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BASELINE BIOLOGICAL SURVEYS AND THREAT ASSESSMENT OF DIVE SITES IN KOROR STATE, PALAU

A report submitted to
Department of Conservation & Law Enforcement
Koror State Government

Community Centered Conservation
2003

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Scuba divers in The Rock Islands Conservation Area

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BASELINE BIOLOGICAL SURVEYS AND THREAT ASSESSMENT OF DIVE SITES IN KOROR STATE, PALAU

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Koror
2003





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ALL MARINE TOUR OPERATORS AND DIVE GUIDES



Underwater survey

EXECUTIVE SUMMARY

Palau has become world-renowned as an international dive destination. Proactive management of the nation's dive sites is vital in order to cope with the continued increase in usage and to maintain or improve them so that they meet the economic and recreational needs of local people as well as tourists.

The aims of this study were: (i) to assess the current condition of dive sites in Palau, the actual and/or potential threats from dive tourism, and (ii) to provide recommendations for diver management within the Rock Islands Southern Lagoon Area.

German Channel is one of the most popular dive destinations in the Rock Islands Southern Lagoon Area, because of the relatively high cover of hard corals and sponges in addition to the diverse fish life and presence of large animals such as manta rays, sharks and turtles. Both sites at Ngerchong have suffered from the 1997/8 bleaching event, with the inside, more sheltered site being the most seriously affected; Ngerchong is thus now visited as a secondary site when conditions are too rough at more popular sites.

Divers' most common interactions with coral involved holding on or touching / kicking it with their fins and divers wearing gloves or using cameras made contact with coral more often. Although damaging contacts by divers were rare, little is known about the long-term effects of high numbers of recreational divers on a small area. Dive guides mainly attributed coral damage to natural events, but recognized diver impact as the second most significant threat.

The main recommendations arising from this study include:

- ***Long-term monitoring and involvement of tour guides in monitoring programs***
- ***Controls on boat traffic and numbers***
- ***Regulations on snorkellers and wearing of gloves***
- ***Bans on fish feeding and fishing at dive sites***
- ***Implementation of best practice guidelines***
- ***Improved communication between government and industry***
- ***Further training of Koror State Rangers***

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Underwater survey transect

1. INTRODUCTION

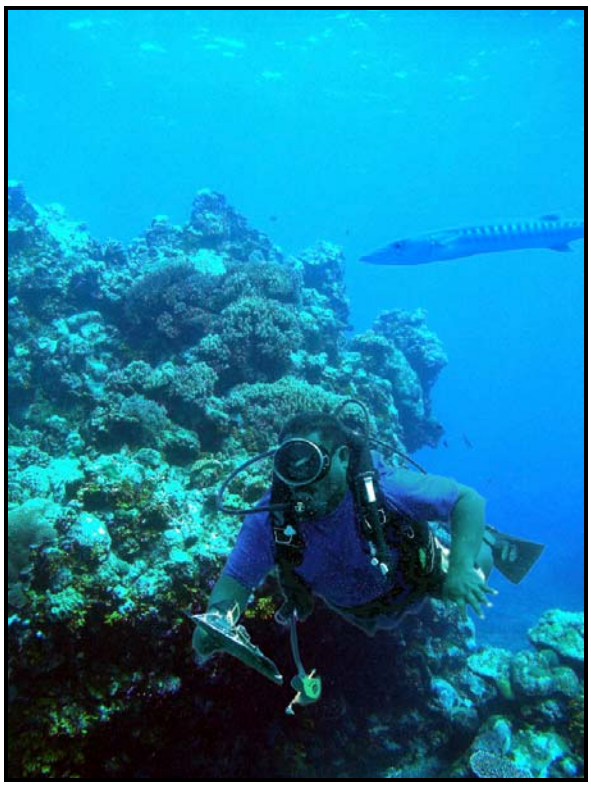
The number of visitors to Palau has increased significantly in recent years: from 4,000 per annum in the 1980's to 64,000 in 1997, to 54,000 in 2001, to 58,500 in 2002; more than half of which come specifically to dive (Palau Visitors Authority pers comm). As the number of tourists coming to dive in Palau continues to rise, maintaining the ecological and aesthetic values of dive sites has become a priority of national importance. Diving and other marine-based activities are largely concentrated in the Rock Islands Southern Lagoon Area. Koror State government has jurisdiction over the most heavily-dived sites in Palau and has recognized the need for information on the physical impacts of these divers in order to formulate a comprehensive management plan for the area. Effective management of tourism in the Southern Lagoon Area will help to ensure the protection of the area's natural resources and their significant biological and economic value.

Palau has become world-renowned as an international dive destination. There are at least 75 dive locations throughout Palau, 75% of which are located in the Rock Islands Southern Lagoon Area (Mersai 2002). These coral reefs, in close proximity to the urban center of Koror, provide the high biodiversity and natural beauty that divers come to enjoy. However, these same resources that have attracted divers to Palau have started to experience the negative impacts of tourism, including pollution and physical damage to coral reefs. While all dive sites are affected by visiting divers to some extent, German Channel and Big Drop-off are highly vulnerable because they are visited by almost every person that dives in Palau. Proactive management of these dive sites is vital in order to cope with the continued increase in usage and to maintain or improve them so that they meet the economic and recreational needs of local people as well as tourists.

Concern is growing amongst coral reef managers that as the popularity of recreational scuba diving has increased so too have the threats of physical damage to reef environments from anchoring, trampling, kicking, and breaking of corals by divers (Jameson et al 1999, Hawkins and Roberts 1992). Research at dive sites in many regions of the world, including the Red Sea, the Caribbean, Australia, and Africa has shown that intensive diving pressure at dive sites can lead to increased numbers of physically damaged corals (Hawkins and Roberts 1992, Talge 1992, Rouphael and Inglis 1995, Muthiga and McClanahan 1997, Jameson et al 1999, Rophael and Inglis 2001). Previous studies have identified two types of environmental impacts that occur as a result of coral reef-based tourism: 'once-off' effects and 'recurrent' effects. Once-off impacts refer to those associated with the initial installation or construction

of tourism infrastructure such as marinas, pontoons, and moorings. Disturbances that directly result from these activities usually cease following their completion (Woodley 1992). Recurrent impacts include recreational activities such as diving, snorkeling, and reef walking, which are ongoing and therefore may inhibit the recovery of impacted reef organisms (Hatcher et al 1989). While impacts of recreational activities have received attention from marine scientists (e.g. *reef walking:* Kay and Liddle 1983, Kay and Liddle 1984, Liddle and Kay 1987; *snorkeling:* Tilmant and Schmahl 1981, Hawkins and Roberts 1993; *anchor damage:* Rogers et al 1988, Rogers et al 1990), there is relatively little information on the effects of recreational scuba diving.

There is currently no information regarding the impact of divers at major dive sites in Palau. Two studies commissioned by Palau Conservation Society (PCS) in 1997 and 1998 examined the value of the dive experience to visiting divers (PCS 2001) and social, economic, and environmental issues associated with Taiwanese visitors to Palau (PCS 1999) but neither of these addressed physical impacts of divers on the marine environment.



Koror State Ranger conducting an underwater survey

2. AIMS AND OBJECTIVES

The aims of this study were:

(i) to assess the current condition of dive sites in Palau, the actual and/or potential threats from dive tourism, and

(ii) to provide recommendations for diver management within the Rock Islands Southern Lagoon Area.

The specific objectives were to:

- assess the condition of three major dive sites within the Rock Islands Southern Lagoon Area (German Channel, Ngerchong and Big Drop-off) using biological surveys;

- evaluate the impact of recreational divers through direct observation of dive boats and divers and interviews with dive guides and dive operators;

- design and implement a long-term monitoring program at each site;

- provide the Rock Islands Management Authority with recommendations for diver management in the area



Rock Islands Southern Lagoon Area

3. METHODS

3.1 STUDY SITES

The study was conducted at three dive sites: German Channel, Ngerchong, and Big Drop-off (See map in Appendix 1; Appendix 2 for detailed site data and Appendix 3 for photographs). These sites were selected by Koror State Department of Conservation & Law Enforcement based on: the lack of data pertaining to the sites, site popularity and need for improvement in management. In a study by Palau Conservation Society (PCS 2003), all three of these sites were ranked within the top 20 out of a total of 34 dive sites; German Channel and Big Drop-off were ranked within Palau's top seven dive sites. Ngerchong was a popular site prior to the 1997-8 coral bleaching event (Eledui pers comm 2002), but currently it is only significantly utilized when there are strong southerly or westerly winds and dive boats cannot travel to more popular dive sites because of adverse sea conditions.

3.1.2 German Channel

Red Buoy

The shallow region of this site consisted of undulating ridges with high cover of live hard corals including *Acropora sp.* and massive *Porites sp*. The reef dropped off steeply at approximately 6m. Both depths surveyed, 5m and 15m, showed high coral cover as well as encrusting sponge (*Katiba milnei*) growing on dead corals, algae (*Halimeda sp.*), and bleaching hard coral (*Seriatopora histrix)*. The currents at this site ranged from moderate to strong.

Buoy 1

The topography of the site was characterized by a gently sloping spur and groove reef formation. There were large patches of coral with sand channels running between individual patches. Hard coral formations were approximately 1-2m in width (predominantly massive *Porites sp.* and *Acropora sp.*) and increased in size with depth. There were occasional small patches of branching corals (*Seriatopora histrix*) that appeared to be bleaching. Other distinctive characteristics included: small amounts of soft coral including green Scleractinia, *Tubastrea micrantha*, large schools of Lutjanidae, and moderate to strong currents.



German Channel widens into the diving area, known as German Wall. (Photo: Dr.P.Colin, CRRF)

Buoy 2

This site was characterized by a sand slope dominated by *Acropora sp.* and massive *Porites sp.* There was also evidence of bleaching in *Seriatopora histrix* colonies. Other substrates included soft corals, foliose hard corals, and massive *Porites sp.* The currents at this site were moderate to strong.

Buoy 3

The shallows of this site consisted mostly of branching *Acropora sp.* rubble, presumably bleached during the 1997-8 El Nino. There was a large coral patch at the beginning of the survey site at 5m that extended for about 5-6m along the 50m transect length. The remainder of the transect was rubble with only small colonies of corals and small sandy sections. The transect ended with another coral patch about 5m in width. Most of the living species of coral were massive *Porites sp.* but it appeared that *Acropora sp.* once dominated the shallows. The slope was similar to the shallow areas and included patchy areas of live corals and sand, with more sand and much less rubble. Other distinctive invertebrates included: green sea whips (*Cirrhipathes*), soft corals (*Dendronephthya*), and sea anemones. Currents were moderate to strong.

Buoy 5

There was a 10m-wide sand patch at the beginning of the site which ran vertically down a slope and continued deeper. This sand 'channel' was also visible from the air. The shallow area (up to 5m) included large patches of *Acropora sp.* rubble interspersed with smaller patches of live hard coral. Most of the healthy hard corals were massive *Porites sp.*. There were few soft corals at this depth and small colonies

of *Seriatopora histrix* that showed signs of bleaching. Moving down the slope there was much *Sinularia sp.* and *Halimeda sp.* growing on dead corals. The hard corals were again dominated by massive *Porites sp.* with a few bleaching *Seriatopora histrix*. There was a large mound running from about 15m to 8m depth, which was covered in *Halimeda sp.*, massive *Porites sp.*, *Katiba milnei*, *Sinularia sp.*, and Favid ('star') corals.

3.1.3 Ngerchong

Outside 1 & Outside 2

These two sites showed similar topographical characteristics and were both seriously affected by the bleaching event in 1997-8. It appeared that almost all of the branching *Acropora sp.* at these sites had been killed as a result of bleaching, resulting in large areas of rubble; however small colonies of juvenile *Acropora sp.* (2/3 yrs old – approximately 10cm in diameter) were found. Only *Porites sp.* remained as the predominant living hard coral at these sites. Coral cover was patchy, with large areas of sand. Other distinctive characteristics included: sinularids, encrusting hard corals and algal film.



Ngerchong (Photo: Dr.P.Colin, CRRF)

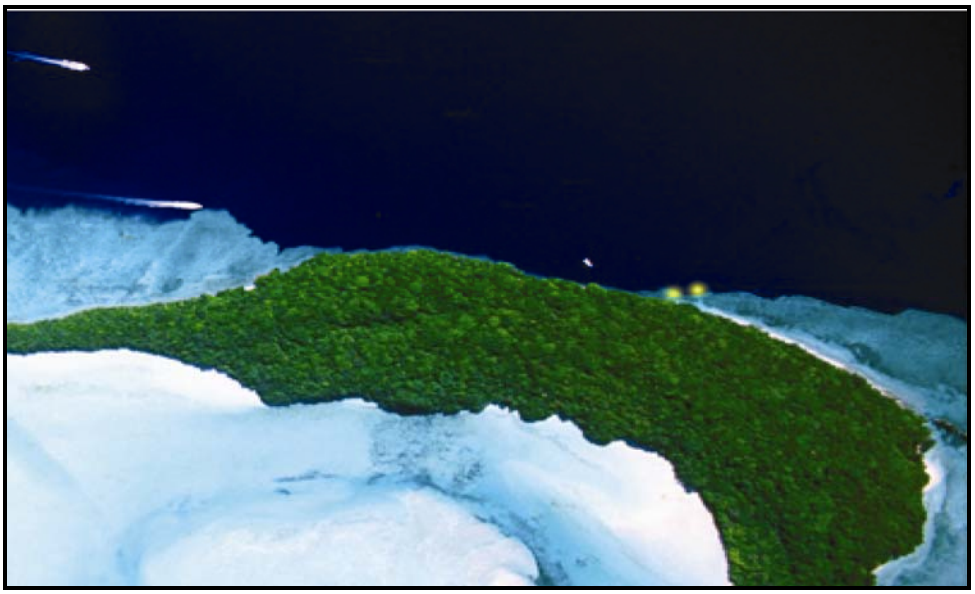
Inside 1

This site was predominantly covered by rubble and bleached corals in the shallows (reef flat to 3m). Large table corals and vast patches of branching *Acropora* were affected by the 1997-8 bleaching event. There were live coral formations, mainly massive *Porites sp.* with abundant green algae, including *Halimeda sp.* and *Caulerpa racemosa*. Recruitment of *Acropora sp.* was observed, although *Seriatopora histrix* was also showing signs of bleaching here. Soft corals were present down the gentle slope and increased in

abundance at about 5-7m deep, where large coral formations of massive *Porites sp.* were observed as well as smaller colonies, which were scattered throughout the sand patches along the slope face. Large areas of rock, covered in encrusting hard corals continued down the slope to a sandy bottom at 15m.

