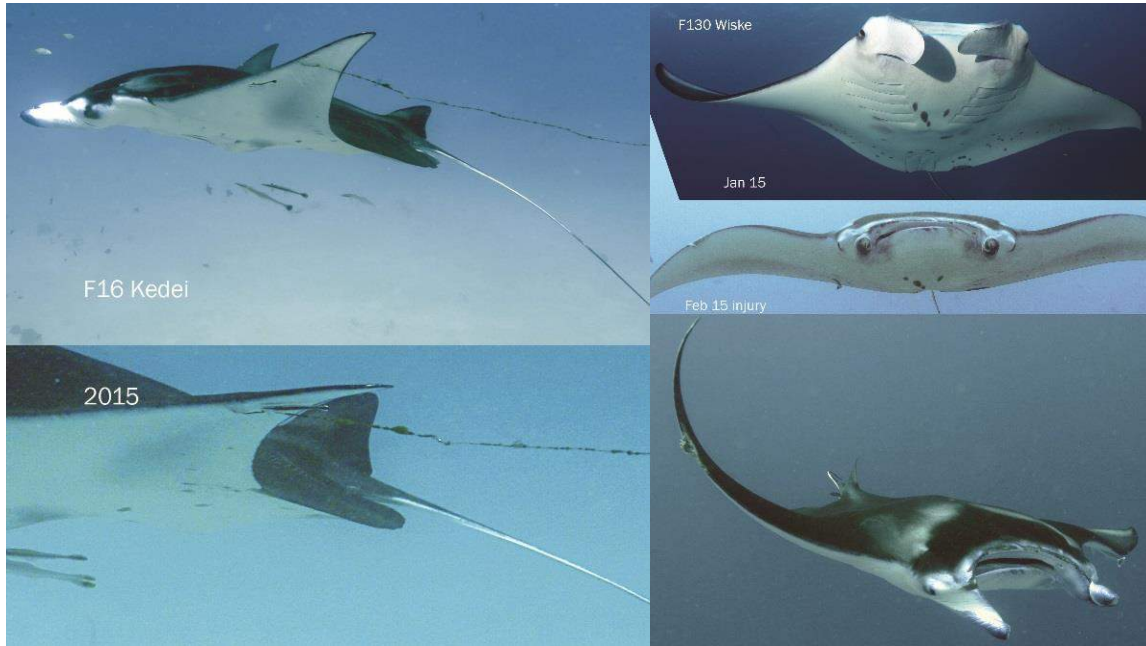


Figure 4.3. Harmed manta rays observed at German Channel⁶²

Albeit aggregate satisfaction levels of tourists regarding manta watching at German Channel was 71%, the 2015 season was very poor. Tourists averaged 2 dives at German Channel during their stay - 68% around a week – and yet the constituency’s success rate of encounter was merely 40%. This study was conducted with a primary sponsor whom had 30 years of experience diving in Palau and yet the encounter success rate for expeditions at the site was 78%. With an aggregate average of just 1.7 manta rays and mode values of 1 manta and 0 minutes of encounter time, data from this study draws a miserable picture to what German Channel is popularly known for. With an average 5.86:1 boat-to-manta ratio, using minimum industry numbers to book a diving trip results in an astounding 53 people for every manta at German Channel (Figure 4.3.). Intense pressure from tourism is a key reason behind the even split amongst industry on the promotion of manta ray tourism.



Figure 4.4. A large crowd watching M125 Begeray⁶³

4.2. Economic Valuation

The importance of manta rays as the key source of economic revenue at German Channel cannot be understated as the 77% of tourists expressing a high interest in watching the species is supported by results from Koike *et al.* that manta rays are top marine organisms tourists want to see.⁶⁴ 71% of dive professionals with at least 5 years of experience in Palau argue that manta ray tourism has increased. Manta ray watching tourism contributed US\$ 6.8 million to the economy of Palau in 2013, and this figure will likely increase as 83% of dive tourists expressed their desire to *maybe or definitely* return to Palau to watch manta rays again.⁶⁵ Yet the market potential of manta ray conservation in Palau remains unrecognized in current legislation hindering the sustainability of this important resource.

Normalizing the results developed by Koike *et al.* on the willingness to pay for napoleon fish and kemedukl, it is estimated that the willingness to pay for manta ray under the present scenario at German Channel of poor management is US\$ 213.25.⁶⁶ This value increases by 16% to US\$246.57 if effective management practices are put into place. With a conservative estimate of 3591 divers observed during the period of this study and a total of 65 manta ray encounters, German Channel would have generated an additional US\$ 765,767.24 of revenue during the high season.

According to Palau Visitors' Authority a total of 60,885 tourists arrived to Palau between January and April 2015 - considered the high season.⁶⁷ Assuming the same figure as 2014 that 42% of arrivals came from diving leaves a total of 25,572 dive tourist arrivals to Palau during the period of this study. Using the same value as Anderson *et al.* of US\$ 40 cost per dive results in a 2015 high season dive tourist expenditure of US\$ 1,022,868 per dive site.⁶⁸ This value embodies direct economic impact and is therefore conservative not including indirect expenditures such as rental gear, food consumption, accommodation and taxes. The estimated resident population of reef manta at German Channel is between 10 and 30, thereby each individual's seasonal value is approximately US\$ 34,096.⁶⁹ Due to the seasonality of manta rays, a yearly value would not differ too much as manta encounters are scarce during low season. Accounting for the entire identified population of manta rays in Palau results in a value of US\$ 9,376,290, a value a third higher than the figure calculated by O'Malley *et al.* for 2013 because the majority of manta encounters in Palau are with the 11% population fraction resident to German Channel. If manta rays were to be protected and manage to live their expectancy of 50 years, the lifetime high season value of one resident manta at German Channel is estimated to be US\$ 622,447 not accounting for any growth and using a 5% discount rate as per Vianna *et al.*'s 2012 valuation of sharks in Palau.⁷⁰

Albeit the economic valuation of resident manta rays from German Channel used conservative figures and assumptions, it must be acknowledged that it remains *estimated simplification* for the purpose of aiding legislative decisions regarding ocean governance.⁷¹

4.3. Sustainable Management

Dive tourists visiting Palau spend a high amount on obligatory environmental fees imposed by the Government of Palau [US\$ 50 Green Fee Departure Tax] and the State of Koror [US\$ 100 Rock Island Permit], yet it does not seem like the revenues from these fees are avoiding the degradation of the resources that attract tourist revenue in the first place. For example, an increase 100% increase fee for Jellyfish Lake did not reduce the number of visitors per year. More than 50% of arriving tourist do not know what the fees they are paying are being used for. 82% of visitors to German Channel believe stricter management is required at the site, of which 88% state that the environmental fees they must pay should be used for conservation and management. Moreover, 64% of dive professionals consider an on-site ranger essential to the effective implementation of a management solution at German Channel.

Amongst the dive industry, 43% consider boat traffic control as the most appropriate way of managing the current tragedy of the commons occurring at German Channel. This makes sense acknowledging that site use at German Channel is product of the ability of boats to transport users and make the site accessible from the population hub in Koror after a 45 minute ride. Thereby within boat traffic control solutions, the fastest and most cost-effective way to manage site use pressure is imposing a no-boat zone above the dive site. For example, unlike Blue Corner which faces the open ocean, the dive site's location at the mouth of German Channel makes surveillance and control of boat traffic a lot easier for enforcing agencies like Koror State Rangers. Complementing this would be the imposition of speed limits and no-wake behaviour

whilst cruising through the site. In regards to buoy distribution, a boat cap of 5 at the time on a first-come-first-serve basis was brought up by many dive professionals. With an 8:1 visitor per guide ratio results in a total of 45 divers in the water at the same time which is reasonable. Yet designing fair mechanisms of site use distribution is complicated as the appearance of manta rays occur at specific windows all operators want to be in. The first buoy should be removed further away as it is too close above the main manta ray cleaning station and under particular conditions boats float above the dive site, posing serious danger to tourist and manta rays (Figure 4.4). Furthermore, size of speedboats must be taken into consideration, where the largest may only use the furthest buoy from the dive site in order not bother or harm other users.



Figure 4.5. Manta rays close to boat propellers⁷²

Oldia's highlights that dive professionals are concerned about new operators who are not familiar with informally established communication rules currently in place.⁷³ Current market dynamics in Figure 3.13 illustrate this situation, as 71% of Palauans have more than 5 years of experience in the dive industry contrasting with 37% of

non-Palauans. Barely half of the industry [58%] has received information on how to dive with manta rays at German Channel while the site itself is the second most visited. As a result of this, 25% of dive professionals expressed the need for compulsory dive guide training, a further 86% noting that an obligatory curriculum should include how to dive with manta rays. Currently, Koror State is in the process of establishing a new tour guide certification scheme but a quick analysis of the preliminary manual suggests a poor adaptation to the market reality in Palau. For a country with a lagoon larger than the total area of the islands within it and an economy reliant on marine resources, it is not understandable that only 23 pages [12%] of the tour guide manual focus on marine resources. Furthermore, the certification covers material that is already a standard prerequisite for working in the dive industry like equipment maintenance, as well as historical and cultural information that is taught whilst at school in Palau. If compulsory training is established it should be concise and effective with further credentials designed in order to make guides accountable to misconduct and also distinguish those with the experience and ability to manage activities at popular sites with those that cannot.

