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Fishing on Ma'uke

An Archaeological and Ethnographic Study of Fishing Strategies on a Makatea Island

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ABSTRACT

An analysis was carried out on a fishbone assemblage from Anai'o, a fourteenth century village site on the island of Ma'uke, in the Southern Cook Islands. The bones were found to be predominantly from species inhabiting the reef-edge zone. These species were most probably taken using various types of angling strategy. There was little evidence to suggest that offshore fishing played a significant role in Anai'o marine exploitation. This view was supported by the type of fishing gear recovered from the site. In a comparison between Anai'o fishing strategies and those practised on the island in recent times, several areas of change were apparent. However, these changes were largely technological and masked a very clear pattern of continuity in the basic structure of Ma'uke fishing over a 600 year period.

Key Words: COOK ISLANDS, MA'UKE, MIDDEN, FISHING.

INTRODUCTION

Anai'o is an archaeological site on the island of Ma'uke in the Southern Cook Islands (Fig. 1). Excavations carried out there in 1987 recovered a quantity of fishbone from two cultural layers dating to the fourteenth and early fifteenth centuries A.D. The site also contained an assemblage of prehistoric fishing apparatus, including hooks and stone sinkers. An analysis of these materials was undertaken in order to reconstruct aspects of the prehistoric marine exploitation strategies on the island. This analysis is presented below, together with some interpretations based on observations of contemporary marine exploitation patterns.

OCEANIC FISHING BACKGROUND

Although the Oceanic marine environment is ecologically diverse, a small number of ecological zones can be defined within which human exploitation strategies are concentrated. Kirch and Dye (1979) and Dye (1983) have suggested that four such zones define the range of marine exploitation strategies practised on Niuaotupapu. This four-fold division also applies in the Southern Cook Islands and probably throughout most of tropical Oceania. These four biotype zones are the reef-flat including the littoral zone; the lagoon; the reef-edge; and the open sea.

REEF-FLAT

The reef-flat is a coralline ledge located between the outer reef and the littoral zone. On some islands, the reef-flat extends from the littoral zone to the lagoon, while on others it lies between the lagoon and the reef-edge. On those islands, including Ma'uke, which lack a lagoon, the reef-flat extends all the way from the littoral zone to the reef-edge. The reef-flat has a shallow covering of water and is cut by a series of pools and by channels which carry water in through the outer reef. These pools and channels provide excellent fishing grounds, which can be exploited by a wide range of fishing methods. These include netting, spearing, trapping, poisoning and angling. In addition to fish, the reef-flat is the most important area for the gathering of other types of marine food. In many Oceanic communities, these gathering activities are often carried out by women and children. The

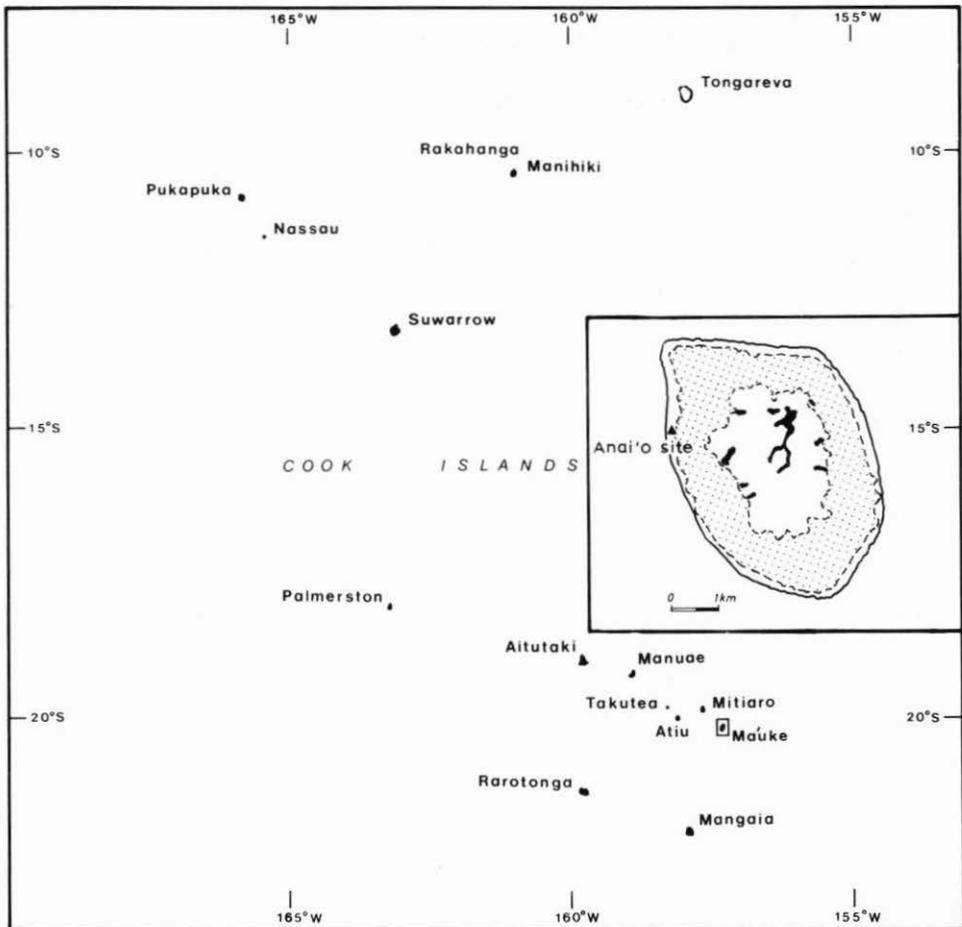


Figure 1: Location of Ma'uke in the Cook Islands showing Anai'o site.

type of foods gathered on the reef-flat include shellfish, echinoderms, holothurians, crabs and seaweeds. The reef-flat is one of the most important sources of marine foods throughout Oceania. The fish taken here are often smaller than those taken in the other zones, but the source is reliable, it is safe and it can be easily exploited by small numbers of individuals with minimal equipment or preparation.