Inside 2

This site was predominantly covered by rubble and bleached coral as a result of the 1997-8 bleaching event. Large bleached table *Acropora sp.* characterized the shallows (3m) at this site. Further down the slope, *Seriatopora histrix* was more prominent and showed signs of bleaching. There were large numbers of Scaridae and Acanthuridae at 3m. Other distinguishing characteristics included: algal film covering most of the dead table *Acropora sp.*, signs of *Acropora sp.* recruits, approximately 3-4 years old and massive *Porites sp.*. From about 12m, the slope consisted of almost all rubble which met a sandy bottom at 15m.



Big Drop-off (Photo: Dr.P.Colin, CRRF)

Big Drop-off

This site was a vertical wall covered with few large hard coral colonies but abundant soft corals. A few representative species included large sea fans, *Dendronephthya* soft corals, and azooxanthellate corals (*Tubastrea micrantha*). The green single-leaved alga of the family *Udotea* dominated the face of the wall in many places.

3.2 SURVEY PROTOCOL

3.2.1 Biological surveys

Underwater surveys were carried out using scuba and all dives were conducted at the same moon phase and tide (see Appendix 4 for dates and times). Identical survey teams were used on every dive to minimize inter-observer variability. Transects were surveyed at 5m and 15m at German Channel and Ngerchong Outside, and at 3m and 10m at Ngerchong inside.

Underwater fish counts were conducted along 50m transects at each of the two survey depths at all study sites apart from Red Buoy at German Channel. Fishes were counted within 2.5m on either side of the transect (English and Wilkinson 1997). The counts were replicated after one month, giving eight replicates for each depth at German Channel, four at Ngerchong Outside and four at Ngerchong Inside. Fish were categorized into small, medium and large size classes using a measuring method with which the survey team was already familiar ('small' fish were of hand-size or smaller (approx. up to 20cm); 'medium' fish could be measured between the fingertip and elbow (up to about 40cm) and 'large' fish were longer than fingertip to elbow (40+cm). Major fish families and species of both economic importance and of aesthetic value to divers were recorded (see Appendix 5 for datasheet).

After the first fish counts, point intercept surveys (English and Wilkinson 1997) were also conducted once along each transect at all study sites, giving five replicates for each depth at German Channel, two at Ngerchong Outside and two at Ngerchong Inside (see Appendix 6 for datasheet).

3.2.2 Diver Impact Observations

Information on diver behavior was recorded using methods based on Rouphael and Inglis (1995). Daily selection of dive sites was dependent on weather and sea conditions, as dive operators chose sites according to these factors. Subjects were selected at random, although, whenever possible, every diver in a group was observed.

One observer remained on the boat and recorded the following:

- number, name, and time of arrival of dive boats
- number of divers or snorkellers and guides
- other observations regarding behavior of tourists / guides / drivers (e.g. fish feeding)

Two underwater observers performed independent observations of the behavior of 123 divers at 3 different dive sites within the Rock Islands Southern Lagoon Area – 52 divers at German Channel, 35 at Ngerchong and 36 at Big Drop-off. Each observer followed groups of two to four divers at a time, dependent on party size and distance between divers. Each diver was observed for ten minutes. Observers remained approximately 5m behind their subjects so as not to be detected. Divers generally remained close to other members of their party and therefore did not appear to notice the observation process. If suspicion arose and the subject became aware of the observer, the data were disregarded.

Quantitative observations were made in the following categories:

- number of times a diver made contact with the substratum
- type of substratum contacted
- nature of the contact (fins, holding, etc.)
- contact obviously damaging / non-damaging to substratum
- type and size of substratum damaged
- additional notes on diver accessories: gloves and cameras

'Damaging impacts' were those which evidently resulted in immediate breakage of coral or other living organism. 'Non-damaging' interactions involved holding or touching living organisms but with no visible damage immediately apparent. Thus only acute damage was recorded and chronic or long-term damage was not quantified. An example data sheet is given in Appendix 7.

3.2.3 Questionnaire

Information was gathered from dive guides about the perceived environmental impacts of diving at German Channel and Ngerchong using questionnaire surveys (see Appendix 8). Questionnaires in Japanese and English were distributed to all marine tour operators in Koror. Eighteen companies participated in the study and 35 questionnaires were completed by their dive guides (see Appendix 9).

4. RESULTS

4.1 BIOLOGICAL ASSESSMENTS

4.1.1 Fish counts

German Channel

Fish diversity was high at German Channel with 13 fish families observed at both depths. At 5m, the most abundant were small and medium Acanthuridae and Scaridae and small Chaetodontidae (Figure 1). A humphead wrasse (*Cheilinus undulatus)* aggregation was noted at approximately 10:30am on 31st July 2003; the aggregation site was located above a massive *Porites sp.* formation (8m wide and 3m high). At 15m, schools of Lutjanidae were seen at Buoy 1 and 2 in early July, accounting for the high mean counts displayed in Figure 2. Small Acanthuridae and Chaetodontidae were numerous, but counts of Scaridae were low in comparison to those at 5m. Hawksbill *(Eretmochelys imbricata)* and green turtles *(Chelonia mydas)* were also observed.

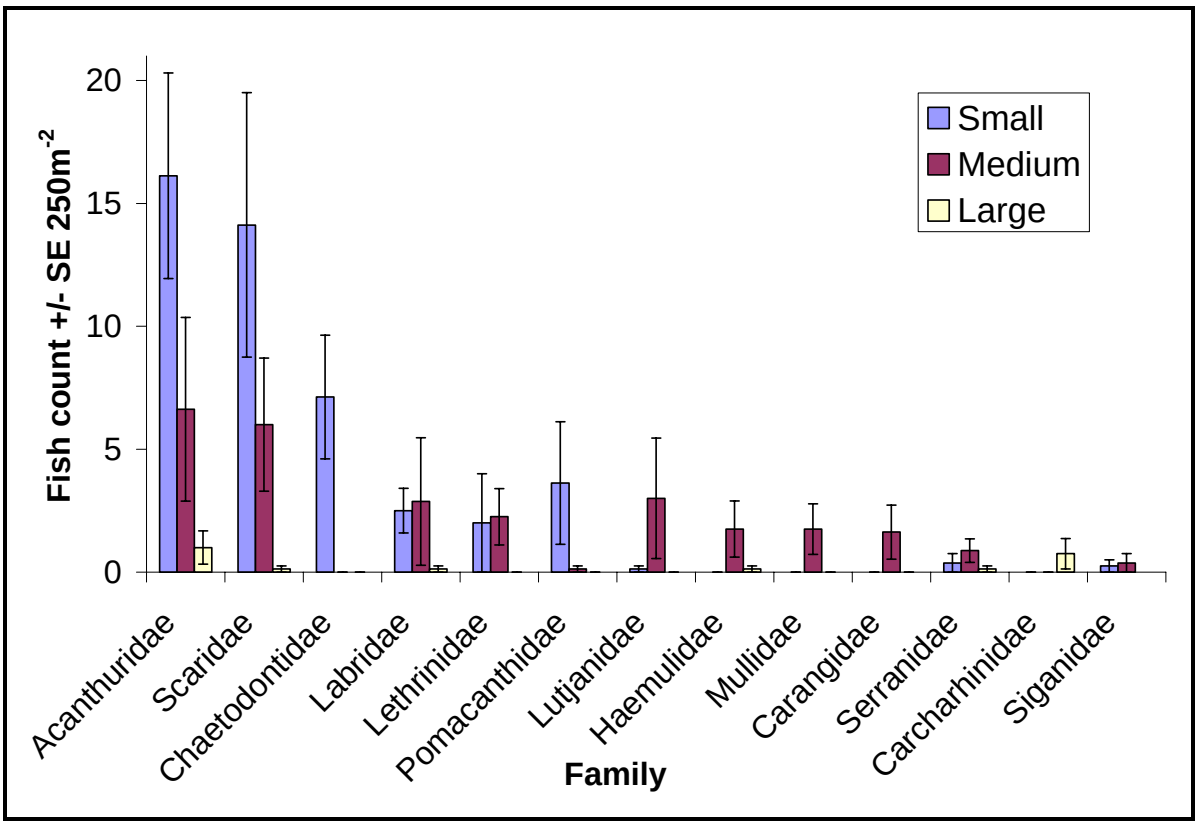


Figure 1: Mean fish counts ±SE in order of total abundance on shallow (5m) transects at German Channel

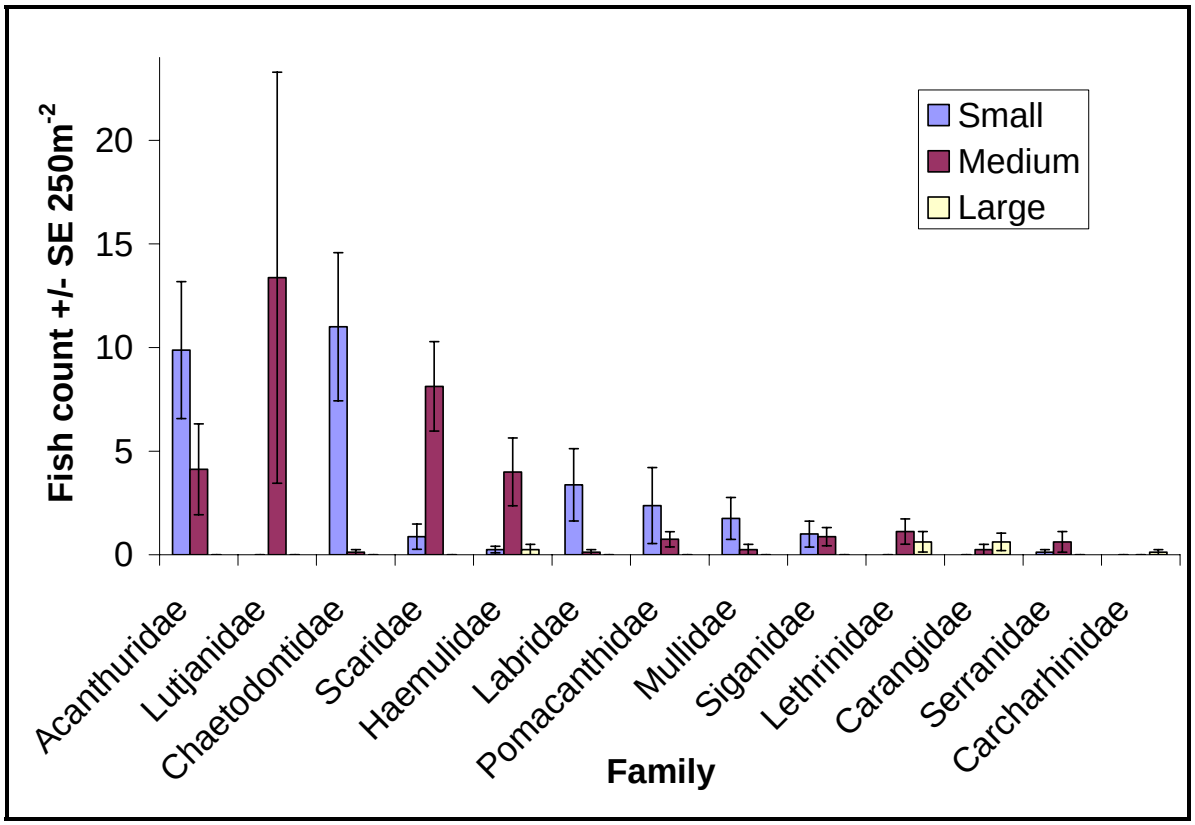


Figure 2: Mean fish counts ±SE in order of total abundance on deep (15m) transects at German Channel

The Inside and Outside sites at Ngerchong were treated separately because the topography, currents and exposure were significantly different.

Ngerchong Outside

Ten target families were observed at Ngerchong Outside sites at 5m (Figure 3). Almost all fishes observed were less than 20cm in length, the most abundant families were Acanthuridae and Scaridae. Counts for Chaetodontidae were skewed since 36 individuals were counted at Outside 1 in July, they were not recorded on any other transects. Twelve of the target families were observed at 15m at the Ngerchong outside sites (Figure 4). Acanthuridae and Chaetodontidae were most abundant (high counts of 61 Chaetodontidae (*Hemitaurichthys polylepis*) and 28 rabbitfishes were recorded at Outside 1 in July, and none on any other transect). Counts of each family were much lower at the deeper site.

