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Report on current status and exploitation history of reef fish spawning aggregations in Palau

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*[This version does not show spawning site locations –
to be released when these are protected]*

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Introduction

Many valuable reef fishes aggregate to spawn (breed), and, if targeted, such aggregations are readily overfished (Sadovy and Domeier, 2005). Since many aggregating species are not known to spawn outside of aggregations, these gatherings are important for the persistence of certain fish populations and the fisheries that they support. The vulnerability of aggregations lies in their extremely predictable formation, the large numbers of fish that gather together at the same time, and place, each year and their attractiveness for fishing because, once known they are easy to find and yield large catches efficiently.

Work in many locations in the western Pacific, Southeast Asia and the tropical western Atlantic has shown or suggested declines in many exploited aggregations and the complete disappearance of some (Colin et al., 2003). It is now widely recognized by biologists, and increasingly acknowledged by fishery managers, that spawning aggregations need to be managed, or effectively incorporated into marine protected areas (MPAs) if they are to persist in the face of growing pressure on reef fish resources. Somewhat surprisingly, given the importance of MPAs for protecting spawning stock biomass, few MPAs have been designed that specifically incorporate spawning aggregations, especially in the Indo-Pacific.

Palau is one of few countries, possibly the first, in the Indo-Pacific that recognized the importance of, and moved to protect, fishes that aggregate to spawn, specifically in the case of five species of grouper, *Plectropomus areolatus* (tiau), *P. laevis* (mokas, katuu'tiau), *P. leopardus* (tiau), *Epinephelus polyphekadion* (kesau or ksau'temekai) and *E. fuscoguttatus* (temekai or meteungerel'temekai). Since the passage of Palau Marine Protection Act in 1994, these species have been protected during part of their spawning season (from April 1 to July 31 they cannot be bought, sold or fished), and one spawning area in Koror State, Ngerumekaol (Ulong), protected. Ngerumkaol is protected under Koror State Public Law No. K9-101-99 (1999) as a no-fishing zone but tourism activities, such as diving, is allowed year-round. A 'Bul' (traditional protection) was imposed back in the 70's by traditional chiefs of Koror to prohibit fishing at the site. This Bul system effectively became the above-mentioned Koror State Public Law. Although no other species is specifically protected during its spawning aggregation, certain other fishes known to concentrate while spawning, such as rabbitfish, cannot be bought, sold or fished during their spawning season (March 1 to May 31). A second site, at Ebiil, was closed in 2000. However, enforcement is limited and despite these regulations, fishing pressure on reef fish resources is increasing and there are concerns regarding the long-term sustainability of several reef fishes and the challenges of enforcing existing regulations (refer to John Gavitt, Marine Protected Areas in the Republic of Palau: Status, Needs and Recommendations 2003).

As for most reef fish fisheries in the Pacific, there has been no standardized long-term monitoring in Palau that can be used to comprehensively determine resource status over time. Although the Marine Resources Division collected data from two known local fish

markets in Koror since 1990 (Palau Modekngai Company Inc. [PMCI] and Palau Federation of Fishermen Association [PFFA]) as part of their fisheries statistics programs, the objective was to have a better sense of fish landing volumes annually rather than management. Fishes sold directly to hotels, restaurant, and local consumption were not included in this project and there no effort or size data were collected. Landings data are no longer collected. Few biological or fishery studies on specific species have been conducted in Palau to provide a baseline against which to compare current catch trends and fishery condition.

One particularly interesting source of baseline information is provided by the 60 fisher interviews conducted by Bob Johannes in 1974 (Johannes, 1981). Johannes' book 'Words of the Lagoon' not only provides insights into fishing methods and activities in Palau at the time it was researched, and documents aspects of the inshore fishery at that time, it is also a tribute to the detailed knowledge and extensive experience of Palauan fishers. Such localized knowledge is being lost as fishers move to modern, less selective fishing gears and practices, as fast boats enable fishing to occur more extensively over the Palauan archipelago, and as exploitation has shifted from a focus on subsistence and 'Custom' (traditional use) to predominantly commercial use.

The objectives of this study were to document, through interviews with experienced fishermen in a range of fishing communities around the coast of Palau, local understanding and knowledge of reef fishes that aggregate to spawn and of their fisheries over the last few decades. Specifically, I focused on knowledge of the timing and locations of aggregations, fish species involved, catch rates past and present and opinions and attitudes of fishers regarding their fishery and its use and management. The interviews were intended to provide a baseline of information from older members of the fishing community who have the long-term perspective necessary to identify trends, if any, in their fishery. The project was funded by the David and Lucile Packard Foundation and forms one component of a larger project conducted on spawning aggregations in the western Pacific by the Society for the Conservation of Reef Fish Aggregations (www.scrfa.org) which aims to document the exploitation of spawning aggregations and aggregating species in a region for which very little information on this topic exists.

Methods

Interviews were conducted in close collaboration with the Palau Conservation Society (PCS) who advised on the communities to be visited, organized introductions to fishers and translated between Palauan and English when necessary; Rengiil Madalarak and Tino Kloulchad translated interviews and participated in all aspects of the study. Jason Kuartei assisted in study design and logistics. Seven areas or fishing communities were visited, selected to cover a diverse range of locations within Palau and incorporating areas with both high and low fishing intensity.

Thirty interviews were conducted one-on-one in all regions of Palau using a standardized (http://www.scrfa.org/server/studying/doc/Fisher_Survey_Interview.pdf) and simple questionnaire in July, 2003. Fishers were selected who had a long history of full- or part-time fishing for at least 10 years and/or were respected patriarch fishers within their community and had long fished in the area where they were interviewed. Fishers were typically interviewed in their homes and questioned about their fishing gears and practices, and the main species taken. They were then asked whether they recalled times in the year when catches were particularly high for certain species, or whether there were seasons when they noticed many fish with eggs; they were not questioned directly about 'spawning aggregations' but were asked to elaborate if they identified either seasonal high catches or lots of fish with eggs in their landings. The links between high catches and eggs present was made later.

Information was also collected on catch rates, fishing effort, regulations, changes noted and any concerns and suggested solutions to problems. Catch rates over time were determined by asking about highest or best catches per day or per trip (whatever was most appropriate) in past decades, or when they first fished an aggregation, and about catches most recently. Numbers of boats fishing and day or nighttime activity was discussed as well as the specific timing of aggregations and their location(s). Questions were also asked about knowledge of local regulations, on general impressions on the fishery (i.e. any changes) over their fishing career, on opinions on reasons for changes (if any), and possible solutions to any perceived problems. Interviews were typically about one hour in length and information on fish biology was exchanged when fishers were interested to know more about the species under discussion. Photos of fish (both live on the reef and freshly dead) were available for identification from local posters and from Myers (1991) and fresh fish inspected whenever possible. A detailed map was provided to identify fishing areas, and spawning sites if any: United States Government, Defense Mapping Agency Map Number 81141 for the Palau Islands – scale 1:165,000. A list of the Palauan fish names used in the survey with English common names and Latin scientific names is given in Table 1.

On completion of the interviews, copies of all raw interview data and a map showing all reported spawning locations were deposited with PCS. A presentation of the results of the interviews was made at the Palau International Coral Reef Centre in July 2003, and a visit made to the Koror State Rangers to discuss results. Details of spawning site locations will not be widely released until the aggregation sites are protected because of continued poaching in Palau, both by local fishers and by live reef food fish traders taking mainly grouper for export. However they are available for conservation and management initiatives

It is always preferable to validate the results indicated by interviews of this nature by follow-up work in the field to confirm species, timing of aggregation, sites reported and current capture rates, if at all possible. Although validation was not possible during the present study, three of the reported sites were subject to research in the late 1990s (Johannes et al. 1999) and there has subsequently been work conducted at a number of sites. These studies facilitate validation of species reported and the timing of aggregation

at the three sites indicated and their results are compared with outcomes of the present interview survey in the Discussion.

Results

The results of the interviews are summarized in Table 2 which is a summary of the interview notes. The table summarizes the 30 interviews conducted. A footnote records additional comments by fishers on the humphead wrasse (*Cheilinus undulatus*) and Bumphead parrotfish (*Bolbometopon muricatum*). Although neither species is targeted in spawning aggregations, many interviewees noted marked declines in their catches over the last few decades. Maps indicating interview locations as well as general locations of spawning sites for different species were created for Figures 1 and 2 and will be released once the sites are better protected. Trends indicated for grouper catches from aggregations are provided in Figure 3. Photographs from several interviews and of the interviewing team are shown in Figure 4.

The results from Table 2 are summarized according to three topic areas: details of the interviewees and their fishing activities; details of aggregating species and their fisheries, and comments and attitudes of fishermen regarding their fishery.

Fishing experience, fishing areas, gears and target species

Interviewed fishers ranged from 10 to 40 years in fishing experience, many were or had been full-time, but even part-time fishers had been or are extremely active. Some fishers had experience going back to the period following World War II. Both day and night fishing was identified. Fishing gears included spear (from throwing spear to speargun), hook and line, castnet, leaf sweep (*ruul* in Palauan and a method little used today). Fishing activity was either conducted in the general vicinity of the fisher's own community to state boundaries, with the notable exception of fishers based in Koror some of whom evidently fish over a much wider area than fishers interviewed elsewhere. The species most commonly taken depend on the type of gear used but predominant fish families reported in catches included parrotfishes (Scaridae), groupers (Serranidae), emperors (Lethrinidae), snappers (Lutjanidae), rabbitfishes (Siganidae), surgeonfishes (Acanthuridae) and pelagic species such as Jacks (Carangidae). Comments were often made that two large and favoured species, the humphead or Napoleon wrasse, *Cheilinus undulatus*, and the bumphead parrotfish (*Bolbometopon muricatum*), had declined substantially over the last few decades and were now uncommon or rare in places where once they were more common. With one exception, neither species was reported to be taken in spawning aggregations, although the bumphead parrotfish was sometimes readily taken at night when sleeping in large schools in shallow waters. The results from these two species are summarized in a footnote to Table 2.