A moratorium on marine activities at German Channel such as banning diving and/or snorkelling was not a popular management solution with just 4% of responses. Hanifaru Bay, the primary manta dive in the Maldives was subject to similar site use pressure as German Channel and the government responded by banning scuba diving.⁷⁴ Results reflect this could not be the case at German Channel. The tourism industries of Palau and the Maldives are very different, and unlike the predominance of high-end resorts in the Maldives, the diving shops in Palau are the largest constituency with stakes in German Channel. With a shifting market now dominated by Asian visitors that predominately snorkel, a clear division must be enforced between sites for diving and for snorkelling.

Various other management suggestions were substantiated but difficult to enforce such as the banning of gloves and tank bangers. Albeit desirable, minimum dive

experience for German Channel is complicated to supervise, especially considering its use as a sheltered dive site and shallow dive for introductory levels. Standardized rules were a prevalent request from Asian constituents whilst gathering dive professional surveys. The Belau Tourism Association (BTA Japan) codified worthy guidelines on dive conduct with manta rays at German Channel based on experience and dialogue between Asian constituencies of the dive industry (see Appendix 4.3).⁷⁵ Codifying rules was a step forward from mere informal communication channels and remains a commendable industry attempt to initiate sustainable management at the site. Yet as guidelines without any enforcement mechanism they remain subject to the will of each operator. As operators have vested interests in German Channel, management cannot be left solely to the industry as it incentivizes free riding behaviour which ultimately results in a tragedy of the commons scenario. Likewise, the sponsor of this study pushed for a bill regarding manta ray protection acknowledging that their sustainable use cannot be left to the industry and requires lawful governance mechanisms (see Appendix 4.4). An objective of this report is to develop standard rules through legislation that must be abided by all dive industry stakeholders. In response, compulsory dive meetings at the beginning and end of the high season between dive shops and government would increase transparency, improve communication between key stakeholders and avoid conflict.

The vibrant wilderness of Palau has garnered it the reputation as one of the “*last great places on earth*” by National Geographic, yet current market dynamics also place substantial stress on the resources that attest to that reputation. The centrality of German Channel as a maritime asset with both commercial and biological resources is what complicates the management of the site as a variety of purposes must be balanced. Albeit the only direct passage to the southern lagoon, it must be acknowledged that part of that commercial utility is driven by a current market that transports visitors to experience the underwater biological wilderness of Palau - both amenity uses are thus synergistically intertwined.

Fortunately, manta ray fisheries never developed in Palau and unlike the spotted eagle ray have never had an important cultural significance. However, these harmless “*devils*” are now a very important source of economic revenue for the republic worth US\$ 6.8 million annually and thus the market potential for conservation must be recognized by legislators and decision makers. The lack of any legislation protecting manta rays nor enforcement of sustainable management practices makes current site use at German Channel akin to a tragedy of the commons. Facing a shifting and burgeoning tourism market, rapid precautionary measures need to take place in order to avoid situations like in Yap and the Maldives where manta rays seem to avoid popular sites.

The 2015 manta ray watching season was very poor, visitors’ success rate of encountering a manta ray was 40% and the average amount of manta seen was 2 [1.7]. Furthermore, with a ratio of 53:1 divers per manta ray, current numbers attest to a tragedy of the commons at German Channel. Yet under conservative parameters, the estimated seasonal value of an individual reef manta from German Channel was approximately US\$ 34,096. Manta rays are the most sought marine specie to watch by visitors of Palau, whom are willing to pay US\$246.57 under a

management scenario that ensures the species sustainability. If manta rays were to be protected by law and proper sustainable management practices enforced; the 50 year lifetime high season value of one resident manta at German Channel is estimated to be at least US\$ 622,447.

In response to current site use pressure and taking into account the perceptions of key stakeholders, the following recommendations should be followed in order to avoid a tragedy of the commons at German Channel.

1. No-Boat Zone

Boat traffic is the source of site use pressure at German Channel and can therefore be subject to a bottleneck response. Imposing a no-boat zone by law above the dive site would rapidly address pertinent site use pressure, create accountability for dangerous behaviour and ensure the safety of both tourist and manta rays. A cost-effective and ecologically-sound way of implementing this is to install one very visible boat traffic control buoy on the southwest side of the dive site, making it obligatory by law that vessels must pass between the buoy and Carp Island before mooring and cruising through. This simple traffic obligation enables efficient surveillance for Koror State Rangers as they must simply observe a boat's location in relation to the new very visible boat traffic control buoy (Figure 5.1.). In addition to the boat traffic control buoy, imposition of no-wake behaviour and a 5 miles per hour speed limit should be enforced for all boats operating through the entire channel.

2. Boat Moorings & Capacity

Buoy 1 should be removed further away from the dive site in order to avoid vessels floating above divers and mantas under certain conditions. In addition, a maximum vessel size must be allocated for the use of the buoys 1, 2 and 3. Large vessels should only be allowed to moor on buoys 4 and 5 to avoid bothering and injuring users. It is recommendable to pilot a one boat per buoy on a first-come-first-serve distribution mechanism to limit site use to a maximum of 5 boats at a time.

Furthermore, PVC pipes should be installed on all mooring lines in order to protect the resident manta rays from entanglement as per the drowning of an individual at Blue Corner.⁷⁶



Figure 5.1. Proposed No-Boat Zone over German Channel mouth

3. On-Site Ranger

A constant presence of surveillance at the site is essential to ensure compliance with the law. The establishment of the Ngemelis Fleet this season is an important step forward to change the dismal perceptions gathered in this report. Yet, further manpower should be provided for Koror State Rangers considering that the Rock Island southern lagoon is the primary destination for all tourism during the day as well as the site of illegal poaching at night. The presence of the rangers must be apparent to all stakeholders in order to deter illegal behaviour. Windows of predicted intense site use like incoming tides early afternoon must be identified and prioritized by the Ngemelis Fleet. Furthermore, proper legislation must be enacted in order to make dangerous behaviour accountable to ranger enforcement. It is recommendable to pilot a program of random ranger checks on operator boats as a cost- and time-effective mechanism to deter illegal behaviour.

4. Compulsory Training

With the growth of new operators from Asian markets and increasing prevalence of seasonal jobs in the industry arriving dive professionals are less experienced. Compulsory training is therefore crucial to make sure the industry retains the high standards of Palau during this rapidly shifting market phase. The development of the Koror State Tour Guide Certification is a good step forward, but the manual must be peer-reviewed by industry professionals to ensure the fulfilment of current market needs. It is recommendable to establish further credential mechanisms such as a sticker ranking in order to make guides accountable to misconduct and distinguish guides based on experience and ability managing activities at popular sites like Jellyfish Lake, Blue Corner and German Channel with those that cannot.

5. Awareness & Scientific Research

German Channel is unique amongst manta ray sites around the world as apart from cleaning behaviour, visitors can witness courtship behaviour, juvenile manta rays, feeding aggregations as well as black morph individuals. Such encounters is rare worldwide, which makes German Channel a very important site for scientific research of this majestic species. Koror State and National Government should put resources into attracting further scientific research for this species to help improve understanding of the resident population and its potential for economic revenue. The non-invasive ability of studying them through “*belly shot*” photo identification makes it simple for any stakeholder to help. A government sponsored app that enables any user to quickly compare a photograph with a centralized database would provide a sense of inclusion and responsibility to visitors as well as gather data for research on the species. Drawing from experiences in Australia, New Zealand and the Philippines it is recommendable to develop an obligatory video on manta ray watching that explains best-in-class practices for both diving and snorkelling to visitors whom want to partake in these activities with manta rays to ensure appropriate modes of conduct and raise awareness amongst visitors (see Appendix 5.1.).^{77, 78, 79}