LAGOON

The lagoon consists of the sheltered inshore waters between the outer reef and the littoral zone. Within the lagoon there are a number of localised regions which provide excellent fishing grounds. These include the submerged and partly exposed reefs and coral heads, as well as the inner faces of the fringing reef. In both these areas reef fish congregate and can be taken using methods such as seine netting, diving and spearing, trapping, angling and poisoning. In the larger, deeper lagoons, such as those found in the atolls, offshore species frequently venture in through the passages and are sometimes caught inside the lagoon. However, by far the greatest quantity of fish taken from lagoons are caught in the immediate vicinity of the standing corals.

REEF-EDGE

The reef-edge zone is the environment around the fringing reef which divides the inshore waters from the open sea. Within the reef-edge zone are a number of habitat regions, each of which is fished using a slightly different range of techniques. Firstly, there are the surge channels and passages which pass through the reef and carry the waters on to the reef-flat or into the lagoon. In these channels and passages, techniques such as trapping, seine and dip netting, diving and spearing, and angling take place.

Secondly, there is the outer face of the reef, which is usually fished using similar angling techniques to those employed in the channels. In both these areas, smaller reef fish are usually caught, although a range of larger pelagic species can also be taken along the outer reef-face.

Thirdly, there is the sloping submarine coral shelf that extends out from the reef-face towards the deep sea. In terms of fish habitat and human exploitation strategies, this area is included in the reef-edge zone and is defined as that area in front of the reef-face extending to a depth of around 20–25 m. This would typically be not much further than 100 m from the actual reef-face. In this vicinity, both surface swimming and bottom feeding fish are taken using methods such as diving and spearing as well as a range of specialised short and long line angling strategies (see below). In addition to the reef fish which feed on the bottom or along the coral margins of the reef, some pelagic species such as shark and tuna sometimes feed in this part of the sea and can also be taken there.

The reef-edge is an extremely important fishing zone in much of Oceania, and a wide range of both general and specialised fishing techniques can be carried out there. Its one drawback is that it holds some potential danger in comparison with the lagoon or the reef-flat. It is probable that throughout Oceania, more fishermen are injured or killed while fishing the reef-edge than in any of the other fishing zones. This is certainly true in the Southern Cook Islands in recent times.

OPEN SEA

The open sea includes all the waters beyond the reef-edge although, as a fishing zone, it is usually restricted to that area in sight of land, or just beyond (Dye 1983: 248). Several regions of Oceania contain submerged reefs within reach of larger fishing canoes and these are particularly important fishing grounds within the open sea zone. Two distinct habitat regions and associated fishing strategies can be recognised within the open sea. Firstly, there is the upper or pelagic zone in which surface swimming fish are caught, and secondly there is the lower or benthic zone in which bottom dwelling fish are taken. The pelagic zone is usually fished using some form of trolling technique, either with a lure or a trolled bait. The benthic zone is fished using a variety of long line bait techniques. According to Kirch (1985: 208), the benthic zone is seldom fished to a depth of more than 350 m in Hawaii, and this would probably hold true throughout most of Oceania. Although the prestige value of trolling and other forms of offshore fishing is often high, the subsistence contribution of open sea fishing is probably lower than inshore fishing in most traditional Oceanic fishing economies (Leach and Davidson 1988: 21).

Each of the four biotype zones contains a varied range of fish species which are exploited using a wide variety of fishing techniques. Some of these techniques are highly specific and are aimed at a single species or a narrow range of species. Others, such as spearing or netting, are more generalised and opportunistic. The full range of fishing methods recorded in Oceania fall into six basic categories: trolling, angling, spearing, netting, trapping and poisoning (Walter 1989a).

MA'UKE ENVIRONMENT AND MARINE EXPLOITATION SYSTEM

ENVIRONMENTAL SETTING

Ma'uke, along with Mangaia, Atiu and Mitiaro, is one of four makatea islands in the Southern Cook Islands group. These islands consist of a central volcanic core surrounded by a series of inland coral beds, or makatea. The coral beds are ancient reef platforms which have emerged from the sea during successive periods of island uplift. The island is surrounded by a fringing reef which is bisected in places by narrow passages from which canoes can be launched. These passages are located every 2 km on average, and there are about 10 on the island in total. The passages are narrow and shallow, although three have been artificially deepened to allow a canoe (or whale boat) direct access to the beach. In addition to these larger passages, the reef is cut by numerous smaller channels which carry water on to the reef-flat.

There is no lagoon on Ma'uke or on the other makatea islands in the Southern Cook Islands. A reef-flat, about 150–200 m in width, extends from the littoral zone to the outer reef, which then drops directly into deep water. The reef-flat is shallow, being covered by about 1.5 m of water in normal high tides (Fig. 2).