Aggregating fishes with eggs and capture trends

There was a very strong and consistent signal from interviews for the occurrence of spawning aggregations for several reef fish species, with the timing, species and habitat type reported extremely consistent across interviews (Table 2, and see below). Notably, three grouper species, *P. areolatus*, *E. polyphkadion*, and *E. fuscoguttatus* were reported to aggregate to spawn by almost all interviewees. Spawning aggregations of *Lutjanus bohar* and *Lethrinus olivaceus* were often indicated, though for these two species the specific timing and locations were less well-defined than for the three groupers, and the spawning season of generally longer duration. Migrations of ripe rabbitfishes, mullets, bonefish and milkfish in inshore areas were reported at several sites around Palau and had, in the past, been heavily targeted. Spawning aggregation sites include a number of inshore areas and major reef channels/passages.

Plectropomus areolatus*, *Epinephelus polyphkadion* and *E. fuscoguttatus

The interviews suggested a marked consistency in the reported timing in the year when aggregations form, the main grouper species involved, and that aggregating fish typically had eggs. In some cases, fishers (divers) were able to describe in some detail the different distributions of the three species of groupers on the substrate at aggregation sites familiar to them. Some differences between interviewees emerged in terms of the timing within the lunar phase when fish numbers were highest during aggregating months (Table 2). The similarities and discrepancies across interviews in timing and location are summarized and compared to earlier interviews by Johannes (1981) and by fieldwork reported in Johannes et al. (1999). Fishing activity and catches will then be discussed.

In terms of consistencies across interviews, it was clear in all cases that three grouper species regularly aggregated at specific sites and that these sites were reef passes and channels as well as at sites along the outer reef slope, often near to channels mouths (Figure 1). The three grouper species were often noted to use different areas of the channel and channel mouth, ranging from the channel itself to the outer apron and varying in depth according to the species. The three species reported were *P. areolatus* and *E. polyphkadion*, the two species that yielded the most landings, and *E. fuscoguttatus* in smaller numbers; in some cases only one or two of the three species were reported to be present, but generally all three were mentioned. In one or two cases, small numbers of *P. laevis* or *P. leopardus* were also noted. The aggregation period was reported to occur for several months between April and August with some differences between species and by year, but often with overlap (i.e. highest catches of all three species combined) in July. August was frequently mentioned as an aggregation month. Some fishers noted that August catches might be lower at times, and that sometimes the fish may not have eggs in this month.

Some differences between interviews were noted in the phase of the lunar cycle when catches were highest and in the principal aggregating months between years. For lunar phase, fish were mainly reported to aggregate from a week or less before the new moon, but other interviews reported aggregations to occur several days before and after new moon, or in the period after full and before new moon. Overall, however, the greatest

numbers were indicated to occur after full and before new moon phases, sometimes just beyond the new moon. Reported aggregating months were mainly within the period from May to August.

Fishing activity was indicated to have started on the aggregations during the second half of the 1900s starting from about the 1960s and to have initiated more recently in northern reefs compared to reef channels or passes in the south of Palau. The longest and most widely mentioned aggregation channel appears to be Ngerumekaol (Ulong), generally thought to have been fished since at least the 1960s. Initially, just a few boats visited aggregations, the number growing to 10 to 30 boats in some areas in southern Palau by the 1980s (fewer boats at more northern sites). Activity was reported to drop in the 1990s, presumably because of the introduction of regulations to protect aggregating fishes in 1994. However, some exploitation still continues in August which does not fall under the current period of protection. Fishing activity was evidently affected by ease of marketing, with gluts of fish occasionally noted to be a problem in the past. Fishing occurred both day and night, including with SCUBA, and catches per trip noted to reach peaks of almost 3,000 lbs of grouper for one boat trip; a boat usually holds several fishers. By the late 1980s, early 1990s, catch rates (all three grouper species combined) had dropped to 200 lbs, often less, per trip (Fig. 3). The change in catches over time is significant (Kruskall-Wallis $H=10.843$; $N= 36$; $df=4$; $p < 0.05$).

The Johannes et al. (1999) field study conducted over 3 years in the late 1990s allows for some verification of the interview data collected in 2003, and comparison with previous interviews is also of interest. Monthly underwater observations were made at 3 known aggregations sites, Ebiil and West Entrance in Ngarchelong State, and Ngerumekaol (Ulong) in Koror State between 1993 and 1995. Numbers of fish were counted and fish inspected for extrusion of eggs or sperm. Highest numbers of *E. polyphkadion*, *E. fuscoguttatus* and *P. areolatus* were found between May and August of each year (with one exception for one species at one site in one year, when gatherings were noted monthly from February through September). Peak fish numbers occurred from 7 days before, up to the time of, the new moon in two to three months for *E. polyphkadion* and *E. fuscoguttatus*, to all months for *P. areolatus* from May to August. Fish were noted to consistently occur in different areas within the aggregation sites; in Ngerumekaol for example, *P. areolatus* occurred on the apron in the mouth of the channel with other species in the channel and deeper off from the apron. From interviews conducted in 1974, Johannes (1981) reported three groupers that aggregate to spawn, *E. fuscoguttatus* and *P. leopardus* (very probably this is intended to be *P. areolatus*) in May to June disappearing at or just after new moon, and *E. merra* spawning at the full moon inside certain channel mouths.

Lethrinus olivaceus (L. miniata)

This species occurs predictably in distinct groupings when it has eggs, and during which times 500 lbs have been caught in one fishing trip. However, the timing of the groupings is evidently not as distinct or predictable as in the case of the groupers. Reports indicated that the new moon or the full moon in many months were times for reproductive gatherings. Aggregations occurred in a variety of places, including areas known to be

close to those of grouper aggregations and outside of reef channels. This was the only emperor consistently reported to spawn in aggregations. In Johannes (1981) this species was reported to spawn throughout the year from new moon plus 5 days along the outer and inner edges of the barrier reef with fish caught both day and night. Their numbers in Ngeremlengui were much diminished by the early 1970s.

Lutjanus bohar

The only snapper consistently identified to aggregate with eggs was *Lutjanus bohar* (*L. gibbus* was also mentioned by one fisher). The time when this species had eggs was reported to vary, from several days after or before full moon to the new moon phase for many months of the year; the months of February to August being identified specifically. Groups of fish with eggs are located over a wide area but are often outside the channel mouth and outer reef slope. At these times, thousands of pounds of fish could be caught. Catches were reported to have been high in the 1980s, but to have since declined. In Johannes (1981) *L. bohar* species was reported to gather with eggs at the full moon from April to July, possibly in more months, at the outer reef slope.

Naso unicornis

This species is found in large groupings when it has eggs and can be caught in large numbers at this time, 500 lbs or more in a fishing trip. Many were once taken using the leaf sweep, a method little used today having been replaced with gillnets. Fish are found with eggs in many months and, although accounts between fishers varied, months often identified were February and August, at both full and new moon times. Fishing was sometimes at night. Large groupings were reported from many locations in Palau, especially outside the reef in the vicinity of reef channels, but also on inner reefs. Many reports indicated declines in this species. No other surgeonfish was specifically identified as aggregating to spawn. In Johannes (1981) this species was noted to move in schools along the outer reef slope, and to show great seasonal variations in abundance; fish with eggs were reported at both full and new moon seasons.

Rabbitfishes

Several species of rabbitfish form migrations when they move to spawn at predictable times along predictable pathways. It was not possible to confirm the species during the current survey but the species implicated are *Siganus canaliculatus* and *S. lineatus*. Rabbitfishes in Palau were reported to occur in large numbers with eggs during a few days mainly around the new moon of several months, particularly February to May, occasionally also in June and July. While a few hundred pounds can be caught during these movements, catches have become much reduced compared to years prior to the 1990s. Since that time, both catches and sizes of fish have declined, according to most interviewees. As just one example, in the 1980s spawning runs of many hundreds of pounds of fish per night were taken for several nights at peak times; now a single net and much fishing effort will only take 50 or so fish. Catches in some areas were said to have been even higher in the 1970s. The places where large numbers of fish gathered when they had eggs were well-known and there was once heavy fishing pressure at these times.

Johannes (1981) reports on several migrating rabbitfishes and at least 20 known locations along outer edges of fringing or barrier reefs to which the species evidently migrate to spawn. Spawning was noted to occur 3-6 days after the new moon phase mainly between February and June, but also in other months. There was once a well-known spawning migration near Airai, but overfishing was thought to have much reduced it and there are now regulations on the use of nets to catch these species and on prohibitions during spawning months. The species is easy to catch in large numbers with small mesh size nets. A study on rabbitfish is underway by Ann Kitalong and Liz Matthews in Airai.

Mulletts

Two species of mullet are indicated from interviews; these are probably *Moolgarda seheli* or *Crenimugil crenilabis* and *Liza (=Ellochelon) vaigiensis*. The species move together in places like Peleliu and the Rock Islands, and were noted to have eggs in many months of the year for a few days around the time of the full moon. Interviewees reported that both species had once been plentiful in several areas when they passed with eggs but that catches had gone down substantially, and body sizes become reduced, since the 1980s. Once it was possible to catch 100s to 1,000s of fish at a time with gillnets; now very few of these species are taken. In some areas, neither species is caught any longer. At one time, fishing methods used for the species included large nets and dynamite.

Likewise, Johannes (1981) reported several species of mullet in Palau to have a lunar periodicity, mainly full moon, to egg presence and to undergo long migrations. November was reported to be a major spawning month with one species, while another was reported to spawn mainly in March or April. Migrations of mullet were known from Peleliu where large numbers could be caught in nets during spawning migrations that lasted for just a few days in certain lunar phases. Migrations were also reported along the western coast of Babeldaob. By the mid 1970s, mullet schools were smaller than in the 1960s, reportedly because of heavy net and dynamite fishing. Best fishing for mullet was said to be during the spawning season.

Bonefish and milkfish

Species of both bonefish and milkfish have largely disappeared from Palau, according to interviews, although once both were caught in high numbers during spawning migrations during the full moon period in many months. *Albula glossodonta* is now evidently rare and, although catches could be variable between years, overall declines were noted to substantial during the 1980s and 1990s in Peleliu. Johannes (1981) reported this species to migrate with eggs at new and full moon from January to June, at which times they were fished with nets.