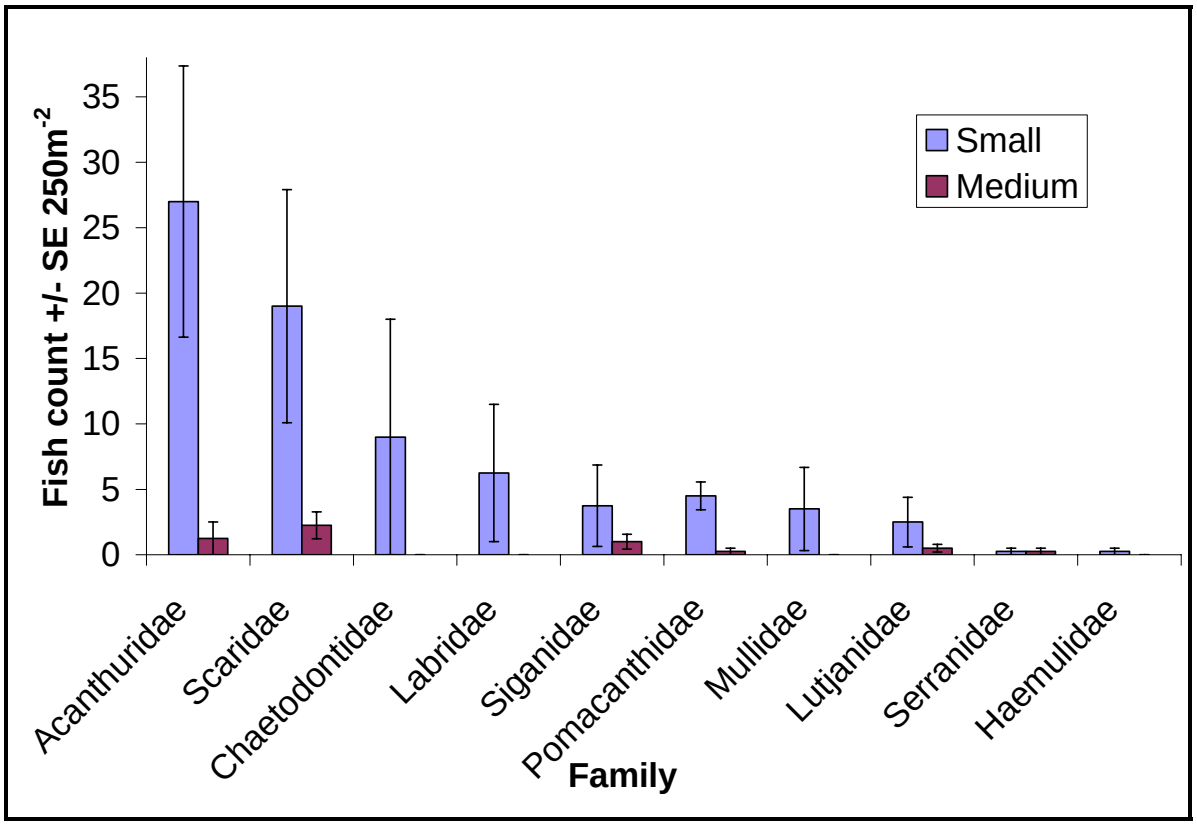


Figure 3: Mean fish counts ±SE in order of total abundance on shallow (5m) transects at Ngerchong Ouside

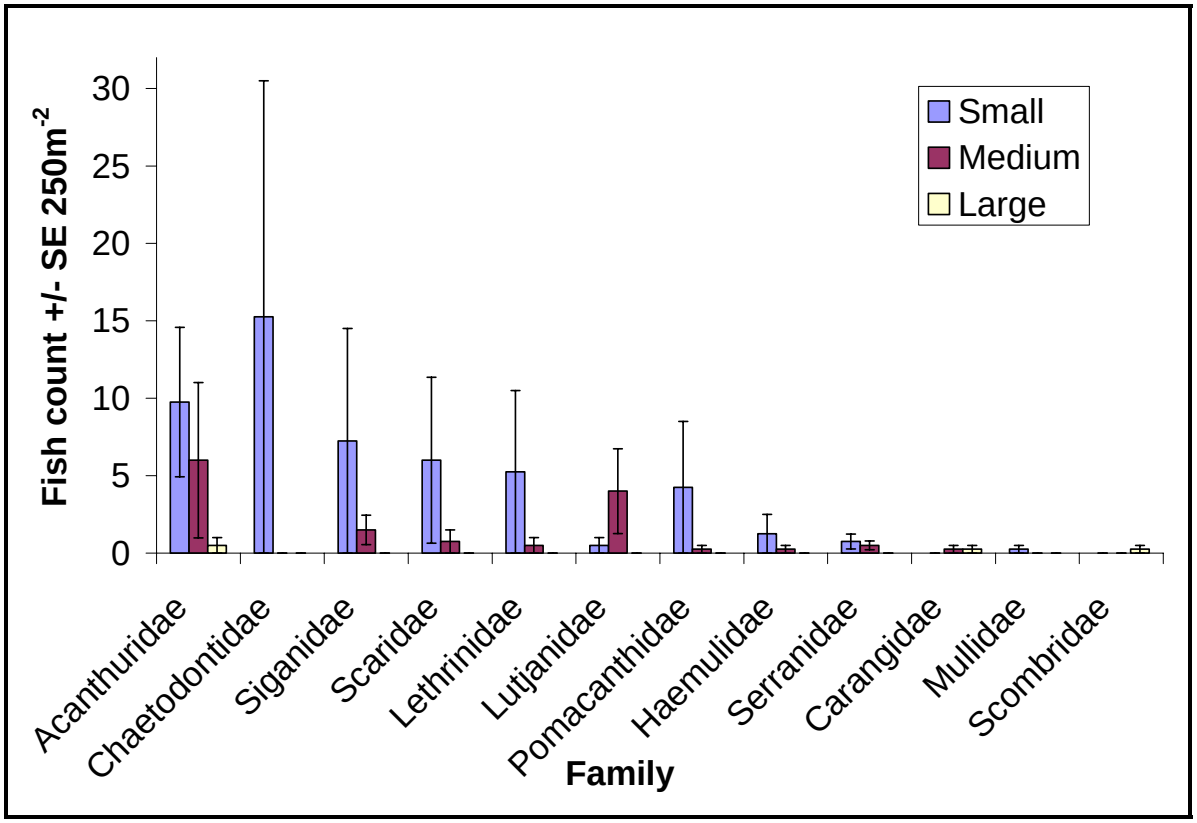


Figure 4: Mean fish counts ±SE in order of total abundance on deep (15m) transects at Ngerchong Ouside

Ngerchong Inside

Only 9 fish families were recorded at 3m at the Inside sites (Figure 5). Small and medium-sized Acanthuridae and Scaridae dominated both sites and counts were consistently higher at Inside 2; Chaetodontidae were the third most abundant family. At 10m, fish diversity was slightly greater, with 11 of the target families observed (Figure 6); however, overall abundance was much lower. Small and medium-sized Scaridae and Acanthuridae were the most abundant groups. Large schools of Lutjanidae were observed at Inside 2 on all dives, accounting for high counts. Counts were consistently higher at Inside 2 compared to Inside 1. It is interesting to note that no turtles or sharks were seen at any sites at Ngerchong apart from two small white tip reef sharks (*Triaenodon obesus)* seen at the Inside sites at 10m in July.

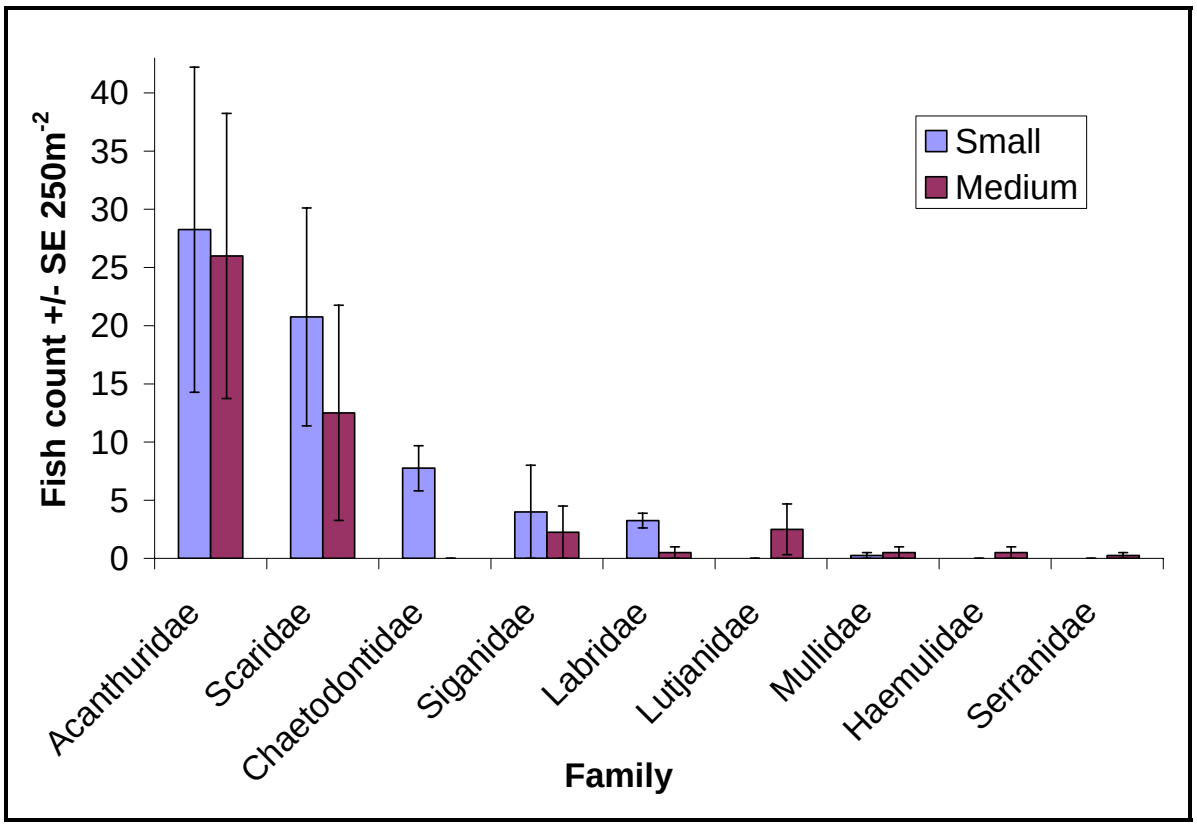


Figure 5: Mean fish counts ±SE in order of total abundance on shallow (3m) transects at Ngerchong Inside

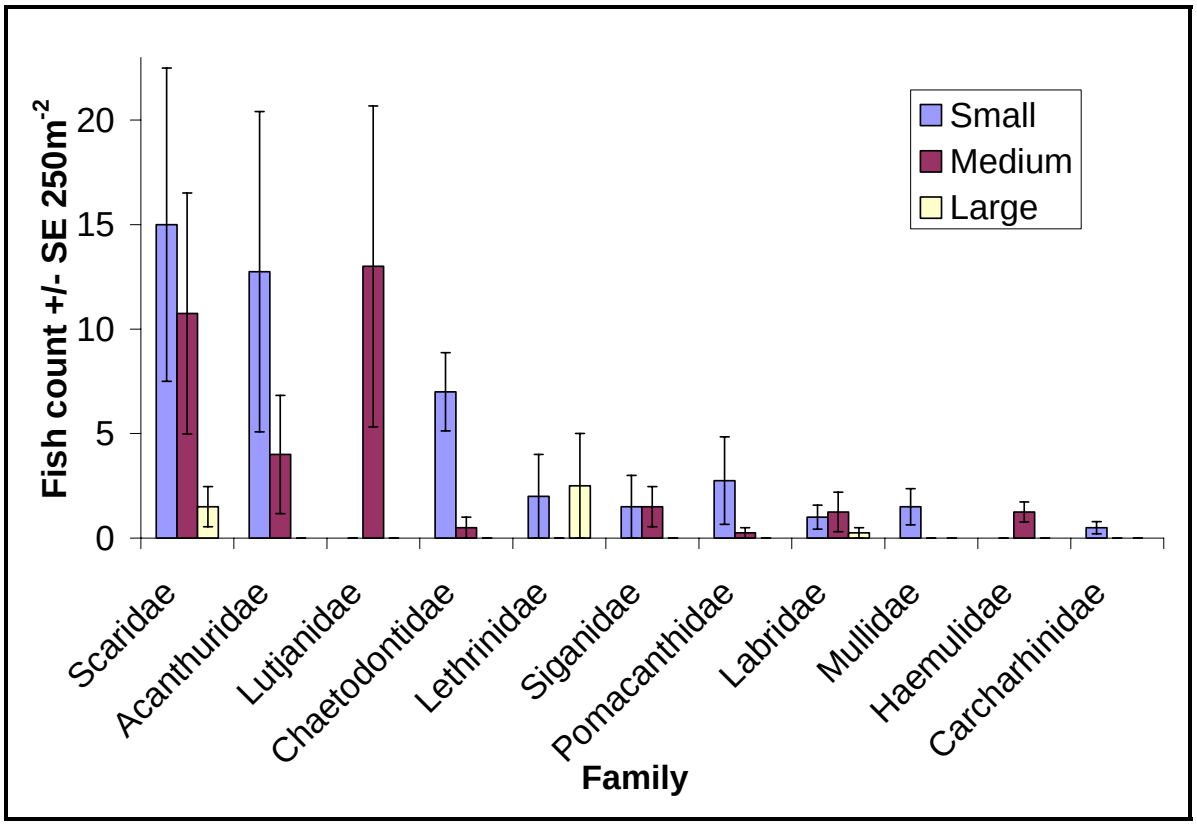


Figure 6: Mean fish counts ±SE in order of total abundance on deep (10m) transects at Ngerchong Inside

4.1.2 Substrate surveys

Hard coral, rubble, sand, rock and sponge were the five most widespread substrates (Table 1). Hard coral was the dominant substrate type at German Channel and Ngerchong Outside. At Ngerchong Inside, the rubble that comprised a significant proportion of the substrate was a result of the 1997-8 bleaching event (in particular, collapsed table *Acropora sp.* corals that were alive and several meters in diameter prior to 1998). Soft coral was noticeably common at 15m at Ngerchong Outside. The algae at the deeper sites of Ngerchong Inside were identified as *Halimeda sp*.