Ma'uke is surrounded by a low beach cliff about 3–4 m in height which encircles the island approximately 10 m beyond the high tide line. This cliff is cut at intervals by ancient channels which developed when the present cliff formed the outer edge of the fringing reef. A beach ridge extends inland from the top of the beach cliff, reaching a maximum width of approximately 350 m. At this point, the sandy ridge merges with the makatea beds. The makatea extends up to 1.5 km inland and surrounds the island's central volcanic mass. This

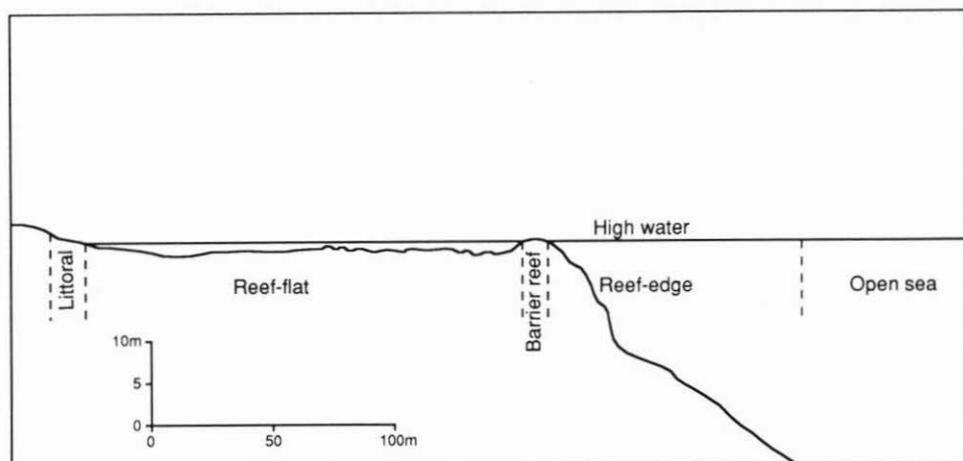


Figure 2: Generalised profile of Ma'uke marine environment showing fishing zones.

central mass consists of weathered basaltic rock and is dissected by a number of streams which flow into large, low-lying swamps on the border of the makatea. It is these swamps and the narrow surrounding bands of dryland soils which support the subsistence planting needs of the Ma'uke community (Wilson 1982).

All horticulture on Ma'uke is confined to the interior portions of the island. Settlement patterns on Ma'uke and the other makatea islands during the ethnohistoric period were characterised by scattered habitation around the interior swamps and dryland soils. On Ma'uke today there are two inland villages on the inner border of the makatea and one village on the coast. The inland dwellers maintain access to the coast via a series of prehistoric radial tracks leading across the makatea beds. The Anai'o site is the only known prehistoric settlement on the coast.

MODERN FISHING STRATEGIES

Over the last 20 years, Ma'uke has been moving more and more rapidly towards a full cash economy and today there are few families who support themselves solely through subsistence activities. Nevertheless, fishing still provides an important part of the diet for most Ma'uke households.

Between 1984 and 1987, I spent five months on Ma'uke and during this time I gathered information on local fishing practices. I participated in about 30 day time fishing expeditions as well as several night time gathering expeditions on the reef-flat. As I did not have access to a canoe, most of the fishing in which I took part consisted of angling or netting on the reef-face. In addition, I participated in several fishing trips and diving expeditions in deeper waters up to 100 m off the reef-face. On several visits to Atiu, I also accompanied local fishermen who operated dip nets on the reef-edge. During three years' residence on Rarotonga, I fished the inshore waters regularly using nets in the lagoons, or with angling techniques on the reef-face. During the time I was on Ma'uke and Atiu, I took a note of the variety and number of fish taken in each expedition in which I took part. The information

given below pertaining to Ma'uke fishing strategies is based largely on my own personal observations. It has been checked and supplemented by information from Ma'uke informants residing in New Zealand.

The makatea marine environment of Ma'uke restricts the range of available fishing zones and thus the strategies that can be successfully utilised there. Because of the lack of a lagoon, the fishing spots around the coral heads and the inner margins of the reef face are not available to the fisherman. One result of this is that set nets cannot be used in Ma'uke waters. Set nets are widely used throughout Oceania and are a very important part of the modern Oceanic fishing adaptation (although it is unlikely that set nets were of such importance before the introduction of nylon varieties). Another consequence of the absence of a lagoon is that less water passes through the reef and so the channels and pools on the reef-flat are relatively shallow and quite small in extent. This means that the reef-flat is also a less productive fishing zone than on most of the high islands or atolls of Oceania. It is still an important gathering zone, however, and collecting activities are aimed at providing shellfish, crabs, holothurians and echinoderms.

The offshore fishing resources around Ma'uke are as good as those found anywhere in the Southern Cook Islands but today, offshore fishing is a relatively minor part of the overall Ma'uke fishing system. According to local informants, the exploitation of the offshore zone has steadily decreased over the last few decades and this can be traced to changes in the structure of the Ma'uke economy. The catch of offshore species is not secure enough to provide a steady income, and with most adult males tied to a cash economy, few can afford the time spent fishing the offshore zone. The main fish species which are taken by those fishermen who still fish the offshore waters are tuna and barracouta. In addition, other species such as *paara* (*Acanthocybium solandri*) and shark are sometimes caught also. As far as I am aware, benthic fishing for bottom dwelling species is not carried out in the offshore waters by Ma'uke fishermen. Canoe manufacture is in decline on Ma'uke so most offshore fishing takes place from aluminium craft which are usually equipped with outboard motors. These activities take place both in daytime and at night.