The milkfish, *Chanos chanos*, is a very important food fish in the tropics. Up until the 1980s, it was known to occur in large numbers, with eggs, on the eastern side of Peleliu. It no longer appears to be a significant fishery. One interviewee at Airai noted that he would like to see this species come back. Johannes (1981) noted that large groups of this species were known from the southern tip of Palau up until at least the 1970s, and had eggs during new and full moon periods, for a few days in each of January to May. At

such times individuals were easily speared and dynamite reportedly reduced its numbers after the 1960s.

Other

While the humphead wrasse, *Cheilinus undulatus*, and bumphead parrotfish, *Bolbometopon muricatum*, were not targeted specifically during spawning aggregations, the parrotfish was once taken in large numbers as it slept in groups in shallow waters, and both species were noted to have declined substantially over the last two decades. Accounts on these species were given by 9 (*C. undulatus*) and 8 (*B. muricatum*) fishers and are summarized in the footnote to Table 2. Overall, many fishers expressed concern over the declines in these two important species and there was a general consensus that declines had occurred because of heavy fishing at night when both species are easily caught, especially on compressed air. *C. undulatus* is considered to be an uncommon fish, important for 'Custom', but showing marked declines in catch rates and sizes over several decades. Fishers of *B. muricatum* could catch tens or hundreds of fish at a time in one school; some fishers noted that there were many fish with eggs at certain phases of the lunar cycle.

Both species are regulated in Palau: neither can be exported and neither can be taken, bought or sold below 25 inches in total length. Ongoing work shows that reproductive populations of the humphead wrasse are viable in Palau (Pat Colin, pers. comm).

Comments and attitudes of fishers

The comments of interviewees regarding the status of their fishery and the possible or necessary actions for addressing perceived problems provided valuable insights into some current perspectives and concerns in the fishing communities visited. In general, observations or attitudes were consistent across interviews although in a few instances seemingly contradictory comments were made by individuals, such as there are no problems with the fishery but there is a need for protection. Fishermen were generally well-informed about regulations.

In almost all cases, declines, often substantial, in numbers and sizes of fishes over the last several decades were reported; some fishers could not explain the declines, others suggested a range of possible causes. Mullet and milkfish species had largely disappeared from areas where once they had been abundant, and rabbitfishes and groupers had clearly shown marked declines in many areas. The aggregating species had declined more noticeably than most other reef fishes according to some responses. Reasons given for declines in catches ranged from natural increases or decreases in water temperature, pollution from erosion, and heavy boat traffic inshore, which can affect species such as rabbitfishes or mullet, too many fishermen and lack of enforcement of existing laws, to persistent use of illegal gears or fishing methods (such as illegal gill nets, compressed air and flashlights at night). Several interviewees complained about fishers who were traveling further and further from Koror into areas where they did not have permission to fish and many considered that existing protection was not helping the fishery because of poor enforcement outside of Koror. There was a wide acknowledgement of persistent

illegal fishing either through disrespect of the grouper aggregation ban, fishing without permits, or using illegal gears such as compressed air with speargun. There was concern expressed that the current administration is not committed to protecting inshore fishery resources adequately.

Means and solutions to address the identified problems consistently fell into a clear set of categories, ranging from the need for enforcement and additional management measures, to the need to be proactive through the introduction of restocking. There was clear widespread concern over the lack of effective enforcement of existing regulations, especially fishing with SCUBA and illegal grouper aggregation fishing at night, because of too few enforcement staff and/or enforcement being limited to daylight hours. Greater enforcement was perceived to be a major area for attention. Support to protect spawning fishes and allowing time for females to release their eggs was often voiced. Additional management measures were identified such as closing grouper aggregations during August (as well as from April to July), increasing the number of closed areas (at least on a temporary or rotational basis and especially to protect spawning or nursery areas), banning certain fishing methods such as gillnets and fishing at night, and controlling inshore boat traffic. One interviewee suggested that fines for illegal fishing should be higher, while several suggested that reef fishes should be kept for 'Custom' and home use only, and not used for commercial activities. Finally, suggestions for research to determine whether current protection is effective and to develop aquaculture and restocking initiatives were made. Market controls could be used to influence fishing activity and assist in management, it was proposed. Interviewees were well aware of the prevailing fisheries regulations of Palau, with the possible exception of the use of underwater breathing apparatus for fishing in some cases.

Discussion

The 30 interviews conducted in July 2003 clearly and consistently indicated that several culturally and commercially important fishes aggregate to spawn in Palau at specific times and places and are, or were, targeted at such times and places. Some species are evidently more predictable than others in their times and places of spawning, and in most cases declines in catches have occurred over the last few decades. Many reasons were proposed for these declines and many of the fishers expressed concern that not enough was being done to protect the reef fish fishery of Palau. Although current laws are considered to be good and probably adequate, a major problem was perceived to be in their enforcement. The message was clear that more action is needed to ensure long-term sustainable use of reef fish resources, especially those that aggregate to spawn.

This discussion section covers fishers' knowledge and the need for validation of interview information, summarizes patterns identified in species exploited and in fishing activity, and provides recommendations based on these surveys.

Fisher perception and knowledge

Many of the older fishermen, whether fishing for part of their lifetime full-time, or taking fish part-time for home use or for 'Custom' had an extremely detailed recall of the species important to them. While this is not surprising, and is fully consistent with the work of Johannes (1981) conducted in the 1970s, experiences from fisher interviews conducted in many other countries in Southeast Asia and the western Pacific (see country reports in www.scrfa.org), suggest that Palauan fishers are particularly knowledgeable. One fisher had maintained a written log of catches and moon phases when fish had eggs from his fishing days decades before, and others (divers) were able to describe in detail the different areas within specific grouper aggregation sites frequented by three different groupers species. Moreover, the information was generally consistent for particular species in terms spawning months, aggregation sites and trends in the fishery over time.

Interviewees were also generally knowledgeable about fishery regulations in effect in Palau, had considered reasons for changes in catches and sizes of fish over their fishing careers and were concerned about overfishing and other impacts. It was interesting to note that, while declines in grouper aggregations were often attributed to overfishing, declines in species that aggregate at inshore sites were more often attributed to pollution and increases in boat traffic. Most fishers noted substantial declines in certain aggregating species such as in mullets, milkfish, and also declines in landings from grouper, rabbitfish, unicornfish and red snapper aggregations. However, overall declines were also noted in the reef fish fishery, in general. There were expressions of concern and recognition that more management is needed and that current regulations need to be better enforced. Although not taken in spawning aggregations, many fishers noted extreme declines in bumphead parrotfish and humphead wrasse. A number of fishers commented that reef fishes should be kept for 'Custom' and home use only, and not traded commercially. It was considered that the regulations in place were good but that these were often not enforced.

Validation of Spawning Aggregations

Information collected during interviews can be extremely valuable if interpreted carefully and if likely errors are considered, but whenever possible it is critically important to validate interview outcomes with field-work, before management is implemented. Validation is advisable to confirm species identifications, verify times and locations of spawning and to verify information that could be used for effective management and conservation initiatives. Given year-to-year natural variability in the formation of spawning aggregations in a range of species, information should be collected over several years to properly document the full extent of areas used for spawning, as well as the timing of spawning annually (for full methodology and background, see: Johannes *et al.* 1999; Colin *et al.* 2003). In respect of the current study, there are relevant validation data only for grouper spawning aggregations. Interviews compared favorably with previously conducted field-work for *P. areolatus*, *E. fuscoguttatus* and *E. polyphekadion* at three of the spawning locations reported in interviews, Ebiil, Ngerumkaol and West Entrance

(Johannes et al. 1999). Concordance was good with respect to the months of spawning for the three species, the dominance of two of them in terms of numbers aggregating, and in the identification of spawning sites and species involved. Much less consistent was concordance between interview data and field data with respect to the more specific timing of aggregation or spawning during the lunar phase: this may be due to natural variability or to faulty recall but is an important detail for management and monitoring and requires scientific study. Surveys of aggregations are variously being conducted by Dr. Pat Colin, Palau Conservation Society and the Palau International Coral Reef Centre.

Trends in the fisheries of aggregating reef fish species

The interviews clearly suggest that several reef and inshore fish species that predictably aggregate or migrate to spawn, and that are targeted at such times, have declined: key spawning areas and times are the outer reef channels and passes around Palau during the months of February to August. In many cases declines have been substantial. Mullet and milkfish populations have evidently been compromised by years of heavy targeting during their spawning runs, and rabbitfish catches during spawning migrations have considerably reduced. Many aggregations of *P. areolatus*, *E. fuscoguttatus* and *E. polyphkadion*, *Naso unicornis*, *Lutjanus bohar* and *Lethrinus olivaceus*, as well as overall catches of some of these species (i.e. including outside of the aggregation period), are perceived to have declined. All are valuable species for domestic (including subsistence, 'Custom', commercial and tourism) use and their apparent declines, if unchecked, could ultimately lead to the loss of commercial value and greater dependence on costly imports. Declines in such species are likely to put greater fishing pressure on other reef fishes such as surgeonfishes, emperors and parrotfishes, as indicated in several interviews. The message is consistent with findings elsewhere in the western Pacific and southeast Asia, that reef fish species cannot withstand high levels of exploitation associated with unmanaged commercial use (e.g. Birkeland 1997; Sadovy 2005). Declines in spawning aggregations in particular, and in the catches of particularly vulnerable species such as the bumphead parrotfish and the humphead wrasse (Table 2 footnote) are clear indicators that management is needed. Such warning indicators are evident from the interviews conducted in Palau, and should be heeded as a sign that all is not well with the important fisheries of inshore coral reefs.

For the three aggregating groupers, while it is not possible to readily compare landings data over time at specific aggregation sites for each species individually, or to validate reported changes in landings over time, nonetheless there was a strong signal suggesting an overall decline in landings per fishing trip over the last few decades (Fig. 3). This outcome is consistent with anecdotal accounts and reports (e.g. Johannes et al. 1999). It should be noted, however, that care is needed in using landings data as an indicator of grouper population condition partly because of possible natural variations in numbers across months or years for certain species at certain sites, partly because of possible problems of recall by fishers going back several decades, and partly because of changing conditions and markets that could influence fishing effort and affect landings. As two examples of such considerations: (1) fishing on aggregations started much more recently at northern sites than in southern Palau such that patterns over time might differ

depending on the location of the aggregation (in Figure 2 all data per decade are included irrespective of aggregation site); (2) prohibition of exports resulted in reduced effort due to market gluts. Nonetheless, the overall indication is of declines over the last 40 years.

