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New Flesh for Old Bones: Using Modern Reef Fish to Understand Midden Remains from Guam, Mariana Islands

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Introduction

In the mid-1990s, I tried to build a strong prehistoric cultural context for the findings from an extensive archaeological survey and testing project sited at the northern end of Guam (Olmo 1996). While I had limited success with this, one area that caused me great consternation was my inadequate treatment of the midden remains, and in particular the fish remains. It is from my discontent with my discussion from that time that I have embarked in the direction outlined below.

I suspect that I am not alone in being frustrated by an inadequate discussion of fish remains after reading what many of my colleagues have written on the subject. I proceed by introducing three of these writings to illustrate why I am, and I think my colleagues are, disquieted. I use as examples only projects that I was involved with, although I could have chosen almost randomly from the wealth of archaeological reports available on Guam. In 1992, at the beginnings of my career on Guam, I had the opportunity to participate in archaeological survey and testing on Orote Peninsula on the west, south-central coast of the island (Figure 1). James Carucci wrote the report for this project, and the late Alan Ziegler analysed the vertebrate remains (Carucci 1993). Ziegler identified the fish remains to the family level, as was/is the common practice. He identified 10 families from 59 skeletal elements (maxillary, quadrate, vertebra, bone fragment and scale). Although only a small amount of midden was excavated for this project, over 1100 skeletal elements were recovered with 1044 not being identified beyond the category “fish” (Figure 2).



Figure 1. Map of Guam showing Orote Archaeology Project.

Source: Map by Richard K. Olmo.

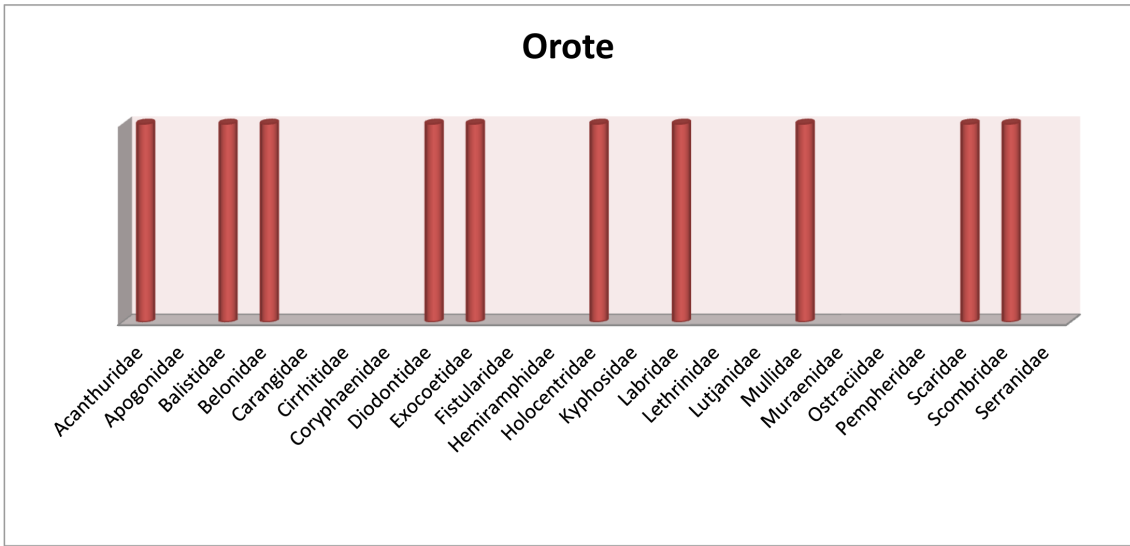


Figure 2. Graph of the fish families identified from the Orote Archaeology Project middens.

Source: Adapted from Amesbury and Hunter-Anderson 2003.

Carucci's discussion of these remains contains a single sentence and reads as follows: "Not only are there several families of inshore fish, but there are also two or three families of fish requiring offshore fishing technology" (Carucci 1993:95).

In 1995, I worked on the project that I introduced in the opening paragraph (Figure 3). Jolie Liston wrote the archaeological volume for this project, and again, Alan Ziegler analysed the vertebrate fauna (Liston 1996). He identified 14 families from 52.67 grams of faunal elements, while 207.33 grams were identified only as “fish” (Figure 4). Liston’s discussion of the fish remains reads as an expanded version of Carucci’s statement:

The fish families represented in the collection are all relatively common inshore types, and of only small-to-medium size (usually no greater than about 20 or 25 cm in length). The Lutjanid, Carangid, and Serranid, which occur in small quantities in Sites 7-1605, 7-1614, 8-1588 could have been obtained by fishing from watercraft at least a short distance offshore. They are not, however, represented in enough quantity to indicate an intensive practice of offshore fishing. (Liston 1996:146).



Figure 3. Map of Guam showing the location of the Tarague Embayment Project.

Source: Map by Richard K. Olmo.

Lastly, in 1998 I conducted archaeological survey and testing on several Navy-owned parcels located along the west coast of Guam, between Tanguisson and Urunao (Figure 5). I was first author for the report, along with Tina Mangiere, David Welch and Thomas Dye, and once again Alan Ziegler analysed the vertebrate fauna (Olmo et al. 2000). Fourteen families were identified from 677 skeletal elements (Figure 6).

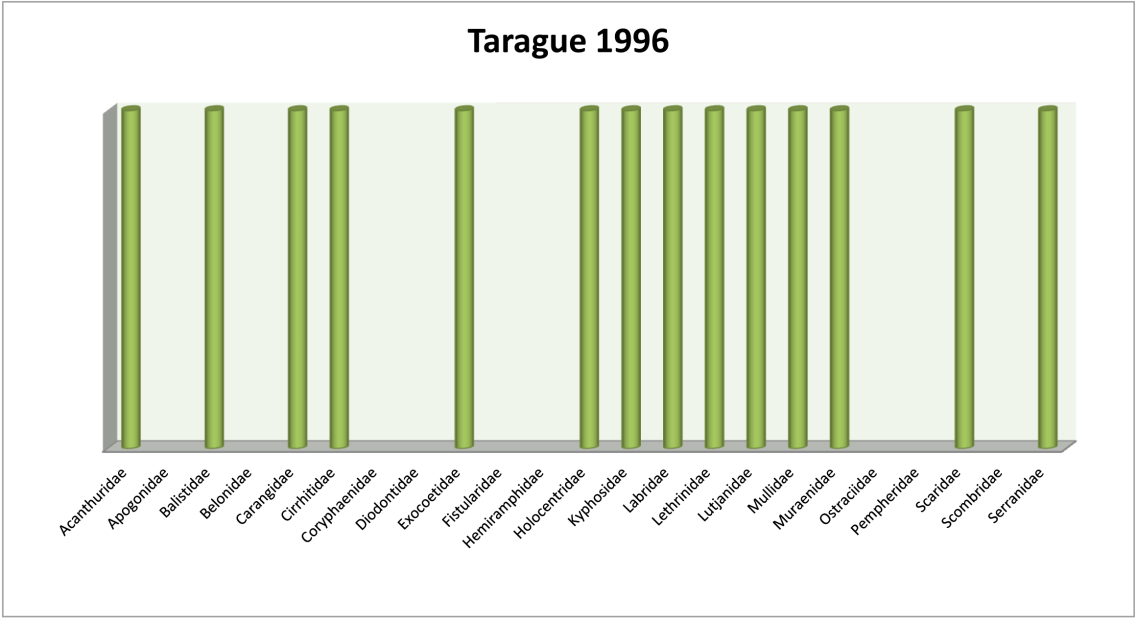


Figure 4. Graph showing the fish families identified for the Tarague Embayment Project.

Source: Adapted from Amesbury and Hunter-Anderson 2003.



Figure 5. Map of Guam showing the locations of the Naval Computer and Telecommunications Station (NCTS) Archaeology Project.

Source: Map by Richard K. Olmo.

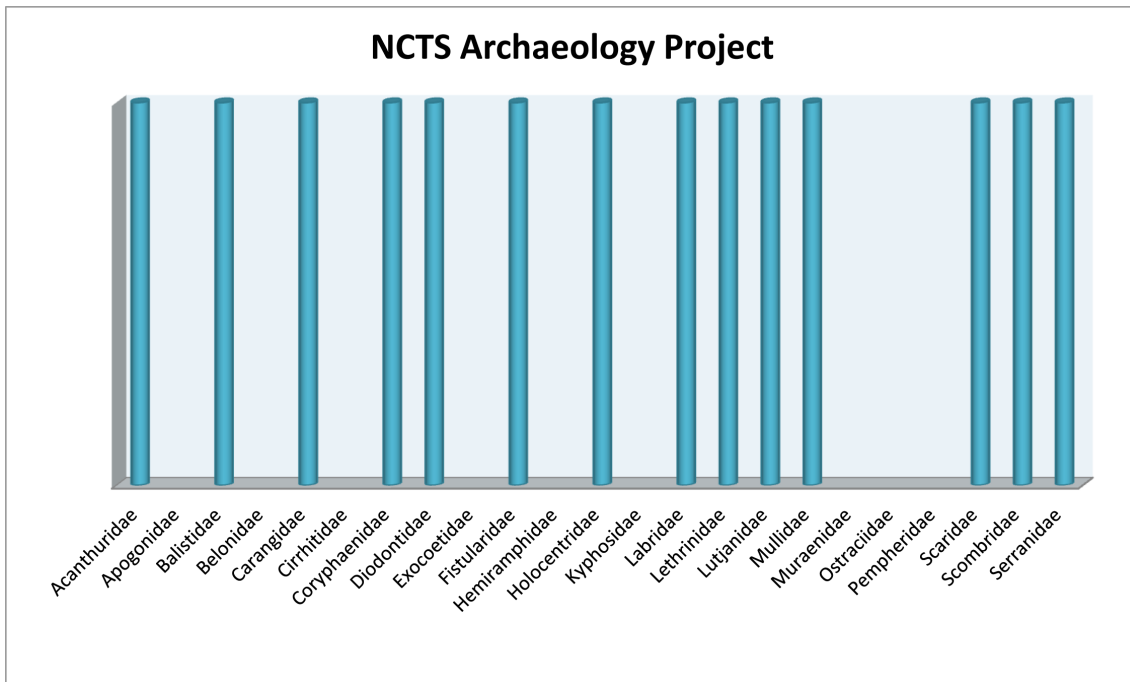


Figure 6. Graph showing the fish families identified for the NCTS Archaeology Project.

Source: Adapted from Amesbury and Hunter-Anderson 2003.

My discussion of the fish remains in the project report is best considered an expansion of Liston's, and reads as follows:

Most of the fish families identified are common inshore groups whose members could have been taken by various traditional and/or modern methods (with or without the use of watercraft) from or near the shore in relatively shallow water. Most individuals of these groups recovered are of no more than small or medium body size (i.e., between about 10 cm or 15 cm and 25 cm or 30 cm in length). Members of the family of Scaridae are noticeably abundant among this material.

There are, however, also a few families represented whose recovered members were very likely taken relatively far from shore – or at least in deeper water – by trolling and bottom fishing. Trolling presumably yielded the large “Coryphaenid” and “Scombrid” individuals, while the “Serranid” and “Lutjanid” individuals could very well have been taken by bottom-fishing, both methods necessitating the use of some type of watercraft. The two or more quite large “Carangid” could have been taken either very close inshore or well out in deeper water. In all, the 14 identified fish taxa provide evidence for at least four fishing strategies. The Acanthurids, Balistids, Mullids, and Scarids were mostly likely caught in nets; Labrids, Lethrinids, Lutjanids, and Serranids, were likely caught with demersal baited hooks; Carangids, Coryphaenids, and Scombrids were caught with pelagic lures; and Diodontids, Fistularids, and Holocentrids were likely captured during general foraging (Davidson and Leach 1988:350). The presence of so many fishes captured with pelagic lures, although relatively common in Mariana Islands faunal assemblages, is unusual in the wider context of Pacific Islands. Coryphaenids or Dolphinfishes in particular, are big fish found rarely in Pacific island archaeological faunal assemblages. The identification of a Coryphaenid bone at Haputo indicates that fishermen here shared the deep-sea fishing skill identified for the people of Rota by Leach and his associates (Leach et al. 1985; Davidson and Leach 1988). (Olmo et al. 2000:208-209).

