

Section 3: The New Zealand fishery

INTRODUCTION

When the first Polynesian settlers arrived in New Zealand, the new marine environment would have been quite a shock. People in the Pacific world had been confronted with essentially the same marine environment for some 35,000 years. The accumulated knowledge resulting from such experience could not have forewarned the first immigrants to New Zealand of what to expect in this southern corner of the Pacific. The sea conditions and marine foods in these southern temperate waters are so different from those of the tropical Pacific that it is hard to get an adequate perspective on the experiences of the new arrivals.

It is by no means certain that New Zealand was settled only once from the tropical Pacific, so the experience of new discovery may well have been repeated several or many times. In fact, it is still happening today, as people from the Cook Islands, Niue, Tokelau, Samoa and Tonga come to New Zealand. They too explore the marine environment around the cities they live in. It would be interesting to study the behaviour of modern immigrant Polynesians in the New Zealand marine environment and their attitudes towards it. This would be bound to uncover some clues as to what it was like for people arriving here in the pre-European period.

In putting together some comments about the New Zealand fishery environment, I am conscious of the fact that this will be from a quite different perspective than that which would be meaningful to the people who lived here in the pre-European era. The entire conceptual framework would be different, not only the names of fish and how they relate together taxonomically, but the ideas relating to fishing zones, seasonality and tidal patterns. The sources of information are the same, but the knowledge derived from them is different. Some may think that this merely states in polite language that ancient people were ignorant savages; nothing could be further from the truth. Having had some experience with fishermen in remote corners of the Pacific I can state with con-

viction that the knowledge of all aspects of the fishery is profound amongst Pacific island peoples, but it is a different form of knowledge from European scientific knowledge, which is different again from European common knowledge.

MĀORI TAXONOMY AND THE FISHERY

Europeans are prone to believing (without giving it a second thought) that their methods of classifying the world are the only sound ways of doing so. It is perfectly natural to think like this: Polynesians think exactly the same way – that their taxonomy (classification of plants and animals) is the only sensible one. Examining a different system of taxonomy, such as Māori fish names, can be a challenge to one's entrenched way of thinking.

As a young person learning the vocabulary of the natural world through the spectacles of the European scientific tradition, I was exposed to nothing except the Linnæan binominal system for classifying the natural world using a formal system of names¹, and did not realise that there were alternative, equally valid, systems. This experience is no different to any other form of enculturation; religion being a good example. If I had been born in Thailand, I might today be a Buddhist. Linnæus did a lot of people a huge favour by introducing order amongst chaos, by proposing something neatly logical and systematic. But it would be wrong to think that the Linnæan system has a monopoly on what is right and correct – there are numerous alternative systems which can be described as logical and systematic. In short, when it comes to classification of the natural world, there is no such thing as right and wrong in an objective sense. This merits a little further explanation.

¹ The binominal system assigns two names for an organism –genus and species– using predominantly Latin and Greek words. Species names are usually referred to as binomials, because they have two parts.

Numerous attempts have been made to introduce objectivity into classificatory systems, and many consider that the best approach lies in numerical taxonomy (Sokal & Sneath 1963; Sneath & Sokal 1973). Scientific literature is now replete with various forms of this, applied to an ever increasing range of classificatory problems, not just animals and plants: types of rocks and fossils (Miller & Kahn 1962: 245 ff.), detecting time series in the morse code (Kruskal 1971: 124 ff.), classifying the works of Plato (Boneva 1971: 173 ff.), the classification of diseases (D'Andrade *et al.* 1972), type of human cultures (Doran & Hodson 1975: 161 ff.), biological populations of humans (Rao 1952: 357 ff.; Constandse-Westerman 1972).

These all suffer from the same underlying problem: how the specimens finally group together depends entirely on which characteristics are chosen to depict them. Numerical taxonomy helps to give us confidence that two different researchers will get the same results, assuming they have chosen the same characteristics in the first place, but the idea that this is the one and only objective view of reality is an illusion. The results of such analyses are seldom any more than statistical verification of what was blindingly obvious at the outset. Contrary to this, organisms can be more or less identical in outward characteristics, yet qualify as different species using genetic markers:

The problems of classification have been compounded over the past 25 years by the introduction of biological and molecular techniques demonstrating that biological and genetic divergence is not always accompanied by morphological change. Thus they may demonstrate that two genetically distinct populations meriting recognition at a species level may be identical in their appearance (Tyler 1991: 164).