The long-term declines strongly indicated by the interviews conducted are reason for concern. Given that actual fish numbers at several aggregations of groupers were estimated by underwater visual census to be hundreds or few thousands at any one time at an aggregation sites (e.g., Johannes et al. 1999) catches of a 0.5-1 ton of fish or more during a single fishing trip by one boat could represent a significant number of all the fish present (assuming an average of about 1 kg per fish) being removed before they have had a chance to spawn at any one site in any one month. Summed over many boats, months, years and sites, it is, perhaps, not surprising that marked declines in catches are indicated within a short period of time after sites are initially exploited. Even low levels of fishing pressure can clearly cause rapid and substantial declines if unchecked.

Monitoring species-specific catch rates over time is an essential part of understanding trends and conditions in a fishery and must be incorporated into any effective management regime. Unfortunately, this information is no longer collected on a regular basis in Palau, such that there is no means to establish the condition of the fishery from long-term catch or size trends, other than by one-off studies or fisher knowledge. This also means that it is difficult to assess the outcome of management interventions.

Recommendations

- Enforcement of regulations at night, especially with respect to grouper aggregation fishing, fishing on compressed air and poaching in northern areas of the country
- Strengthen fine for repeat offenders
- Extend existing law to protect grouper aggregations to include August
- Monitor landings of key reef fish resources, by species, on a regular and standardized basis
- Determine status of surgeonfishes, parrotfishes, snappers, and emperors
- Conduct education campaign to inform the public of the importance and relevance of laws that protect marine resources.
- Prohibit export of all reef fishes
- Ban night fishing with spear
- Protect additional aggregating reef fishes from February to August inclusive (e.g. lethrinids, snappers, *Naso unicornis*)
- Determine status of milkfish, bonefish and mullet stocks
- Include some reef channels and passes in marine protected areas
- Use reef fish resources principally for subsistence use and 'Custom', with limited commercial exploitation
- Validate the aggregations reported in this study

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Figures

Figure 1: Spawning aggregation sites of *Lutjanus bohar*, *Lethrinus olivaceus*, *Epinephelus polyphekadion*, *E. fuscoguttatus* and *Plectropomus areolatus*, several grouper species. Locations where interviews were conducted are named. **Map removed temporarily until sites managed.**

Figure 2: Spawning aggregation sites of *Naso unicornis*, mullet, rabbitfish, and *Chanos chanos*. Locations where interviews were conducted are named. **Map removed temporarily until sites managed.**

Figure 3: Peak catches in pounds per trip taken at spawning aggregations of groupers (*E. polyphkadion*, *E. fuscoguttatus* and *P. areolatus*) as reported from fisher interviews conducted in July 2003 from the 1960s, 1970s, 1980s and 1990s at different aggregations sites in Palau. For each decade, different symbols represent a separate estimate but the same symbol across decades may not represent estimates from the same fisher. There is a significant difference in landings over the 1960-2000 time period.

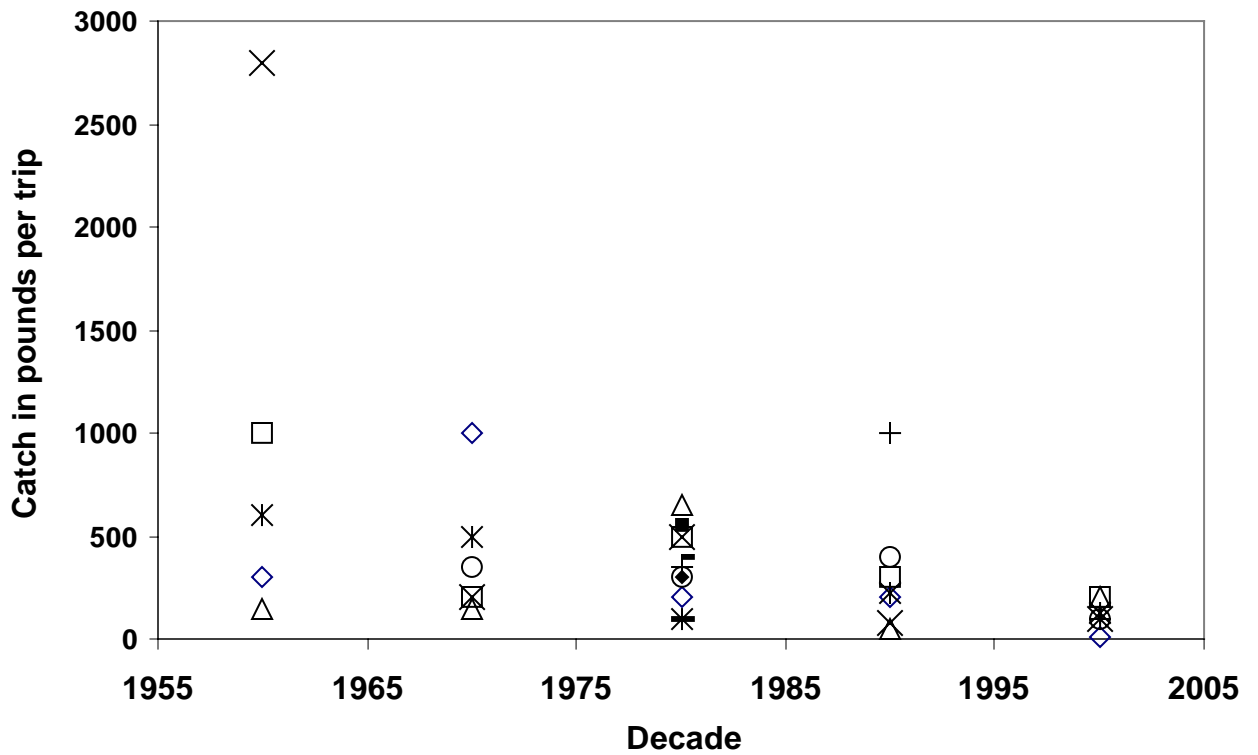


Figure 4.



Fisher Interviews: Palau 2003. A total of 30 interviews was conducted. For each interview, cards were used to assist in fish identification (a, b) and maps provided (b) to identify aggregation sites. Gear was inspected, whenever possible (c). Fishing interview team: Rengiil, Yvonne and Tino (d).

Table 1 - Fish Species Name Glossary

Besechaml: large-eyed porgy (*Monotaxis grandoculis*)
Um: surgeonfish (*Naso unicornis*)
Meyas/Meas (Kelsebuul, Terekrik): rabbitfish (*Siganus* spp, probably *S. canaliculatus* and *S. lineatus*)
Tiau (black): squaretailed coral grouper (*Plectropomus areolatus*)
Tiau (red)=mokas: leopard coral grouper (*Plectropomus leopardus*)
Karamlal: snapper (*Lutjanus gibbus*)
Temekai=meteungeral'temekai: tiger grouper=marbled grouper (*Epinephelus fuscoguttatus*)
Kesau=ksau'temekai: camouflage grouper (*Epinephelus polyphekadion*)
Kelat: fringelip mullet (*Crenimugil crenilabus*; could be *Moolgarda seheli*)
Uluu=yellowtail mullet *Liza* (= *Ellochelon*) *vaigiensis*
Mesekekat: milkfish (*Chanos chanos*)
Aol: Indo-Pacific bonefish (probably *Albula glossodonta*)
Kotiko: mojarra (*Gerres* spp.)
Mlangmud: Long-nosed emperor (*Lethrinus olivaceus*=*L. miniatus*)
Maml=Ngimer: humphead wrasse (*Cheilinus undulatus*)
Kedesau: red snapper (*Lutjanus bohar*)
Katu'u'tiau=mokas: saddled grouper (*Plectropomus laevis*)
Berdebed=kemedukl: bumphead parrotfish (*Bolbometopon muricatum*)

Table 2 - PALAU FISHER SURVEYS

Summary table of 30 fisher interviews conducted 8-17th July, 2003

Interviews conducted in Palauan unless indicated with an *.

Spawning site locations are indicated on map depicted in Figs. 2 and 3 (for later release).

Additional notes of *Cheilinus undulatus* and *Bolbometopon muricatum* are summarized as a footnote.

spear= speargun, as distinct from throwing spear; *leaf sweep* = 'ruul'

Date of interview (fishing area): how long fishing	Gears (major gear, if any, given in bold) Main species caught	Evidence for spawning seasons; large numbers of conspecifics caught with eggs	<i>Catch rates and history</i>	Comments, opinion, and concerns of interviewees
08/07/03 (Koror): Since childhood, now retired	Gillnet, hook and line , spear Milkfish, rabbitfish, <i>Lethrinus olivaceous</i> , groupers, snappers, surgeonfish	Rabbitfish near Happy Landing (Feb-May at new moon with eggs (spear and cast net). Groupers: April-August (mainly May to July) group for 4 days before new moon at Ngerumekaol. Mainly <i>P. areolatus</i> and few <i>E. fuscoguttatus</i>	Groupers: before ban could catch 200 lbs, mainly <i>P. areolatus</i> in one night and 10-15 <i>E. fuscoguttatus</i> in 2-3 hours at night. Many ('tons of') fishers at site before regulation. Rabbitfish: In 1980s spawning runs 100-200 lbs in one night for several nights. Now, 1 thrownet catches 50	Rabbitfish declines due to pollution, erosion, long nets being used by outsiders, too many fishers