With no lagoon, a restricted fishing potential on the reef-flat and a decline in offshore marine exploitation, the reef-edge is by far the most important fishing zone in Ma'uke waters today. Fishing techniques used to exploit the reef-edge are varied and fall into two categories; those that take place on the reef-face itself, and those that are carried out in the waters just off the edge of the reef.

The most important technique used on the reef-face is netting in the surge channels. However, because the reef-flat is shallow, these passages are also shallow and the fish are much smaller than those caught in the passages on many other island reefs. The nets used on Ma'uke are hand-held and most fishermen utilise seine nets for the purpose. On nearby Atiu, which has a virtually identical marine environment to Ma'uke, small dip nets are often used for this purpose. The nets are held over the surge channels by two fishermen while other assistants chase the fish into the nets from adjacent crevices on the outgoing waves. The fishermen work up and down the coast for a kilometre or more, covering in turn most of the small channels. The fish most commonly caught with nets include various species of Acanthuridae, Chaetodontidae, Mugilidae, Mullidae, Scaridae and Tetradontidae.

The other major form of fishing from the face of the reef is called *tautai* and utilises the bamboo rods known in the Cook Islands as *matira*. The *matira*, which are used on the reef, are about 2 m long, with several metres of nylon and a small metal hook attached. The baited hooks are cast into the short channels and passages over the reef-edge. The hooks are usually baited with *unga* (a hermit crab which inhabits abandoned *Turbo* shells) or with

small pieces of fish. The fish caught with *matira* are similar to those caught in the nets, with the single exception of Scaridae, which seldom take a bait.

A variation on this angling theme has been described by Buck (1944), but is now obsolete on the island. In this form of fishing, known as *titomo*, schools of *koperu* (*Decapterus pinnulatus*), were regularly fed in specific places around the reef. At certain times, fishermen would gather in these spots and cast short lines attached to bamboo rods into the feeding schools from a position on the reef-face. The *koperu* were jerked out of the water and on to the reef. *Titomo*, as a fishing term, is now restricted to a similar, related technique described below.

A different range of techniques are used to fish the waters off the edge of the reef-face. Fishing in this part of the reef-edge zone takes place up to about 100 m from the reef, although usually closer. In this zone, angling is particularly important. This can take place from canoes or other small craft which work up and down the reef-face just outside the swell zone. The most usual species taken in this way are Epinephelidae, Lethrinidae and Lutjanidae species. When canoes are taken out to fish this zone at night, it is the 'red fish' (*Holocentrus cruentatus* and *Epinephelus fasciatus*) which are usually caught. A single fisherman may catch 100 or more of these fish in several hours.

In addition to bottom fishing, *maroro* (flying fish) are also caught at night from canoes lying up to 200 m offshore, using hand-held nets and torches. This latter form of fishing is an ancient practice in the Southern Cooks; the missionary Rev. John Williams participated in one such expedition in Aitutaki in 1823 (Williams 1838: 86).

A small range of techniques are used in this fishing zone which involve some form of diving activity. The first of these involves diving and spearing fish alongside the reef-face. Several Ma'uke divers are able to attain depths of up to 25 m but it is unusual for any divers to spear fish or retrieve *Tridacna* at depths greater than 10–12 m. The divers usually enter the water from the reef-face but they may occasionally use a canoe or other craft to get into a suitable offshore position. This is an extremely popular fishing method on Ma'uke today and accounts for the major portion of the subsistence catch in many Ma'uke households. However, while spearing is clearly an ancient Polynesian fishing strategy, it is much more important now that glass face masks are available than it would have been in former times.

A second strategy which involves some form of diving or swimming and which appears to be an ancient Polynesian fishing method is known on Ma'uke as *titomo* fishing (see also above). *Titomo* is a technique used to catch *koperu* (*Decapterus pinnulatus*). This variation of *titomo* fishing utilises a short line with a small hook attached to a metre or so of bamboo. The fishermen spread masticated coconut flesh into the water and when the *koperu* are attracted, the fishermen position themselves in the water. The *koperu* gather to feed about 60 cm to 1 m below the surface and the fishermen introduce a baited hook into the feeding school. The fish are jerked out of the water and the entire rod is tossed into a waiting canoe with the fish attached. The boatman hands out another baited rod and the process continues until the *koperu* move on. From a position in the water, the fishermen are able to feed the fish and manipulate their hooks with extreme accuracy. The entire fishing operation takes place up to 100 m offshore, but usually much closer (Walter 1988). Similar short-line methods have been observed elsewhere in Polynesia. Gill (1885: 148), for example, describes a related method used to catch slightly larger fish in Penrhyn in the Northern Cook Islands. Rolett also reviews a number of similar techniques, now obsolete, recorded in the Marquesas and the Tuamotus (Rolett 1990: 215).

The third fishing technique used by swimming fishermen involves bottom fishing with bait lines in up to 30 m of water. In this technique, the fishermen swim beyond the wave zone and drop baited long lines down to catch the bottom dwelling fish. When the fish are caught, they are threaded around the waist on a length of fencing wire. With a face mask the fishermen can observe the best spots and catch a good range of small fish as well as octopus. A catch taken in May 1986, in which the author participated, is shown in Table 1.