Table 1: Substrate composition at German Channel and Ngerchong

Substrate	% Cover					
	German Channel		Ngerchong Outside		Ngerchong Inside	
	5m	15m	5m	15m	3m	10m
Hard Coral	30.4	37.8	34	42	16	19.5
Rubble	20.4	13.8	20	12	68	40
Sand	18.4	20	10	4.5	8	11
Rock	12.4	10.2	12.5	15	0	8.5
Sponge	9.4	11.4	15	7	0.5	2.5
Soft Coral	2.6	4.2	8	14.5	0.5	0.5
Algae	4.4	0.2	0	0	4	15
Bleached Coral	2.2	2.4	0	4.5	3	3
Other	0	0	0.5	0.5	0	0

4.2 DIVER IMPACT OBSERVATIONS

German Channel (52 divers observed)

At German Channel, coral was the most frequently impacted substrate (Figure 7). Divers also knelt or rested their fins on the sand at some point during the dive, normally while they were waiting for manta rays. Interactions with soft corals and sea fans were rare. Most interactions with coral involved holding or touching / kicking corals with fins (Figure 8) Divers were also observed dragging gauges over the substrate and kneeling indiscriminately on corals, usually to take photographs. Two guides were also observed and neither made any contact with any substrate during the period of observation.

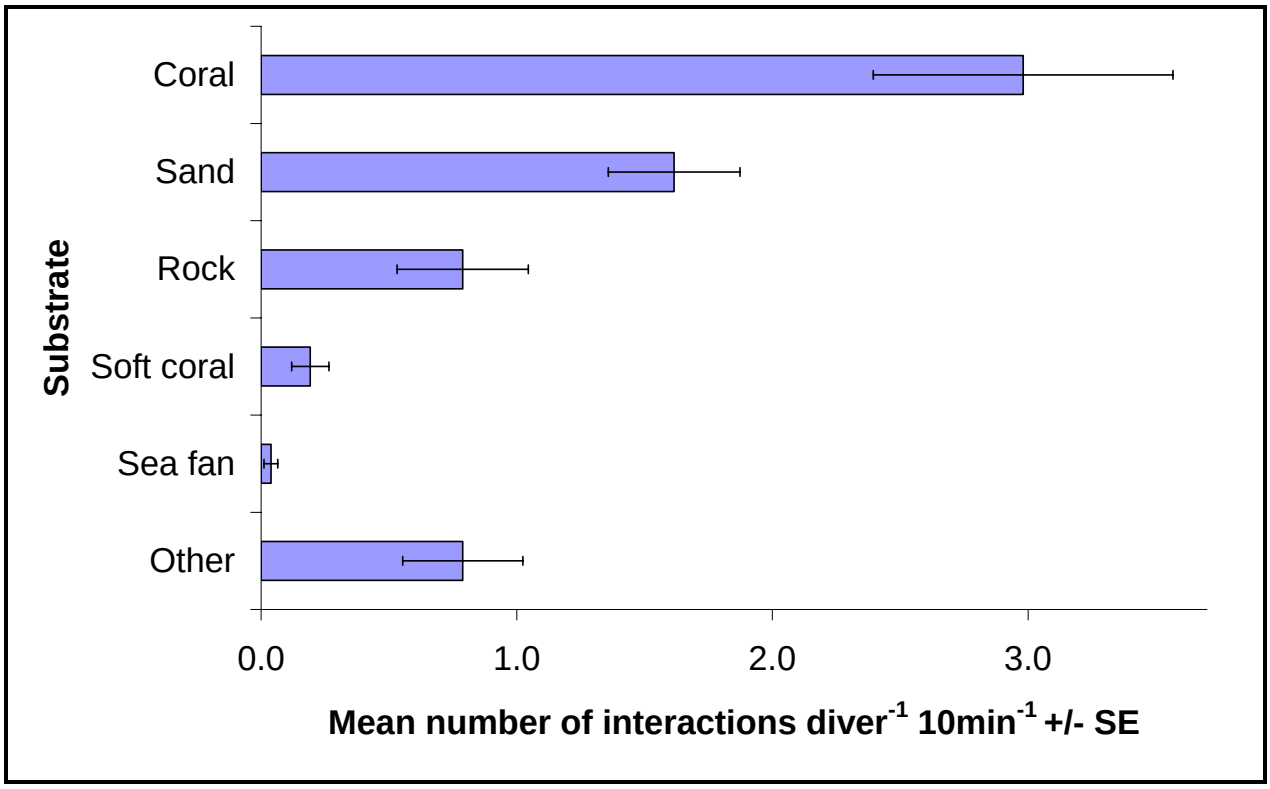


Figure 7: Mean number of interactions diver^{-1} 10min^{-1} ±SE with each substrate at German Channel

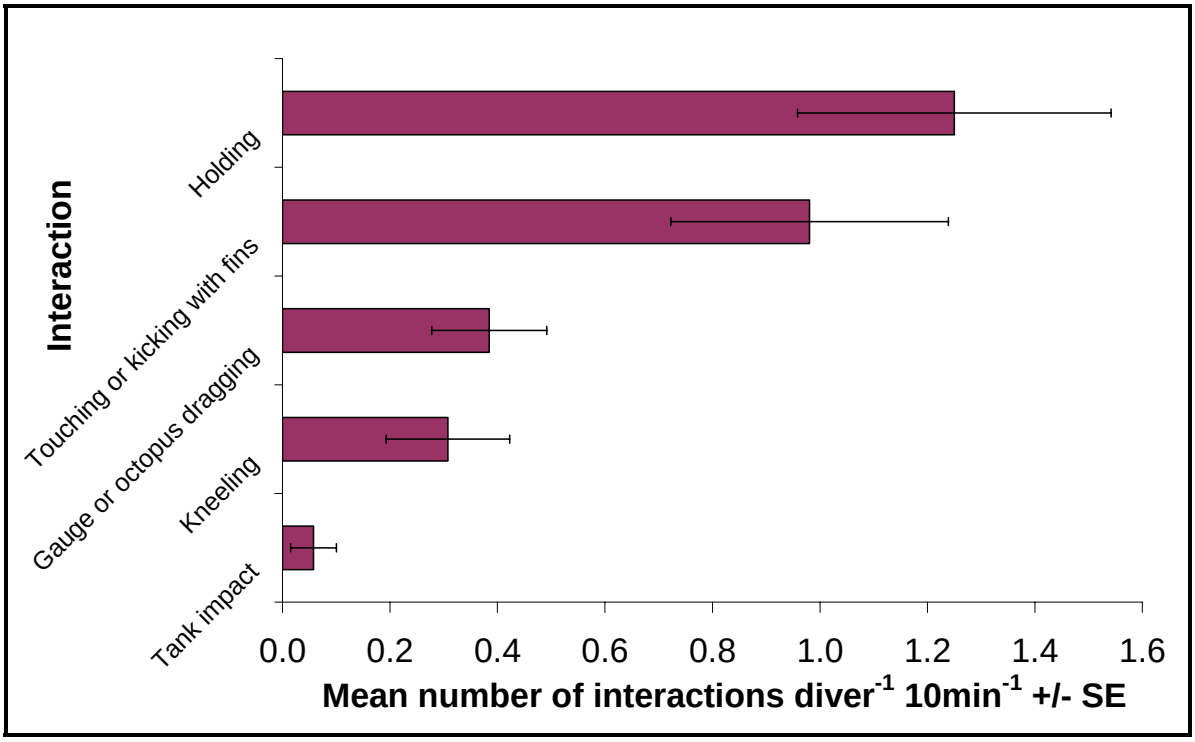


Figure 8: Mean number of each type of interaction diver^{-1} 10min^{-1} ±SE with coral at German Channel

Ngerchong (35 divers observed)

At Ngerchong, diver interactions with the substrata were overall less frequent, although contacts with coral were again most common (Figure 9). The number of interactions with sand was similar to that for German Channel and there were few interactions with soft corals and sea fans. Interactions with coral most commonly involved touching / kicking with fins or holding as at other sites (Figure 10). There were also instances of divers hitting corals with their tanks as a result of buoyancy-control problems.

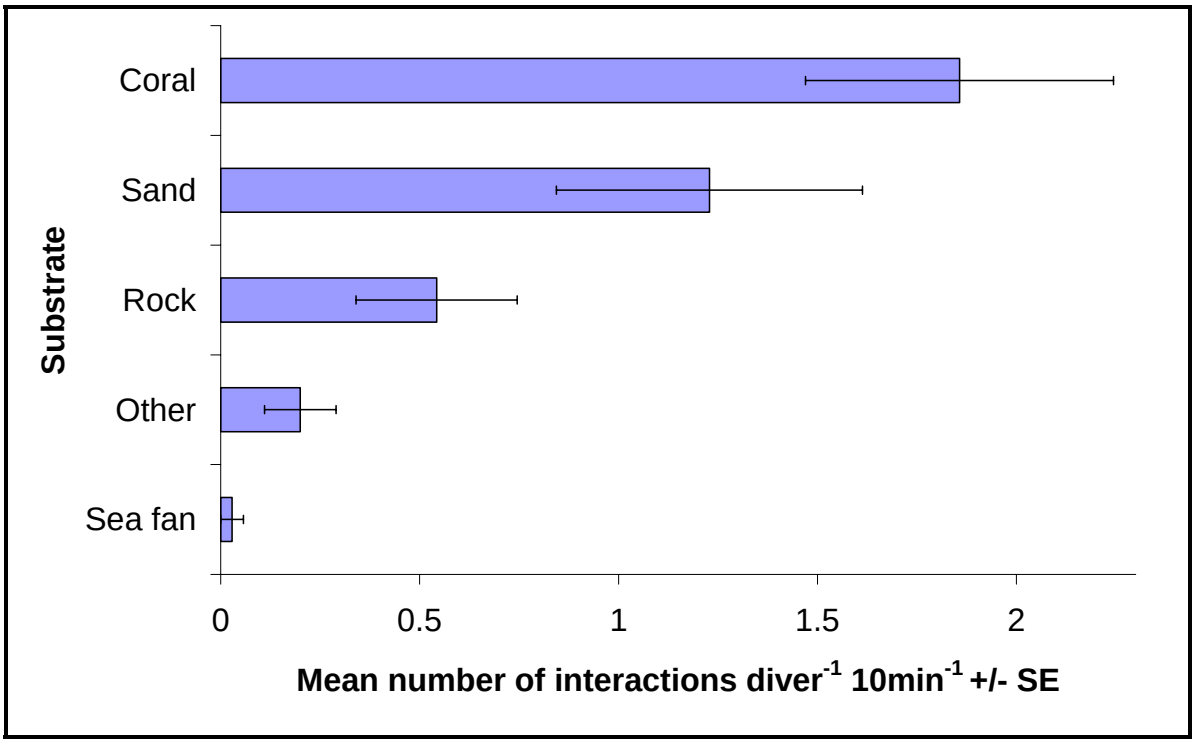


Figure 9: Mean number of interactions diver^{-1} 10min^{-1} ±SE with each substrate at Ngerchong