			fish and there is much more effort.	
*08/07/03 (Ollei); full-time 7 years (1980s), part time for life. Interview covers full-time period.	Spear at night, hook and line, castnet (bait) <i>Bolbometopon muricatum</i> (night spearing), parrotfishes, surgeonfish, <i>Lutjanus gibbus</i> (nighttime), spawning groupers	Groupers: two grouper spawning areas known; Ebiil discovered 1985, West Passage discovered late 1980s approximately. <i>E. polyphekadion</i> present (May-August), also <i>Plectropomus areolatus</i> (June-July) but harder to catch at same sites and <i>E. fuscoguttatus</i> (May-August) but few of this species in catches. <i>L. olivaceous</i> aggregates but months not so distinctive – 2 days before full moon. Groupings occur inside grouper spawning areas and at a larger number of areas compared to the groupers but these areas are also distinctive. <i>Lutjanus bohar</i> ; full moon groups in outer channels over wider area than groupers and timing less predictable. <i>B. muricatum</i> with eggs 4 days before new moon.	Groupers: few <i>E. polyphekadion</i> caught outside of aggregations. Often caught so many that there was no market for them in 1980s and could have caught more: 500-800 lbs in one day. <i>P. areolatus</i> 200 lbs a trip and only about 10 <i>E. fuscoguttatus</i> per trip. At Ebiil used to be 10 boats and 3 fishers per boat; West Passage 3 boats, at aggregation time. <i>L. olivaceous</i> could get up to 500 lbs in one night. NOTE: says that Ngerumekaol aggregation site was discovered before 1969	Noted that grouper numbers caught at aggregations declined over time but not the fish sizes. Public understands need to protect aggregations; have learned from Palau Conservation Society. Also noted declines in <i>Lutjanus gibbus</i> . Thinks cause of declines is overfishing.
08/07/03 (Ngerem-lengui): 30-40 years. Fishes oppor-	Spear at night, hook and line at day. Cast/gill net. Reef fishes, incl.	Groupers: in all reef channels (mentions Lengui, Ebiil, Ngerumekaol). <i>E. polyphekadion</i> , <i>E. fuscoguttatus</i> and <i>P. areolatus</i> speared in aggregations but did not sell much of his catch so did not	Groupers: noted declines in aggregating groupers. Per trip catches at aggregations changed from 150 lbs/trip in 1970s to < 50 kg per trip (2-3 fishers in a boat per trip)	Does not know why catches declined. Suggests recent coral bleaching could be a cause. Suggests declines in rabbitfish size and numbers due to

tunistically, part-time	Goatfish, small <i>Cheilinus undulatus</i> , <i>Lethrinus</i> spp. <i>Lutjanus gohar</i> and <i>E. polyphkadion</i>	catch much. Months June-August. Rabbitfishes: used cast/gill nets March-April and new moon for 9 days.		speedboats inshore that kill their eggs.
09/07/03 (Ngerem-lengui): 40 years full-time fisher	Various gears: gill/cast net, throwing spear, spear, hook and line. <i>P. areolatus</i> , <i>E. fuscoguttatus</i> , <i>Lethrinus</i> spp, <i>Lutjanus</i> species, skipjack tuna, mullet, rabbitfish	Rabbitfish: Feb-April for 6 days after full moon. Groupers: Lengui channel is aggregation site for many species and he thinks that most channels probably have aggregations. He found his aggregations by chance. Groupers aggregated April-August on apron and in channel. Three species together, <i>E. fuscoguttatus</i> , <i>E. polyphkadion</i> and <i>P. areolatus</i> . Also some other species such as <i>L. olivaceous</i> (new moon, most months) and <i>L. bohar</i> .	Rabbitfish: one cast net throw would need 2 people to haul. Now fewer and smaller fish. Groupers: could once get > 500 lbs in 3 hours. In 1980s, about 30 boats present. Lutjanus bohar: could get 300 lbs during aggregations (usually with eggs)	For rabbitfish and groupers, feels that declines in numbers and sizes of fish occurred after protection was introduced. Generally noted that all fishes fewer nowadays and more effort is needed to catch them. Also noted big increase in number of fishers in his area by the 1980s, including from Philippines. 1997/8 Taiwanese came for <i>P. areolatus</i> and <i>C. undulatus</i> – thought they caught too many fish to export.
*09/07/03 (Ngerem-lengui): 30 years, full-time	Gill net, cast net, throwing spear, spear (sometime with light at night), hook and line	Rabbitfish: Feb-April at specific places fish with eggs, inshore location. Groupers: fishes day and night. Best fishing was 1967-1974 (approx.). Thinks Lengui site known for at least 70 years but not	Rabbitfish: 500-600 lbs caught at peak times and has seen no change over time. Groupers: (several species) used to be 600 lbs a trip (1967-74) (boat with several fishers). Did not fish much	Has not noted declines in catches of rabbitfishes or groupers but did not fish groupers after about 1974. Taiwanese and Chinese boats came to take many live fish in a big ship. He

	<p><i>Lethrinus</i> spp., <i>Lutjanus bohar</i>, groupers esp. <i>P. areolatus</i>, <i>P. leopardus</i>, <i>E. polyphkadion</i> and <i>E. fuscoguttatus</i>, rabbitfish, <i>Caranx</i> spp. <i>Scarus</i> spp. small <i>C. undulatus</i></p>	<p>much fished until late 1960s. Aggregated fish with eggs March-August for about 2 weeks coming up to full moon. Different species at different areas in channel. Two sites: Lengui and Ebiil but thinks occur in most reef passes. Mullet: catches few with eggs in lagoon at full moons (two types of mullet involved). <i>L. bohar</i>: full moon in grouper season with eggs.</p>	<p>after 1974 since so many fishers catching aggregating groupers that they flooded the markets and price per fish was low. <i>L. bohar</i> catches declining; used to be 1,000 fish in a day, now only 20-60.</p>	<p>was concerned because of large numbers taken. There are not now enough fish for all the fishers and for the market demand. Coral suffered after El Nino water temperature rise, and boat traffic causes pollution inshore. Erosion also affects inshore waters. Need aquaculture and restocking and control of boat traffic. Thinks that protection is not a good idea and that fishing keeps the fishery healthy.</p>
<p>09/07/03 (Ngerem-lengui): Full-time since 1974</p>	<p>Spear day and night, hook and line, throw spear</p> <p>Goatfish, surgeonfish, parrotfish, groupers (mainly <i>E. polyphkadion</i>, <i>fuscoguttatus</i>, <i>P. laevis</i>, <i>P. areolatus</i> and <i>P. polyphkadion</i>, rabbitfish, mullet,</p>	<p><i>Naso unicornis</i>: 1980-5 many with eggs caught with gillnet outside Lengui channel. <i>L. olivaceous</i>: New moon, many months, including April-August Groupers: mainly <i>E. polyphkadion</i>, <i>E. fuscoguttatus</i> and <i>P. areolatus</i>, apron of Lengui channel, April-August (July/Aug. most important) with eggs, few days either side of new moon Rabbitfish: April-May/June with eggs.</p>	<p><i>Naso unicornis</i>: could get 700-1,000 lbs in one trip; now there are no more. Groupers: 1965 2,800 lbs in 2 hours 1 boat and 3 people; total 4-5 boats; 1975, 200 lbs per boat, about 3 boats; 1985 100 lbs per boat, one boat – at night, with 8-10 boats during the day. Rabbitfish: Once in enormous schools too big for castnet. Now < 50 lbs per haul Mullet: many caught before</p>	<p>Declines due to too many fishers, use of SCUBA and flashlights at night, big nets that block migrations of rabbitfish. Problems with prices declining with gluts on market at aggregation times. Most reef fishes have declined. 1980s in 2-3 hours at night 500 lbs (2 people); recently 4-5 men fish > 4hours for 300 lbs mixed reef fishes. Protecting spawning females is important but</p>

	<i>B. muricatum</i> , <i>C. undulatus</i> , <i>L. olivaceous</i> , <i>L. bohar</i> .		but very few now.	some illegal catch continues. Not enough enforcement. Should not use SCUBA with spear. Too many compressors. <i>C. undulatus</i> used to be caught in reasonable numbers but after use of SCUBA with flashlight does not see many. <i>B. muricatum</i> ; 1970s could catch 60 at a time and on SCUBA could take whole school in one night.
09/07/03 (Ngerem-lengui): 20 years	Trolling, spear, gill/cast net, mud crab traps Rabbitfish, groupers, <i>L. olivaceous</i>	<i>L. bohar</i> : aggregate with eggs many full moons. <i>L. olivaceous</i> : new moons in many months Groupers : aggregate April-August at few days around new moon in apron and sides of Lengui channel. <i>E. polyphkadion</i> , <i>E. fuscoguttatus</i> (deepest) and <i>P. areolatus</i> , few <i>P. leopardus</i> Rabbitfish : 6 days around new moon, March-April	<i>L. bohar</i>, <i>L. olivaceous</i> numbers have increased – not high value. Groupers : 1990 8 am – 3 pm 300-400 lbs per boat with 10-20 boats present; 1995 200-250 lbs per boat. Recently 100 lbs. Rabbitfish : catches have declined	Number of fishers have changed over time with full time fishers declining because fish flooded market once fish export was banned. Declines in rabbitfish and groupers noted in fishery. Reasons for rabbitfish decline is erosion from compact road construction. Does not know why groupers declined but does not think that conservation helps and he had to catch other reef fish when aggregations were protected.