TABLE 1
FISH CAUGHT BY TWO SWIMMING FISHERMEN WITH
BAIT HOOKS OVER A 7 HOUR PERIOD

Fish	No. Taken
Epinephelidae sp.	28
Holocentridae sp.	14
Scaridae sp.*	5
Octopus	7-10*

* See text

Table 1 shows Scaridae as part of the catch taken using this baited hook technique. These fish are not usually taken on baited hooks, but they nearly always investigate a dropped bait, and then it is relatively easy to jig them, especially when glass face masks provide extra visibility. About seven to ten octopus were also taken; some of these were thrown back, some were used as bait and five were finally brought ashore. Dye describes a similar fishing technique, which is practised on Niuaotupapu, where it is known as *fakalukuluku* (Dye 1983: 252). As on Ma'uke, *Holocentrus* spp. and octopus are caught using this technique, but Dye does not mention *Epinephelus* spp. which were the most abundant species taken in the Ma'uke waters.

To summarise, Ma'uke fishing strategies share with those of most other Oceanic islands a primary selection towards the exploitation of inshore waters. The main element that sets Ma'uke apart is that because it is relatively shallow and narrow, the reef-flat is not as important a fishing zone as it is on many other Pacific islands. Instead, the fishing areas around the outer face of the reef are of greatest economic significance in the Ma'uke fishing regime.

THE ARCHAEOLOGICAL EVIDENCE

THE ANAI'O SITE

The Anai'o site is a prehistoric village settlement located on the north-west coast of Ma'uke approximately 1 km south of the modern coastal village of Kimiangatau. The site itself is located on the beach ridge and stretches from several metres above the beach cliff up to the edge of the makatea beds. The site lies adjacent to Anai'o passage, one of the better natural landings on the island.

Two cultural horizons were found at Anai'o. Occupation 1 (Layer 4) represented a village settlement constructed on a cleared beach ridge. The excavated areas of this layer displayed a number of dwelling structures, cooking houses, storage pits and manufacturing floors

TABLE 2
NUMBER OF ANATOMICAL PARTS IDENTIFIED

	No. Bones	Percent
Standard Mouth Parts		
Left Dentary	29	10.9
Right Dentary	24	9.0
Left Articular	14	5.3
Right Articular	16	6.0
Left Premaxilla	18	6.8
Right Premaxilla	25	9.4
Left Maxilla	20	7.5
Right Maxilla	15	5.6
Other Mouth Parts		
Inferior Pharyngeal	14	5.3
Right Superior Pharyngeal	5	1.9
Left Superior Pharyngeal	8	3.0
Tooth	7	2.6
Special Bones		
Dorsal/Erectile Spine	5	1.9
Dorsal Spine Cage	3	1.1
Dermal Spine	17	6.4
Scute	2	0.8
Caudal Peduncle	4	1.5
Vertebra	40	15.0
TOTAL	266	100.0

(Walter 1990). These latter features included areas associated with both shell and stone working activities.

Occupation 2 (Layer 2) was separated from the first occupation layer by about 10 cm of wind and wave-borne sands. It contained few features, but the artefacts were similar to those recovered in Occupation 1. Radiocarbon dates obtained from Anai'o indicate an initial occupation in the mid fourteenth century followed by a very brief hiatus and a second occupation in the early fifteenth century (see Walter 1989b: 69)

THE FISHBONE ASSEMBLAGE

Fishbone was found at a low density throughout both occupation layers, with the greatest quantity (by a factor of 3) deriving from Layer 4. A collection strategy was employed which recorded the majority of bone to depth and to 1 x 1 m quadrant. The exception to this was that bone which was collected in the sieves. In these cases, the bone was recorded to depth and to 2 x 2 m excavation square. Identifications were carried out using the Pacific Fishbone Reference Collection in the Archaeozoology Laboratory of the National Museum of New Zealand. The methodology employed is outlined by Leach (1986) and Leach and Boocock

TABLE 3
MINIMUM NUMBERS OF FISH IDENTIFIED

Taxon	Family	L2	L4	Total	Percent
Epinephelus/ <i>Cephalopholis</i> sp.	Epinephelidae	11	44	55	37.2
Coridae/Labridae	Coridae/Labridae	2	24	26	17.6
<i>Diodon</i> sp.	Diodontidae	5	8	13	8.8
Lethrinidae	Lethrinidae	1	7	8	5.4
Scaridae	Scaridae	2	6	8	5.4
<i>Caranx</i> sp.	Carangidae	4	3	7	4.7
<i>Holocentrus</i> sp.	Holocentridae	3	4	7	4.7
Balistidae	Balistidae	-	5	5	3.4
Thunnidae/ Katsuwonidae	Thunnidae/ Katsuwonidae	-	3	3	2.0
Aphareidae	Aphareidae	1	1	2	1.4
<i>Gymnosarda nuda</i>	Katsuwonidae	-	2	2	1.4
<i>Lutjanus</i> sp.	Lutjanidae	1	1	2	1.4
Muraenidae	Muraenidae	-	2	2	1.4
<i>Ostichthys murdjan</i>	Holocentridae	-	2	2	1.4
<i>Balistoides</i> sp.	Balistidae	-	1	1	0.7
Elasmobranchii	Elasmobranchii	-	1	1	0.7
Mullidae	Mullidae	1	-	1	0.7
<i>Parupeneus</i> sp.	Mullidae	1	-	1	0.7
<i>Plectropoma</i> sp.	Epinephelidae	1	-	1	0.7
Teleostomi sp.	Teleostomi	-	1	1	0.7
TOTAL		33	115	148	100.0