Even though the above paragraph attempts to more fully link prehistoric activities, e.g., reef gleaning, net fishing, bait fishing, and trolling in open water with the identified fish remains it is far from what is necessary to provide a picture of prehistoric Chamorro life along this stretch of coast as it related to subsistence. When compared with a similar paragraph written by William Lessa, in his short ethnographic monograph on Ulithi, it is easy to see the distance between what we are writing as archaeologists and where we need to be (Lessa 1966:15):

Spectacular catches come seasonally, when certain kinds of fish come in huge schools to the outer reef and are caught by large numbers of men, working communally, who use long nets to herd the fish together as they wade through the shallow water with the slowly shrinking net. Lagoon fishing is by far the most common of all and has many methods. The most successful involves the cooperation of a large number of men in canoes who assemble in traditional fishing grounds to catch fish with seines. This is the most reliably consistent kind of fishing. Some individuals go out into the lagoon alone or in small groups, using hooks, usually made of tortoise shell or coconut shell, or nowadays steel. Dip nets are often employed in fishing. Some angling is done with gorges made of mussel shell. Composite trolling hooks are used for pelagic fishing, especially to catch bonito, but Ulithians are not fond of leaving the safety of the lagoon, which in any event is the more convenient place to fish. Fishlines are made of sennit or coconut string. Basketry traps and stone weirs are occasionally employed in the lagoon. The traps are usually tied to a drifting log. As much for a sport as anything else, men and boys occasionally indulge in torchlight fishing from the outer reef at low tide, walking along with huge torches whose flames attract the fish, which are then gathered with small nets or clubbed into insensibility.

Lessa's description was chosen for its brevity. Many other ethnographic works contain considerably longer treatments describing indigenous peoples' interactions with marine resources. Although Lessa's account is brief, it remains richer than what I had written from the midden analysis. The ability to personally observe the activities associated with fishing most certainly contributes to the better description. Allowing this, however, I believe that the difficulty others and I have had in writing more descriptively about midden remains comes more from the fact that the lowest taxonomic level we work with is the family and less so from the lack of direct observation. Because there are often many genera and species within each family, a wide range of habitat and behaviour is encompassed and it becomes difficult to be more precise with a discussion of human activities, which are crucially tied to understanding the behaviour of individual species.

Within a family, some members prefer shallow reef environments, some channels, some sandy bottoms, some seagrass beds, some hard substrates, and some lagoons while others prefer reef fronts; some are active at night, while others hide at night, and etc. Acheson, in his survey article on the anthropology of fishing, states that fishermen have not only a good understanding of the ocean, including its currents and bottom topography, but that they have a "detailed knowledge of the species of fish they are seeking – their habits, breeding cycles, enemies, food supply, feeding habits, and especially migration patterns and habitats" (1981:291). Therefore, if we are going to be in the position of discussing the what, when, where and how of a prehistoric peoples' exploitation activities, it is imperative to obtain information on the individual species that are represented by these remains.

Methods

In the effort to expand the possible interpretation from midden analyses an important data source has been explored. These are modern fishery catch data collected and compiled by the Guam Department of Agriculture, Division of Aquatic and Wildlife Resources (DAWR). I am working with two ideas here: (1) that catch data reflect the species that commonly occur in Guam's

waters, consequently providing insight to the subset of species most likely associated with the collective midden family results, and, (2) that census data will provide probable species diversity associated with particular midden assemblages. Narrowing down to just a few species the suite of possibilities represented by the broad family designations has the potential of allowing much richer interpretations of prehistoric fishing activities on Guam.

In 2003, Judith Amesbury and Rosalind Hunter-Anderson published a report on reef fishing in Guam and the Northern Mariana Islands for the Western Pacific Regional Fishery Management Council in Honolulu (Amesbury and Hunter-Anderson 2003). The report was a compilation of prehistoric and historic data and offered the Council a window on long-term trends in species abundance and distributions. After an exhaustive review of the grey literature, Amesbury and Hunter-Anderson were able to identify reports from nine different areas around Guam that contained midden analyses reporting fish remains. Twenty-three families were identified, and their site distributions are displayed in Figure 7. While the goal of these authors was to use midden information to expand the modern data, I am proposing that we go in the opposite direction and use modern data to expand upon our understanding of the past.

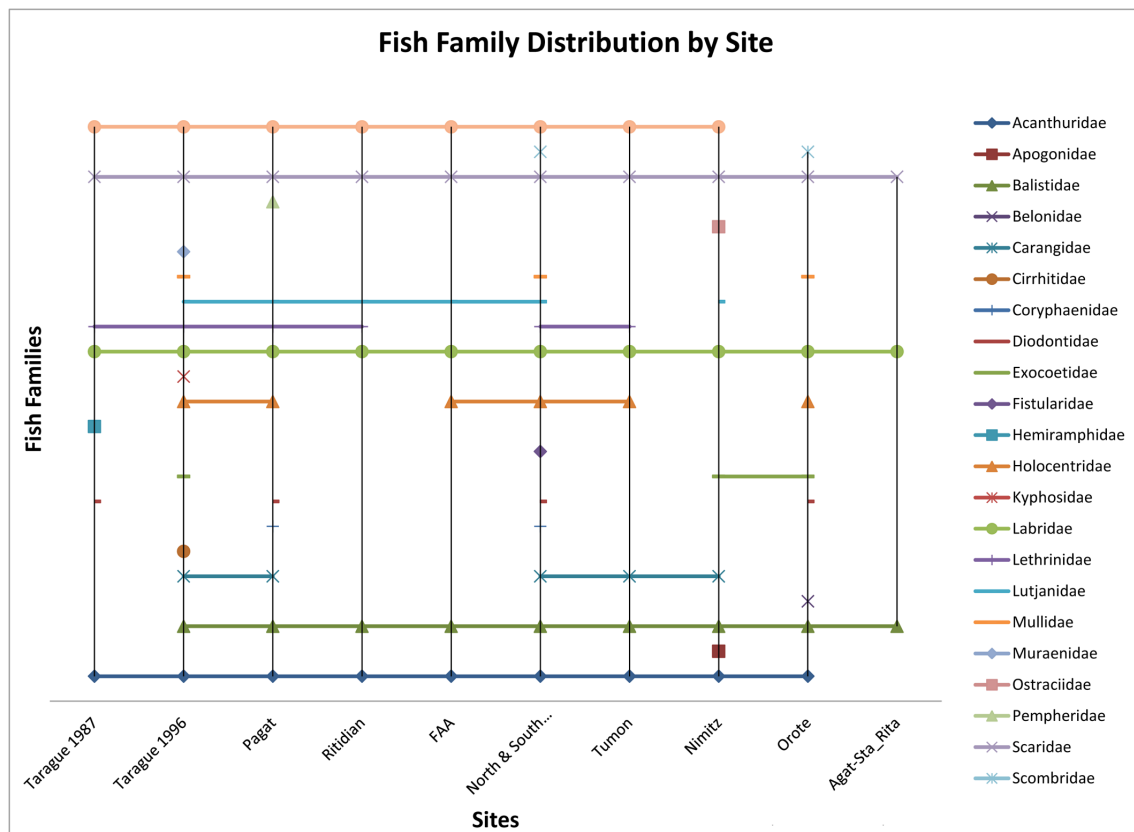


Figure 7. Graph showing the distribution of fish families for nine areas on Guam.

Source: Adapted from Amesbury and Hunter-Anderson 2003.

Analysis and discussion

The data source used in this work was the annual reports from 1986 until 2008 compiled by the Guam Division of Aquatics and Wildlife Resources. I explore several ways of working with the annual reports including the lists of the top-ten families taken, when they were taken, the species that were identified, and the methods that were used. The daytime top-ten were used in this

analysis to construct a table showing the families and the species most frequently taken by local fishers. Because data for the kilograms of fish taken was included in the reports, it was possible to provide a sense of the relative contribution of each family over the roughly twenty-year span (Figure 8).

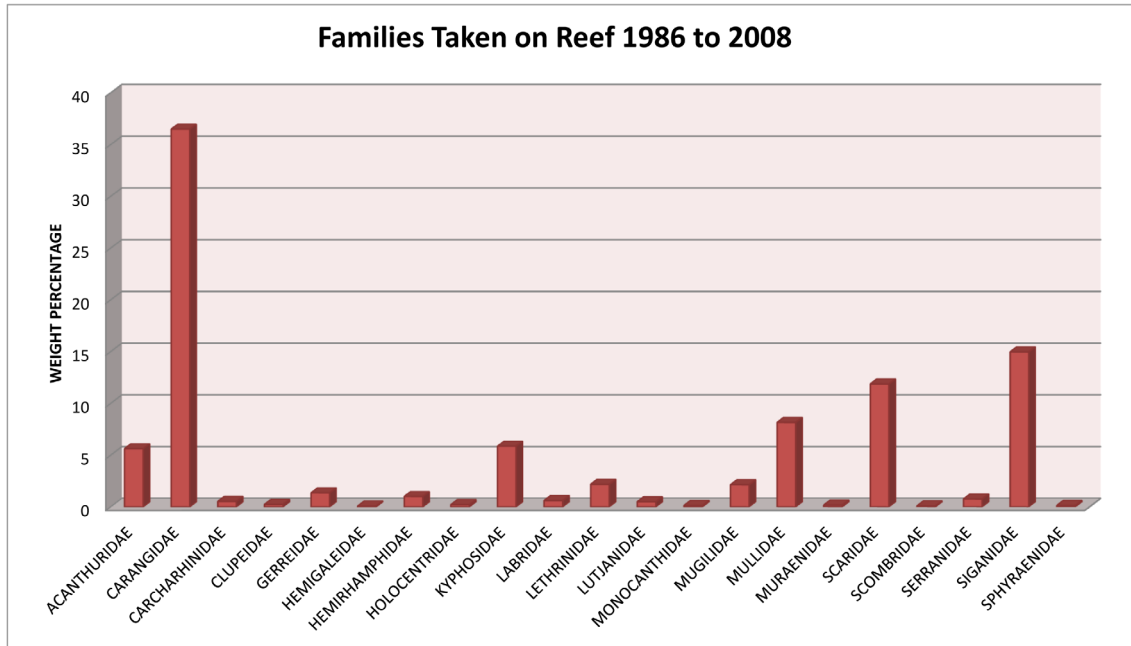


Figure 8. Relative distribution of fish families caught from shore on Guam.

Source: Data from Guam Division of Aquatic and Wildlife Resources (DAWR).

Figure 8 shows that twenty-one fish families comprised the catch taken over the study period. Acanthurids (surgeonfishes, unicornfishes), carangids (jacks, trevallies), kypbosids (rudderfishes, sea chubs), mullids (goatfishes), scarids (parrotfishes) and siganids (rabbitfishes, spinefoots) are the most frequently represented families. Carangids, mullids and siganids are disproportionately represented due to seasonal runs of juvenile species. When the seasonal component is removed, the resulting graph looks considerably different (Figure 9). Acanthurids, kypbosids, lethrinids and scarids dominate, the presence of carangids is greatly reduced, and the mullids and siganids all but disappear. One reason for removing the juveniles from consideration is that they can be eaten whole or processed in such a way as to contribute little but trace elements to the midden assemblage.

Twenty-one families are represented in the catch data while twenty-three are identified from the combined middens. A comparison of the two data sets shows that thirteen families are common to both. The yearly catch data contain representatives of eight families [carcharinids (requiem sharks), clupeids (herrings, shads, sardines), gerrids (mojarras), hemigaleids (weasel sharks), monacanthids (filefishes, leatherjackets), mugilids (mulletts), siganids (rabbitfishes, spinefoots) and sphyraenids (barracudas)], which are not identified from the midden assemblages. Alternatively, the middens contain representatives of seven families [apogonids (cardinalfishes), belonids (needlefishes), cirrhitids (hawkfishes), diodontids (porcupinefishes), fistularids (cornetfishes), ostraciids (trunkfishes, boxfishes) and pempherids (sweepers)] not found among the top-ten families caught (Table 1).

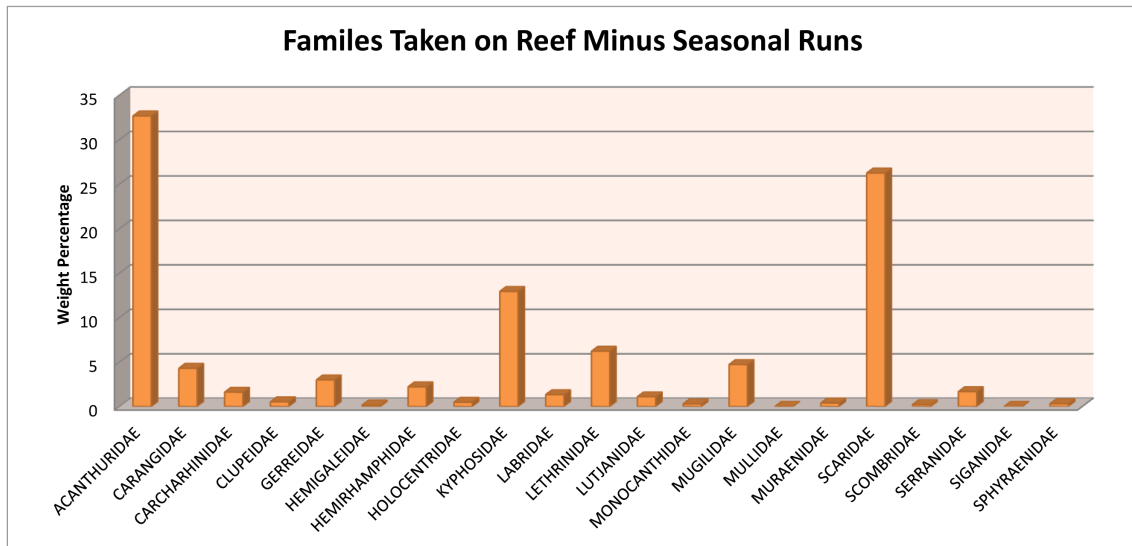


Figure 9. Relative distribution of fish families caught from shore less seasonal component.