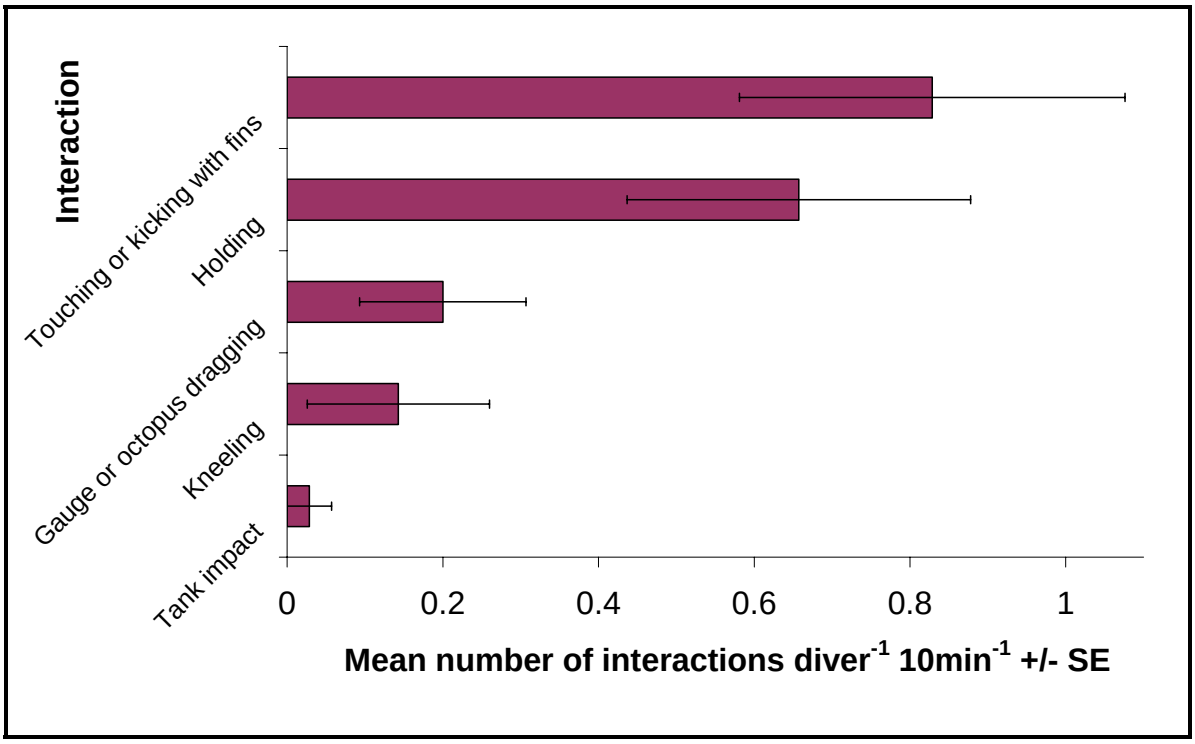
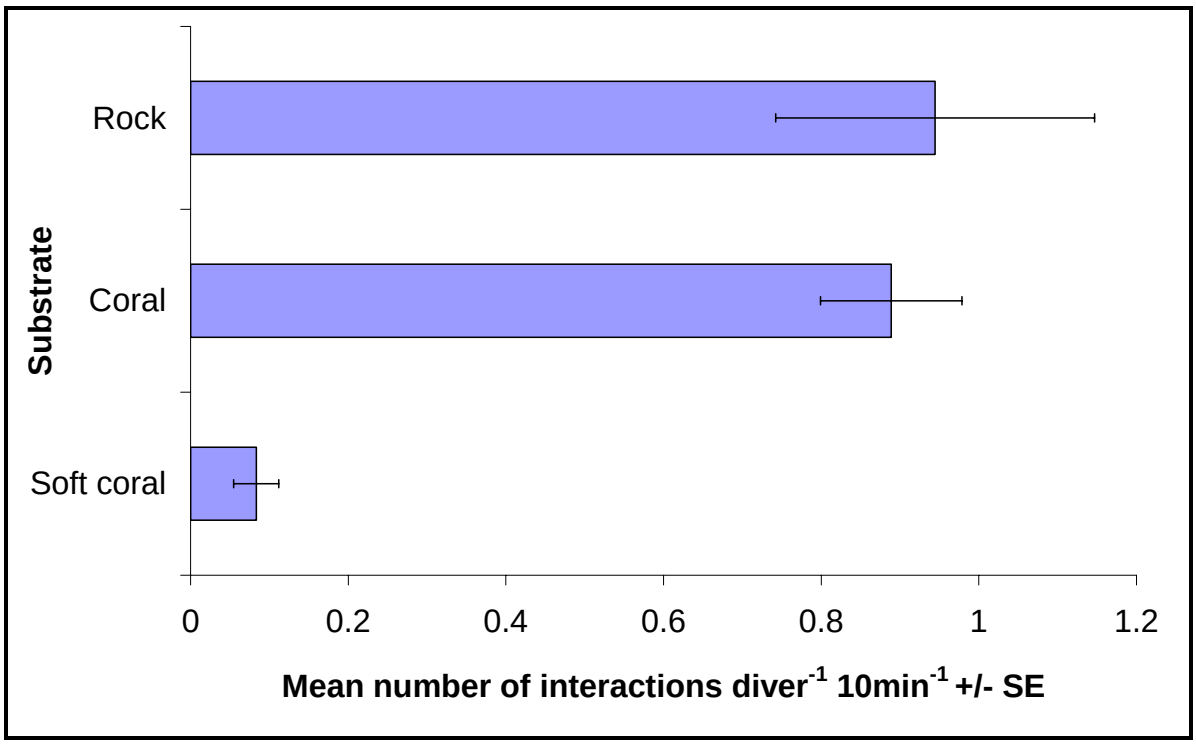


Figure 10: Mean number of each type of interaction diver^{-1} 10min^{-1} ±SE with coral at Ngerchong

Big Drop-off (36 divers observed)

At Big Drop-off, contacts with the substrata were least frequent out of all three sites. Rock was the most commonly touched substrate and coral was less affected (Figure 11). There was no sand at Big Drop-off within the depth range usually dived, therefore no interactions with this substrate were recorded. Interactions with soft coral were rare and no contacts with sea fans were observed. Of the interactions with coral, half involved the diver touching or kicking coral with their fins (0.44 ± 0.15 diver^{-1} 10min^{-1}) and the other half involved divers holding coral (0.44 ± 0.17 diver^{-1} 10min^{-1}). Half of the interactions with rock also involved touching or kicking with fins, the majority of other interactions involved holding, although there were also cases of divers kneeling on and hitting rocks with their tanks.



At

Figure 11: Mean number of interactions diver^{-1} 10min^{-1} ±SE with each substrate at Big Drop-off

All sites (123 divers observed)

Divers wearing gloves touched coral more often (4.1 ± 0.6 interactions diver^{-1} 10min^{-1}) than those not wearing gloves (1.3 ± 0.3 interactions diver^{-1} 10min^{-1}) ($t = 3.86$, $df = 121$, $P \leq 0.001$) and divers using cameras touched coral more often (3.1 ± 0.7 interactions diver^{-1} 10min^{-1}) than those not using cameras (1.8 ± 0.3 interactions diver^{-1} 10min^{-1}) ($t = 1.80$, $df = 121$, $P \leq 0.05$).

Only three physically damaging interactions by two divers were recorded during the course of this study, out of a total of 123 divers observed. One interaction involved the diver scraping their tank against a coral head at German Channel and the other occurred at Big Drop-off, when a diver kicked and broke off two pieces of a branching hard coral.

4.3 QUESTIONNAIRE

4.3.1 Company Backgrounds

- More than half of the 18 companies questioned had been operating in Palau for 10 or more years. Only two companies had been established for less than four years.
- Of the 35 guides questioned, half had been working in the dive industry in Palau for less than four years and seven for more than 10 years.
- Twenty-seven guides had been employed in dive operations overseas for up to three years in addition to their experience in Palau.
- Half of the companies offered snorkeling trips as well as diving (1 - 25% of their business). Five companies offered diving only and four offered snorkeling only.
- Eight companies employed 26-50% Palauan guides. Only three companies employed more than 50% local guides. The company with the highest proportion of Palauan guides (66%) offered snorkeling only. More than 25% of the companies (5) did not employ any Palauans as guides.
- Most companies had small boats that would carry up to five (78%) or 10 (67%) divers. Fourteen companies had boats that would carry more than 15 passengers.

4.3.2 Visits to dive sites

- Guides generally took divers to German Channel once or twice a week, with a third of them visiting the site more than three times a week.
- Two-thirds of the respondents visited Ngerchong once or twice a month or less frequently.
- German Channel was visited throughout the year, with 75% of guides diving the site in the months of January and February (Figure 12).
- Ngerchong was dived throughout the year, in particular when there were strong southerly or westerly winds and it was too rough to take divers to the more popular diving sites at Ngemelis. Usually these conditions arose through the summer months of June, July and August, so most diving was reported in these months, with over 60% of guides taking divers there in August (Figure 12).

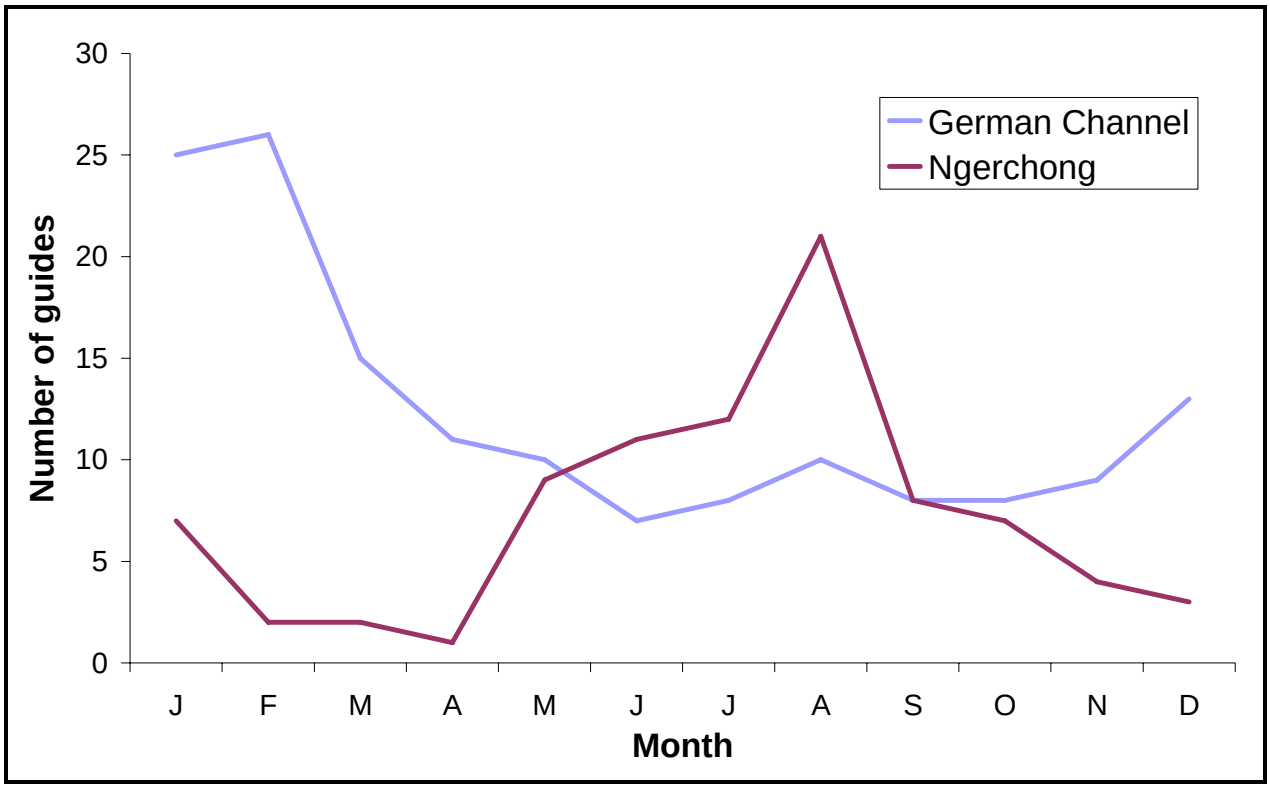


Figure 12: Number of guides visiting German Channel and Ngerchong at each month of the year

- Most guides took divers to Buoy 1 and Red Buoy at German Channel (Figure 13), where there was a greater probability of seeing manta rays at the cleaning stations between these buoys.

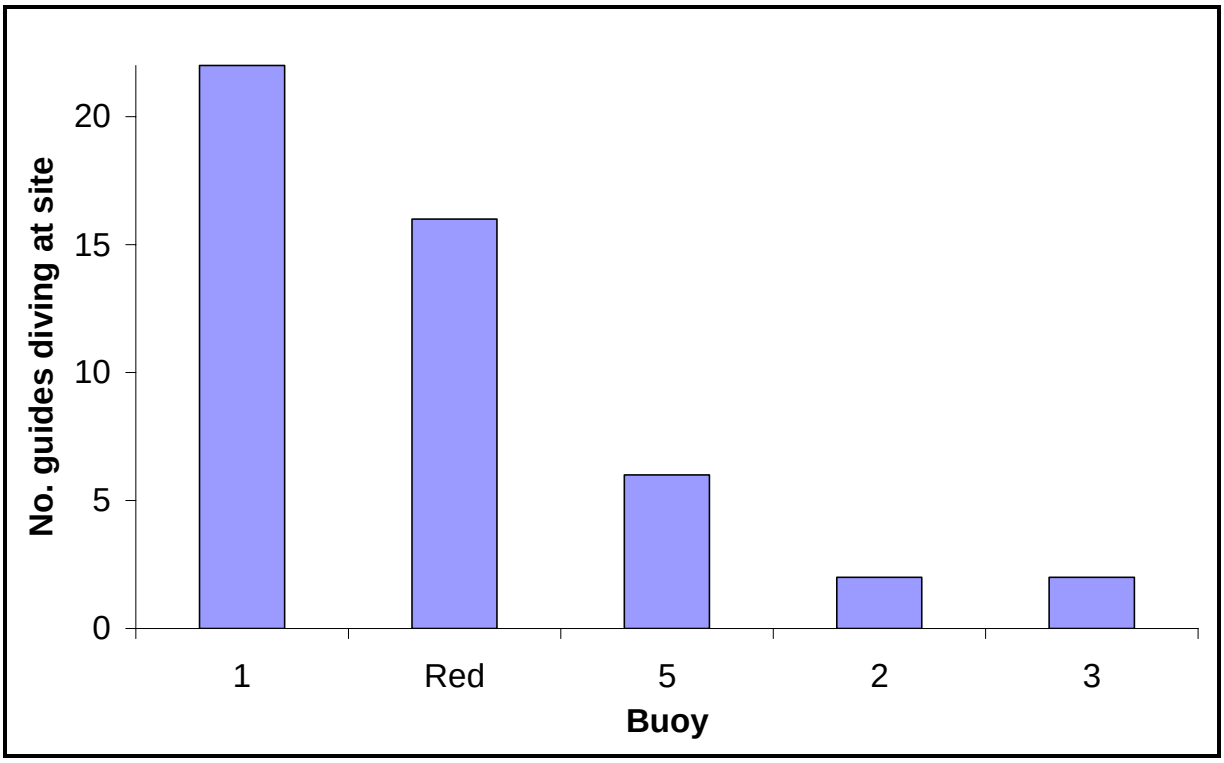


Figure 13: Number of guides visiting each site at German Channel

- Over 70% of guides took divers to both the inside and outside buoys at Ngerchong. Few showed a preference for either one of these dive sites.