(n.d.). The assemblage was first sorted into identifiable anatomical parts. These consisted of the five mouth parts, dentary, articular, quadrate, maxilla and premaxilla, as well as a number of special bones (Table 2). It was decided that quadrates would not be used in this study as they are extremely difficult to identify when dealing with the smaller reef-fish species. The minimum number of individuals (MNI) present in the assemblage has been calculated on the basis of unique bones and provenance information using the PACMIN computer program (Leach 1986, Leach and Boocock n.d.). The decision not to use non-unique bones for MNI was taken because of a situation which arose in setting up PACMIN for the Anai'o assemblage. PACMIN maximises the MNI figures by dividing the assemblage into sub-assemblages on the basis of spatial information and then treating each sub-assemblage as a single discrete unit. Because Anai'o was a large areal excavation, such sub-division was clearly necessary and it was performed using excavated structures as the basic spatial unit. This was appropriate as the vast majority of fishbone was clustered around these features. The problem with the non-unique bones arose from those that occurred elsewhere on the site. Because of the relatively arbitrary nature of the internal site division, PACMIN was forced to assign an MNI value of 1 to many single vertebra specimens. As vertebrae were not only non-unique bones within the skeleton, but could only be identified for two groups, Elasmobranchii and Thunnidae/Katsuwonidae, an unreasonable bias was introduced.

TABLE 4
MINIMUM NUMBERS OF FISH IDENTIFIED (SORTED BY FAMILY)

Family Name	Layer 2	Layer 4	Total	Percent
Epinephelidae	12	44	56	37.8
Coridae/Labridae	2	24	26	17.6
Diodontidae	5	8	13	8.8
Holocentridae	3	6	9	6.1
Lethrinidae	1	7	8	5.4
Scaridae	2	6	8	5.4
Carangidae	4	3	7	4.7
Balistidae	-	6	6	4.1
Thunnidae/Katsuwonidae	-	3	3	2.0
Aphareidae	1	1	2	1.4
Katsuwonidae	-	2	2	1.4
Lutjanidae	1	1	2	1.4
Mullidae	2	-	2	1.4
Muraenidae	-	2	2	1.4
Elasmobranchii	-	1	1	0.7
Teleostomi sp.*	-	1	1	0.7
TOTAL	33	115	148	100.00

* This reef fish had highly distinctive mouth parts, but is not present in the comparative collection of the Archaeozoology Laboratory, National Art Gallery and Museum of New Zealand, where identifications were made.

PREHISTORIC FISHING PRACTICES ON MA'UKE

A total of 266 bones were identified in the Anai'o assemblage. These comprised 20 taxa in 16 families giving a MNI value of 148 individuals (Tables 3 and 4). Of these 16 families, only 3 were present at levels higher than 8 percent. These were Epinephelidae, Coridae/Labridae and Diodontidae, represented at 38, 18 and 9 percent respectively. These three families were clearly the major catch components at Anai'o. Holocentridae, Lethrinidae, Scaridae, Carangidae and Balistidae were each represented at 4-6 percent of the total catch, with between 6 and 9 representatives of each family. The remaining 8 families were present at 2 percent or less, with between 1 and 3 individuals present.

Assessing the probable capture methods from Pacific fishbone assemblages presents a number of problems. Although enough ethnographic examples exist to give a picture of the range of likely capture methods for a given species, most species can be caught using a wide variety of techniques and it is necessary to exercise some caution when trying to assess capture methods from archaeological fishbone counts (Leach and Davidson 1988: 2).

Nevertheless, there is a reasonably close relationship between fish habitat and fishing technology, which allows some general statements to be made. When specific information about the Ma'uke marine environment, modern Ma'uke fishing practices and the archaeological fishing technology from the Anai'o site are added, such statements can acquire greater weight. In the following section, the fishing techniques judged most likely to have been used to capture the various fish species are listed. This information is

organised according to the four major biotype zones and is based on reports from a variety of sources. These sources include Kirch and Dye (1979), Dye (1983), Bagnis *et al.* (1972), Green (1986), Masse (1986), Leach *et al.* (1988), and personal observations. The same information is presented in Table 5.

Biotype Zone:	Open Sea
Fishing Strategy:	Trolling
Fish Family:	Thunnidae, Katsuwonidae.

These fish are the most usual target of trolling activities throughout much of the Pacific. Although they can be caught using other techniques, it is likely that some form of lure or trolled bait would have been employed.

Biotype Zone:	Reef-edge/Open Sea
Fishing Strategy:	Angling
Fish Family:	Elasmobranchii species

Elasmobranchs come close to the reef-edge and are usually caught within several hundred metres of the reef, although they can also be taken in deeper waters. They are nearly always caught using baited hooks, although other inshore methods, such as spearing or noosing, are possible.

Biotype Zone:	Reef-edge
Fishing Strategy:	Angling
Fish Family:	Epinephelidae, Coridae/Labridae, Lethrinidae, Lutjanidae, Holocentridae, Aphareidae, Carangidae and Muraenidae.