This type of problem led to the development of another classificatory system known as cladistics (Kitching *et al.* 1998). In contrast to classifications based on morphological characteristics (phenetics), in cladistics, groupings do not depend on whether organisms share physical traits, but on their evolutionary relationships. Thus, the emphasis is not upon the presence of all shared traits, but upon the presence of shared derived traits. Indeed, in cladistic analyses two organisms may share numerous characteristics but still be considered members of different groups. A cladistic relationship is one expressing recency of common ancestry. In Sneath and Sokal's words: "the term cladistics is used here to mean a study of the pathways of

evolution; that is, how many branches are there, which branch came off which other branch, and in what sequence?" (Sneath & Sokal 1973: 29). Thus it can be seen that the world view in cladistics is focused entirely on evolution. It would be foolish to claim, however, that the cladistic view is the *only valid* view of the natural world. An experienced hunter might classify animals in terms of their behavioural characteristics because that is what is important when hunting for them. This is a valid world view too. In short, judging an alternative method of classifying nature using the rules of your own world view is not very fruitful.

Some years ago I thought it might be interesting to compare the types of fish found in archaeological sites on Nukuoro, with the fish-hooks that had been used to catch them in the same sites. This was a case where we had several different methods of classification in front of us: the Linnæan system for identifying the different types of fish, the Nukuoro people's system of identifying the hooks they used to catch those same fish, and metrical analysis of the hooks followed by numerical taxonomy techniques (Davidson & Leach 1996). There was no useful correspondence between the outcomes of the three systems. Each is valid within its own set of rules.

One problem that has been noted about so-called 'scientific classifications' is that they are constantly being revised. In this respect, Paulin and Stewart made an interesting observation in the foreword to their book *A Checklist of Fishes in the National Museum* that:

...it has been shown that common names carefully chosen can be more stable than scientific names. For example, Gilchrist (1902) listed common and scientific names of South African fishes but today most of the scientific names are obsolete whereas the common names are still in use [citing Smith 1975] (Paulin & Stewart 1985: 5).

This suggests that fishermen, those mainly responsible for allocating common names, might have a better idea of how to classify fish than scientists. As Doak has pointed out:

The science of taxonomy, sorting fish into related groups and individual species, has long been plagued with difficulties arising from lack of direct observation and precise studies. Until the advent of scuba, the fish scientist was sometimes remote from the sea. He could not easily observe closely allied species in their environment and often identified separate species by characteristics which vary with age and maturity (Doak 1972: 97).

An example of over-zealous 'scientific' classification is with the Labridae family in New Zealand. Some species have considerable sexual dimorphism and polychromatism, so that many taxonomists mistakenly classified individuals into discrete species, which were in fact merely sexual phases of the same animal. Examination of the animals in their natural habitat by scuba divers (Doak 1972: 75) revealed this astonishing conclusion. Although all marine zoologists would agree that this was an error, it is only an error within the system of classification that they are using.

In another system of classification, this may not be considered an error at all. Once again this highlights the central issue of classification: that the results you get are dependent on what characteristics are chosen because they are thought to be significant. This was brought into sharp relief in a famous paper by Ralph Bulmer entitled *Why is the cassowary not a bird?* (Bulmer 1967)². Bulmer wrote a number of similar papers which are thought-provoking challenges to western European taxonomy. He commented:

The continual revision of criteria employed by egg-head classifiers, whether biologists, ethnologists or the intellectual sophisticates in 'primitive' or folk societies, does not permit them to evade recognition of the *contextual* [emphasis mine] objectivity of animal species... (Bulmer 1970: 1090).

The Karam people, whom Bulmer studied, classify animals using a consistent system where gross morphology and two-dimensional habitat (horizontal and vertical) permit everything in nature to be accommodated without difficulty. But, as Bulmer points out:

It is not surprising that the result shows little correspondence either to the taxonomy of the professional zoologist, which reflects the theory of evolution, or, for that matter, to our modern western European folk-taxonomies (Bulmer 1967: 6).