4.3.3 Perceived impacts at dive sites

Guides felt that there were sufficient buoys (Table 2), but a third wanted to see more buoys installed. One guide expressed the need for a buoy for lunch stops at Ngerchong. Guides reported that most or all operators used buoys at German Channel (94% of respondents) and at Ngerchong (97% of respondents). At both German Channel and Ngerchong, guides usually saw two or three other dive boats while they were visiting the site.

Table 2: Responses to the question: *'Are there enough mooring buoys (at the two dive sites)?'*

	% respondents	
Site	**Yes**	**No**
German Channel	71	29
Ngerchong	68	32

Two-thirds of respondents felt that there was a problem with boat and diver congestion at German Channel (Table 2), and several made comments about other boats speeding through the diving area and causing a safety hazard to both divers and manta rays.

Table 3: Responses to the question: *'Is boat and or diver congestion a problem at the dive sites?'*

	% respondents	
Site	**Yes**	**No**
German Channel	66	34
Ngerchong	14	86

Over 60% of guides reported coral damage at both dive sites (Table 3). Most guides believed that natural events were the main reason for coral damage (Figure 14). One-third thought diver impact had caused coral damage. A few identified anchors as a problem, one mentioned triggerfish and another blamed trash. 71% had heard about coral bleaching.

Table 3: Responses to the question: *'Is there coral damage at the dive sites?'*

	% respondents	
Site	**Yes**	**No**
German Channel	62	38
Ngerchong	71	29

Kicking ('sometimes' observed by 58% of respondents) and holding ('sometimes' observed by 48% of respondents) coral were thought to be the greatest impacts that divers were having at German Channel. Most impacts were 'rarely' or 'sometimes' observed, with only one guide ranking them as 'often'. At Ngerchong, kicking coral was again the most commonly identified impact, 'sometimes' observed by 55% of respondents. The majority of guides 'rarely' saw coral being broken (71% at German Channel and 68% at Ngerchong).

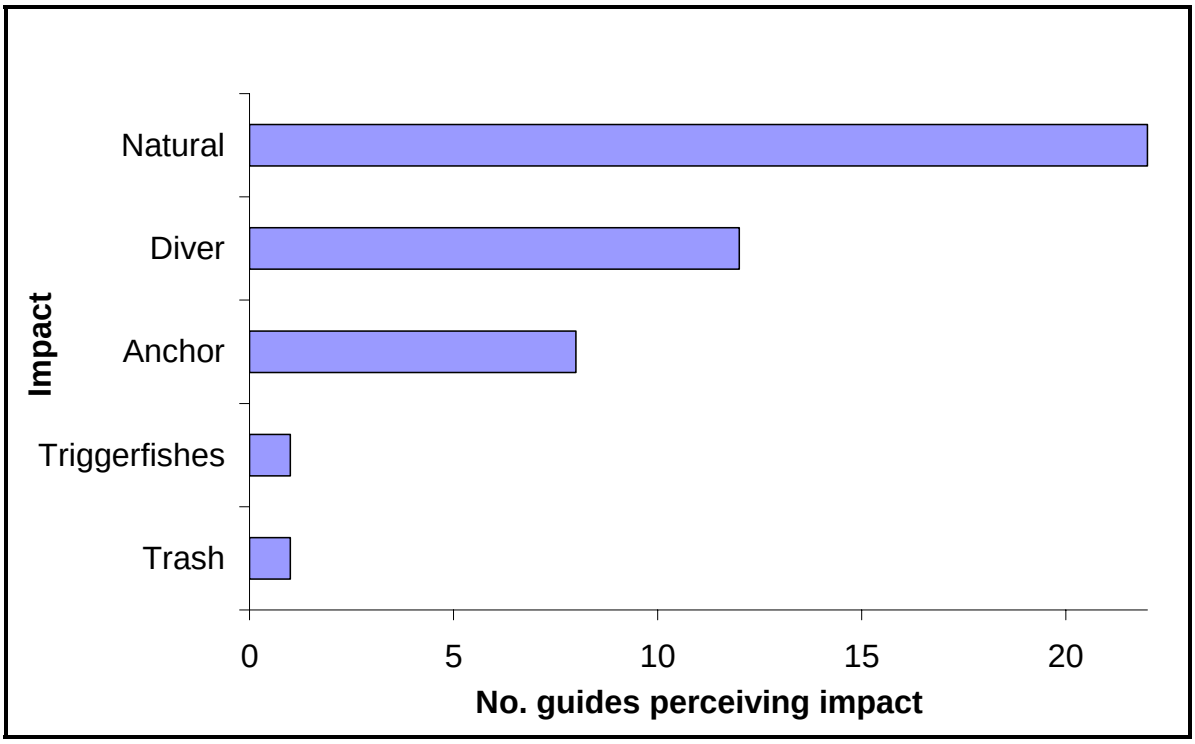


Figure 13: Guides' perceived causes of coral damage

5. DISCUSSION

5.1 BIOLOGICAL SURVEYS

German Channel is one of the most popular dive destinations in the Rock Islands Southern Lagoon Area, because of the relatively high cover of hard corals and sponges in addition to the diverse fish life and presence of large animals such as manta rays, sharks and turtles. At Ngerchong, fish were more abundant in the shallows, although greater diversity was found on deeper transects, including Carcharidae, Scombridae, Sphaeridae and Carangidae. Half as many target fish families were recorded in the shallow waters at Ngerchong compared to German Channel, but counts of small and medium Scaridae were around one and half times greater. Both sites at Ngerchong have suffered from the 1997/8 bleaching event, with the inside, more sheltered site being the most seriously affected. Huge table corals have subsequently died and collapsed, contributing to high levels of rubble. The rubble has become overgrown with algae with an associated abundance of herbivorous Acanthuridae and Scaridae dominating the site.

5.2 IN-WATER DIVER OBSERVATIONS

Divers' most common interactions with coral involved holding on or touching / kicking it with their fins. Usually, the diver was attempting to steady themselves in a current or to get closer to the substrate to see something or take photographs and divers wearing gloves or using cameras made contact with coral more often. Divers kicked corals because of buoyancy problems and often appeared unaware that they were knocking anything as they swam.

Hard coral cover was highest and currents were strongest at German Channel; where these two factors may explain divers' increased tendency to hold coral. Interactions with rock and coral were similar in proportion to their percentage cover at this site so divers may not have differentiated between these substrates when searching for something to hold onto in strong currents. Soft corals and sea fans, although constituting less of the total substrate were rarely held onto or kicked, which may be partially because of recognition and avoidance by divers. Little is known about the long-term effects of touching live hard corals aside from a few studies on trampling (Kay and Liddle 1983). A group of 10 divers on a 40 minute dive at German Channel could result in 119 ± 23 coral contacts per dive in a limited area and this will clearly have long-term effects on the health of individual colonies at a particular site.

Contacts with rock were relatively low at Ngerchong and German Channel, but were high at Big Drop-off. The vertical wall at Big Drop-off was dominated by soft corals, sea fans, algae and sponges with fewer hard coral colonies than at the other two sites. Therefore, divers may purposefully have avoided making contact with soft, obviously living substrate types and touching rock in preference. Impacts of kicking and kneeling on sand dwelling animals are likely to be minimal. Sand is often shifted naturally by water movements; therefore the impacts of divers' fins and knees are negligible in comparison.

All guides were observed deliberately keeping away from the substrate, although few paid attention to their clients' interactions with the substrate because the guide tended to remain at the front of the group.

5.3 QUESTIONNAIRES

Although guides generally believed that there were enough buoys at dive sites, most stated that boat congestion was a problem. Guides had noticed coral damage at both sites, which was attributed mainly to natural events; this is further supported by the absence of fresh breaks, typical of diver damage, and the obvious presence of rubble from post-bleaching damage. Kicking and holding onto coral were the most common diver impacts according to guides; this was supported by in-water observations. The seasonality of diving patterns in the Rock Islands Southern Lagoon Area must be taken into account when planning management actions. At Ngerchong, no recreational diving activity was recorded at Inside 2 during the course of this study which may improve the recruitment and survival of juvenile corals.

6. RECOMMENDATIONS

6.1 SITE-SPECIFIC RECOMMENDATIONS:

6.1.1 German Channel

Long-term monitoring – Koror State should continue monitoring the site annually to record substrate and fish abundance and diversity data. It is recommended that the fish surveys be conducted twice, one month apart at the same lunar and tidal phase as in this study. Buoy 1 and Buoy 5 have been marked for long-term monitoring, with stakes placed at 5m and 15m depths. These stakes need to be reinforced, preferably by drilling, and marked for future identification. Buoy 1 is the most heavily-dived site whereas Buoy 5 has recently been installed and is rarely dived, therefore monitoring will provide representative data on changes in substrate and fish assemblages over time. Fish monitoring will require two mornings in July / August each year and the substrate surveys will take one morning and can be conducted at any time, but preferably at approximately the same time each year. The work can be completed by two rangers, diving as a buddy pair.

Boat Traffic - A 'no-wake' zone should be implemented and enforced by Koror State at the dive sites. The zone should include the area between Buoy 1 and Buoy 5, where divers are often surfacing. This will not only increase the safety of divers but will ensure minimal disturbance to marine life, in particular manta rays and turtles, which are frequently seen at or close to the surface.

6.1.2 Ngerchong

Long-term monitoring – Koror State should continue to collect fish and substrate data at Inside 2 and Outside 1 at the same time each year at the same time as the surveys at German Channel. The Inside and Outside sites are quite different in topography, exposure and susceptibility to bleaching, so these surveys will provide a good representation of the overall status of the reef.

Buoys – Koror State should consider installing another buoy close to the existing one at the Outside dive site. Boats were observed drifting in the water close to the buoy as there was no room for them to moor and they pose a hazard to surfacing divers, in particular when there are swells and divers' bubbles or safety marker buoys are more difficult to see. The Inside 1 site has two buoys in close proximity to

one another which are fully utilized, often with up to seven boats waiting for divers or having a surface interval. Although the site gets crowded, it is recommended that another buoy is not installed at Ngerchong Inside as it is likely to attract more boats to an already-crowded site.

6.1.3 Big Drop-off

Snorkellers – Although only small groups of up to six snorkellers were observed at Big Drop-off during the course of this study, there have recently been concerns raised by both tour operators and Koror State Department of Conservation & Law Enforcement about the safety risk of large groups of 10 or more snorkellers at the dive site. As Big Drop-off is a vertical wall, snorkellers are often swimming directly above divers in close proximity to dive boats, which move back and forth along the wall to pick up their divers. There is a real risk of collisions involving boats and snorkellers and also the possibility that snorkellers will get in the way of surfacing divers. Rather than designate the site as suitable for 'advanced/proficient' snorkellers, it would be better to enforce a limit on the number of snorkellers allowed in the water at any one time, for example, a maximum of five or six, and to require them to wear lifejackets so that they are not only visible to boats some distance away, but also unable to dive below the surface. As all snorkel tour companies questioned in a previous study (Community Centered Conservation (C3) in press) considered their customers to be proficient or experienced, it may be difficult to designate Big Drop-off as an advanced site as there may be confusion about the perceived snorkeling ability of customers. An alternative, though rather extreme, management strategy would be an outright ban on snorkeling at the site.

Human impact appears to be low at this site as most divers stayed several feet away from the wall. The impact of bleaching has also been less severe at this site than the others, so long-term biological monitoring at this site is not a priority considering the limited human and financial resources available.

6.2 GENERAL RECOMMENDATIONS

Ban Fish Feeding – Feeding fish at dive sites compromises not only the fishes' health, due to ingestion and digestion of unnatural foodstuffs, but also alters the ecosystem as a whole. With large amounts of nutrients entering the water at specific sites over long periods of time, algal growth is promoted and coral health undermined. In this study and in consultations carried out previously (Community Centered Conservation (C3) in press), several tour guides commented on the changes seen at Ngermeaus since fish feeding began on a large scale. Algal growth has been accelerated and fish behavior altered, in

particular there are concerns over the regular feeding of sharks at the site. Legislation banning fish feeding within the Rock Islands Management Area should be implemented and enforced through spot-checks by Koror State rangers and also a reporting system for tour operators initiated.

Ban Fishing at Dive Sites – During surveys at German Channel, a boat carrying six or more spear fishers arrived at the Red Buoy in German Channel. Reports had been received from tour operators a few days earlier that people were regularly seen spear-fishing at this particular location. The fish populations, in particular the large surgeonfish and Humphead Wrasse at the dive sites are highly vulnerable to exploitation as they are accustomed to divers and therefore do not usually swim away when approached. Spear-fishing is not compatible with diving at any site. Not only do fishers target larger fish that divers enjoy seeing during a dive, but their presence in the area concerns divers who are there to appreciate the marine life. If large fish are constantly fished from such a location, the site will lose its value to the dive industry. In addition, the discovery of a Humphead Wrasse (listed as vulnerable (Baillie and Groombridge 1996)) spawning aggregation site at German Channel warrants legislative protection of the area from fishing.