Source: Data from Guam DAWR.

A review of the information on these families suggests the possibility that a majority (six out of seven) could have been taken by night fishing. Night fishing with torches is documented in the ethnographic literature for Micronesia. The apogonids and the pempherids are inactive during the day, remaining hidden in caves and crevices, and the cirrhitids, diodontids and ostraciids all spawn in the dark. The belonids are attracted to lights at night and will skip out of the water when disturbed. Although normally diurnal, this behaviour may allow them to be more easily obtained at night. The nocturnal activity of these families might also explain why they are missing from the catch data, which represents only daytime fishing. Because of the prevalence of night-time spear fishing on Guam using a variety of technical advances not available to prehistoric peoples, the night catch was omitted from this analysis. This leaves only the fistularids to be caught during the day. A single species is known from Micronesia, *Fistularia commersonii*. It occurs in all reef habitats, but is often observed in schools in open, sandy areas (Myers 1991).

Table 1. Families identified in middens but not the top-ten catch data.

Family	Habit	Food	Spawn	Caught
Apogonidae	Hide by day, roam reef at night	Zooplankton and small benthic crustaceans		
Belonidae	Surface dwelling, inshore reefs	Small fishes		Casting, trolling, floating nets ^b
Cirrhitidae	Perch on outer branches of coral	Benthic crustaceans and fish	Dusk or early night	
Diodontidae	Adults inshore, young pelagic ^a	Hard-shelled invertebrates ^a	Surface, dawn or dusk	
Fistularidae	Diurnal, all reef areas, open sandy areas	Small fishes and crustaceans		
Ostraciidae	Diurnal, males territorial w/harems	Small invertebrates and algae ^a	Night above outcrops	
Pempheridae	Hide in caves by day, feed at night ^a	Zooplankton ¹	Pelagic ^a	

Source: All table data are from R.F. Myers (1991), otherwise; (a) data from J.S. Nelson (1994); (b) data from B.B. Collette (2003).

Before continuing with this analysis, one question worth addressing is if the catch data represent a proportional take from the available taxa. The answer seems to be no. Species taken from Marianas waters are not proportional to those available to be taken. A graphical representation

of the relationship between species observed versus those obtained is shown in Figure 10. While only the family level data are available for the middens, scarids are identified from all middens and represent the most abundant minimum number of individuals (MNI) when present. Only 25 scarid species are recorded for the Marianas, so the aggregated midden data is also probably not proportional to the available taxa.

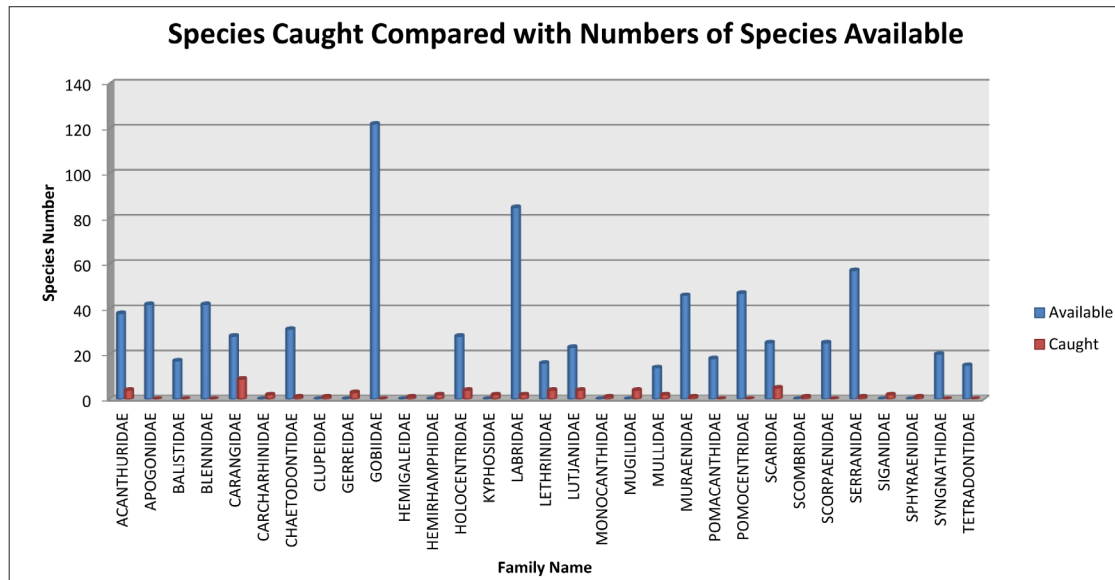


Figure 10. Species available versus numbers caught for each family.

Source: Species data from Myers and Donaldson, 2003; catch data from Guam DAWR1986-2008.

The thirteen families that are common to the middens and the modern catch are acanthurids, carangids, hemirhamphids, holocentrids, kyphosids, labrids, lethrinids, lutjanids, mullids, muraenids, scarids, scombrids, and serranids. The distributions of species identified from the modern catch that represent the common families are shown in Table 2.

Table 2. Species identified in Top-Ten Catch 1986-2008.

Family	Species
Acanthuridae	<i>Acanthurus lineatus</i> , <i>A. triostegus</i> <i>triostegus</i> , <i>A. xanthopterus</i> , <i>Naso literatus</i> , <i>N. unicornis</i>
Carangidae	<i>Carangoides orthogrammus</i> , <i>Caranx ignobilis</i> , <i>C. Melampygus</i> , <i>C. Papuensis</i> , <i>C. Sexfasciatus</i> , <i>Decapterus macrosoma</i> , <i>Scomberoides lysan</i> , <i>Selar crumenophthalmus</i> , <i>Trachinotus blochii</i>
Hemirhamphidae	<i>Hyporhamphus acutus acutus</i> , <i>Hemiramphus (archipelagicus) lutkei</i>
Holocentridae	<i>Myripristis berndti</i> , <i>Neoniphon sammara</i> , <i>Sargocentron spiniferum</i> , <i>S. tiere</i>
Kyphosidae	<i>Kyphosus cinerascens</i> , <i>K. vaigiensis</i>
Labridae	<i>Cheilinus trilobatus</i> , <i>C. Undulates</i> , <i>Cheilio inermis</i>
Lethrinidae	<i>Lethrinus erythracanthus</i> , <i>L. microdon</i> , <i>L. harak</i> , <i>L. obsoletus</i> , <i>L. xanthochilus</i> , <i>Monotaxis grandoculus</i>
Lutjanidae	<i>Aprior virescens</i> , <i>Lutjanus bohar</i> , <i>L. fulvus</i> , <i>L. gibbus</i> , <i>L. monostigmus</i>
Mullidae	<i>Mulloidichthys flavolineatus</i> , <i>Parupeneus barberinus</i> , <i>P. insularis</i>
Muraenidae	<i>Gymnothorax javanicus</i>
Scaridae	<i>Bolbometopon muricatum</i> , <i>Cetoscarus bicolor</i> , <i>Chlorurus frontalis</i> , <i>C. microrhinos</i> , <i>C. sordidus</i> , <i>Hipposcarus longiceps</i> , <i>Leptoscarus vaigiensis</i> , <i>Scarus altipinnis</i> , <i>S. psittacus</i> , <i>S. rubroviolaceus</i> , <i>S. schlegeli</i>
Scombridae	<i>Gymnosarda unicolor</i>
Serranidae	<i>Cephalopholis urodeta</i> , <i>Epinephelus merra</i> , <i>E. polyphkadion</i> , <i>Plectropomus laevis</i>

Source: All table data are from Guam Division of Aquatic and Wildlife Resources 1986-2008.

In the analysis done by Amesbury and Hunter-Anderson, cited earlier, acanthurids were found at all of the areas except for Agat-Santa Rita. Only three families were identified from that assemblage. There were five species of Acanthuridae identified from the catch data, each exhibiting differences of habit. *Acanthurus lineatus* (lined surgeonfish) commonly occupies the exposed, seaward portions of reefs and prefers the surge zone. It is the most shallow-living of the acanthurids in this list, rarely found below 15 m. Large males are territorial with harems of females (Kuiter and Tono-zuka 2001a). Adults are usually found schooling in shallow channels that are from 1 m to 3 m deep (Randall 1986). Data obtained from the DAWR specifically derived from Guam fisheries indicate that about one third of the time *A. lineatus* is caught using hook and line, and about two fifths of the time using a gill net (Figure 11).

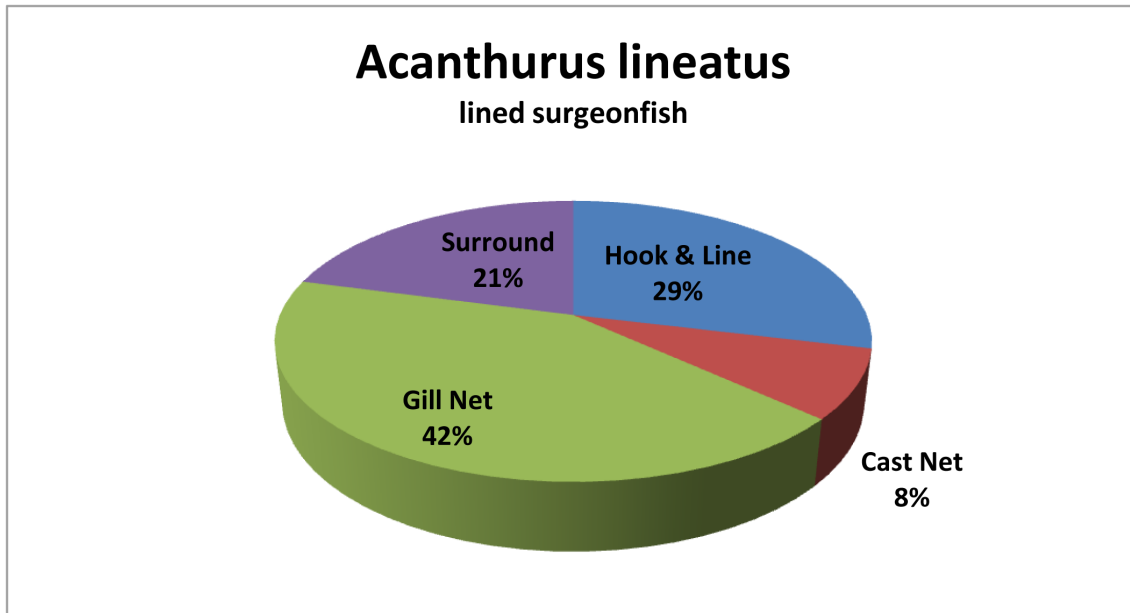


Figure 11. Catch methods for the lined surgeonfish.

Source: Guam DAWR 1986-2008.

Acanthurus triostegus triostegus (convict surgeonfish) is found in the wider context of the seaward portions of reefs, the hard-bottomed portions of lagoons, and waters up to 90 m deep (Randall 1956). This species will occasionally school, particularly when feeding on a favourite algae which grows on rocks where there is fresh-water runoff (Kuiter and Tono-zuka 2001a). *A. triostegus triostegus* is taken by hook and line 10% of the time, by cast net about half of the time, with gill and surround nets the remainder of the time. This may reflect its wide range and feeding habits (Figure 12).

Acanthurus xanthopterus (yellowfin surgeonfish) inhabits an even wider range of environs including outer and inner reef areas, sand slopes and lagoons (Ibid.). It tends to school and unlike some acanthurids will readily take bait. This is evident in the catch data, as more than 90% of the time it is caught using hook and line (Figure 13).

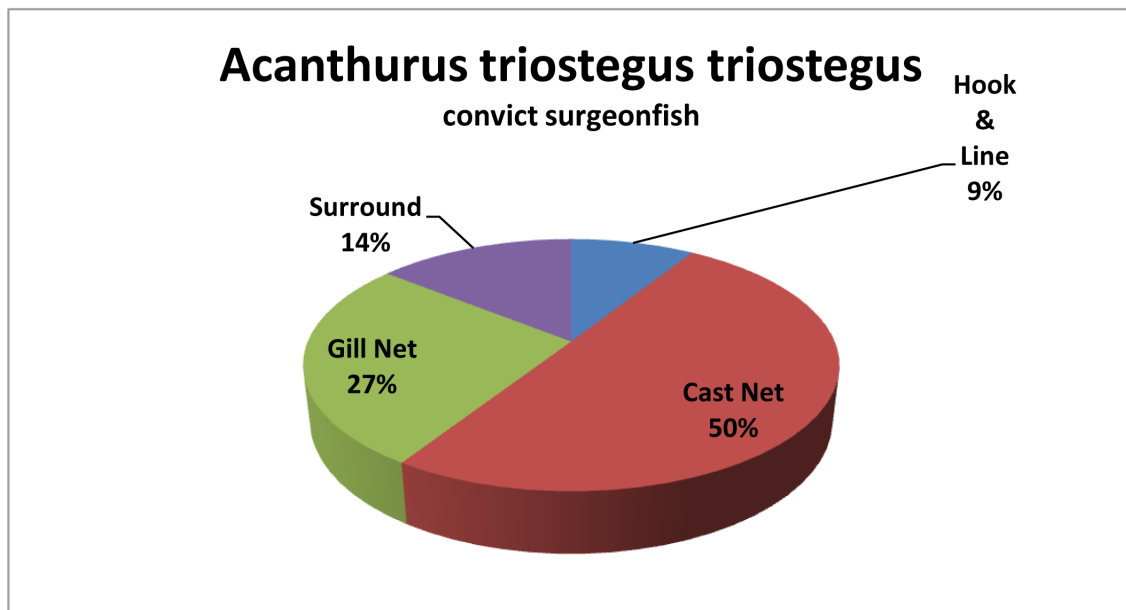


Figure 12. Catch methods for the convict surgeonfish.