<p>10/07/03 (Ngchesar); 30 years full- and part-time</p>	<p>Gillnet, spear, hook and line, gill/cast net</p> <p>Rabbitfish, mullet, <i>Lethrinus olivaceous</i>, <i>L. bohar</i>, groupers</p>	<p>Mullet: used to be many, now only a few left, migrate southwards past Ngchesar. Groupers: with eggs in May-July between full and new moon – August lower numbers but at aggregation sites. Two sites nearby discovered in late 1990s by chance. Rabbitfish: numbers much reduced compared to before. Used to be very large numbers migrating in March, new moon plus 5 days.</p>	<p>Groupers: 100-150 in one day in August (when it is legal to fish) Rabbitfish: in early 1970s could get one gill net with 500 lbs on a good day, declined to 30 lbs in 1980s; now very few.</p>	<p>Same price for grouper irrespective of season. Does not know why rabbitfish declined but thinks suffer from boat oil. Need studies to see if management working. Would like to see aquaculture.</p>
<p>10/07/03 (Koror and south); 37 years</p>	<p>Gill/cast net, spear</p> <p><i>B. muricatum</i>, rabbitfish (2 species), yellowtail mullet</p>	<p>Yellowtail mullet: with eggs around Rock Islands at full moon + 1 day monthly. Also at Peleliu. Rabbitfish (2 species): travel together with eggs in April and May and sometimes large groups in June and July always at same places 3-6 days following new moon. Groupers: many fish in June at Ngerumekaol with eggs and breed shortly after full moon. Site known since before 1960. <i>P. areolatus</i>, <i>P. leopardus</i> (few), <i>E. polyphkadion</i>, <i>E. fuscoguttatus</i>. 1965-1975 saw many layers of fish. Also Denges channel.</p>	<p>Yellowtail mullet: many in 1965-70 (200-300 lbs per trip) but declined after 1980. Rabbitfish: 1965-70 catches at good time would be 100-300 lbs/haul, now only 20-30 lbs/haul. Fishers have increased a lot from 10 in 1970s. Groupers: 1965-1975 - 8 fishers in one boat could catch a ton in one night.</p>	<p><i>B. muricatum</i> much fewer than before. SCUBA fishing caused declines. Rabbitfishes have declined a lot and does not know why. Protection should help them and they should be left to recover. Thinks temperature changes might be involved as well as inshore pollution affecting rabbitfishes. Groupers declined after tourists came and because of SCUBA fishers.</p>
<p>*11/07/03</p>	<p>Hook and line,</p>	<p>Groupers: with eggs May to July</p>	<p>Groupers: Ngerumekaol 0.5</p>	<p>Denges channel</p>

<p>(Koror and south): Fished all life, mostly full-time, now retired</p>	<p>spear, cast net <i>L. gibbus</i>, <i>Lethrinus</i> spp. Jacks, groupers</p>	<p>and a little in August; before full moon release eggs but gather for 13-14 days before new moon. <i>P. areolatus</i>, few <i>P. leopardus</i>, <i>E. polyphekadion</i>, <i>E. fuscoguttatus</i>. Ngerumekaol known since at least 1960. Knows of Ebiil, Lengui, Denges, Ngerumekaol, German channel. L. bohar: summer full moons with eggs outside Ngerumekaol. Rabbitfish: Migration routes known, one going under KB bridge and also fish gathered at Airai, Ngchesar, and Lengui. Main time is May-June for 1 day before to 5 days after moon. Milkfish: At Peleliu used to be many in August with eggs at full moon, gathering on east side outside reef; up until late 1980s. Mullet: once very common at Peleliu (<i>Crenimugil</i>), while another mullet (species not clear) occurred in large groups at Aimeliik inside river mouth.</p>	<p>ton per trip before protection in 1970 when 4-5 boats fished by day; Rabbitfish: declines in catches notes in mid 1980s and declines have continued.</p>	<p>aggregation overfished by live fish trade in about 1984. By 1980 groupers declining he thinks but could have been impression due to market controls with too many fish being caught so effort declined. Milkfish and mullet mainly gone. General declines in fish catches and sizes due to too many fishers. Pollution caused by outboards and coastal developments destroys nearshore areas. Protective regulations are good but they need enforcement. Restocking, mariculture, management and market controls are needed. Fish should be only for home consumption</p>
<p>*11/07/03 (Koror and south to Peliliu); 10 years full-</p>	<p>Spear, hook and line, throwing spear in the past</p>	<p>Groupers: <i>E. fuscoguttatus</i>, <i>E. polyphekadio</i> and <i>P. areolatus</i> with eggs in groups March-June (<i>P. areolatus</i>) and June-August (<i>E. polyphekadion</i> and <i>E.</i></p>	<p>Groupers: 1960s could get 300 lbs in a day in one hour per boat with two people. Now get very few. In early years few people fished</p>	<p>Thinks overfishing has caused declines but also due to fish markets (PFFA) buying fish because gave a new incentive to go</p>

<p>time (1981-91) also part-time</p>	<p><i>B. muricatum</i>, skipjack tuna rabbifish mullet, parrotfish spp, groupers</p>	<p><i>fuscoguttatus</i>) with overlap for all three species in July mostly.</p> <p>Ngerumekaol was discovered by the Japanese and his father learned about it then taught him in 1960s.</p>	<p>aggregations but in 1960s many people started to fish at Ngerumekaol so from few boats increased to 15 in 1970s.</p>	<p>fishing. Aggregation protection has not improved fish numbers as too many loopholes (e.g. August not protected) and little enforcement (only 7.30-4.30 pm) and people still fish, especially at night. Also need more studies for better management. Should protect nursery areas. Should not fish for trade, just subsistence. Concerned about pollution.</p>
<p>*11/07/03 (Koror but mainly outer reef and in many places in Palau); 15 years, since arrived in Palau</p>	<p>Spear both day and night</p> <p>Pelagic species and reef fishes, <i>L. bohar</i>, <i>L. fulvus</i>, bigeye emperor, <i>L. olivaceous</i>, groupers, few <i>C. undulatus</i> and <i>B. murcatum</i></p>	<p><i>L. bohar</i>: sometimes with eggs in tight groups just off outer reef such as German Channel. February maybe? After new moon but not sure about other months.</p> <p>Groupers: <i>P. areolatus</i>, <i>E. fuscoguttatus</i>, <i>E. polyphkadion</i>, few <i>P. leopardus</i> in various channels, Ngerumekaol, Denges, West Entrance, Lengui. April-July for 4 days around new moon. Thinks groupers spawn earlier further north than south Palau. <i>E. malabaricus</i> February and March gravid fish at Peleliu corner but not in passes.</p>		<p>Feels fishing at night should be banned and quotas for fish for only home use introduced. Rangers only go to Ngerumekaol, not other places, and enforcement is needed. Some people still fish aggregations. Should have bigger fines.</p>

		Also: has seen 25 <i>C. undulatus</i> spawning and groups of <i>Caranx ignobilis</i> outside channels with eggs.		
*11/07/03 (Koror and south, sometimes as far north as Kayangel); Since 1980, always parttime	Hook and line, spear <i>L. gibbus</i> , <i>L. bohar</i> , <i>L. olivaceous</i> , groupers	Groupers: 1990-1997 has fished aggregations. Main species, <i>E. fuscoguttatus</i> , <i>E. polyphekadion</i> , <i>P. areolatus</i> and a few <i>P. leopardus</i> . Channels Ngerumekaol, Lengui, Koror channel, Ngardmau, Ngchesar. L. bohar: sometimes seen outside reef channels at full moon for a few days with eggs	Groupers: 1990-1997 – initially caught 300 lbs or more per trip, using hook and line. Declined to 200-300 lbs; about 3 other boats at site in day and more at night.	Noted declines in groupers but not in reef fishes overall. Goes to north Palau as can get many more fish there. Sees fish declining despite regulations. Need to protect grouper better and included August.
*12/07/03 (Koror, but fishes east and west and outer reef): 25 years part-time and last 5 years full- time since retirement	Barracuda, skipjack tuna, yellowfin tuna, <i>L. bohar</i> , <i>L. olivaceous</i> , groupers, <i>Naso unicornis</i> , parrotfishes, few <i>C. undulatus</i>	Groupers: 1970s and 1980s Ngerumekaol had many groupers May-July between full and new moon. 1990s fish numbers dropping. Mainly <i>E. polyphekadion</i> , also, <i>E. fuscoguttatus</i> , <i>P. areolatus</i> and few <i>P. leopardus</i> . Naso unicornis: 1970s and 1980s had eggs in June-August at Ngerumekaol outside reef.	Groupers: 1970s, 1980s, in a day with few other boats, would get 200 lbs in 5 hours; now hard to catch fish. Naso unicornis: 1970s/80s could easily spear 600 big fish in one trip, now only SCUBA divers catch big fish.	Knows fish are declining but does not see solution. Cause is cold water making fish go deeper or maybe hotter water; did not think there are too many fishermen. Should have aquaculture by getting ripe fish from aggregations.
12/07/03 (Airai); 73 years, part-time, just for food	Gillnet Rabbitfish (<i>Siganus ?canaliculatus</i>),	Rabbitfish: many in certain months with eggs 3 days before full moon but he tries to wait until they have no eggs. Large numbers used to be at KB bridge during	Rabbitfish: before could get 300-400 lbs per haul. Now few fish caught. <i>Chanos chanos:</i> once common on Peleliu but now	Feels a law is needed to stop speedboats coming into shallow waters as speeding boats kill eggs. Would like to see <i>Chanos</i>

	<i>Chanos chanos</i> , mullet.	migration on eastern coast of Airai. Chanos chanos : Peleliu Mullet : thinks releases eggs outside of reef after full moon monthly. Dynamite has been used to catch this species. Gillnet also used but can catch so many.	few. Mullet : used to be thousands in groups a long time ago. Few fish today. One gillnet could catch 100 fish at a time.	<i>chanos</i> brought back. Gillnet should be banned. Knows about minimum mesh size regulation on nets but not the reason for it. In the past people would not catch fish until after egg release. Feels young people not interested in conservation and do not respect the law; are greedy and take more than their needs.
*13/07/03 (Kayangel including Kossol passage); 10 years part-time	Hook and line, spear <i>L. gibbus</i> , <i>L. bohar</i> , <i>L. erythrinus</i> . Groupers, few <i>C. undulatus</i> , parrotfishes, goatfishes, <i>B. muricatum</i> (catches many in large groups throughout year), <i>Monotaxis grandoculus</i> , <i>Naso literatus</i> .	Groupers : two channels have large numbers of fish which release eggs on strong currents. Can catch many <i>E. polyphemadion</i> , <i>E. fuscoguttatus</i> and <i>P. areolatus</i> over very short time period. First fished the sites in 1989. L. bohar : 2-3 days before full moon catch large numbers in many months outside channels and especially April-August	Groupers : 1989 fishing with 5 people in boat and caught 2 tonnes of fish in 4 days of which 500 lbs were groupers. At sites also saw 3-4 other small boats. More recently heard that fishers caught 200 lbs of fish. L. bohar : caught thousands of fish at certain times.	Fish prices affected when exports no longer allowed and fishes flooded local markets. Noted that catches are declining due to boats coming from other places without permits. Enforcement is needed. Rotational closures of NE Kossol passage are needed. He has to work harder to maintain catches and move to more places compared to 10 years ago.