The usual way in which Epinephelidae and Holocentridae are caught on Ma'uke today is by fishing just off the reef-face with baited lines. Coridae/Labridae can be taken on lines dropped beyond the reef but are also caught in numbers by angling with short lines off the reef-face. Throughout much of the Pacific, Carangidae are frequently caught using trolling techniques in the open sea zone. However, these species also feed off the reef-face where they can be caught with bait hooks. Because the specimens in the Anai'o assemblage are relatively small, it is unlikely that they were taken offshore. Muraenidae (moray eel) inhabit coral crevices around the reef and on the sea floor. They are often caught on bait hooks dropped to catch the bottom dwelling fish (Baquie 1977: 102).

Biotype Zone:	Reef-edge
Fishing Strategy:	Dip Netting
Fish Family:	Balistidae, Mullidae, Scaridae.

Throughout much of the Pacific, Balistidae and Mullidae are taken in set nets, but on Ma'uke they are usually caught using hand-held nets on the reef-edge. Scaridae are usually caught with nets, spears or a number of general foraging techniques although, again, dip netting is the most likely option in the Ma'uke environment.

Biotype Zone:	Reef-flat or Reef-edge
Fishing Strategy:	Spearing or generalised foraging
Fish Family:	Diodontidae.

These fish are usually speared in shallow waters on the reef-flat where they tend to rest in rocky clefts during the day time. On Ma'uke they are frequently taken in pools on the shallow reef-flat and in the deeper passages on the reef-edge.

Like modern Ma'uke fishermen, the prehistoric inhabitants of Anai'o relied heavily on fishing the inshore waters. The assemblage is dominated by inshore reef fish and the only fish found exclusively outside the Ma'uke reef are Elasmobranchii, Carangidae and Thunnidae/Katsuwonidae. All three of these families are commonly caught within several hundred metres of shore, however, and there is no clear evidence here that offshore fishing was a major part of the Anai'o fishing adaptation.

The two most abundant taxa in the assemblage are usually caught with a baited hook and at 55 percent, these dominate the assemblage. It is likely that angling from standing canoes off the reef-face accounts for the majority of fish represented in the Anai'o assemblage. A peculiarity of the assemblage is the relative paucity of species which are usually taken in netting activities. Only the Balistidae, Scaridae and Mullidae species are likely to have been caught in nets and, if nets were an important part of the fishing strategy at Anai'o, one would expect to see a larger proportion of Chaetodontidae, Acanthuridae, Tetrodontidae and Scaridae in the assemblage. These species are amongst those most commonly caught in netting activities on the Ma'uke reef today and are also taken in a similar manner around the reefs of many other Pacific islands.

THE ANAI'O FISHING ASSEMBLAGE

In addition to the fishbone, the excavations at Anai'o also recovered a quantity of fishing apparatus. This included a number of one-piece fishhooks, a two-piece fishhook point and some stone fishing sinkers. A single lure and several one-piece hooks were also found during roadwork activities at Anai'o during the 1960s. In total, 45 one-piece hooks and hook fragments were recovered as well as 15 hook tabs (Walter 1989b). All the fishhooks were made of pearlshell, although two part-finished *Turbo* shell hooks were also recovered. The hooks recovered from the excavation were small, the largest having a shank length of only

TABLE 5
PROBABLE CAPTURE METHODS FOR ANAI'O FISHBONE ASSEMBLAGE

Biotype Zone	Capture Methods	Fish Taxa	MNI	Percent			
OPEN SEA	Trolling	Katsuwonidae	5	3.4			
		Thunnidae					
REEF-EDGE/OPEN SEA	Angling	Elasmobranchii	1	0.7			
REEF-EDGE	Angling	Epinephelidae	112	76.2			
		Coridae/Labridae					
		Holocentridae					
		Lethrinidae					
		Lutjanidae					
		Carangidae					
		Muraenidae					
		Aphareidae					
		Dip Netting			Balistidae	16	10.9
					Mullidae		
Scaridae							
Spearing, Generalised foraging		Diodontidae	13	8.8			
TOTAL			147	100.0			

39 mm. However, two larger hooks were recovered from Anai'o in the 1960s and are now in the Cook Islands Museum on Rarotonga. The hooks are divided about equally between jabbing and rotating varieties.

In general, the fishing apparatus recovered from Anai'o fits well with the type of fish represented in the fishbone assemblage, being about the size that would normally be used to fish the bottom dwelling species in the reef-edge zone. Two of the smallest hooks, measuring only 10 mm and 12 mm in length respectively, were of a size usually associated with *titomo* fishing. Similar sized hooks were manufactured by the author in the field and tested in *titomo* fishing about 60 m off the coast and directly opposite the Anai'o site. They proved to be extremely successful (Walter 1988). Fishhooks of this size could also be used for short line angling on the reef-edge.

EXTRA ISLAND COMPARISONS

The only other well described fishbone assemblages from the Southern Cook Islands are from Aitutaki. Like those at Anai'o, the Urei'a assemblages are dominated by inshore taxa throughout the entire sequence (Allen and Steadman 1990). However, at Urei'a, there are a greater proportion of species likely to have been taken with nets and with general foraging techniques on the reef-flat than at Anai'o. Such species include Scaridae, Diodontidae and Acanthuridae. The contrast between the two assemblages reflects differences in local marine environments. Urei'a lies adjacent to a wide lagoon with many coral heads. In those places netting, spearing and foraging techniques are more commonly used than angling. The assemblage from the nearby Moturakau site also contains a predominance of inshore species (Allen and Schubel 1990). The fishing zones in the vicinity of Moturakau are dominated by shallow lagoonal waters and reef-flat and similar fishing techniques to those used at Urei'a are likely.