Source: Guam DAWR 1986-2008.

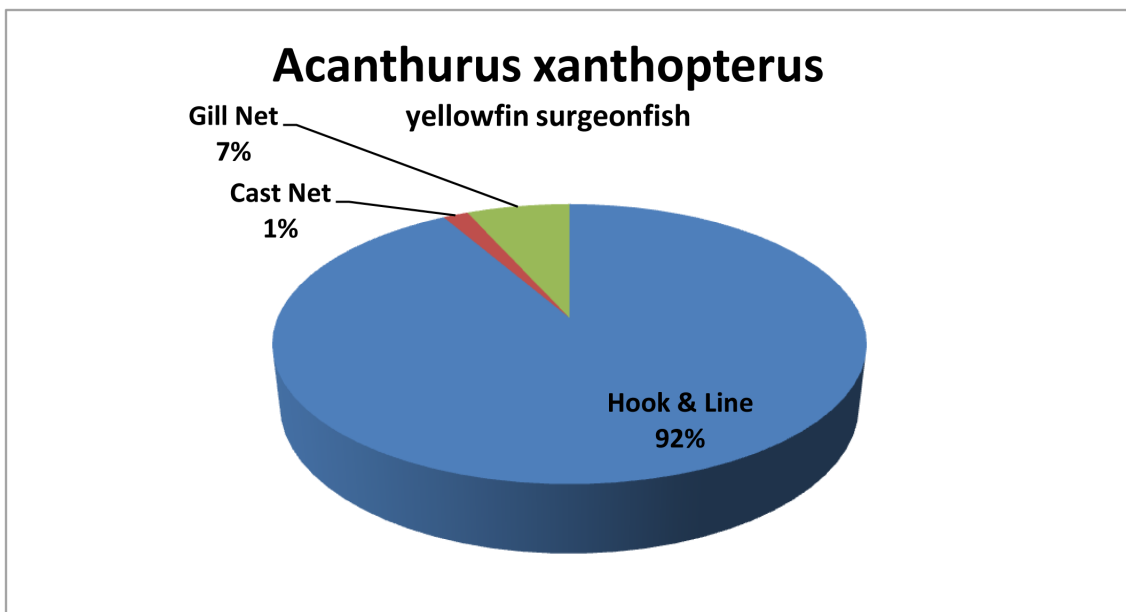


Figure 13. Catch methods for the yellowfin surgeonfish.

Source: Guam DAWR 1986-2008.

Naso literatus (orangespine unicornfish) is found in rock, rubble and coral areas of the lagoon and outer reef (Ibid.). It is usually observed in small groups with other acanthurids but will sometimes form large aggregations (Randall 2001). About 70% of the time *N. literatus* is caught using hook and line, while gill and surround nets account for the remainder of the catch (Figure 14).

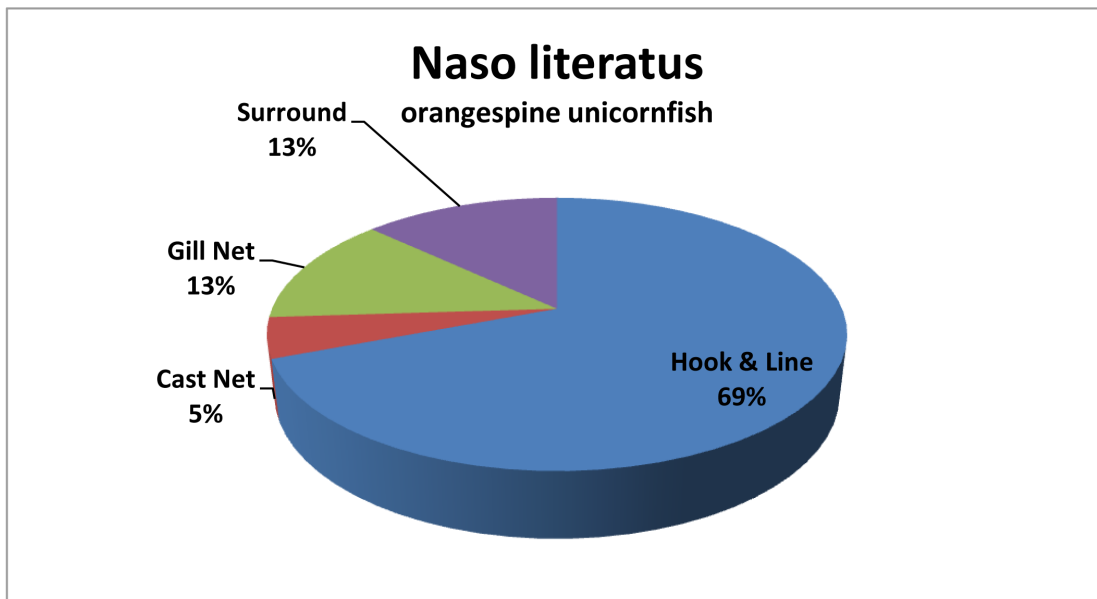


Figure 14. Catch methods for the orangespine unicornfish.

Source: Guam DAWR 1986-2008.

Finally, *Naso unicornis* (bluespine unicornfish) exhibits some behaviour similar to *Acanthurus lineatus*, occupying channels, moats, lagoons and seaward reefs with strong surge. It remains in small groups. Despite the similarity in showing preference for strong moving waters *N. unicornis* is also most often taken using hook and line (Figure 15).

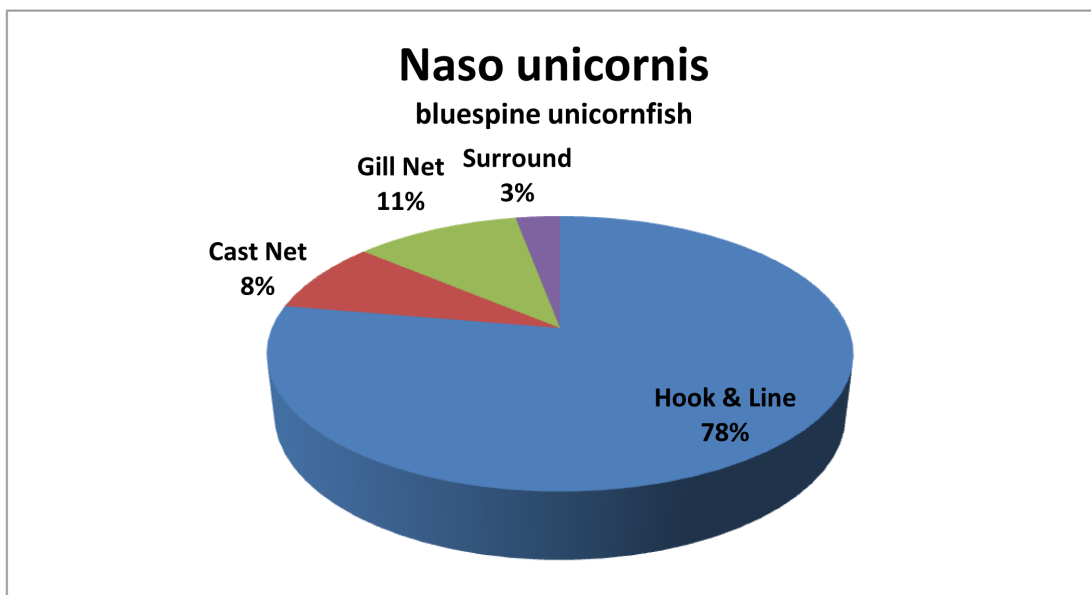


Figure 15. Catch methods for the bluespine unicornfish.

Source: Guam DAWR 1986-2008.

By linking prehistoric procurement activities to the fish behaviour for these acanthurids, we can place people at a variety of locations on the reef, including the surge channels building weirs and setting nets, with hand lines and baited hooks in the lagoonal areas and fishing from canoes anchored at or patrolling the reef front, or with a group of lineage mates or fishing partners

working a collective surround net in the lagoon. Fishing using weirs and gill nets provides people with different time- and place-engagements than when they are using cast nets, surround nets or angling. Just comparing *Acanthurus lineatus* with *Naso unicornis* reveals some important differences in behaviour. *A. lineatus* provides for people being elsewhere doing other things as they allow their equipment to capture fish in their absence while *N. unicornis* suggests the presence of people at channels and troughs during the changing tides, or when swells are rolling in on the reef. So, the importance of developing a more precise understanding of the midden beyond the family level is not to be underestimated when it comes to illustrating peoples' daily activities.

Carangids were identified in five of the midden locations and nine carangid genera were identified from the catch data. They occupy a wider range of habitats when compared with the acanthurids, in part because they are hunters and eat other fish. Because of their diet they will take bait, and are primarily caught using hook and line. The following table gives a good picture of this relationship. That said, one commonly caught species, *Trachinotus blochii*, departs from this rule, as it is almost exclusively captured using a gill net; and, about one third of the time *C. papuensis* is as well.

Table 3. Carangids and their relative catch methods.

Genera	% Hook and line	% Gill net	% Cast net	% Drag
<i>Carangoides orthogrammus</i>	100	-	-	-
<i>Caranx i'e</i> *	73	4	23	-
<i>Caranx ignobilis</i>	71	15	-	14
<i>Caranx melampygus</i>	82	13	1	-
<i>Caranx papuensis</i>	61	31	8	-
<i>Caranx sexfasciatus</i>	78	18	4	-
<i>Decapterus macrosoma</i> **	100	-	-	-
<i>Selar crumenophthalmus</i>	92	3	5	-
<i>Scomberoides lysan</i>	98	2	-	-
<i>Trachinotus blochii</i>	2	82	15	1

Source: All table data abstracted from Guam Division of Aquatics and Wildlife Resources 1986–2008.

* Commonly taken in large numbers from shore using a cast net.

** Catch data from 1998–2000.

Carangoides orthogrammus (yellow-spotted trevally) is found individually or in pairs or small schools that range from sandy river bottoms to sandy channels of lagoons and the outer reef (Smith-Vaniz 1995). Although they are found over a wide range of depths (3 m to 168 m), larger adults tend to move into the deeper waters (Myers 1991). *Caranx ignobilis* (giant trevally) is the largest of the trevallies. Although it has been observed ranging from 10 m to 188 m, it spawns in the shallow, outer reef zone (Myers 1999). Juveniles are often found in estuarine environments, while adults are found in clear lagoon waters and the outer reef (Lieske and Myers 1994).

Caranx melampygus (bluefin trevally) ranges from river channels to sandy inshore waters to the reef (Ibid.; Marquet 1993). Juveniles are more commonly found in the inshore areas. It will sometimes school. *Caranx papuensis* (brassy trevally) adults range from rivers to lagoons and the outer reef. Juveniles are frequently encountered in estuaries (Kuizer and Tono-zuka 2001). *Caranx sexfasciatus* (bigeye trevally) is a reef species that is mainly active at night or twilight. It remains in large fairly slow-moving schools in passes or outside the reef during the day (Bagnis et al. 1984). Juveniles frequent estuaries and may penetrate a good distance up-river (Allen et al. 2002).

Decapterus macrosoma (slender scad) usually schools, and is occasionally observed in small groups feeding on zooplankton along the reef slope near deep water (Kuizer and Tono-zuka 2001). The doublespotted queenfish, *Scomberoides lysan*, is found in clear, lagoon and outer reef waters as an adult, and inshore and brackish waters as a juvenile (Lieske and Myers 1994). This carangid is usually solitary, but it is sometimes observed in small, loose aggregates (Kuizer and Tono-zuka 2001). *Selar crumenophthalmus* (bigeye scad) prefers clear, ocean waters around islands, but ranges into turbid waters (Cervigón et al. 1992). It is nocturnal, and travels in tight groups numbering in the hundreds of thousands (Smith-Vaniz 1995). The last of the carangids identified from the fishery data is the snubnose pompano, *Trachinotus blochii*. Juveniles inhabit sandy shorelines and shallow sandy or muddy bays near river mouths, while adults school and move into the clearer waters of seaward reefs where they are found in the vicinity of coral and rock (Fischer et al. 1990).