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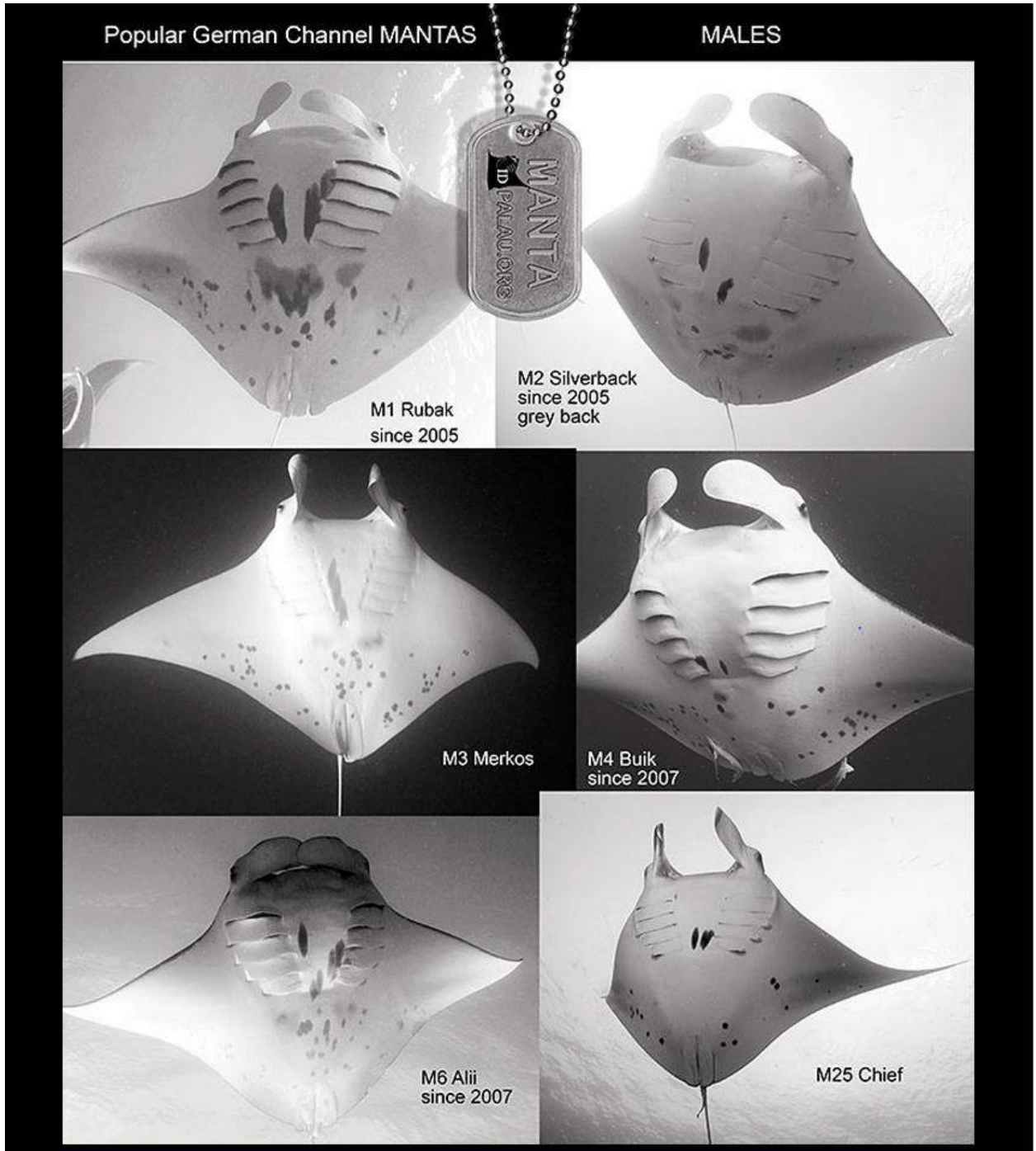
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Appendix 1.1. Taxonomy of manta rays

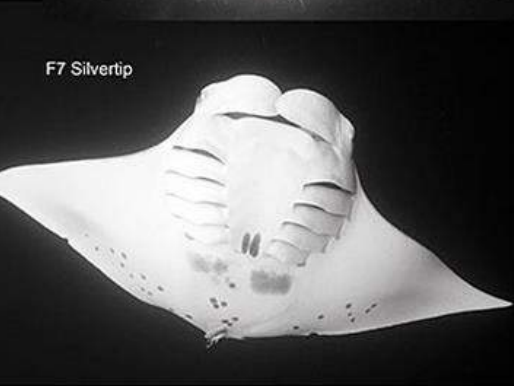
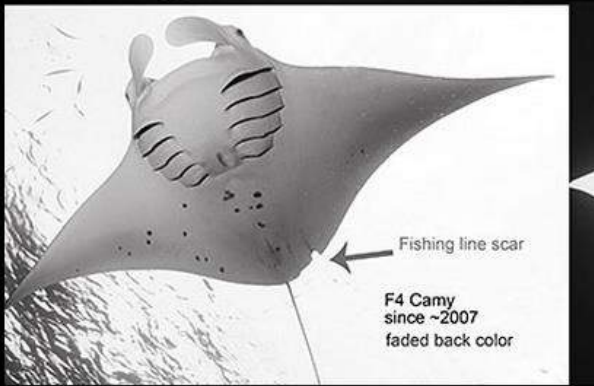
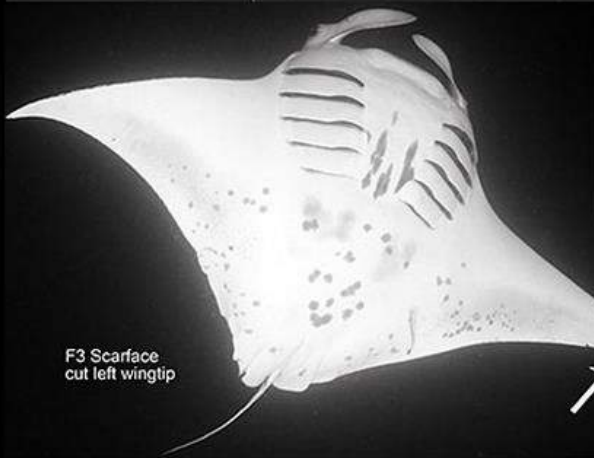
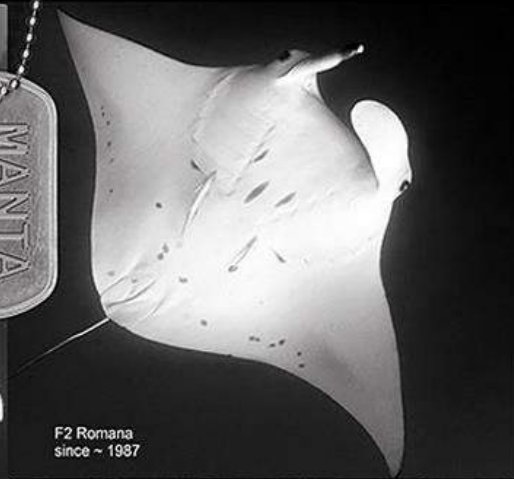
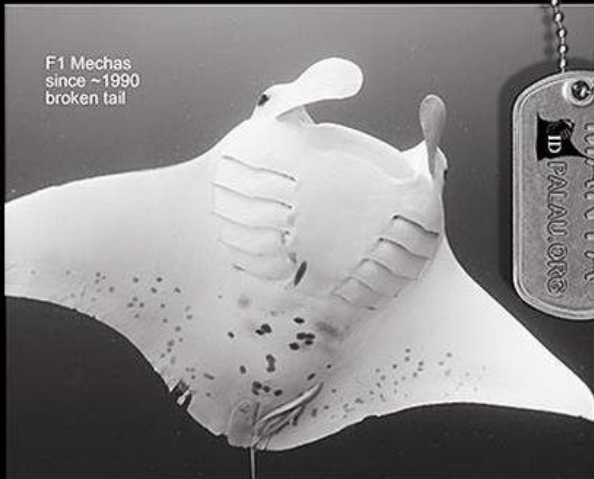
KINGDOM	Animalia
PHYLUM	Chordata
SUB-PHYLUM	Vertebrata
CLASS	Chondrichthyes (Cartilaginous fish)
SUBCLASS	Elasmobranchii (Sharks & rays)
SUPERORDER	Batoidea (All rays)
ORDER	Rajiformes (True rays & skates)
SUBORDER	Myliobatoidei (Eagle rays & relatives)
FAMILY	Mobulidae (Devil rays: manta & mobula)
GENUS	Manta
SPECIES	Alfredi (reef manta) Birostris (oceanic manta)

Appendix 1.2. Resident *Manta alfredi* population of German Channel (Etpison, 2015a [Extracted from www.mantaidpalau.org])



Popular German Channel MANTAS

FEMALES



Appendix 1.3. Distribution map of current fishing bans, management regulations and specific species protection for mobulids [Property of and extracted from Couturier et al, 2012:1099]



FIG. 4. Distribution map of current fishing bans, management regulations and specific species protection for mobulids: ① Hawaii, June 2009: introduction of criminal penalties and administrative fines for knowingly killing or capturing *Manta* spp. within state waters, House Bill 366 signed into law as Act 092; ② Mexico, May 2007: the Mexican official standard rules that regulate the shark and ray fisheries in Mexican waters, Pesca responsable de tiburones y rayas. Especificaciones para su Aprovechamiento, 2005. Norma Oficial Mexicana Nom029-Pesc-2006, NOM 029 provides specific protection for *Manta birostris*, *Mobula japonica*, *Mobula thurstoni*, *Mobula munkiana*, *Mobula hypostoma* and *Mobula tarapacana* in Mexican waters; ③ Ecuador, August 2010: ban on fishing, taking, keeping incidental catch for *M. birostris*, *M. japonica*, *M. thurstoni*, *M. munkiana* and *M. tarapacana*, La subsecretaría de recursos pesqueros considerando. Acuerdo 093; ④ Mediterranean, 1995: *Mobula mobular* protected under U.N. (Barcelona) Convention for the Protection Of The Mediterranean Sea Against Pollution Annexe II; ⑤ Republic of Maldives, June 1995: export ban on ray products (preventing commercial fisheries). Regulation No A-23/95; January 1996: export of ray skins prohibited Regulation No A-26/95 (of 15.7.95); June 2009: marine park areas created at two sites recognized as critical habitat for *Manta alfredi*; ⑥ Western Australia, *Manta* spp. protected from any fishing (Fisheries Act) and disturbance and harassment (Environment and Conservation Act) within marine parks only; ⑦ Philippines, March 1998: ban on the taking or catching, selling, purchasing and possessing, transporting and exporting of whale sharks (*Rhincodon typus*) and *M. birostris*. Fisheries Administrative Order 193 (implanted in 1998 then lifted in 1999 before being re-established in 2002. *Mobula* spp. are not protected under this ban); ⑧ Yap, Micronesia, 2008: protected area for *Manta* spp. and their habitat [includes 16 main islands and 145 islets representing 21 349 km² (8243 square miles)]. Manta Ray Sanctuary and Protection Act of 2008. Bill No 7-69,D1. Yap State Law No. 7-36 (note: not yet added to the Yap State Code, new Chapter 12 of title 18 of the Yap State Code to be created see law 7-36 in Seventh State Legislature); ⑨ New Zealand, 2010: *M. birostris* and *M. japonica* fully protected within New Zealand waters. Wildlife Act 1953, Schedule 7A.