The fishing pattern represented at Anai'o compares well with that reported by Chikamori for post-A.D. 800 levels on Rennell (Chikamori 1986). Rennell, like Ma'uke, is an uplifted makatea island with a shallow reef platform although, unlike Ma'uke, it also contains some areas of lagoon. On Rennell, the fishing was concentrated on the exploitation of the inshore zones and the most important species included Lethrinidae, Labridae, Scaridae, Balistidae, Diodontidae and Tetrodontidae. These species are all characteristically caught on the reef-flat, reef-edge and along the coral margins of the lagoon. It is likely, however, that netting was more important on Rennell than on Ma'uke. This is indicated by the greater quantities of Scaridae, Balistidae and Tetrodontidae in the Rennell assemblage. Unfortunately, however, Chikamori's interpretations were based on identified fishbone weights, not on MNI. Because of this, it is difficult to be confident about the overall structure of the assemblage or about his conclusion that offshore fishing was an early period adaptation displaced by inshore techniques after about A.D. 800.

The Fa'ahia fishing assemblage from Huahine provides an interesting contrast with the Anai'o material. This site shares many general similarities with Anai'o. They are both 'archaic' sites with a similar material culture and they are both villages containing complex arrangements of domestic structures and work areas. However, at Fa'ahia, 42 percent of the fish identified from the middens were pelagic predators (Leach *et al.* 1984: 195). The assemblage also contained a number of other species, such as dolphin, whale and turtles, which were also likely to have been taken offshore. As the authors indicate, this suggests a very unusual adaptation for a tropical Pacific island. However, the site lies adjacent to a good reef passage and most of the pelagic fish could have been taken within a kilometre of the site. In addition to offshore fishing, inshore netting, angling and foraging techniques were also practised at Fa'ahia.

DISCUSSION

On Ma'uke, the peculiarities of the marine environment have encouraged the development of a fishing system which is adapted towards the exploitation of the reef-edge zone. The two approaches which are most successful in this zone are those which exploit the reef-edge surge channels and those which aim at species which feed in deeper water just off the reef-face.

Layers 2 and 4 at Anai'o produced a similar range of fish, although there is some variation in the relative quantities of various of the species. Most significant is the higher proportion of Coridae/Labridae in the Layer 4 horizon. As this species is taken using similar methods to Epinephelidae (the most abundant taxon in both layers), no major change in fishing techniques can be assumed. However, the changing proportion of this taxon is interesting and may represent changing patterns of dietary choice.

On the whole, the archaeological evidence from Anai'o points strongly to a type of reef-edge exploitation strategy similar to that practiced by modern Ma'uke fishermen. Despite this apparent continuity, however, considerable changes are evident in the manner in which this zone has been exploited over the last 600 years. During the period in which Anai'o was occupied, the successful exploitation of the reef-edge zone was accomplished through the predominant use of baited hooks. These would have been used from offshore canoes, or by angling directly off the reef-face. In recent times, however, there has been a partial abandonment of canoes, which have been replaced by diving and other related techniques which utilise more modern technology, and by hand-held nets.

The reason why these new methods have been adopted is largely to do with the changing structure of the Ma'uke economy. Because most households rely to a varying extent on a cash income for labour, there is less incentive to spend a great deal of time and effort in maintaining and operating canoes. Instead, fishermen prefer the less time consuming and labour intensive techniques associated with the use of modern diving equipment (face masks, fins and speargun). These are also highly regarded recreational activities for the younger men. The main advantage of the newer diving techniques is that they are so versatile. A diver can operate virtually anywhere off the reef and can easily carry all his equipment to whichever fishing spot is most suitable on a given day. The canoe fisherman, on the other hand, is restricted to launching his canoe in an area adjacent to where it was last beached. Although the changes in technology are quite extreme, the new techniques of exploiting the reef-edge are aimed at a range of species similar to those taken by the more traditional methods.

Unfortunately, little is known about the fishing adaptation on Ma'uke in the period between the Anai'o occupation and the ethnohistoric period. A decline is known to have occurred in the use of shell bait hooks in the Southern Cook Islands, but whether other forms of reef-edge exploitation were adopted, or whether shell hooks were replaced by hooks of less durable materials, is unclear.

The Ma'uke fishing adaptation has been described as specifically adapted to reef-edge exploitation and is ideally suited to the conditions which prevail in the makatea islands of the Southern Cook Islands Group. It would be tempting, therefore, to describe Ma'uke fishing practices as a specific makatea island adaptation. Chikamori (1986), however, has already described what he calls a makatea island fishing adaptation in respect to the Rennell Island assemblage, yet the Anai'o assemblage differs from that of Rennell in a number of important ways (see above). As the makatea island form exhibits a unique ecological structure, it would seem useful to examine the claim for a typical pattern of marine exploitation. Several aspects of this type of island form might encourage the development of a characteristic exploitation strategy. Some relevant variables might include the absence of a lagoon, the absence of extensive areas of sheltered inshore waters, and the presence of expansive reef-flats. However, there are various responses possible in these environments. For example, Chikamori has proposed that the response in the early phases of Rennell prehistory was to concentrate on open sea fishing, while the exact opposite of that has been proposed here for Ma'uke. Nevertheless, the makatea island form is relatively common in

the tropical Pacific and a study of the particulars of subsistence economics in these places would provide a very useful contrast with those of the better described atoll and high island environments.

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