Hemirhamphidae was identified from one midden assemblage and two genera were identified from the catch data, while six species are known in total from the Marianas (Myers and Donaldson 2003). *Hyporhamphus acutus acutus* (pacific halfbeak) is found at the surface at the reef front and in lagoons (Lieske and Myers 1994). It is captured about three quarters of the time on Guam using surround nets and 20% of the time with hook and line. *Hemiramphus lutkei* (jumping halfbeak) is found in immediate coastal waters. Unlike *H. acutus acutus* it is exclusively taken with hook and line.

Myers and Donaldson have recorded twenty-eight genera of holocentrids in the Marianas (2003). Six midden assemblages contained holocentrids and four species were recognised from the catch data. *Myripristis berndti* (big-scale soldierfish) hides in caves and under ledges of the sub-tidal inner reef during the day and becomes active at night (Mundy 2005). It is consequently one of the species captured after dark using gill nets. *Neoniphon sammara* (bloodspot squirrelfish) is found in schools in the reef flats, in seagrass beds and in the lagoon waters over hard substrates such as the coral, *Acropora* sp. (Lieske and Myers 1994).

Catch data for 1995 and 2004 indicate that the majority of *N. sammara* are captured in gill nets, with a small amount caught on hooks. *Sargocentron spiniferum* (long-jawed squirrelfish), like *Myripristis berndti*, is also active at night, hiding under ledges in the lagoon, reef flat and reef front during the day (Lieske and Myers 1994). Unlike *M. berndti*, it is caught using hook and line. The last of the holocentrids that has been identified in the catch is *Sargocentron tiere* (blue-lined squirrelfish). It is reclusive during the day and inhabits deep crevices in surge channels (Myers 1991). *S. tiere* is taken using gill nets. Three of the four commonly taken species of holocentrid are active during the night. While two of the three species can be caught with gill nets set at dusk and then retrieved in the morning, *S. spiniferum* implies active fishing after dark.

Kyphosidae (rudderfishes) were identified from one midden and two species have been identified in the top-ten catch data. Both are caught primarily using gill nets, but about 10% of *Kyphosus cinerascens* are caught with hook and line. *K. cinerascens* (highfin rudderfish) is found grouped in the surf-influenced zone of the outer reef, usually over calcareous algae (Sommer et al. 1996). *Kyphosus vaigiensis* (lowfin rudderfish) occupies the same habitats as its congener and is also found around exposed areas of rock reefs (Masuda et al. 1984). It is most often taken using a gill net.

Labrids (wrasses) were recognised in all ten midden groups and three genera are represented in the top-ten catch data. *Cheilinus trilobatus* (tripletail wrasse) is common in shallow reef margins where good coral cover is available. Consequently, it is found in both lagoon and reef front areas (Lieske and Myers 1994). *C. trilobatus* is almost always taken by net, and in particular, by gill net (Figure 16). *Cheilinus undulatus* (humphead wrasse) is a diurnally active species found over steep areas of the reef front, channel slopes, and the inner reef of the lagoon (Myers 1991). Juveniles are observed in a variety of lagoon habitats including seagrass beds (Ibid.). They rest in caves

during the night. Catch method was not available for this species. *Cheilio inermis* (cigar wrasse) is commonly found over algal flats and seagrass beds (Myers 1991). It is recorded as a species taken using spear and snorkel.

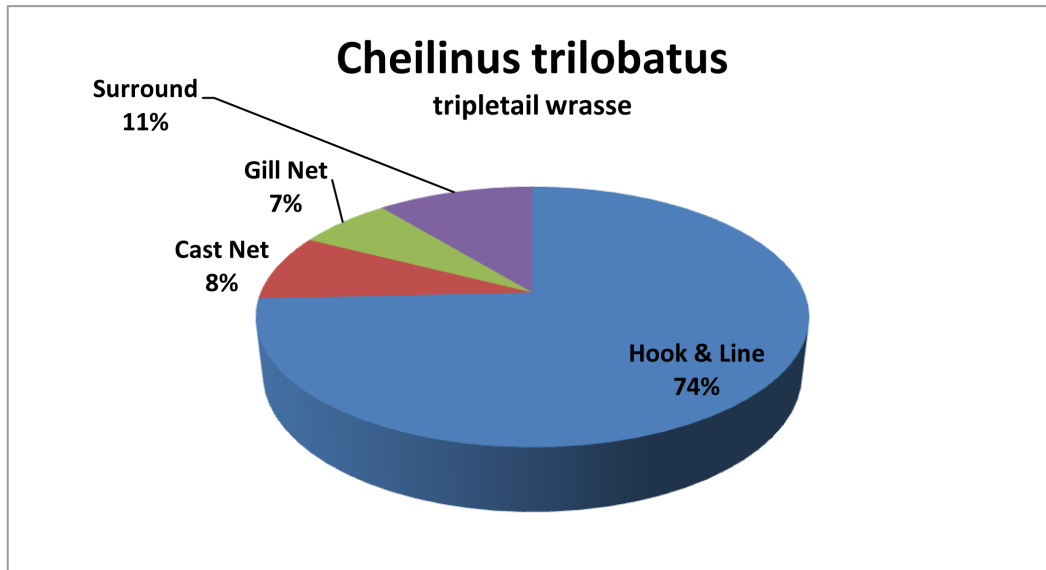


Figure 16. Catch methods for the tripletail wrasse.

Source: Guam DAWR 1986-2008.

Six genera of lethrinids (emperors) appear in the top-ten catch data and the family was identified from six midden assemblages. *Lethrinus erythracanthus* (orange-fin emperor) is found in a variety of coral reef habitats: deep lagoons and channels, reef front slopes and sandy-bottomed areas (Sommer et al. 1996). It is taken exclusively by hook and line according to the 1997 data. *Lethrinus harak* (blackspot emperor) is found individually or in small schools within a wide range of coral reef and mangrove habitats. It is usually observed within the upper 20 metres of the water column and is considered the most common emperor in the Marianas (Myers 1991). More than half of the time it is caught using hook and line, otherwise gill nets (31%) and other nets are used (Figure 17).

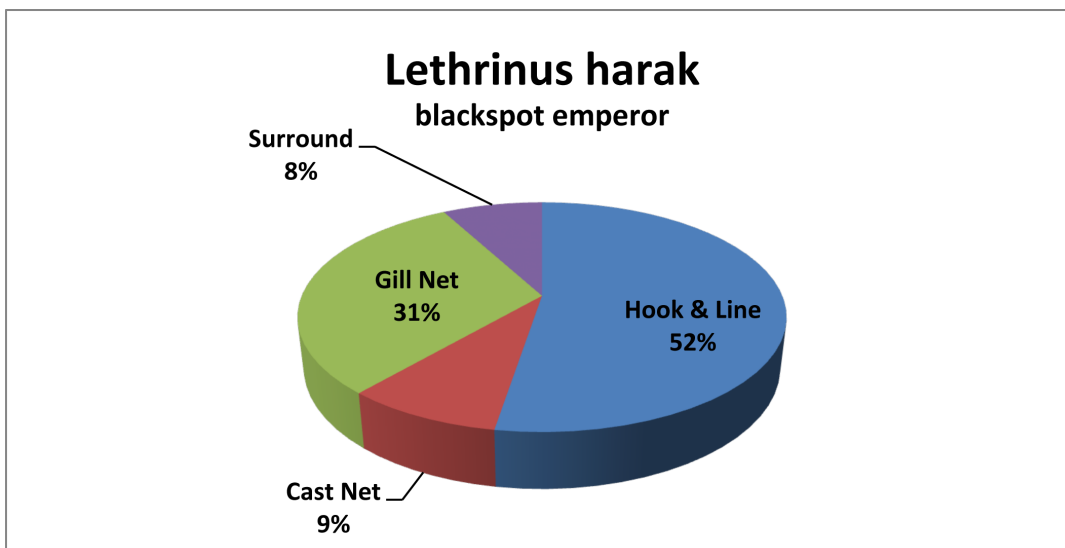


Figure 17. Catch methods for the blackspot emperor.

Source: Guam DAWR 1986-2008.

The small-tooth emperor (*Lethrinus microdon*) is found in small schools and is most frequently observed over sandy areas of the coral reef (Myers 1991). No catch method data were available. *Lethrinus obsoletus* (yellowstripe emperor) occurs individually or in aggregations in sand and rubble areas of the lagoon and in the waters over seagrass beds (Gell and Whittington 2002; Sommer et al. 1996). Approximately three fifths of the time, it is caught with hook and line, otherwise a gill net dominates its capture (Figure 18).

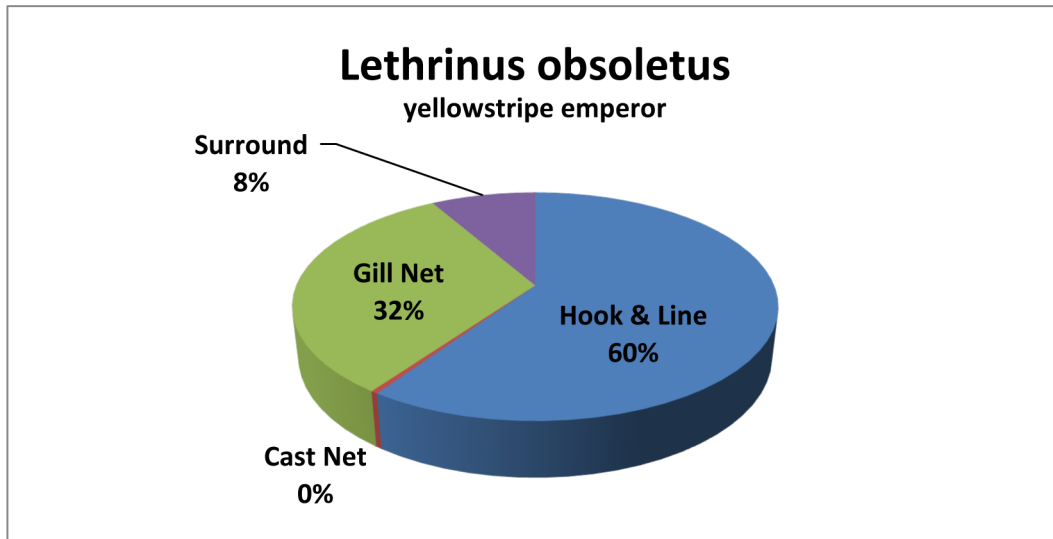


Figure 18. Catch methods for the yellowstripe emperor.

Source: Guam DAWR 1986-2008.

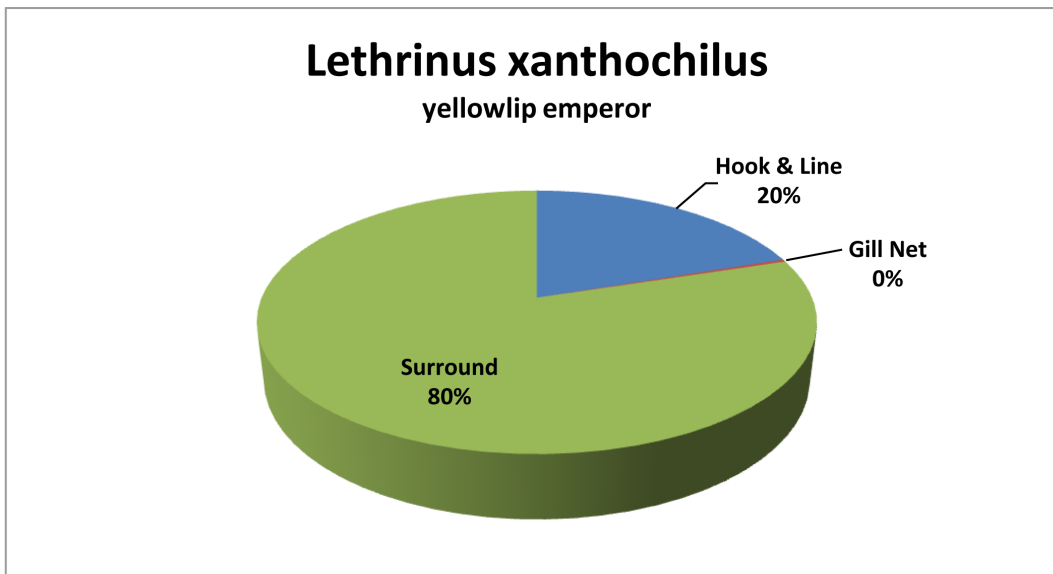


Figure 19. Catch methods for the yellowlip emperor.

Source: Guam DAWR 1986-2008.

Lethrinus xanthochilus (yellowlip emperor) is observed in small schools in the same areas as *Lethrinus obsoletus*, but also in deep channels. Juveniles are most common in seagrass beds (Sommer et al. 1996). Approximately 80% of the time, *L. xanthochilus* is caught with a surround net, and the remainder of the time it is captured using a hook and line (Figure 19). *Monotaxis*

grandoculus (bigeye emperor) is the last of the emperors identified in the top-ten catch data. Large adults are most often encountered in groups of approximately fifty individuals (Myers 1991). They are active at night and frequent sand-bottomed and rubble-strewn areas around coral reefs. 65% of the time *M. grandoculus* is caught with hook and line, the remainder of the time using a gill net.