Appendix 2.1. Permit waiver within the territorial water of Koror



Koror State Government
P.O. BOX 116
KOROR, REPUBLIC OF PALAU 96940

Office of the Governor

Tel. No.: (680) 488-2439/488-2576
Fax No.: (680) 488-2862
E-mail: gov@kororstategov.com

December 04, 2014

Mandy Etpison
Palau Project Leader, Manta Trust
Managing Director, Etpison Museum
Honorary Consul of France to the Republic of Palau
P.O. Box 7049
Koror, Republic of Palau 96940

Dear Mrs. Etpison:

Subject : *Permit waiver within the territorial water of Koror*

In response to your request dated November 10, 2014, exemption is hereby granted pursuant to Section 9(a) of Koror State Public Law K8-207-2009, for the *Manta Trust* representatives, a worldwide research and survey data on Manta Rays. The group will be in Palau during the period of January 15 to April 30, 2015, to conduct a study on various dive spots as well to research and survey data on Manta Rays especially around Ngemelis area and German Channel within the territorial waters of Koror.

The fieldwork and their stay on Palau will be sponsored by Etpison Museum and Neco Marine, working together with Mandy Etpison to develop and implement sustainable management plan for German Channel to ensure tourists can continue to have safe Manta encounters.

The people covered by this permit are: Isabel Ender; David Prieto and Justin Rizarri.

Koror State Government appreciates your support and please anticipates observance of all National and State Marine Protection Laws. Thank you.

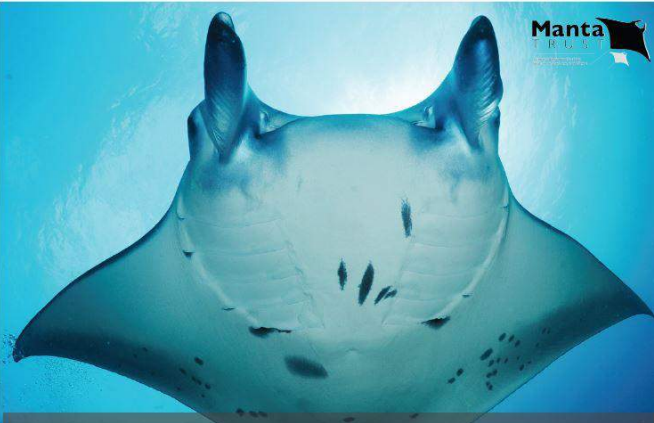

Sincerely,


Yositaka Adachi
Governor

cc: Director Jose A. Ise, Conservation and Law Enforcement Department – KSG

Appendix 2.2. Marketing pamphlet for introductory presentation of the study

Appendix 2.3. Island Times article on the introductory presentation of the study



Introduction to Palau's Manta Ray Tourism Study

**Friday, 6th February @ 6pm, Koror State Assembly Hall
Presentation and Fingerfood**

From January-April 2015, the Manta Trust and Columbia University New York, together with the MantaID Palau project, are conducting a study about the tourism activities at German Channel to support the development of sustainable management practices under the permit of Koror state.

Come join us and find out how this affects you and how you can help!
All dive operator management and staff are invited.
Learn more at www.mantatrust.org and www.mantalDpalau.org

Any questions?
Contact us: isabel@mantatrust.org

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Palau's Manta Ray Tourism study

The Republic of Palau is recognized as one of the prime destinations for scuba diving, offering visitors the opportunity for spectacular encounters with marine animals. Sharks have long been the flagship species for Palau, however a "surprising" finding from the 2014 Palau Visitor Authority Survey shows that tourism focused on other species in Palau, specifically manta rays, is becoming increasingly popular. In 2013, it was estimated that manta ray watching tourism contributes US\$ 6.8 million to the economy in Palau (O'Malley et al., 2013) and most of the manta watching tourism occurs at only one dive site: German Channel. Over the last five years the number of boats and divers at German Channel has increased dramatically and local operators have voiced the need for increased site management to ensure the safety and sustainability for this tourism.

The Manta Trust, an international organization dedicated towards research and conservation of manta rays and Columbia University New York have joined forces with the local Manta ID Palau project to conduct a study about the tourism activities at German Channel from January-April 2015 under the permit of Koror State. This study is sponsored by the Etrason Museum and the Manta ID Palau project to benefit all operators and stakeholders in Palau. The objective is to generate a clear understanding of the current size and impact of tourism activities at German Channel, including its site use and traffic, perceptions and experiences from tourists and dive operators/guides across Palau, to support the development of sustainable management practices for German Channel. This will ensure that the safety of tourists and sustainability of this important dive site are maintained for the future.

Isabel Ender, The Manta Trust Head of Conservation Strategy, and David Prieto, Master Student of Sustainability Management at Columbia University New York gave an introduction to Palau's Manta Ray Tourism Study on Friday,



Isabel Ender and David Prieto.

6th February, Koror State government, representatives from National Government, local research and conservation organizations and dive guides and operators, as well as dive tourists attended this event, which took place at Koror State Assembly Hall. Over the coming weeks the team will be interviewing tourists and dive operation staff across Koror State as well as survey the activities at German Channel to generate a report with recommendations to Koror State based on the findings, suggestions from local operations, an evaluation of current rules that exist for diving at German Channel and their experience of working with manta ray tourism in other places, such as the Maldives and Yap where the Manta Trust also has projects. This report will be made publicly available and presented to Koror State in June 2015.

To learn more about the local manta ray population, please visit www.mantalDpalau.org. To find out more about the Manta Trust please visit www.mantatrust.org or contact isabel@mantatrust.org if you have any questions about this study. We thank Koror State, all the operators and participants of this study for supporting this important work to ensure that German Channel remains one of the most stunning and important sites for tourism in Palau.

Appendix 2.4.1. Questionnaire used for dive professionals



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Survey Administration Survey Number: Operator: Date:
--

QUESTIONNAIRE FOR DIVE PROFESSIONALS IN PALAU

This survey is part of an in-depth study by The Manta Trust and Columbia University New York to develop a management model for German Channel that supports a sustainable future for Palau under the growing pressure from tourism.

The survey takes approximately 10 minutes to complete. If you have any questions, please feel free to ask the interviewer or contact us by e-mail at dp2694@columbia.edu. All the information provided will be treated as confidential. All data will be used in an aggregated manner and no individual responses will be identified in any reports or papers. Thank you very much for your participation! To learn more visit www.mantatrust.org and www.manta1Dpalau.org.

Section A. Operations in Palau

A.1 Where are you from? _____

A.2 What is your diving qualification? Divemaster Instructor

A.3 How many years have you been working in the dive industry of Palau? ____

A.4 What is your current work status in Palau? Part-time (e.g. only during high season)
 Fulltime (all year long)

A.5 Please rank in your opinion the following dive sites in order of popularity amongst tourists. (1 = Most Popular & 5 = Least Popular).

Dive Sites	Ranking (1 to 5)
a. Blue Corner	
b. German Channel	
c. Ngemelis (Other Sites)	
d. Ulong Channel	
e. Pelelu Express	
f. Other Site (please specify)	
g.	

A.6 What are the most common dive sites that you go to specifically to see manta rays and how often do you dive at these sites?

Sites	Number of days dived per week during high season	% Successful manta sighting	Estimated number of mantas per dive

Section B. Activities at German Channel

B.1 Have you changed how often you dive at German Channel since 2010?

Yes, increased Yes, decreased No change Don't Know



B.2 Have you noticed a change in the *total number of boats/divers* at German Channel since 2010?

- Yes, increased Yes, decreased No change Don't Know

B.3 On a busy day during high season (December – May), what is the estimated number of boats your operator would *use*?

2010	2014	2015

Comments:

B.4 On a busy day during high season (December – May), what is the estimated number of boats you would *see* at German Channel?

2010	2014	2015

B.5 Do you feel that the current *number of boats/divers* per day at German Channel is having an effect on the dive site? Yes No

B.5.1. If *yes*, how?

- Boat Traffic Manta Ray Safety Coral Damage
 Tourist Experience Tourist Safety Other _____

B.6 Are you satisfied with the boat moorings at German Channel? Yes No

B.6.1. If *no*, why?

- Too Many Bad Location
 Too Little Other _____

B.7 How often do you see boats fishing at German Channel?