<p>13/07/03 (Kayangel including Kossol passage); 10 years full-time</p>	<p>Spear, hook and line</p> <p>Many species, groupers, <i>E. polyphekadion</i>, <i>E. fuscoguttatus</i>, <i>P. areolatus</i> and few <i>P. leopardus</i>, rare <i>C. undulatus</i>.</p>	<p>Groupers: gather August-September in first and second quarters but no eggs. Knows that gather earlier but not allowed to fish now. First fished aggregation in 1998 and found it by chance. <i>P. leopardus</i> more along inside of reef and the other three groupers more in and around channel; <i>P. areolatus</i> is the most common and concentrated and extends also along outer part of reef northwards.</p> <p><i>L. gibbus</i> – with eggs at full moon and many fish together, in most months.</p>	<p>Groupers: 1998 got 400 lbs in a trip and 2002 got < 100 lbs in a trip possibly because other people got there before him. Does not usually try to catch too many as he mainly eats what he catches. Does not see other boats in the day- time.</p>	<p>Feels there has been a decline but maybe because other fishermen get to the aggregation site before him and take the fish. Has noted for his overall catches (all species) that typical catches have dropped about 50% and that fish sizes are smaller than 10 years ago. Reason is too many fishermen and should give fish a ‘rest’. The April-August (sic) regulation he feels is good to protect the fish. Since cannot get grouper at this time, has shifted focus to parrotfish and surgeonfish.</p>
<p>*14/07/03 (Kayangel including Kossol Passage); part-time – fishes mainly to eat and for Custom</p>	<p>Spear with light, hook and line</p> <p>Wide variety of reef fishes, <i>L. gibbus</i>, <i>L. bohar</i>, <i>Lethrinus</i> spp. Jacks, groupers in season, including <i>P. leopardus</i> but this species</p>	<p>L. bohar: full moon minus 2 days and new moon has eggs in most months and seen in big groups in several places.</p> <p>Groupers: Several sites where they gather, including SE Ngarungl on the outside, especially <i>P. areolatus</i>; other groupers in high numbers are <i>P. laevis</i> and <i>E. fuscoguttatus</i>. Also two other good sites. Most fish in April-July especially July and</p>	<p>Groupers: once got 1,000 lbs at SE Ngarungl – 1992/3 and over several years but stopped fishing because of Bul and law. With speargun could get 200 lbs per trip. Catches of <i>P. leopardus</i> (<=100 lbs per trip) not so big as <i>P. areolatus</i> but aggregating season similar. More recently catches < 100 lbs per trip.</p>	<p>Has noticed aggregation catches declining and in general has noted that reef fishes are getting fewer and smaller with about 50% decline in 10 years. Thinks that aggregations declining because too much fishing before fish release eggs. Protection is good to allow egg release but need radar and surveillance, and</p>

	occurs in different places from other grouping groupers. Catches sleeping <i>B. muricatum</i>	some fish, but fewer, in August. High numbers 8-12 days after full moon is the best time. Fish seem to like areas where there are currents. For <i>P. leopardus</i> finds in many locations inside Kossol reef in smaller groups than the other groupers.		studies, and time for fish to recover. Wants people of Kayangel to be able to market fish and solve problem of illegal fishers entering their waters. Now Kayangel has 9 boats; 3 boats 10 years ago.
*14/07/03 (Kayangel incl. Kossol passage); 15 years fishing full-time, now part-time for food for family and Custom	Spear <i>Naso</i> , surgeonfish, <i>L. gibbus</i> , <i>L. bohar</i> , groupers (mainly <i>P. areolatus</i>), few <i>C. undulatus</i> , <i>B. muricatum</i>	Groupers: <i>P. areolatus</i> gathers in large numbers in areas with big corals where also sees <i>E. polyphkadion</i> and then <i>E. fuscoguttatus</i> in fewer numbers. Gather May to August. <i>P. areolatus</i> has eggs and gathers where currents are strong at sites and outside part of NW Kossol reef. Large numbers a few days around new moon.	Does not catch many fish because only getting for home use 10 lbs or so, but has caught up to 300 lbs in one trip between 1980-1994. Catches were good in those years then fishing stopped because fish harder to find. <i>B. muricatum</i> sleeps in predictable places and many people catch with SCUBA – fish few now.	Stopped fishing full-time in 1990s because could no longer sell fish. But thinks too many fish were taken from Kossol reef and feels it is important to keep enough fish for Custom – these types of fish should not be sold. The growing commercial market has encouraged many people to go out and catch too many fish. <i>P. areolatus</i> very popular in Palau and its aggregation (fishing) season is well-known. Needs more protection although current regulation is good. Perhaps should control fish size and enforce law since still illegal fishing by many people from Koror.

				President should help to solve problem and he would like a meeting to discuss problems with fishery.
14/07/03 (Kayangel); fishiung 42 years part- time, mainly for family use	Spear (long and short) and hook and line Parrotfish, <i>P. leopardus</i> , <i>B. muricatum</i> , few <i>C. undulatus</i> , <i>P. areolatus</i> , Jacks, goatfish, surgeonfish, <i>Lethrinus spp.</i> <i>Monotaxis grandoculis</i> , <i>L. bohar</i> , <i>L. gibbus</i>	Groupers: <i>P. areolatus</i> with eggs April to August from just after full moon to new moon, mainly at two sites. First fished one site in 1972 and found aggregation by chance although had heard of them in general. Also at site sees <i>E. fuscoguttatus</i> and a few <i>E. polyphkadion</i> which are deeper	Groupers: in early 1970s got 300-400 lbs by hook and line with several other people and alone in 1980s would get 100lbs a trip. In early 1990s (last time went out) got 80 lbs himself. About 8 other boats from main island came. Has not noticed much decline and he still sees many fish when he dives on the site.	Feels that overall the fishery has declined (all reef fish). Regulations are good to protect fish from too many spearguns, which are so effective. Too many fish taken for Custom. Management difficult because so many people take fish to sell in addition to Custom and eating at home. Thinks that such fish should not be sold.
14/07/03 (Kayangel); started fishing after 1945,	Poking spear – fishes close to shore, mainly in lagoon	When young had never heard of aggregations of groupers, thinks people learned about them more recently and especially when Chinese and Taiwanese wanted		Most fishers at Kayangel once took just for Custom and family needs. In general, fish are fewer than before since so many

full and part-time, not so much since 1972	Surgeonfishes, parrotfish, small groupers, haemulids, surgeonfishes.	groupers.		fishers are selling. Thinks enforcement is needed with only local people fishing in Kayangel.
14/07/03 (Kayangel); 35 years part-time and full-time from 1980-90	Spear, mostly at night Parrotfish including <i>B. muricatum</i> , groupers, <i>C. undulatus</i> and mix of other species	Groupers: aggregate in large numbers but cannot remember sites specifically. Fish had eggs, mainly <i>P. areolatus</i> .	Groupers: 1980-90 caught up to 300 lbs at the aggregation site in each year he fished it, mainly <i>P. areolatus</i> .	<i>B. muricatum</i> used to be many, could get 20 in one year, now very few because many people fishing, using SCUBA sometimes. Reef fishes have declined about 20% because more fishers are catching more fish. For some species, fish sizes are declining. Thinks God will solve problem but thinks the protection is good to protect breeding fish.
15/07/03 (Ollei); fishing since 1945, home use and some selling	Throwing net and leaf sweep (before), cast net, hook and line, fishes close to shore Parrotfishes,	<i>Naso unicornis</i>: had eggs for about 5 days after full moon but not sure which months. Rabbitfish: best months for catches February and April and less in March.	<i>Naso unicornis</i>: Used a leafsweep with about 10 people and could catch 500 lbs at a time and would target fish specifically. Rabbitfish: good catches from 1970-80, at 40 lbs per haul which declined 50% after 1980. Throwing net was	Does not know status of <i>Naso</i> at present time. Has seen declines in rabbitfish and feels that are too many people fishing, coral s are dying and speedboats stir up nearshore substrate. Cannot think of a way to reduce fishing but

	<i>Naso unicornis</i> , rabbitfish, surgeonfish, <i>L.bohar</i> , <i>Lethrinus olivaceous</i> and other spp., small groupers		used and 12 fishers would catch fish.	protection of rabbitfish is good.
14/07/03 (Ollei); 20 years active particularly 1980-90, afterwards just fished for food	Leaf sweep (no longer used), spear, hook and line <i>Naso unicornis</i> , groupers, parrotfishes, surgeonfishes, <i>B. muricatum</i> ,	<i>Naso unicornis</i> : many at mouth of Ebiil channel past – high catches March-July. Groupers : mainly <i>P. areolatus</i> in May to August for 2-3 days around new moon at Ebiil and on apron of northern side of West Entrance. First fished aggregation in 1987-8 when heard about it from others. Ebiil also had <i>E. polyphkadion</i> and <i>E. fuscoguttatus</i> .	<i>Naso unicornis</i> : used leaf sweep and could catch large numbers at certain times. With one sweep could get 1,2000 lbs in early 1980s but fish catches declined later. Now gone. Groupers : Late 1980s caught 600-700 lbs at West Entrance and later caught less but did not fish aggregation after 1994 when protected. From Ebiil caught 400 lbs in 1989- several other boats present.	Catches changed in composition after typhoon destroyed all leaf sweeps. From 1980-95 does not remember much change. Declines a lot for <i>B. muricatum</i> and <i>Naso unicornis</i> particularly by the early 1990s. <i>B. muricatum</i> was caught up to 80 fish per night. Law to protect aggregations is good but should include August. To improve fisheries need special fishing areas with rotational closures.
14/07/03 (Ngerbau); 40 years fishing for family and selling in	Spear, hook and line, castnet <i>P. laevis</i> , <i>P. areolatus</i> ,	Groupers : had eggs April-May and July, especially <i>P. areolatus</i> . Mainly at east side of North Entrance. Discovered site by chance between 1960 and 1970. Thinks he was the first to discover	Groupers : when first discovered in 1960s, caught about 150 lbs and by 1980s recalls that 7 people got 400 lbs. Feels that numbers have declined because fishermen	Numbers of fish declining probably because too many fish taken from aggregations but does not know why rabbitfish declined. Thinks that