Five genera represent the snappers (lutjanid) in the top-ten catch data and the family is identified from six midden areas. *Aprion virescens* (jobfish) is usually observed in open areas of deep lagoons, in channels and the reef front. It is sometimes found in small groups (Lieske and Myers 1994). It is caught exclusively using hook and line according to 1995 through 2004 data. *Lutjanus bohar* (twinspotted snapper) is usually solitary and can be found on both the reef front and the lagoon side (Sommer et al. 1996). It is most often taken using snorkel and spear. *Lutjanus fulvus* (flametail snapper) is often located in the lagoon or on the reef front where deep holes or large boulders are found (Lieske and Myers 1994). Juveniles are sometimes observed in lower portions of river channels and mangroves (Sommer et al. 1996). About 60% of the time *L. fulvus* is caught with hook and line, and about 40% of the time captured using a gill net (Figure 20).

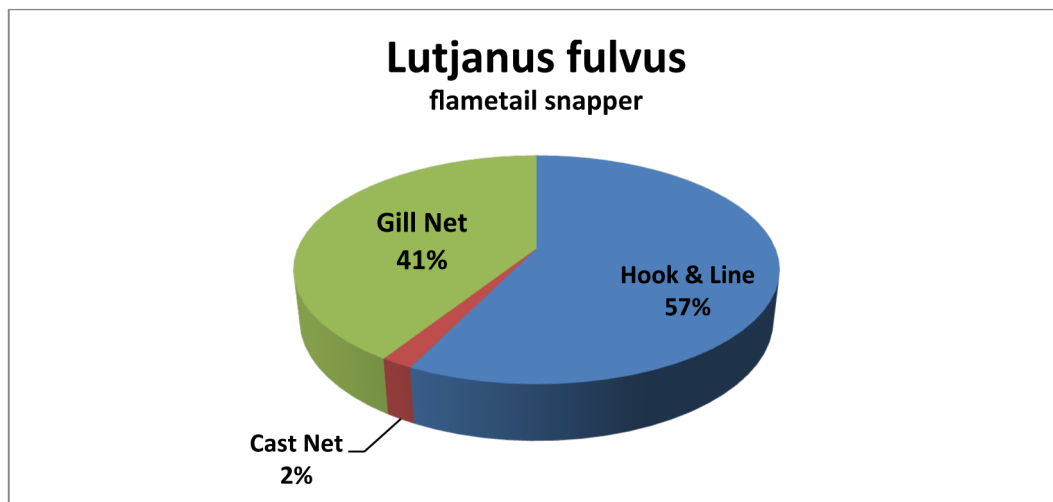


Figure 20. Catch methods for the flametail snapper.

Source: Guam DAWR 1986-2008.

Lutjanus gibbus (humpback snapper) is found in a variety of habitats depending upon its age (Myers 1991). Juveniles are observed in the more sheltered areas of the seagrass beds and in shallow sand and coral environs of the lagoon. Sub-adults cluster in large schools that slowly range or drift over the reef slopes throughout the day. They disperse over the reef at night to feed (Ibid.). According to the 1997 data, *L. gibbus* is exclusively taken by hook and line. *Lutjanus monostigmus* (onespot snapper) is found in the outer lagoon and outer reef during the day and comes into more-shallow reef flat waters at night. It frequents large coral formations, caves and shipwrecks (Sommer et al. 1996). *L. monostigmus* is primarily taken with hook and line; less than 10% of the time it is caught using a cast net, possibly at night.

Three midden assemblages contain mullids (goatfishes) and three genera are identified in the catch data. *Mulloidichthys flavolineatus* (yellowstripe goatfish) is among the more abundant members of the family in shallow, sand-bottomed flats (Myers 1991). It is found in schools in these areas as well as along the outer reef. It is captured using nets, more than 80% of the time using gill nets (Figure 21).

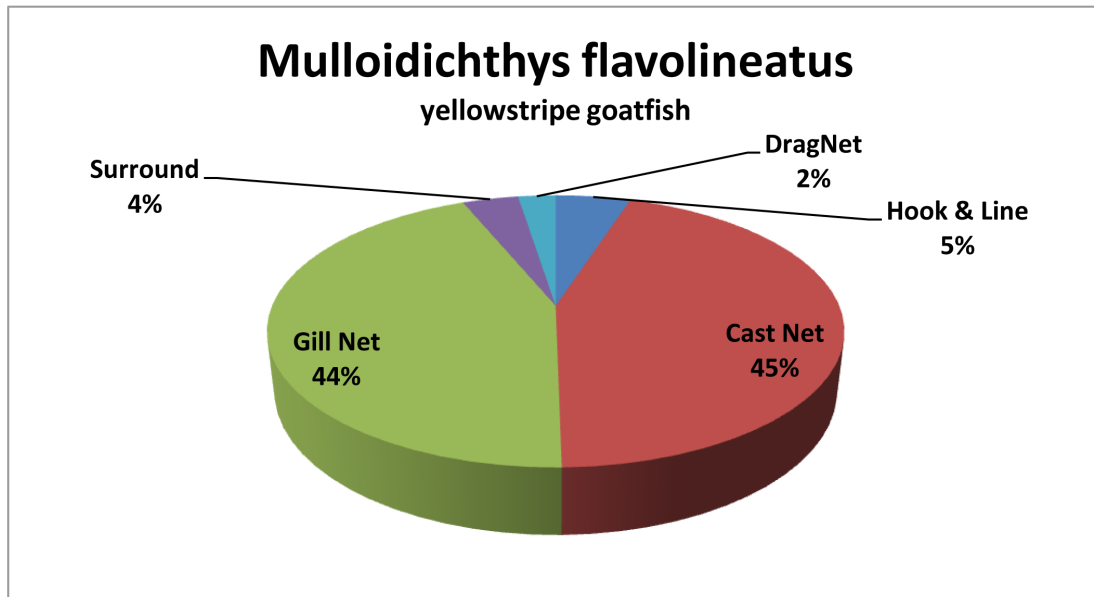


Figure 21. Catch methods for the yellowstripe goatfish.

Source: Guam DAWR 1986-2008.

Mulloidichthys ti'ao is juvenile goatfish that comes in close to shore and is usually taken using a cast net (Amesbury et al. 1986). *Parupeneus barberinus* (dash-and-dot goatfish) is “one of the most abundant species of *Parupeneus* over large sandy patches as well as sand and rubble areas of reef flats, and lagoon and seaward reef” found in the Marianas (Myers 1991:149). Juveniles are often observed in small, mixed-species groups in areas of seagrass (Kuiter and Tono-zuka 2001b). It is captured in gill nets about two thirds of the time, surround nets 15%, and hook and line 12% of the time (Figure 22). *Parupeneus insularis* (two-saddled goatfish) is a relatively newly identified species for Guam whose habitat has not been well defined (Randall and Myers 2002). Catch data indicate that *P. insularis* has been taken using a gill net.

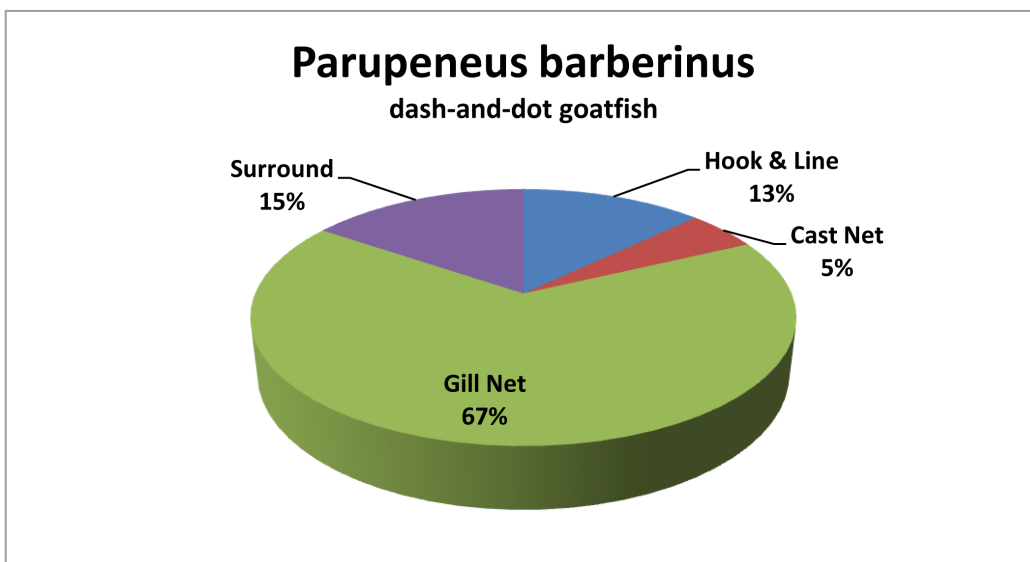


Figure 22. Catch methods for the dash-and-dot goatfish.

Source: Guam DAWR 1986-2008.

One species of muraenid (moray eels) was identified from the catch data for 2007-2008 and the family was identified from only the 1996 Tarague assemblage. *Gymnothorax javanicus* (giant moray) may be the world's largest eel. It is found in the lagoon-side waters of the reef and on the reef front (Myers 1991). Juveniles are frequently observed in fairly shallow water. Catch method data were not available, but considering that this species is usually ciguatoxic, it is perhaps taken only rarely.

Eleven genera of parrotfishes (Scaridae) were identified, making it the family most represented by individual species in the top-ten catch record. Scarids were identified from all of the middens. Parrotfishes are often easily identified in middens because of the differential preservation of their mouthparts. In many of the midden analyses from the late 1980s until the mid-1990s, their relatively easy recognition caused scarids to frequently be the only family identified. Parrotfishes feed on algae and some on live coral.

As a consequence of their food source, they are most often found in clear, outer-lagoon and reef-front areas where corals grow best. Also, as a consequence of their diet, they are frequently speared while snorkelling. The humphead parrotfish (*Bolbometopon muricatum*) is often-times found in schools (Myers 1991). It consumes live coral, and adult males are harem and territorial (Ibid.). It was taken using scuba gear according to the 1995 catch data.

Cetoscarus bicolor (bicolor parrotfish) is found in the same habitat as *Bolbometopon muricatum*, but adults seem to prefer the upper end of steep coral slopes (Ibid.). Juveniles are frequently observed in areas dense with coral and algae (Kuitert and Tono-zuka 2001b). *C. bicolor* is sometimes taken in nets. *Chlorurus frontalis* (tan-faced parrotfish) is observed in small schools on exposed reef flats and in reef front waters (Myers 1991). *C. frontalis* is most often taken using snorkel and spear. *Chlorurus microrhinos* (steephead parrotfish) is found in clear reef waters. While adults congregate, juveniles are usually solitary. No catch method data for this species are included in the records. *Chlorurus sordidus* (daisy parrotfish) range from coral-thick areas to the more open reef flats (Broad 2003). They are observed to behave differently in the different reef habitats (Kuitert and Tono-zuka 2001b). *C. sordidus* is caught in gill nets or taken with snorkel and spear according to the 2007-2008 data.

Hipposcarus longiceps (Pacific longnose parrotfish) is often found in groups in turbid waters (Ibid.). Juveniles are observed around patch reefs in lagoons and above coral rubble. Adults and sub-adults frequent sandy areas where their natural colouring provides some protection (Myers 1991:194). The 2008 data show *H. longiceps* as exclusively caught in gill nets. *Leptoscarus vaigiensis* (seagrass parrotfish) lives up to its common name and is found in seagrass areas where it consumes seagrass and algae (Sommer et al. 1996). It is usually found in small groups. No catch method data from 2007-2008 were available.

Scarus altipinnis (filament-finned parrotfish) is known to remain in protected reef habitats while young and to move out into the reef front margins as an adult (Lieske and Myers 1994). The 2008 catch records show *S. altipinnis* as being taken using snorkel and spear. *Scarus psittacus* (common parrotfish) ranges from lagoon to reef flats to the reef front, and is usually found over corals (Fischer et al. 1990). It grazes algae (Bruce and Randall 1984). *S. psittacus* is sometimes taken in a surround net, but more than 90% of the time by gill net. It cocoons at night and is frequently taken using spear and snorkel when it is thusly immobilised. *Scarus rubroviolaceus* (redlip parrotfish) is found on reef fronts and frequently in the rocky talus and coral substrates below sea cliffs, "where it may occur in large schools" (Kuitert and Tono-zuka 2001b). Again, this species is most often taken with spear and snorkel. The last scarid on the list is *Scarus schlegeli* (yellowband parrotfish). The yellowband parrotfish is common to areas rich in coral with high

relief (Lieske and Myers 1994). Juveniles and females are found in mixed-species groups; juveniles being more common on slopes rather than flats (Kuitert and Tono-zuka 2001b). 50% of the time it is taken using a throw net and about one third of the time using a gill net.