- Never A Few Times a Month
 A Few Times a Year A Few Times a Week

B.8 How often has a Koror State ranger inspected you and/or your boat at German Channel?

- Never A Few Times a Month
 A Few Times a Year A Few Times a Week



B.9 Have you received any information or resources on how to conduct the dives with manta rays at German Channel? Yes No

B.9.1. If yes, by who?

- Palau Government
- Dive Operators
- Koror State
- Other

Section C. Sustainable Management for German Channel

C.1 Do you have any suggestions on how Koror State could improve the site management at German channel?

- On-Site Ranger
 - Compulsory Dive Guide Training
 - Ban Diving/Snorkeling
 - Additional Dive Fee
 - Boat Traffic Control
 - Other _____
- (No-Boat Zone, Entry/Speed Limits...)

Comments:

C.2 Is an on-site ranger *essential* to your management suggestions (Question C.1) at German Channel? Yes No

C.3 Do you consider there is currently too many permit fees? Yes No

C.4 If Koror State developed a training program for dive professionals, should dive conduct with manta rays and safe driving in German Channel be taught? Yes No

C.5 Overall, do you feel that tourism focused on diving with manta rays in Palau has changed since 2010?

- Yes, increased
- Yes, decreased
- No change
- Don't Know

C.6 Do you feel that manta ray tourism is currently promoted in Palau? Yes No

C.6.1. If yes, by who?

- Palau Government
- Dive Operators
- Koror State
- Other

C.7 In your opinion, do you feel that manta tourism should be promoted in Palau? Yes No

C.8 Do you have any other comments about the manta rays and/or tourism at German Channel?

Thank you for completing this survey!

Appendix 2.4.2. Questionnaire used for dive tourists



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Survey Administration Survey Number: Operator: Date:
--

QUESTIONNAIRE FOR DIVE TOURISTS IN PALAU

This survey is part of an in-depth study by The Manta Trust and Columbia University New York to develop a management model for German Channel that supports a sustainable future for Palau under the growing pressure from tourism.

The survey takes approximately 10 minutes to complete. If you have any questions, please feel free to ask the interviewer or contact us by e-mail at dp2694@columbia.edu. All the information provided will be treated as confidential. All data will be used in an aggregated manner and no individual responses will be identified in any reports or papers. Thank you very much for your participation! To learn more visit www.mantatrust.org and www.mantaIDpalau.org.

Section A. Travelling to Palau

- A.1 How many times have you come to Palau previously? ___
- A.2 What will be the total duration of your stay in Palau on this visit? ___ days Undecided
- A.3 For what main activity did you come on this trip to Palau?
 - General Dive Activities Snorkeling Sight-Seeing
 - Specific Dive Sites Fishing Other _____
- A.4 Are you aware how the Palau Government "Green Fee Departure Tax" is used?
 - Yes No
- A.5 Are you aware how the Koror State "Dive Permit Fee" is used?
 - Yes No
- A.6 In your opinion, do you consider there to be too many permit fees?
 - Yes No

Section B. General Dive Trip Information

B.1 Please rank the following dive sites in order of importance to you. (1 = Most Important & 5 = Least Important).

Dive Sites	Ranking (1 to 5)
a. Blue Corner	
b. German Channel	
c. Ngemelis (Other Sites)	
d. Ulong Channel	
e. Peleliu Express	
f. Other Site (please specify)	



B.2 How many day trips to dive are you planning to do *in total* on this visit to Palau? ___

B.3 Overall, how would you describe your interest in diving/snorkeling with manta rays?

- High Medium Low

B.4 What dive sites did you go to specifically to see manta rays and how often did you dive at these sites?

Site	Number of days dived	Number of mantas

Section C. Experience at German Channel

C.1 Please rate by ticking the box the level of satisfaction of your experience at *German Channel*. (1 = Not Satisfied; 2 = Barely Satisfied, 3 = Quite Satisfied, 4 = Satisfied, 5 = Very Satisfied)

Criteria	1	2	3	4	5
a. Numbers of manta rays seen					
b. Quality of the interaction with manta rays (e.g. time watching manta rays, proximity to manta rays)					
c. Pre-dive/snorkel briefing (including safety considerations and in-water conduct)					
d. Information received about manta rays (e.g. behavior when cleaning and/or feeding)					
e. Overall satisfaction with manta dive/snorkel experience					

C.2 How would you describe the overall crowdedness during your activities at German Channel?

- Not crowded Crowded Too crowded

C.3 Did the level of crowdedness have an effect your satisfaction from your German Channel experience?

- Negative effect Positive effect No effect

C.4 Did you feel unsafe at any point during your underwater experience at German Channel?

- Yes No

C.4.1. If yes, why?

- Boat Traffic Poor Briefing
 Crowdedness Underwater Other _____

C.5 Did you see a Ranger monitoring activities at the German Channel site?

- Yes No Don't know



C.6 In your opinion, do you think German Channel needs stricter site management?

- Yes No

C.7 Would you come back to Palau to dive with manta ray?

- Yes No Maybe

C.8 Do you feel the permit fees you have paid (e.g. Green Fee, Dive Permit, etc) should be used more for site management at German Channel?

- Yes No

Section D. Demographic information

D.1 Please indicate your gender. Male Female

D.2 What is your age?

- Less than 20 years old
 Between 21 and 30 years old
 Between 31 and 40 years old
 Between 41 and 50 years old
 More than 50 years old

D.3 What is your nationality? _____

Thank you for completing this survey!

Appendix 2.5. Questionnaire used for dive tourists translated in Japanese



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Survey Administration
Survey Number:
Operator:
Date:

パラオのダイビングツアー者用アンケート

このアンケートは、マンタトラストという団体とニューヨークにあるコロンビア大学による、将来にわたってパラオの観光を支えていくジャーマンチャネルを、よりよく管理していくことを目的とした調査の一部です。

このアンケートは全て答えるのに10分程度かかります。質問等ございましたら、係の者にお尋ねください。もしくはdp2694@columbia.eduまでEメールにてお問い合わせください。お答えいただいた全ての情報は当社にて厳重に管理し、研究以外の目的では使用いたしません。また個々の答えを特定することなども致しません。詳細はこちら。→www.mantatrust.orgまたはwww.mantalDpalau.orgまで。ご協力感謝いたします。

設問A パラオでのご旅行について

- A.1 これまでに何回パラオに来たことがありますか? ___ 回
- A.2 今回は合計何日間のパラオ滞在となりますか? ___ 日間 決めていない
- A.3 主に何の活動目的でパラオに来られましたか?
 一般的なダイビング スノーケリング 観光
 特定のダイビング・ポイント 釣り その他 _____
- A.4 パラオ政府の「環境出国税」がどのように使われているか知っていますか?
 Yes 知っている No 知らない
- A.5 コロール州の「ロックアイランド許可証」の費用がどのように使われているか知っていますか?
 知っている 知らない
- A.6 パラオでは許可証などの費用が高すぎると思いますか?
 そう思う そう思わない

設問B 一般的なダイビングの情報

B.1 以下のダイビング・ポイントをあなたにとって好きな（興味のある・行きたい）順番にランキングしてください。（1=最上位 5=最下位）

ダイビング・ポイント	ランキン グ (1~5)
a. ブルーコーナー	
b. ジャーマンチャネル	
c. ビッグドロップオフ	
d. ブルーホール	
e. ウーロンチャネル	
f. その他のポイント (ポイント名をご記入ください)	

B.2 パラオ滞在中、合計何日間のダイビングを予定していますか？ ____

B.3 マンタとのダイビングもしくはスノーケルについて、どれくらい興味がありますか？

すごく興味がある 興味がある あまり興味はない

B.4 あなたはどのダイビング・ポイントでマンタを見るためにダイビングしましたか？また、これらのポイントには何日間行きましたか？

ポイント名	何日間	見たマンタの数

設問C ジャーマンチャネルでの体験について

C.1 ジャーマンチャネルに関する各項目について、あなたの満足度に当てはまる数値の下にチェックマーク☑をご記入ください。

(1満足していない 2ほとんど満足していない 3少し満足している 4満足している 5とても満足している)

判定基準	1	2	3	4	5
a. 見えたマンタの数					
b. マンタとの交流の質の良さ (例：マンタを見ている時間の長さや、マンタとの近さなど)					
c. ダイビングのブリーフィングもしくはスノーケルの前の説明 (安全考慮や水中での指揮も含む)					
d. マンタについての情報 (例：マンタがクリーニングにくるときや捕食時の観察中の行動の注意点についての説明が十分かどうかなど)					
e. マンタとのダイビングもしくはスノーケル経験についての、総合満足度					