<p>1960s NOTE: kept notebook and has excellent records of good fishing times and times with eggs.</p>	<p>surgeonfishes, parrotfishes, <i>L. gibbus</i>, <i>bohar</i>, <i>Lethrinus</i> spp.</p>	<p>this site. By 1980s other people were coming to the site. <i>Siganus lineatus</i>: with eggs March, May and June at new moon + 7-9 days. In channel at eastern side south of Ollei. Used a throwing net.</p>	<p>took too many fish. <i>Siganus lineatus</i>: with throwing net, 10 years ago, could catch plenty of fish (100 lbs per trip). Now there are few fish. About 3-4 other fishers known at site.</p>	<p>regulations should be stronger and that enforcement is needed.</p>
<p>15/07/03 (Ollei area, to north); 40 years fishing, full-time from 1985-1992</p>	<p>Spear, trolling, hook and line Parrotfish, surgeonfish, rabbitfish, <i>Naso unicornis</i>, groupers, <i>B. muricatum</i>, <i>C. undulatus</i></p>	<p>Rabbitfish: has eggs when gathers in large numbers along the shoreline from April to August. Groupers: many channels have aggregating groupers (Iengel, Ebiil, Tlechor, West Entrance, North Entrance). In June and July <i>P. areolatus</i> has eggs and also there are large numbers of <i>E. polyphkadion</i> and <i>E. fuscoguttatus</i> with a few <i>P. laevis</i>. Also groups in August. Timing is new moon +4-7 days. <i>P. areolatus</i> more shallow than <i>E. polyphkadion</i>. He discovered Ebiil in the 1980s. <i>Naso unicornis</i>: with eggs February- May at new moon plus 7 days at Ebiil channel and other</p>	<p>Rabbitfish: Many fishermen go in August. Uses cast net and this is now regulated. 1960s; 50 lbs per cast; 1980s, 30 lbs for whole day and by 1990s was not catch fish. Groupers: In mid-1980s got 300 lbs at aggregation time. Later more fishers came and so he kept moving to unfished channels <i>Naso unicornis</i>: fishing occurred at night and has seen marked declines in fish numbers caught.</p>	<p>Thinks that night-fishing is too efficient.</p>

<p>18/07/06 (Peleliu); > 15 years regular parttime and has fished since 1970s</p> <p>(Note: I felt he knew more about areas and timing of aggregations but did not want to say)</p>	<p>Gillnet and spear</p> <p>Surgeonfish, <i>Naso unicornis</i>, rabbit fish, mullet, milkfish, mojarra, sweetlips, snapper, goatfish <i>Bolbometopon muricatum</i>, <i>Cheilinus undulatus</i></p>	<p>channels.</p> <p><i>Naso unicornis</i>: found in a specific area in large numbers mainly in June, some July and August and in high numbers together with eggs.</p> <p><i>Albula glossodonta</i>: at full moon period has eggs over many months and assembles in large numbers where there is a strong current.</p> <p><i>Crenimugil crenilabis</i>: full moon has eggs but not specific for a particular month.</p> <p><i>Liza vaigensis</i>: similar to above mullet in both timing of eggs and in places where goes to release eggs.</p> <p>Rabbitfish: occurs in large numbers for 2-3 days of the year but cannot remember the month</p> <p>Groupers: found large numbers of <i>E. polyphekadion</i> and <i>E. fuscoguttatus</i> at Ngerumekaol on one trip and the fish had eggs. Does not usually catch groupers since the aggregation area is too far for him to travel.</p>	<p><i>Naso unicornis</i>: 1980s could get 1,000 lbs per trip to 400-500 lbs per trip in the 1990s. Many fishers came to fish the site – has seen 25 fishers during one aggregation period.</p> <p><i>Albula glossodonta</i>: 1980s could get 500 lbs in one trip and 1990s less than 100 lbs.</p> <p><i>Crenimugil crenilabis</i>: 1980s could get 400-500 lbs per trip and 1990s 200 lbs or less around Ngemelis Island</p> <p><i>Liza vaigensis</i>; in 1980s could get 500 lbs a trip and in 1990s declined to 100lbs per trip.</p> <p>Rabbitfish: few people catch the fish – has caught 800-1,000 lbs in one gillnet haul in peak season in the past.</p> <p>Groupers: 1974 just fished once at Ngerumekaol since usually does not take groupers; with 5 other fishers got 1,000 lbs in the trip.</p>	<p>He has seen declines in the fishery of many species and is concerned. Feels that more conservation areas are needed to allow fish to breed and that enforcement is also needed. Felt that many people of Peleliu would like to see more conservation areas. He attributes declines in mullet to boats, propellers, exhaust and also feels that there are too many fishers.</p> <p>Is aware of grouper aggregation regulation.</p>
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<p>17/07/03 (Peleliu); 30 years fishing full-time for much of it</p>	<p>Spear and gillnet <i>Lutjanus bohar</i>, <i>Naso unicornis</i>, groupers, <i>C. undulatus</i>, <i>B. muricatum</i>.</p>	<p>Groupers: not interested in groupers but knows of aggregations in the past at German and Denges channel. Species was mainly <i>P. areolatus</i>. L. bohar: has eggs in April and some other months, possibly around the full moon. Large groups of this species occur at the southern end of Peleliu with eggs. Naso unicornis: has eggs between April and August and occurs in groups off northern Peleliu.</p>	<p>Naso unicornis: when it has eggs, can catch 100 lbs at a time</p>	<p>Has noticed declines during the 1980s in fishes overall in sizes and catches but does not know the reason. Feels that number of fishers is increasing and suggests banning fishing for one year to allow recovery in certain places. Commented that about 20 years ago a large Chinese boat came and took many fish.</p>
<p>17/07/03 (Peleliu); full-time 1977-2002</p>	<p>Gillnet, spear <i>Lethrinus</i> spp., parrotfishes, jacks, rabbitfishes, mojarrans, chub, groupers, goatfish, squirrelfish, milkfish, mullets,</p>	<p>Albula glossodonta: once caught in large numbers at certain times with eggs. Rabbitfish: March and April at new moon for about 3 days for one species (Klsbuul) at a known location. Mullet: <i>Liza vaigensis</i> has seen in small groups with eggs in many places, including near Carp Island. <i>Crenimugil crenilabis</i> has heard of this fish and that some fishers used dynamite to catch it when fish is in groups.</p>	<p>Albula glossodonta: in 1980s could get 200 lbs at a time when fish were grouping with eggs although catches were variable. About 15 fishers he knew about using gillnets. Not so popular for food. Rabbitfish: Not many rabbitfish left nowadays, although managed to get 100 lbs last year at one location. Before 1990s there were many of this fish and numbers have declined a lot. Mullet: <i>Liza vaigensis</i> At low tide last June got 100 lbs</p>	<p>Noted marked declines in catches and sizes for species he once caught in large numbers with eggs. Does not know why they declined but many people used to fish them. Feels that current Governor does not support fish protection but that previous Governor did. Would like to see no gillnet use; only spear and throwing spear. Knows of gillnet mesh size regulation. Notes that more people come to Peleliu from Koror than before.</p>

Table 2 Footnote

Comments on humphead wrasse, *Cheilinus undulatus*, provided from 9 fishers

1. Has never seen HHW in large groups – most ever seen at one time as 10 – is concerned about this species
2. Used to catch big ones with spear – up to 72 lbs. Estimates he has taken about 150 of this species in his fishing career of 40 years. Catches at night in holes – no SCUBA. Few of this fish now. Declined especially after divers started catching this fish with SCUBA
3. Never common in his area. Numbers declined especially when spears started to be used together with SCUBA. Before, could catch reasonable numbers of 18” long fish and 10-20 fish over a number of months. But after torches were used together with SCUBA and at night very easy to catch – torches appeared before about 1960
4. Largest ever caught by him 90 lbs and often can catch 2 in one weekend of 50-60 lbs each
5. Not a common species – catches 5-6 in a year
6. Not a common fish, only about 20-30 individuals he catches in a year for traditional events. There are fewer fish now than in the past and the big ones can only be found in deeper waters now.
7. Gets less than 10 of these a year and considers it was never a common species – sometimes catch this species with landcrab on hook and line but mainly caught with a spear.
8. 1960-1970 – only a few people fished in the area where he fishes for this species and for special occasions. Got about 10 fish a month of 40-50 kg each for traditional events. 1980-1990 – declines noted in this fish – thinks it is because of much fishing at night and fish being so easy to catch at night and also more fishermen came his area to fish from more heavily fished areas.
9. Few of this species left now – in 1980s could bet 10 fish of 50-70 lbs each in one trip, and in 1990s only 1 per trip and much smaller fish.

Comments on bumphead parrotfish, *Bolbometopon muricatum*, provided from 8 fishers

1. Speared the species at night 1985-1990 – used to spear at night sometimes and remember had eggs 4 days before new moon. There are fewer fish now than there were then.
2. 1970s could catch 60 at one go in shallow water at night with spear. On SCUBA could remove whole school at a time. Numbers have declined.
3. Maximum catch was 250 fish in one fishing trip – this was in 1975 – now catches are much fewer. Used to spear the species at night in shallow water. In 1965-70 could get many fish and after 1975, 30-50 fish per trip and nowadays very few.

4. The species sleeps in predictable places outside of a known reef and can be easily found – the numbers are declining because too many people now try to catch it and the numbers are much less than they used to be – need SCUBA and fish are deeper than they used to be.
5. Used to be lots and could get 20 or more big ones in a year – now very few and many more people are fishing them and gears are better, such as SCUBA.
6. Species has declined a lot and this was noticeable by the early 1990s. Could catch before up to 80 fish in one night, now much fewer and catches much less.
7. 1960-1970 – could often catch 100-150 fish in a month of about 60 lbs each. After 1990 could get 30-60 in a month of about 30 lbs each. Caught in particularly large numbers when it has eggs about 8-9 days after the full moon. Very predictable in time and place. People use SCUBA to get fish deeper than 20-30 metres.
8. Many caught especially at new moon in very predictable places – can catch more easily at this time in shallow (2-3 m) waters and when tide is low. On a good new moon could catch 1,000 lbs in the early 1980s. Now still fish around but catches fluctuate a lot and there is not much market interest in the fish now.