Two midden assemblages contain Scombridae. A single scombrid (tunas and mackerels) is recorded from the top-ten catch record, *Gymnosarda unicolor*, the dogtooth tuna. *G. unicolor* is one of the few tunas that frequent the reef, although it is a pelagic species. Usually solitary, it is sometimes found in small groups along steep slopes and pinnacles (Myers 1991). Tuna are usually taken with hook and line, but according to the 2006 data, *G. unicolor* is taken by gill nets.

The last family common to both top-ten catch and the midden assemblages is Serranidae, which was identified from eight assemblages. Four genera of serranids (groupers) were identified in the top-ten record and all are members of the subfamily Epinephelinae. Serranids are generally large-bodied, voracious bottom dwellers but may be found in a range of habitats (Myers 1991:103). They will take bait and are usually caught using hook and line.

Cephalopholis urodeta (flagtail grouper) is a relatively small grouper and inhabits a variety of reef habitats including front and lagoon side. Although it utilises a greater depth range, it is usually found within the upper 20m of the water column (Lieske and Myers 1994). *C. urodeta* is usually caught on hook and line according to the 1998-1999 data. *Epinephelus merra* (honeycomb grouper) is most often found in protected areas of the reef front and in the shallows of the lagoon. Juveniles are often found in *Acropora sp.* thickets (Myers 1991). According to the catch data more than 80% are caught using hook and line (Figure 23).

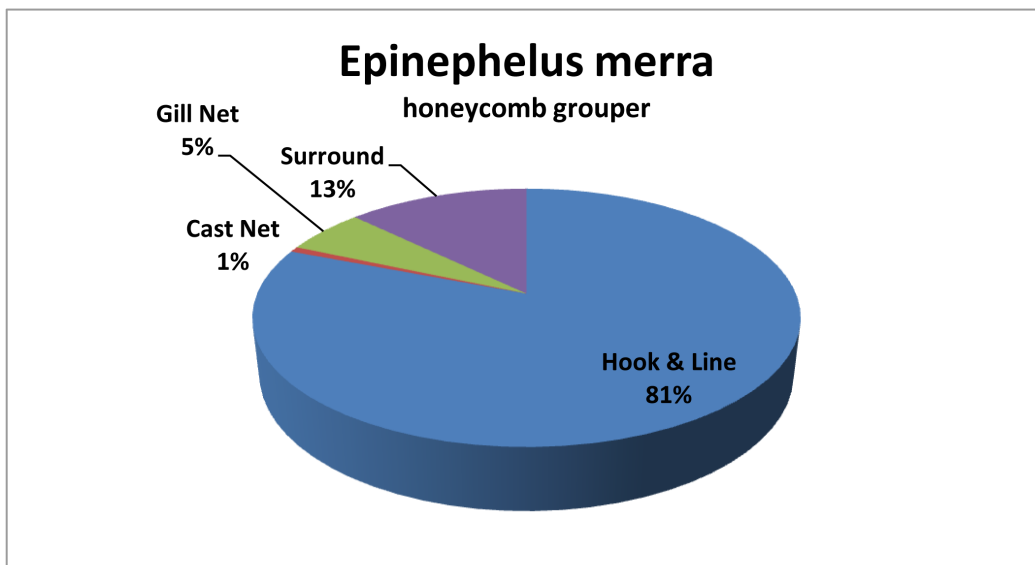


Figure 23. Catch methods for the honeycomb grouper.

Source: Guam DAWR 1986-2008.

Epinephelus polyphekadion (marbled grouper) is usually found in areas of rich coral growth in lagoons and reef fronts (Kuitert and Tono-zuka 2001). It is common in un-fished areas, but is rare on Guam as a result of the island's heavy fishing pressure (Myers 1991:108). Data from 2003 suggests that it is taken with spear and snorkel. *Plectropomus laevis* (saddleback grouper) is found most often in channels and outer reef shelves (Kailola et al. 1993). Juveniles inhabit more turbid waters than adults (Myers 1991:110). *P. laevis* is also scarce in the heavily-fished waters of Guam. No catch method data were available for *P.laevis*.

Conclusions

It should be clear from the examples given that family level data obscure important information that is essential to discussions of prehistoric subsistence activities. It also frequently introduces inaccuracies into the interpretive discussion offered by researchers. This is particularly true when entire families are considered to represent either a near-shore, reef flat and/or lagoonal fishery, or an off-shore reef-front or pelagic fishery.

By revisiting two of the more detailed report discussions that were referenced in the introductory pages we can illustrate how the method described in this paper contributes to remedying the problems of interpretation. The Tarague report suggests that carangid, lutjanid, and serranid might indicate fishing offshore from watercraft. While this could be the case, it would depend upon which species are involved. Following the information given in Table 3 for the carangids, we see that the overwhelming majority is caught on hook and line. Significantly, though, *Trachinotus blochii* is caught primarily in gill nets, as is 31% of *Caranx papuensis* and 18% of *C. sexfasciatus*; 29 % of *Caranx ignobilis* are caught in various nets. Cast nets (a tool thought to have been introduced historically) are used to capture an additional 23% of *Caranx* i.e. Among the lutjanids, ~41% of *Lutjanus fulvus* is obtained using gill nets and a small amount of *Lutjanus monostigmus* is obtained by cast net. Among the Serranids, about 20% of the *Epinephelus merra* is caught in nets. The discussion from Olmo et al. (2000:208,209) highlights additional problems. The first statement from that discussion is that trolling was responsible for the “coryphaenid” and “scombrid” remains. It is the only one that is mostly accurate. Only two species of Coryphaenidae are recorded and one, *Coryphaena hippurus* (common dolphinfish or mahimahi), is common in Guam’s waters. As stated, it is almost exclusively taken by trolling. Four species of scombrids are routinely taken by fishing boats in Guam’s waters: wahoo, dogtooth tuna, skipjack tuna and yellowfin tuna. Dogtooth tuna also visit the reef and are frequently taken in gill nets, and possibly in weirs. The next statement is that “acanthurids, balistids, mullids, and scarids were most likely caught in nets”. There are numerous inaccuracies associated with this statement. Thirteen species of acanthurids were observed in the waters of this project area. Two prehistoric villages that are located in the project area were tested, one located at Haputo and the other at Double Reef. Five of the thirteen species were common to the waters off of each village. Four species were observed at Double Reef and not at Haputo, while four were seen at Haputo and not at Double Reef. The distribution of acanthurids is shown in Table 4.

Table 4. Distribution of acanthurids observed in NCTS waters.

Species	Double reef, outer reef front and submarine terrace	Double reef, patch reef	Haputo
<i>Acanthurus lineatus</i>	x	x	x
<i>Acanthurus nigricans</i>	x	x	x
<i>Acanthurus nigrofusus</i>	x	x	x
<i>Acanthurus olivaceus</i>			x
<i>Acanthurus pyroferus</i>			x
<i>Acanthurus xanthopterus</i>			x
<i>Ctenochaetus striatus</i>	x	x	x
<i>Naso brevirostris</i>			x
<i>Naso hexacanthus</i>		x	
<i>Naso literatus</i>	x	x	x
<i>Naso unicornus</i>	x	x	
<i>Zebrasoma flavescens</i>	x		
<i>Zebrasoma veliferum</i>	x	x	

Source: All data from Stojkovich 1977.

Pie charts showing catch methods for some of the identified acanthurids are found in the earlier pages. Table 5 provides catch method data available for the species identified in Table 4. As can be seen in Table 5, four of the species of acanthurids identified from NCTS waters were likely not captured in nets, but were probably obtained using hook and line. Of the remainder for which we have catch method data, only three species are mostly taken using nets, and one is exclusively obtained using spear and snorkel. At least for the Acanthuridae known from the project area, the statement that they were most likely obtained using nets is not accurate.

Table 5. Catch method by percentages for acanthurids observed in NCTS waters.

Species	Hook & line	Cast net	Gill net	Surround net	Drag net	Spear
<i>Acanthurus lineatus</i>	29	8	42	21	-	-
<i>Acanthurus nigricans</i>	*	*	*	*	*	*
<i>Acanthurus nigrofusus</i>	-	-	100	-	-	-
<i>Acanthurus olivaceus</i>	-	-	-	-	-	100
<i>Acanthurus pyroferus</i>	*	*	*	*	*	*
<i>Acanthurus xanthopterus</i>	92	1	7	-	-	-
<i>Ctenochaetus striatus</i>	17	59	24	-	-	-
<i>Naso brevirostris</i>	100	-	-	-	-	-
<i>Naso hexacanthus</i>	*	*	*	*	*	*
<i>Naso literatus</i>	69	5	13	13	-	-
<i>Naso unicornus</i>	78	8	11	3	-	-
<i>Zebrasoma flavescens</i>	*	*	*	*	*	*
<i>Zebrasoma veliferum</i>	*	*	*	*	*	*

Source: Species identifications from Stojkovich, 1977; Catch methods from Guam DAWR, 1986-2008; * no catch method data.

Eight species of Balistidae were recorded from NCTS project waters and these are shown in Table 6. Five species were recorded from Double Reef and four from Haputo. Only the halfmoon triggerfish, *Sufflamen chrysopterus*, was observed at both areas.

Table 6. Distribution of balistids recorded in NCTS waters.

Species	Double reef, outer reef front and submarine terrace	Double reef, patch reef	Haputo
<i>Balistapus undulatus</i>	x	x	
<i>Melichthys niger</i>		x	
<i>Melichthys vidua</i>			x
<i>Pseudobalistes flavimarginatus</i>		x	
<i>Rhinecanthus aculeatus</i>		x	
<i>Rhinecanthus rectangulus</i>			x
<i>Sufflamen bursa</i>			x
<i>Sufflamen chrysopterus</i>	x	x	x

Source: All data from Stojkovich 1977.

Six of the 8 species are usually caught using hook and line (Table 7). One, *Melichthys niger* (black triggerfish) is exclusively captured using a gill net, and *Balistapus undulatus* (orange-lined triggerfish) is obtained with spear and snorkel. Balistids that are found in the project area, like the acanthurids before them, are not accurately depicted as likely caught using nets.

Table 7. Catch method by percentages for balistids observed in NCTS waters.

Species	Hook & line	Cast net	Gill net	Surround net	Drag net	Spear
<i>Balistapus undulatus</i>	-	-	-	-	-	100
<i>Melichthys niger</i>	-	-	100	-	-	-
<i>Melichthys vidua</i>	100	-	-	-	-	-
<i>Pseudobalistes flavimarginatus</i>	100	-	-	-	-	-
<i>Rhinecanthus aculeatus</i>	72	4	24	-	-	-
<i>Rhinecanthus rectangulus</i>	80	18	2	-	-	-
<i>Sufflamen bursa</i>	100	-	-	-	-	-
<i>Sufflamen chrysoptera</i>	100	-	-	-	-	-

Source: Species identifications from Stojkovich 1977; Catch methods from Guam DAWR 1986-2008.

Three (four^Δ) species of Mullidae were recorded for NCTS waters and these are shown in Table 8. *Parupeneus barberinus* (dash-and-dot goatfish) was only observed at Haputo, while *P. cyclostomus* (yellowsaddle goatfish) and *P. multifasciatus* (manybar goatfish) were recorded at both areas.

Table 8. Distribution of mullids recorded in NCTS waters.

Species	Double reef, outer reef front and submarine terrace	Double reef, patch reef	Haputo
<i>Parupeneus barberinus</i>			x
<i>Parupeneus cyclostomus</i>	x	x	x
<i>Parupeneus multifasciatus</i>	x	x	x
<i>Parupeneus trifasciatus</i>	Δ	Δ	Δ

Δ. *P. trifasciatus* was identified in 1977 as a separate species but is now considered *P. multifasciatus*.

Source: This table is adapted from WPRFMC (2011) Stojkovich (1977).

While only *Parupeneus barberinus* is most often taken using nets, about half of the time the remaining species are caught using hook and line (Table 9). Including mullids in the list of those families most likely caught using nets is less erroneous than doing so for acanthurids and balistids, but describing them in this way clearly hides significant fishing method diversity.

Table 9. Catch method by percentages for mullids observed in NCTS waters.

Species	Hook & line	Cast net	Gill net	Surround net	Drag net	Spear
<i>Parupeneus barberinus</i>	13	5	67	15	-	-
<i>Parupeneus cyclostomus</i>	56	-	44	-	-	-
<i>Parupeneus multifasciatus</i>	48	30	22	-	-	-

Source: Species identifications from Stojkovich 1977; Catch methods from Guam DAWR 1986-2008; Δ same species as *multifasciatus*.

The last family listed as likely caught using nets is Carangidae. Nine species of carangids were listed in Table 3 and discussed earlier. All, except for *Trachinotus blochii*, which is mostly caught in a gill net, are usually, if not exclusively caught on hook and line. Unfortunately, no carangids were observed in the waters off of NCTS at the time of the marine survey, so it is not possible to more closely match fishing methods with the midden remains for this family.