C.2 ジャーマンチャネルでの、混雑具合はどのようでしたか？

混んでいなかった 混んでいた 非常に混んでいた

C.3 混雑具合はあなたのジャーマンチャネルでの満足度に影響しましたか？

悪い影響を与えた 良い影響を与えた 影響はなかった



C.4 ジャーマンチャネルにて、何らかの事象で危険だと感じたことはありましたか？

はい いいえ

C.4.1. はいと答えたら、それはなぜですか？

ボートの移動 ブリーフィング（説明）の不十分さ
水中での混雑 その他 _____

C.5 レンジャーがジャーマンチャネルでダイビングやスノーケルの監視をしているのを見ましたか？

はい いいえ わからない

C.6 ジャーマンチャネルでは、より厳重な管理が必要だと思いますか？

そう思う そう思わない

C.7 マンタとのダイビングをするために、またパラオに戻ってきたいですか？

はい いいえ 多分

C.8 あなたが払った許可証代（ロックアイランド許可証や環境出国税）はジャーマンチャネルの管理にもっと使用するべきだと思いますか？

そう思う そうは思わない

設問E. 統計情報調査

D.1 あなたの性別はなんですか？ 男性 女性

D.2 あなたの年齢層を教えてください

20歳以下

21～30歳

31～40歳

41～50歳

50歳以上

D.3 あなたの国籍はなんですか？ _____

ご回答いただき、ありがとうございました。

Appendix 2.6. 31/03/2015: Interview with the Ngemelis Fleet, Koror State Department of Conservation and Law Enforcement



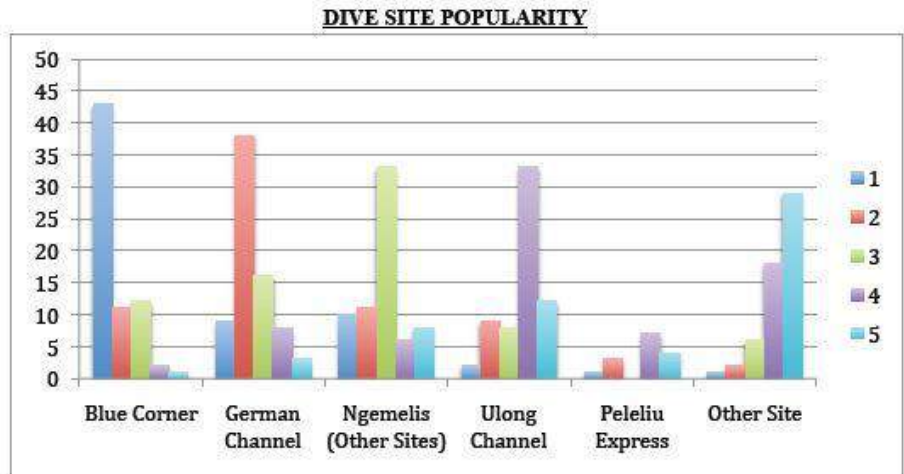
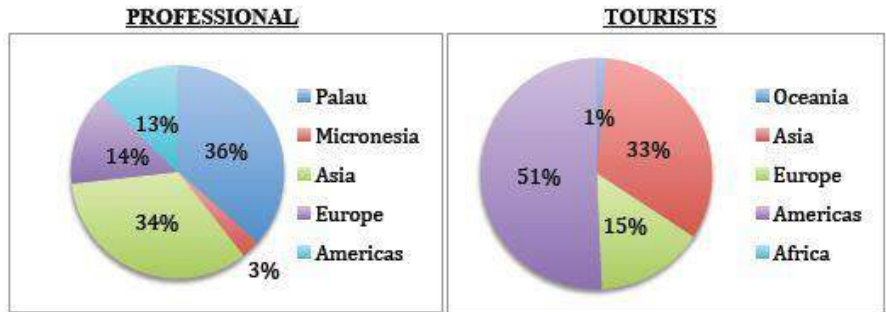
Appendix 2.7. Preliminary Fact sheet for legislators



GERMAN CHANNEL: PRELIMINARY RESULTS 2015

The following information represents *preliminary* data of an in-study on tourism activities at German Channel under the permit of Koror State and sponsored by the Etpison Museum and the Manta ID Palau project. The Manta Trust and Columbia University conducted the study during January, February, March and April 2015. The objective is to generate a clear understanding of the current size and impact of activities at German Channel to support the development of sustainable management practices that ensure the safety of tourist and manta rays, as well as long-term economic revenue.

Completed Surveys	152
Dive Professionals	71
Dive Tourists	81





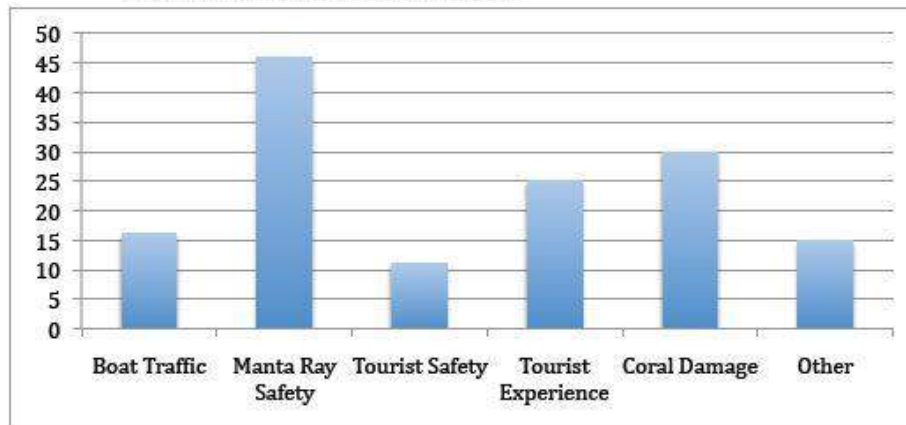
TOURISTS EXPERIENCE

- 77% OF SURVEYED TOURISTS EXPRESSED A **HIGH** INTEREST IN MANTA RAY WATCHING
- 73% OF SURVEYED TOURISTS EXPRESSED THAT GERMAN CHANNEL WAS **“CROWDED” OR “TOO CROWDED.”**
- 42% OF SURVEYED TOURISTS EXPRESSED THAT THE CROWDINESS HAD A **NEGATIVE EFFECT** ON THEIR EXPERIENCE
- **84% OF SURVEYED TOURISTS FELT THAT STRICTER SITE MANAGEMENT IS REQUIRED AT GERMAN CHANNEL**
- **55% to 80% OF SURVEYED TOURISTS WOULD RETURN TO WATCH MANTA RAYS**

PROFESSIONAL PERCEPTIONS

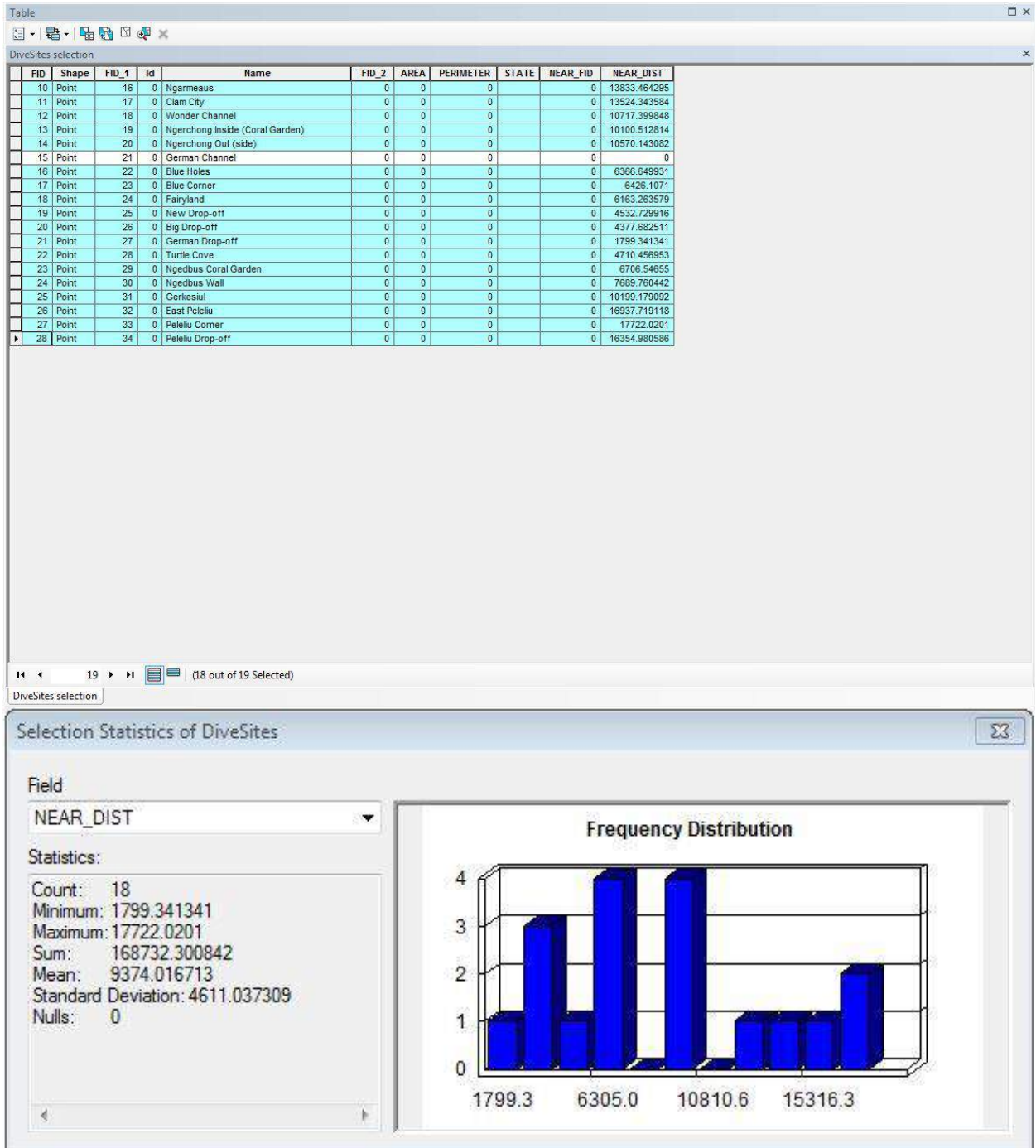
Average number of dives per week	Average % successful manta sighting	Average number of mantas
2,99	72,43	2,96