Regulate Numbers of Boats at Dive Sites – It is recommended that a maximum number of boats per buoy be introduced at all the dive sites. Boats often tie up to other boats that are already moored, therefore sites can quickly become crowded. Often the issue of over-crowding is addressed by installing more buoys. This works to a certain extent but in some cases serves only to attract more boats to a site, which previously would have been forced to seek out a less congested dive site.

Best Practice Guidelines – A number of 'best environmental practice' guidelines will be included in the Koror State Government Marine Tour Guide Certification course, currently being designed by C3. The need for some of these guidelines has largely become apparent through consultations with the dive industry and in-water observations. Some of these may be strengthened by legislation introduced by Koror State in the future. Examples include; discouraging divers from wearing gloves (lessening the likelihood of them holding corals and other invertebrates), minimum distances to be kept between divers and manta rays and diver and boat operator etiquette at dive sites.

Communication between Government and Industry – There is a need for increased communication between Koror State government and the tour operators, especially in relation to updated legislation and regulations as well as discussion of problems and concerns relating to specific sites. It is also recommended that Koror State produces some informative pamphlets about the Rock Islands

Management Area, which include maps detailing various activity zones and their respective regulations as well as information on the use of the Rock Islands User Fee and the programs it funds. An annual meeting inviting all tour operators to discuss management and operational issues could be hosted by Koror State Government. This would be more economical than constantly updating and distributing printed information brochures.

Monitoring of Dive Sites by Tour guides – During the course of our consultations it became apparent that many operators were keen to participate in regular monitoring of fish and substrate at various dive sites in the Rock Islands. It is recommended that Koror State Department of Conservation & Law Enforcement in conjunction with the Palau International Coral Reef Center take the lead in training interested tour guides in the monitoring procedures used in this study. The methods are simple, and with some classroom lectures followed by in-water practice surveys (where each guide is accompanied by an experienced surveyor) the training could be completed within a few days during the low season (June-September). This would provide a valuable opportunity for Koror State to distribute information about current and future monitoring work among tour operators and for the latter to increase their understanding of coral reefs and reinforce their commitment to the conservation of these local resources. It is recommended that a particular company is allocated a specific dive site ('Adopt-a-Reef') which they can monitor annually, possibly on Earth Day, and submit their findings to Koror State for analysis and subsequent distribution to all participating operators.

Ranger Training – It is recommended that Koror State has a permanent monitoring team of four rangers, ensuring that two of these will be available to conduct surveys as and when required throughout the Rock Islands Management Area. The rangers who have already completed survey training urgently need to undergo dive safety training as well as rigorous training in the identification of substrate types, over which there was sometimes confusion during this study. In addition to slide shows, it is recommended that they complete several substrate surveys in the company of biologists who can ensure that they are making correct identifications of soft corals, hard corals and sponges before the next monitoring trip.

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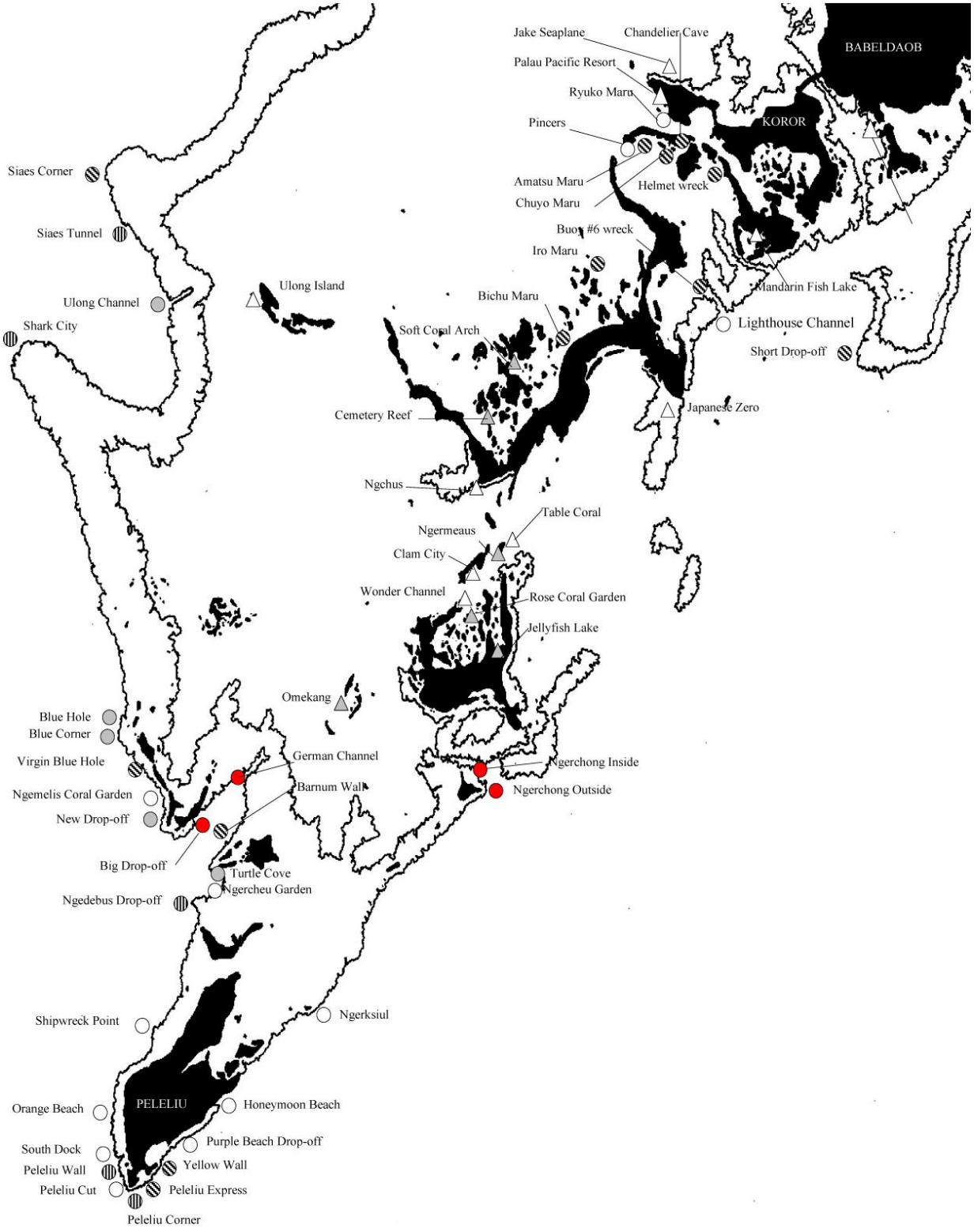
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7. APPENDICES

7.1 DIVE SITES IN THE ROCK ISLANDS SOUTHERN LAGOON

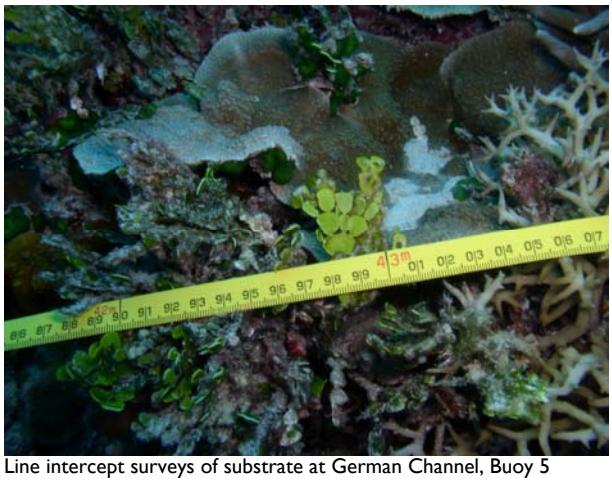


6.2 SITE DATA

SITE	COORDINATES		START OF TRANSECT	END OF TRANSECT
German Channel				
Red Buoy	07 07 05N	134 16 15E		
Buoy 1	07 07 12N	134 16 12E		
Buoy 2	07 07 12N	134 16 04E		
Buoy 3	07 06 59N	134 15 55E		
Buoy 4	07 06 43N	134 15 54E		
Buoy 5	07 06 49N	134 15 38E		
Ngerchong				
Inside 1	07 07 02N	134 22 00E	20m N of buoy	70m N of buoy
Inside 2	07 07 43N	134 22 01E	20m S of buoy	70m S of buoy
Outside 1	07 06 43N	134 22 12E	at Buoy	50m E of buoy
Outside 2	07 06 42N	134 22 12E	10m E from end of outside 1	60m E from end of outside 1

6.3 PHOTOGRAPHS

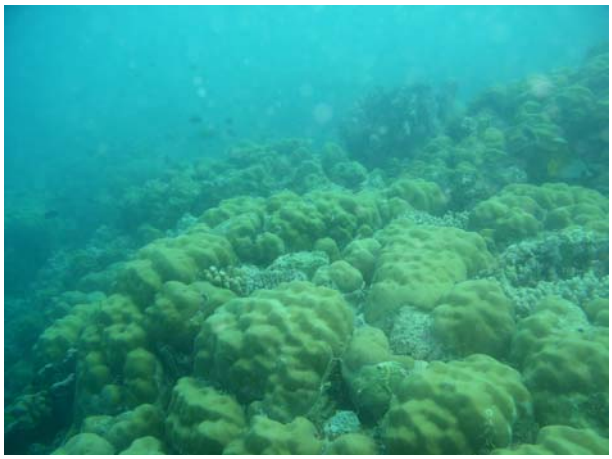
All photos courtesy of Dr. Katherine Chaston, Koror State Dept. Conservation & Law Enforcement

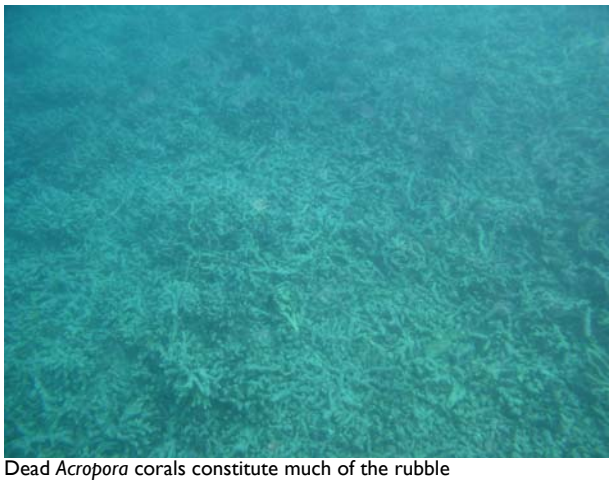


Line intercept surveys of substrate at German Channel, Buoy 5



Seriatopora (histrix?) showed signs of bleaching

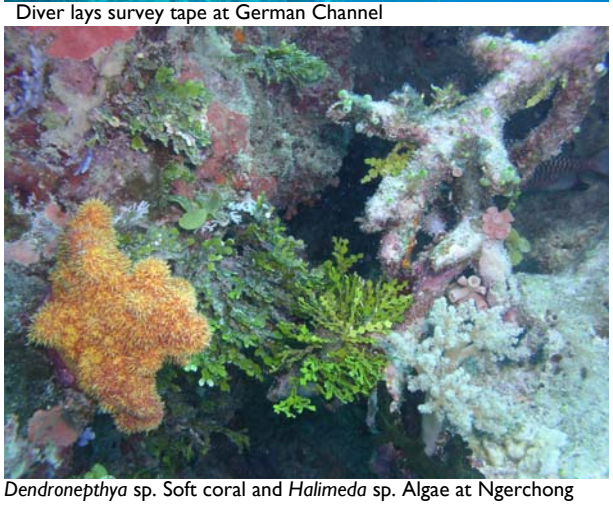

An extensive area of *Porites* sp. German Channel

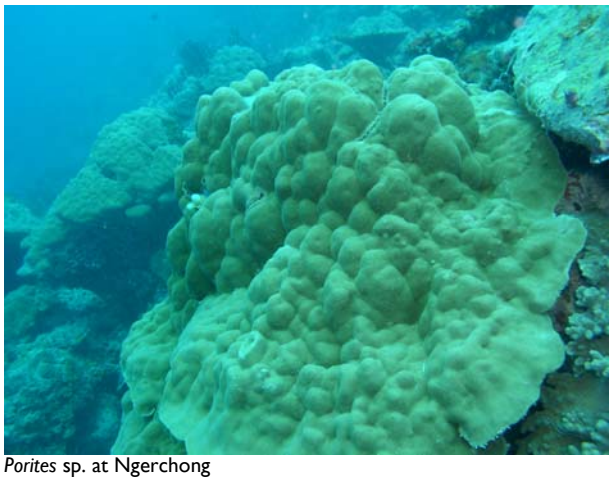

Dead *Acropora* corals constitute much of the rubble at German Channel


A variety of substrate types at German Channel

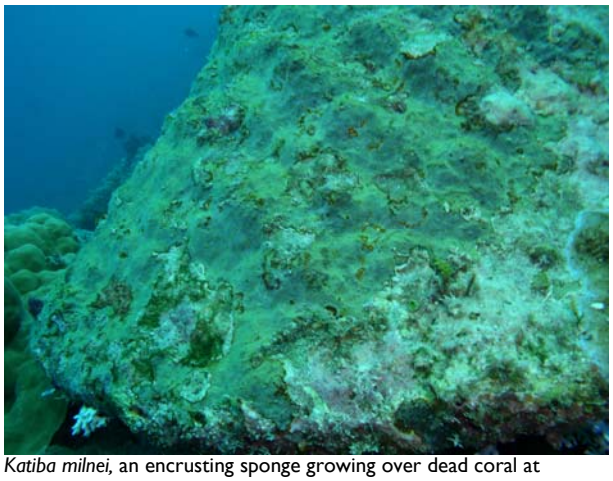

Diver lays survey tape at German Channel


Azooxanthellate corals at Ngerchong


Dendronepthya sp. Soft coral and *Halimeda* sp. Algae at Ngerchong



Porites sp. at Ngerchong



Katiba milnei, an encrusting sponge growing over dead coral at Ngerchong



Extensive rubble at Ngerchong due to the 1997 Bleaching Event.