The remaining fish families referred to in the NCTS report, the labrids, lethrinids, lutjanids and serranids were stated as having been caught with pelagic lures. Again, assigning these families to

this catch method is problematic once the habits of individual species are taken into account. While it is true that the serranids and three of the four lutjanid species are mostly caught using hooks, the majority of the labrids and between half and a third of the lethrinids are captured in nets.

More species (23) of Labridae were observed in the waters off of NCTS than were species of any other family. Eight of the 23 species were seen at Double Reef and not Haputo, while 2 species were observed at Haputo and not at Double Reef. The species distributions are shown in Table 10.

Table 10. Distribution of labrids observed in NCTS waters.

Species	Double reef, outer reef front and submarine terrace	Double reef, patch reef	Haputo
<i>Anampses caeruleopunctatus</i>	1	1	
<i>Anampses twisti</i>	1		
<i>Bodianus axillaris</i>			1
<i>Cheilinus trilobatus</i>	1	1	1
<i>Coris aygula</i>	1		1
<i>Coris gaimard</i>	1		1
<i>Epibulus insidiator</i>	1	1	1
<i>Gomphosus varius</i>	1	1	1
<i>Halichoeres hortulanus</i>	1	1	1
<i>Halichoeres margaritaceus</i>	1	1	1
<i>Halichoeres marginatus</i>	1	1	
<i>Halichoeres trimaculatus</i>			1
<i>Hemigymnus fasciatus</i>	1		
<i>Hemigymnus melapterus</i>	1	1	
<i>Labroides bicolor</i>		1	1
<i>Labroides dimidiatus</i>	1	1	1
<i>Macropharyngodon meleagris</i>	1	1	1
<i>Novaculichthys taeniourus</i>	1	1	
<i>Oxycheilinus unifasciatus</i>		1	1
<i>Stethojulis bandanensis</i>	1	1	
<i>Thalassoma hardwicke</i>	1	1	
<i>Thalassoma lutescens</i>	1		1
<i>Thalassoma quinquevittatum</i>	1	1	1

Source: Species identifications from Stojkovich 1977.

Labrids and their catch methods are shown in Table 11. Catch data were available for 18 of the 23 species, and of these only seven could be considered to be preferentially caught using pelagic lures. Ten of the species are most often captured using some combination of gill, cast or surround nets. *Thalassoma trilobatum* is caught in equal amounts by net or hook and line.

Table 11. Catch methods by percentages for labrids recorded from NCTS waters.

Species	Hook & line	Cast net	Gill net	Surround net	Drag net
<i>Anampses caeruleopunctatus</i>	-	25	75	-	-
<i>Anampses twisti</i>	*	*	*	*	*
<i>Bodianus axillaris</i>	*	*	*	*	*
<i>Cheilinus trilobatus</i>	74	8	7	11	-
<i>Coris aygula</i>	-	-	100	-	-
<i>Coris gaimard</i>	86	-	14	-	-
<i>Epibulus insidiator</i>	73	-	27	-	-
<i>Gomphosus varius</i>	65	-	35	-	-
<i>Halichoeres hortulanus</i>	-	-	100	-	-
<i>Halichoeres margaritaceus</i>	-	100	-	-	-
<i>Halichoeres marginatus</i>	*	*	*	*	*
<i>Halichoeres trimaculatus</i>	92	3	5	-	-
<i>Hemigymnus fasciatus</i>	-	-	100	-	-
<i>Hemigymnus melapterus</i>	10	23	67	-	-
<i>Labroides bicolor</i>	*	*	*	*	*
<i>Labroides dimidiatus</i>	*	*	*	*	*
<i>Macropharyngodon meleagris</i>	-	-	100	-	-
<i>Novaculichthys taeniourus</i>	11	6	22	61	-
<i>Oxycheilinus unifasciatus</i>	2	-	35	63	-
<i>Stethojulis bandanensis</i>	-	-	100	-	-
<i>Thalassoma hardwicke</i>	93	-	7	-	-
<i>Thalassoma lutescens</i>	*	*	*	*	*
<i>Thalassoma quinquevittatum</i>	87	-	13	-	-
<i>Thalassoma trilobatum</i>	49	31	20	-	-

Source: Species identifications from Stojkovich 1977; Catch methods from Guam DAWR 1986-2008; * no catch method data.

Two species of Lethrinidae were recorded from the waters off of NCTS (Stojkovich 1977). Both are reef dwellers and are found in less than 30 m of water (Lieske and Myers 1994). *Gnathodentex aureolineatus* (striped large-eye bream) is a night feeder, and the diurnal *Monotaxis grandoculus* (humpnose bigeye bream) is sometimes found in large aggregations (Ibid.). Just over half of the time (55%) *Gnathodentex aureolineatus* is caught with hook and line, see Figure 24. Approximately two-thirds of the time (65%) *Monotaxis grandoculus* is caught with hook and line, and the remainder is captured by using a gill net (DAWR records 1986-2008).

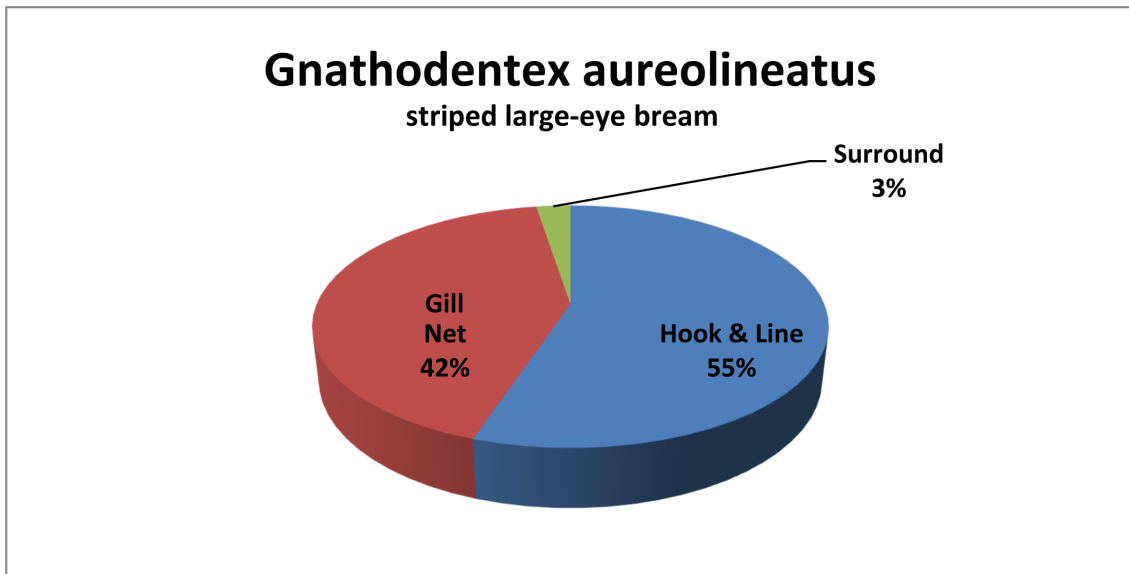


Figure 24. Chart showing catch methods for *Gnathodentex aureolineatus*.

Source: Guam DAWR 1986-2008.

Four species of Lutjanidae (snappers) were identified in the waters of NCTS (Stojkovich 1977). *Aphareus furca* (small toothed jobfish), *Aprion virescens* (green jobfish), and *Lutjanus gibbus* (humpback red snapper) are all most often caught with hook and line (DAWR records 1986-2008). The blacktail snapper, *Lutjanus fulvus*, is taken by both net and hook and line, see Figure 25.

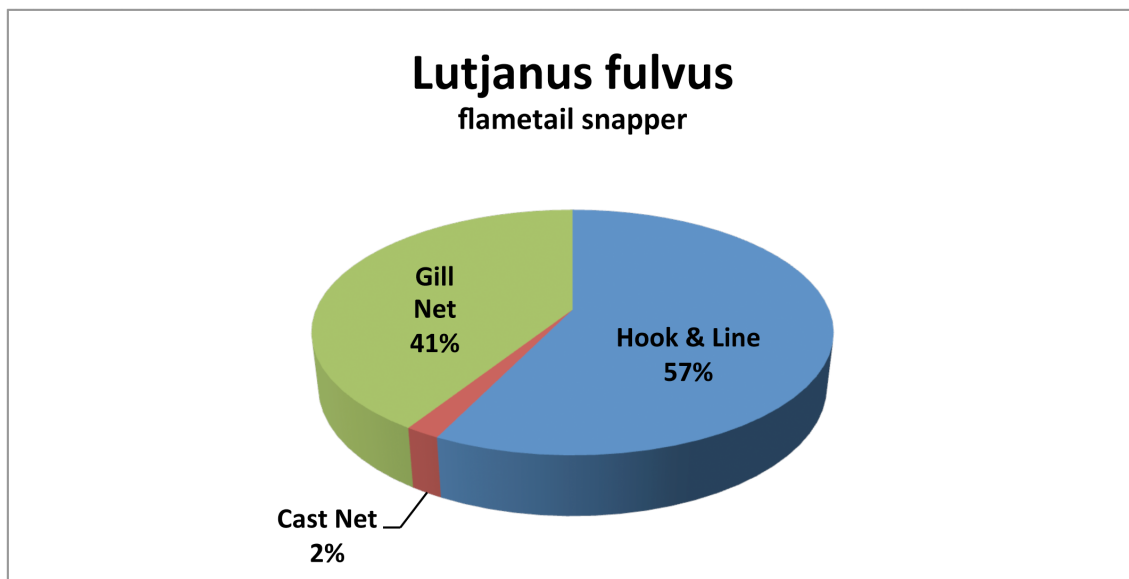


Figure 25. Chart showing catch methods for *Lutjanus fulvus*.

Source: Guam DAWR 1986-2008.

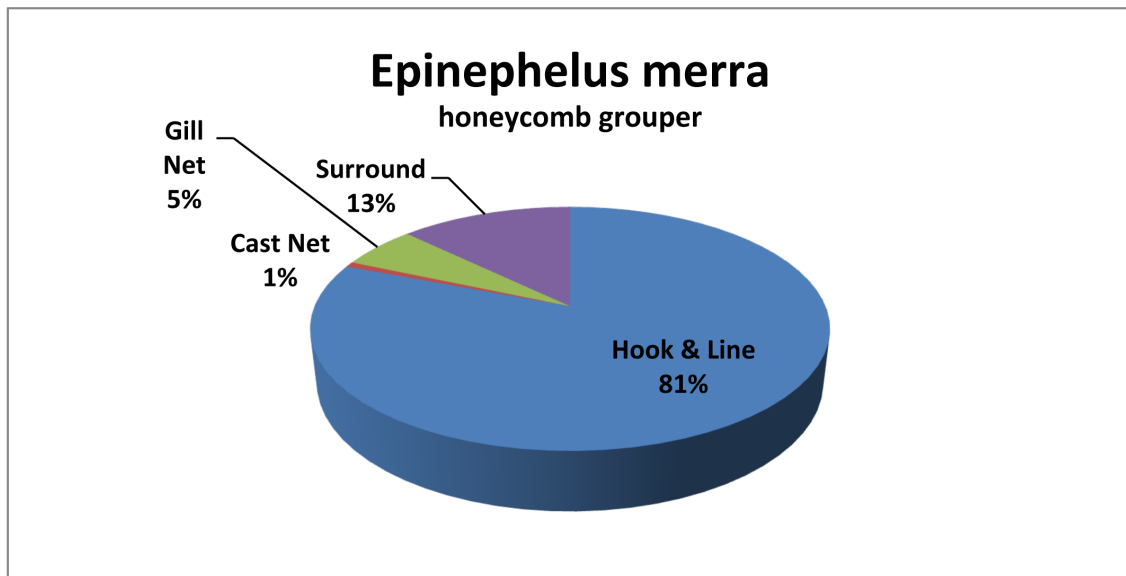


Figure 26. Chart showing catch methods for *Epinephelus merra*.

Source: Guam DAWR 1986-2008.

Lastly, three species of Serranidae were recorded from NCTS waters (Stojkovich 1977). *Cephalopholis urodeta* (darkfin hind) and *Grammistes sexlineatus* (sixline soapfish) are both principally caught on hook and line. These two species were observed at Haputo and not Double Reef. *Epinephelus merra* (honeycomb grouper) was introduced earlier in this paper, and exhibits the greatest variability of catch methods of the serranids from NCTS. About 20% of the time it is captured using nets, otherwise it follows the other serranids in being mostly caught using hook and line. It was only seen at Double Reef.

In addition, two important indigenous fishing methods, trapping (using woven tools or tidal impounds) and stunning (using fish poisons), are not currently in use on Guam, and their species associations and the way these methods might have influenced midden composition remains unknown.

As a consequence of this work, it is strongly recommended that discussions of midden fish remains abandon the general and often misleading interpretations that accompany the use of family data. Instead, family data should be used as a first step that is then fleshed-out with probable representative species from site-local fishery or fish census data. Once that is done, prehistoric fishing strategies can be more accurately assessed, and the associated prehistoric behaviours more meaningfully described.

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