- 96% OF PALAUAN PROFESSIONALS SURVEYED CONSIDER THERE HAS BEEN AN **INCREASE** IN TOTAL AMOUNT OF OPERATORS AT GERMAN CHANNEL.
 - **13% ESTIMATED INCREASE BETWEEN 2010 AND 2015**
- 94% OF PROFESSIONALS SURVEYED CONSIDER THE AMOUNT OF BOATS AND PEOPLE HAS AN EFFECT ON THE DIVE SITE.
 - **MANTA RAY SAFETY, CORAL DAMANGE, AND TOURIST EXPERIENCE BEING THE MOST CITED EFFECTS.**




- **POPULAR MANAGEMENT SUGGESTIONS**
 - **BOAT TRAFFIC CONTROL** INCLUDING NO-BOAT ZONE, ENTRY & SPEED LIMITS, BOUY CHANGES – **41%** –
 - **COMPULSORY PROFESSIONAL TRAINING** –**26%** –
- 67% SURVEYED PROFESSIONAL CONSIDERED AN **ON-SITE RANGER IS ESSENTIAL** TO SITE MANAGEMENT.

Appendix 4.1. Near geoprocessing analysis of German Channel in relation to Koror State and Peleliu State dive sites



Appendix 4.2. Examples of dive tourist crowdedness perceptions

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D.6 In your opinion, do you think German Channel needs stricter site management?
 Yes No

D.7 Would you come back to Palau to dive with manta ray?
 Yes No Maybe

D.8 Do you feel the permit fees you have paid (e.g. Green Fee, Dive Permit, etc) should be used more for site management at German Channel?
 Yes No

Section E. Demographic information

E.1 Please indicate your gender. Male Female

E.2 What is your age?
 Less than 20 years old
 Between 21 and 30 years old
 Between 31 and 40 years old
 Between 41 and 50 years old
 More than 50 years old

E.3 What is your nationality? USA

Thank you for completing this survey!

There were 30+ divers dropped off right above the cleaning station that had no respect for the Mantas or other divers. Having come from Yap where the Manta interactions were intimate & controlled I think Palau can do the same. We saw 12+ mantas at a time in Yap up close & personal, but only 2 in German channel & they were 30'-40' away. You should limit the number of divers in the channel at any one time so as not to scare the Mantas away. A max of 20 divers should be sufficient.



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D.6 In your opinion, do you think German Channel needs stricter site management?

Yes No

D.7 Would you come back to Palau to dive with manta ray?

Yes No Maybe

D.8 Do you feel the permit fees you have paid (e.g. Green Fee, Dive Permit, etc) should be used more for site management at German Channel?

Yes No

Section E. Demographic information

E.1 Please indicate your gender. Male Female

E.2 What is your age?

- Less than 20 years old
 Between 21 and 30 years old
 Between 31 and 40 years old
 Between 41 and 50 years old
 More than 50 years old

E.3 What is your nationality? US

Thank you for completing this survey!

There was at least 6 boats, so maybe 100 people, many swam across the channel as others watched right across where the mantas would ~~prob~~ probably pass. It was ridiculous.

Appendix 4.3. 2012 BTA Japan guidelines for watching manta rays at German Channel

Guide line for watching mantas at German Channel

1 The purpose and circumstances of establishing a guide line

In order to improve the percentage of encountering mantas at German Channel, BTA Japan has established this guide line to keep the environment of German Channel where mantas are willing to visit by lowering the stress from divers against mantas and by protecting the unique nature of German Channel where mantas gather.

What are the reasons of decreasing the percentage of encountering mantas?

- The change of underwater environment by increasing the number of divers.
- The stress from divers to mantas has increased.
- The change of diving style : watching the feeding mantas from mid-water.
- Boat traffic passing German Channel has increased.
- The impact to underwater environment by worldwide climate change.
- The change to underwater environment caused by natural eco cycle system, etc.

German Channel is not a dive site only for watching mantas, but it is an important tourism asset for the republic and for the personnel engaging in the diving industry. It seems there are people saying the necessity of regulating, or prohibiting, the diving at German Channel. If the reason for decreasing the number of mantas coming to German Channel is caused by human being, there is a good chance of changing the environment, where mantas are willing to come like former times, by regulating the diving. But by doing so, it will affect us seriously.

BTA Japan concerns that by regulating the diving at German Channel may decrease the number of tourists visiting Palau or it will be difficult to meet guest's expectations, so that we have discussed about this guide line of watching mantas at German Channel over and over and have tried to seek for compromise plan but by regulating, or closing German Channel, we won't be able to show mantas at German Channel.

With the considerations above, we think that what we have to do is to reduce the negative man-made effects, possibly we may be creating at the moment, and to establish a better underwater environment for mantas. We also think that the cleaning behavior is essential for fishes so that encouraging the preservation of cleaning station is necessary for mantas to keep coming back to German Channel.

We would like to add a proposal to preserve the cleaning station;

The mantas appearing at German Channel hover not only over the cleaning station that we are recognizing now, but they also hover over much wider area including some coral heads close to the cleaning station. So we think we need to recognize much wider area as cleaning station and need to try to preserve that area as well.

2 Guide line

The rules of time zone for watching mantas.

* Everybody must stay on the bottom when watching mantas between 9:00am to 3:30pm.

* Watching mantas from mid-water will be allowed excluding the time zone above.

When waiting mantas at the cleaning stations.

- Do not go too close to or on the cleaning stations.
- Squeeze your group tight and stay on sandy bottom.
- When manta comes, take a low position and watch.
- When leaving the cleaning stations, swim close to the bottom.
- It is prohibited to swim deeper side of the main cleaning station, when moving from deeper cleaning stations at the German Drop Off side.

When watching mantas feeding.

- Must keep the cleaning stations available to mantas all the time. (Do not go too close to or on the cleaning stations. Do not swim or hover above the cleaning stations.)
- Avoid swimming deeper side of the main cleaning station.
- Must keep the depth of 10 meters or deeper when watching feeding mantas.
- Do not swim or stay right in front of the fish ball.
- All the dive guides must control their guests' depth and be aware of their safety.
- Refer to Mandy's rules as well.

The rules in general.

- Do not touch mantas even if they are close enough to reach.
- If divers encounter mantas when swimming, try not to move around, stay on the bottom and watch.
- Refrain from any actions which may stress mantas such as chasing, blocking their ways, blowing bubbles on them, etc.
- Do not drive a boat close or over the school of fish feeding close to the surface.
- Do not enter the water from deeper side.
- Squeeze your group tight.
- All the dive guides must decide their courses underwater taking in consideration of other divers.
- Do not approach to the main cleaning station from deeper side even if entering the water from German Drop Off side, approach to the main cleaning station along the reef.
- When ascending, ascend more inside of the mooring buoy. ??
- Unless emergency situation, do not use the calling devices or bang the tank too much.
- All the boat operators must drive the boat slow when driving the diving area.
- All the dive guides must guide their guests without putting stress to fish, and must follow this guide line when mantas appear.

Guide line for snorkeling.

- Snorkelers must be equipped with floating devises such as life jackets, floats etc. so that they can be easily identified from other boats.
- When manta comes, skin diving will be prohibited, they must watch from the surface.
- Skin diving with disturbing the school of fish will be prohibited.
- If it is a situation that mantas feeding behavior can be expected, the guide and boat operator must be very careful about operating the boat, entry and exit. Do not drive a boat close or over the school of fish feeding close to the surface. Do not enter the water from deeper side. When exit from the water, move more inside of the mooring buoy and exit.

Written by: Palau Diving Association BTA Japan

Official members: Aqua Magic , Antelope, Blue Marlin, Cruise Control, Day dream, Maml Divers, MSO, Pacific Divers Oasis, Palau Diving Center, Palau sport, Southern Marine Divers, Splash Diving Center.

Associate members: Neco Marine, Rock Island Tour Company, Sea World, Fish and Fins, Impac Tours, Pleasure Island.

Appendix 4.4. 2012 Proposed Bill for an Act

NINTH KOROR STATE LEGISLATURE

5th Day, *Fifth Regular* Session, February *29*, 2012

L.B. No. *9-64*

A BILL FOR AN ACT

To establish guidelines for the observation of manta rays in German Channel, to prohibit the touching or pursuit of manta rays in the German Channel, to provide penalties for violations of this Act, and for related purposes.

THE PEOPLE OF KOROR REPRESENTED IN THE LEGISLATURE OF THE STATE OF KOROR DO ENACT AS FOLLOWS:

Section 1. Findings.