Tubastrea microcantha

6.4 SURVEY DATES

2nd July 2003 : German Channel Fish & Substrate

3rd July 2003: Ngerchong Fish & Substrate

31st July 2003: German Channel Fish

1st August 2003: Ngerchong Fish

6.5 FISH DATA SHEET

Location:	**Reef zone:**	**Tide:**	**Date:**
Site #:		**Sea:**	**Time:**
Rep #:	**Heading:**	**Wind:**	**Collectors:**
Depth:	**Substrate:**		

	Small	Medium	Large
Groupers			
Epinephelus spp.			
Plectropomus spp.			
Snappers			
Emperors			
Rabbitfishes			
Goatfishes			
Wrasses			
Humphead Wrasse			
Parrotfishes			
Bumphead			
Sweetlips			
Surgeonfishes			
Angelfishes			
Butterflyfishes			
Jacks /Trevallies			
Tunas			
Barracudas			
Sharks			
Blacktip			
Whitetip			
Gray reef			
Other shark			
Turtles			
Hawksbill			
Green			
Others			

6.6 SUBSTRATE DATA SHEET

Collector's Name: _____

Date: _____ Time: _____ Location: _____ Depth: _____ft

Coral Reef Survey - Substrate Codes

HC hard coral	BC bleached coral	RC rock	SD sand	SP sponge
SC soft coral	AG algae RKC recently killed coral	RB rubble	SI silt/clay	OT other

SEGMENT 1 0 - 19.5 m							SEGMENT 2 25 - 44.5 m						
0		5		10		15	25		30		35		40
0.5		5.5		10.5		15.5	25.5		30.5		35.5		40.5
1		6		11		16	26		31		36		41
1.5		6.5		11.5		16.5	26.5		31.5		36.5		41.5
2		7		12		17	27		32		37		42
2.5		7.5		12.5		17.5	27.5		32.5		37.5		42.5
3		8		13		18	28		33		38		43
3.5		8.5		13.5		18.5	28.5		33.5		38.5		43.5
4		9		14		19	29		34		39		44
4.5		9.5		14.5		19.5	29.5		34.5		39.5		44.5

Collector's Name: _____

Date: _____ Time: _____ Location: _____ Depth: _____ft

Coral Reef Survey - Substrate Codes

HC hard coral	BC bleached coral	RC rock	SD sand	SP sponge
SC soft coral	AG algae RKC recently killed coral	RB rubble	SI silt/clay	OT other

SEGMENT 1 0 - 19.5 m							SEGMENT 2 25 - 44.5 m						
0		5		10		15	25		30		35		40
0.5		5.5		10.5		15.5	25.5		30.5		35.5		40.5
1		6		11		16	26		31		36		41
1.5		6.5		11.5		16.5	26.5		31.5		36.5		41.5
2		7		12		17	27		32		37		42
2.5		7.5		12.5		17.5	27.5		32.5		37.5		42.5
3		8		13		18	28		33		38		43
3.5		8.5		13.5		18.5	28.5		33.5		38.5		43.5
4		9		14		19	29		34		39		44
4.5		9.5		14.5		19.5	29.5		34.5		39.5		44.5

6.7 DIVER IMPACT OBSERVATIONS DATA SHEET

Observers Name: Time start : Date:

Site : Time end : Company:

OBSERVATION 1 ***TIME PERIOD:***

Substrate (NO damage) Substrate (damage)

Holding																							
Fins																							
Kneeling																							
Gauge																							
Other																							
Buoyancy																							
Notes																							

OBSERVATION 2 ***TIME PERIOD:***

Substrate (NO damage) Substrate (damage)

Holding																							
Fins																							
Kneeling																							
Gauge																							
Other																							
Buoyancy																							
Notes																							

OBSERVATION 3 ***TIME PERIOD:***

Substrate (NO damage) Substrate (damage)

Holding																							
Fins																							
Kneeling																							
Gauge																							
Other																							
Buoyancy																							
Notes																							

OBSERVATION 4 ***TIME PERIOD:***

Substrate (NO damage) Substrate (damage)

Holding																							
Fins																							
Kneeling																							
Gauge																							
Other																							
Buoyancy																							
Notes																							

S = sand BC = branching coral MC = massive coral RK = rock SP = sponge SC = soft coral AN = anemone SF = sea fan

6.8 QUESTIONNNAIRE

Community Centered Conservation (C3) has been contracted by Koror State Government to conduct research into the impacts of dive tourism at German Channel and Ngerchong. C3 is sending out this questionnaire to all dive companies operating in Rock Islands Southern Lagoon area in order to collect information about the levels of visitation and perceived environmental impacts at these sites. We would be grateful if at least two of your dive guides could fill out the following questionnaire so that their valuable knowledge, suggestions, and concerns can contribute to the successful management of these important dive sites in the future.

Thank you for your time and cooperation.

If you have further questions please do not hesitate to contact Patricia Davis (488-8980) or Colby Kearns (488-6937) or email cthree@palaunet.com

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I. COMPANY BACKGROUND

Name of Company _____

What is your main position and duties?_____

How long has your business been in operation in Palau?_____

How long have you been involved in dive business in Palau? __ Elsewhere?_____

What percentage of your business is **(A) diving?_____(B) snorkeling?_____**

How many guides of different nationalities? **(A) Palauan_____(B) Japanese_____**

(C) American_____(D) Taiwanese_____(D) Other (please specify)_____

How many boats does your business operate? **0-5 tourists_____6-10 tourists_____**

11-15 tourists_____16-20 tourists_____>20 tourists_____Live-aboards_____

How often does your company take tourists to German Channel or Ngerchong?

Please circle:

(A) German Channel :

1-2 visits a week / 3+ visits a week / 1-2 visits a month / once every 2-3 months / <4 times a year

(B) Ngerchong :

1-2 visits a week / 3+ visits a week / 1-2 visits a month / once every 2-3 months / <4 times a year

2. VISITATION LEVELS

Circle the times in the year that you make most of your trips to German Channel:

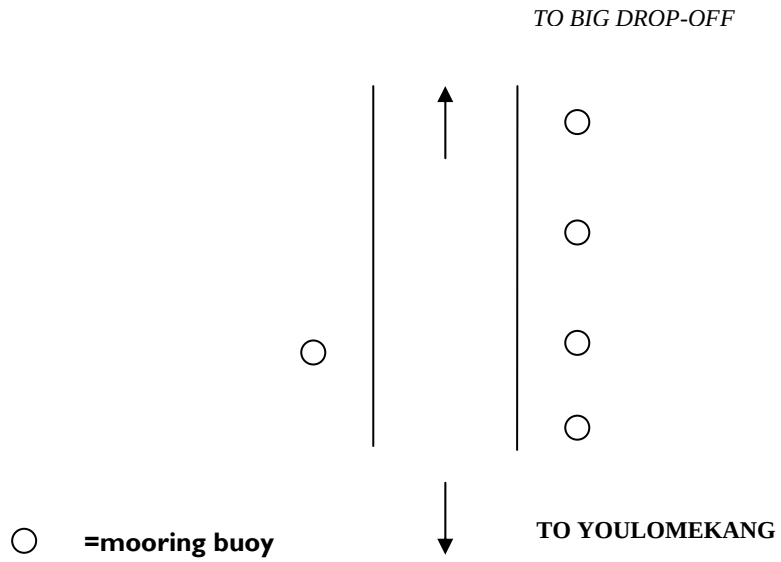
Jan. Feb. Mar. Apr. May. Jun. Jul. Aug. Sep. Oct. Nov. Dec

Circle the times in the year that you make most of your trips to Ngerchong:

Jan. Feb. Mar. Apr. May. Jun. Jul. Aug. Sep. Oct. Nov. Dec

What are the most common sites you take your customers to dive at German Channel?:

Please circle mooring buoys for sites most commonly used and feel free to add notes below:



At Ngerchong, do you take customers to dive the 'inside' or 'outside' sites?_____On average, how many other dive boats do you see at German Channel when you take customers diving there? Please circle:

None 1 2 3 4 5 5+

And at Ngerchong?

None 1 2 3 4 5 5+

Do the boats you see at German Channel use the mooring buoys? Please circle:

All Most Few None

Do the boats you see at Ngerchong use the mooring buoys? Please circle:

All Most Few None

In your opinion, are there enough mooring buoys at these sites? If no, which sites need more buoys and where?

3. IMPACTS

Do you think that diver or boat congestion is a problem at either of these sites? Yes/No

Please provide details:

Ngerchong and/or German Channel?_____

Suggestions_____

Have you noticed any damage to corals at either of these sites? Yes/No

Please describe:

Ngerchong and/ or German Channel?_____

_____

Damage from what? Please circle: anchors divers natural events Other_____

When diving with customers at German Channel, do you notice divers doing any of the following:

Please tick √	rarely	sometimes	often
Kicking corals with fins	☐	☐	☐
Holding onto corals in strong currents	☐	☐	☐
Breaking off corals with hands	☐	☐	☐
Sitting/standing on corals	☐	☐	☐
Chasing after manta rays	☐	☐	☐

When diving with customers at Ngerchong, do you notice divers doing any of the following:

Please tick √	rarely	sometimes	often
Kicking corals with fins	☐	☐	☐
Holding onto corals in strong currents	☐	☐	☐
Breaking off corals with hands	☐	☐	☐
Sitting/standing on corals	☐	☐	☐

Have you heard about the 1998/9 Coral Bleaching event in Palau? _____

If you can recognize bleached coral, how do you rate the degree of damage, in 1998/9 from this event to corals at German Channel? Please circle:

Severe moderate slight unnoticeable

Other comments_____

_____

Please add any concerns you may have regarding the state of either of these 2 dive sites:

Please add any suggestions of how you think Koror State could better manage/improve these sites in order to provide quality dive experiences for tourists:

6.9 LIST OF STAKEHOLDERS

Dive/Tour Operators	**Phone**	
A-Way Marine Entertainment	2947	Taiwanese
Antelope	1059 / 2077	Japanese
Aqua magic	1119	Jap/English
Blue Marlin (UBDI)	2214	Jap/English
Carp / Palau Diving Center	2978	Jap/Eng/Palau
Cruise Control	6691	Jap/Eng/Palau
Daydream	3551/2199	Jap/Eng/Palau
Dive Palau	3548	English/Jap
Fish N' Fins	2637	English
IMPAC	3779 / 5079	Japanese
Lesson Two Palau Sport	1120 / 1125	Jap/English
Long Rainbow Happy Tours	3240	Taiwan/English
Neco Marine Corp	2009 / 1755	English/Jap
Ocean Hunter	2637 / 1070	English
Pacific Divers Oasis	6960 / 514	Japanese
Palau Aggressor II	6075 / 6076	
Paradise Divers	5008	Japanese
Planet Blue Kayaks	1062	English
Power Passion Club		Taiwanese
Pro Dive Palau	4130	Japanese
Rock Island Tour Co., Ltd.	1573	Jap/Eng/Palau
Sam's Tours	1062 / 5305	English/Palau
Southern Marine Divers	2345	Jap/English
SPLASH	2600 ext. 485	Jap/English
Water World Palau	3826 / 3979	Korean/English

6.10 QUESTIONNAIRE COMMENTS (unedited)

We need information on corals so we can inform our customers about how rare it is. She wants to be able to explain to her customers why they should not touch the coral.

All dive guides should be educated especially the local guides.

Why did you choose these two sites? German channel is sand and Ngerchong is visited only in the summer – the main sites are west, Aren't they?
Each shop should tell their customers not to kick corals during their briefing and stress it. Customers are holding onto corals in areas of strong currents.

Please drive slowly in German Channel – especially the state boat that travels between Koror and Peleliu. Tell to customers about caring for corals during the briefing. Just put some more buoys in both sites. Because it always crowded that some people don't know where to park their boats, so they end up throwing their anchor in the water which can damage corals.

Add some more buoys and maintain them. Customers and we should improve our conscious awareness about protecting nature. We don't feed fish – including from the boat. We should be constantly researching coral. Plan some events that for improving educational awareness and conservation. Do a financial report about the Is. Permit and let customer know how it is contributing the conservation of nature. There should be buoys everywhere. Explain about protecting the sea – animals and plants, including corals to customer. Koror State should improve bathrooms, improve beaches and open others, could dress better when coming to work!!

We cannot do anything about damage caused by El Nino but at least research will find out what the effects are. German channel is a very popular site so we need at least two buoys at each site. It is also a dangerous place and the possibility of accident is very high. There are rules that drive slowly but plenty of boats run fast. I recommend that we give something to customers about rules that conservation of nature, safety diving, and what are we doing with customers permit fee.

The Japanese tour operators are not encouraging their divers not touch the corals. Most of them are negatively buoyant so they tend to sink to the bottom kicking up all the sand and breaking corals. Koror State should never let the Chinese or Taiwanese snorkellers in either dive site because they will break corals and take clams. Do NOT let them go to Big Drop-off!! Keep them at Ngermeaus! Stop all fishermen from fishing in dive sites. NO MORE Suggestions – come and dive with us and see yourself.