1 The Ninth Koror State Legislature hereby finds that the area commonly known as the
2 "German Channel", the boundary between the State of Koror and the State of Peleliu, is frequented
3 by large numbers of manta rays, which utilize the reef areas as "cleaning stations". The
4 concentration of manta rays, combined with their docile behavior, serves to attract many tourists,
5 such as scuba divers, snorkelers, and as passengers on tour boats which follow the manta rays. This
6 congregation of manta rays and other sea life takes place in an area of heavy boat traffic, as the
7 German Channel is one of the few areas that allow boat traffic from outside the barrier reef to inside
8 the reef even at low tides. The congregation of scuba divers and snorkelers and natural wildlife,
9 poses dangers due to the volume of boat traffic, and unregulated human activity may have a
10 detrimental impact on the continued presence of marine life which is threatened or harassed by boat
11 traffic and divers and snorkelers.

12 It is in the best interests of the people of the State of Koror to take affirmative steps to protect
13 the health and safety of persons, and to help conserve wild populations of manta rays by regulating
14 human interaction with them in the German Channel area.

Section 2. Definitions.

15 A. As used in this Act,

16 (1) "German Channel" means the area commonly known as "German Channel",

17 between the Koror and Peleliu State boundaries, as shown on the photograph attached to this Act.

1 (2) "manta ray" in the singular and plural form, means all rays in the scientific
2 family "mobulidae", subfamily "myliobatidae", and including but not limited to *manta birostris* and
3 *manta alfredi*, and also known as manta rays, cownose rays, and devil rays.

4 **Section 3. Prohibitions.**

5 Within the German Channel as defined by this Act,

6 A. It shall be unlawful to touch any manta ray.

7 B. It shall be unlawful to pursue, chase, or otherwise follow any manta ray in a motorized
8 boat.

9 C. It shall be unlawful to operate any boat in excess of five miles per hour (5 m.p.h.).

10 D. It shall be unlawful to operate any motor boat to allow any person to touch any manta ray,
11 or to allow any person to pursue, chase, or otherwise follow any manta ray.

12 **Section 4. Penalties.**

13 A. Any person convicted of violating any provision of Section 3 of this Act shall be
14 sentenced to pay a fine in the amount of two-hundred and fifty dollars (\$250.00) for a first offense,
15 and five-hundred dollars each subsequent violation.

16 B. It shall be unlawful to anyone to aid, abet, counsel, command, induce, or procure or cause
17 commission of a violation of any provision of Section 3 of this Act, which directly performed by
18 anyone would be a violation of Section 3 of this Act, and such person shall be punished as a
19 principal and shall pay the maximum fines stated herein above in this Act. No distinction is made
20 between principal in degrees, and no distinction is made between principal and what may be referred
21 to as accessory before the fact.

22 **Section 5. Severability.**

23 In the event that a court of competent jurisdiction determines that any part or portion of this
24 Act are invalid or otherwise unenforceable, then the offending part or portions may be stricken, and
25 the remaining portions shall continue in full force and effect.

NINTH KOROR STATE LEGISLATURE

21 Day, Fifth regular Session, February 29, 2012

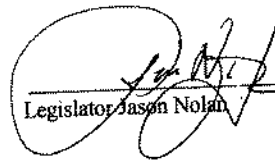
L.B. No. 9-64

1
2

This Act shall become effective upon its becoming law by operation of the Koror State Constitution.

Date: February 28, 2012

Introduced by:


Legislator Jason Nolan

Appendix 5.1. Manta Trust guidelines for diving and snorkelling with manta rays

Manta Ray Tourism
**INTERACTION
GUIDELINES**
FOR DIVERS

**Manta
TRUST**

10m
Vessel approach limit

3m
Diver approach limit

Approach Exclusion Zone

Position to the side of mantas

Do not chase mantas

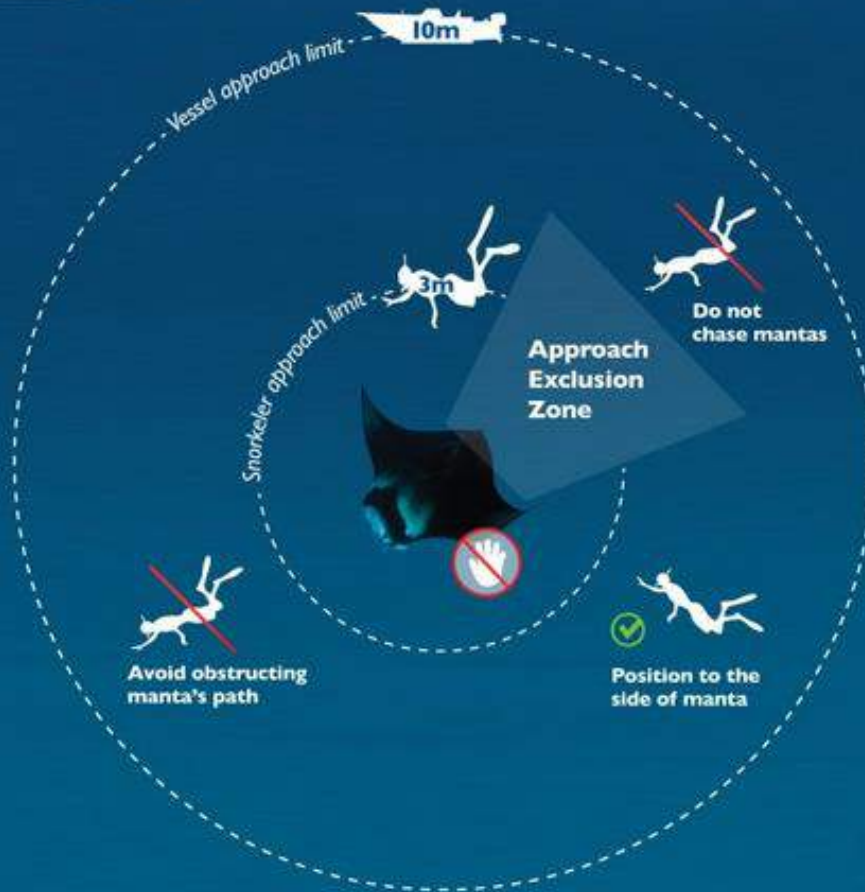
Avoid obstructing manta's path

Position close to seabed

Based on studies by *The Manta Trust* (2005-2013) and manta tourism programs worldwide. *The Manta Trust* is a UK-registered charity; our mission is to advance the worldwide conservation of manta rays and their habitat through robust science and research, raising awareness and providing education, influence and action.

For more information, email info@mantatrust.org or visit www.mantatrust.org


Manta Ray Tourism
**INTERACTION
GUIDELINES**
FOR SNORKELERS



Based on studies by *The Manta Trust* (2005-2013) and manta tourism programs worldwide. *The Manta Trust* is a UK-registered charity; our mission is to advance the worldwide conservation of manta rays and their habitat through robust science and research, raising awareness and providing education, influence and action.

For more information, email info@mantatrust.org or visit www.mantatrust.org



	Conduct	Explanation
M	MAKE a quiet entry	Splashing and loud entries into the water may scare the animals away. This is important at both cleaning stations and feeding aggregation sites.
A	ADHERE to minimum distance	Very close approaches can startle mantas as they may perceive you as a threat. Do not approach manta rays closer than three metres. However, mantas are curious and often approach you. If this happens remain still and observe!
N	NEVER CHASE	Manta rays have excellent vision, however they have a blind spot directly behind them. Therefore, do not approach a manta from the back because this may startle and scare the animal away. It is best to approach mantas slowly from their side allowing the animal to see you while it can maintain a clear path of travel ahead. Never chase after a manta ray. If you stay still they often come back for a closer look at you.
T	NO TOUCHING	Like you and I, mantas appreciate their personal space. The majority do not like to be touched. In some locations touching may also lead to a fine.
A	ALERT and CALM	Manta rays are gentle, graceful and calm animals, but they are alert to your presence. They can sense your demeanor and will react accordingly. Therefore, the calmer you remain the closer the manta is likely to approach you. So, try to stay calm and avoid sudden movements when around mantas.
R	REST and REMAIN still	While SCUBA diving with manta rays at cleaning stations you should position yourself to the side and remain close to the seabed. This allows mantas a clear swimming path over the cleaning station. Divers and freedivers should never swim directly onto or over the cleaning station. In some locations specifically designated areas have been defined for SCUBA divers to observe the cleaning mantas. Snorkellers among a group of feeding manta rays should remain still and allow the feeding animals to manoeuvre around them.
A	AVOID obstructing	Divers should never swim up into the path of an approaching manta and freedivers should never swim directly down in front of an approaching manta. Mantas may also be disturbed by cameras that are held in front of their faces. If diving is allowed at manta feeding sites divers should try to position themselves to the side of the main feeding aggregation to avoid creating a “curtain of bubbles” that can disperse the manta’s planktonic food and create an artificial barrier for the feeding animals.
Y	Enjoy YOUR experience!	Mantas have the largest brains of all fish and are thought to be one of the most intelligent marine animals. When you look into the eye of a manta ray it is probably just as interested in you as you are in it. So seek direct eye contact and enjoy this unique encounter, and if you respect these simple guidelines the manta rays will be much more likely to enjoy the encounter as well!