This term 'folk taxonomy' has been used when referring to systems of classifying plants and animals in small-scale societies, such as in Polynesia or amongst the New Zealand Māori. This term is

suggestive of something slightly quaint, and has a patronising ring to it. There should be no need for any negative connotations here; such systems are just as valid as the Linnæan binominal system. It may surprise some readers to learn how extensive the scientific literature is on the subject of 'folk taxonomy'. Conklin prepared a bibliography with 5,000 entries in 1972, arising from students courses and seminars in the Department of Anthropology at Yale University (Conklin 1972). In Māori taxonomy all animals and plants, including humans, are linked together by descent (*whakapapa*) from one of several supernatural deities, and therefore possess spiritual qualities. This in turn "emphasises to humans the fact that their environment and its resources are both ancestors and kin... a relationship based on respect and reciprocity" (Roberts *et al.* 2004: 4). Such a relationship is very different to that of western Europeans, whose taxonomy stresses phylogenetic ancestry in which humans are usually considered to be the most evolved species. Respect and reciprocity are not features of the Linnæan binominal system.

The ancestral homeland of the Māori is in eastern Polynesia; it is hardly surprising therefore that the taxonomy and nomenclature of fishes in New Zealand find close parallel in tropical Polynesia. A good example is provided by the word *tuna*. This is the Māori name for freshwater eels. This word occurs in many parts of the Pacific, also referring to freshwater eels. In New Zealand there are numerous Māori terms for eel, recognising far more varieties than in modern European zoological taxonomy. They are all nevertheless encompassed by the word *tuna*. This just goes to show that Māori taxonomy of the natural world is rich in clearly understood levels of grouping, in much the same way that Europeans recognise Order, Sub-Order, Family, Genus, Species, Sub-species, and so on. The subject of *tuna* is further discussed at a later point in this paper.

'Naming the land' is often seen as an integral part of the process of becoming familiar with New Zealand when humans first settled here. However, we should realise that coming to understand the fishery also required naming. It would be useful to know a great deal more about this than has currently been investigated from early historical records of Māori marine taxonomy. Regional differences in naming the fishery may provide clues about the origins of different immigrant groups. Possibly of greater importance, however, such research would provide insights into how Polynesians

² I can not explain in a few sentences why the Karam people of Papua New Guinea classify the cassowary separately from birds; instead I leave the readers to explore this fascinating subject themselves by reading Bulmer's paper. However, I will say that the Karam classification makes perfect sense to me.

sians classified this part of a temperate environment, using a tropical world as a reference point. Biggs (1994) has explored this in some detail for some other aspects of the New Zealand environment, including Māori names for plants. He suggests three ways of naming the features of a new environment – coining new words (which he thinks was unusual), assigning new meanings to old words, and borrowing words from other languages (which was not an option for the Māori colonists of New Zealand). He cites the example of *tio* (oyster) as a case where a feature of the New Zealand marine environment, although not the same as in tropical Polynesia, was sufficiently similar to be given the same name without needing qualification.

The process of exploring the New Zealand fishery should not be thought of as a cold and miserable experience with dismay at the lack of familiar foods. On the contrary, there would have been intense interest and excitement too. Although hardly any fish species in the new environment were the same as 'back home', the early immigrants certainly recognised fishes that were to some extent familiar and gave them names which reflect this.

Hooper (1994) has identified 147 fish names which are widespread in Polynesia and can, in most cases, be reconstructed as part of the vocabulary of Proto Polynesian. Fewer than 40 of these words have been recorded for Māori. Some, such as *mangō* (shark) and *whai* (ray), represent broad categories of fish and were further qualified in Māori and other languages (e.g., *whai manu*, eagle ray). The Proto Polynesian term **tanifa*³ has variants in many languages, usually meaning a particular fierce or dangerous kind of shark, and sometimes also a sea monster. In Māori, *taniwha* was used for sea monsters and for sharks generally, but also as a qualifier referring to a particular kind of shark. *Mangō taniwha* is a white pointer (great white).

Occasionally, a Māori name described a fish that was identical or very close to a species found in tropical Polynesia. For example, variants of the Māori *kanae* (grey mullet) are found throughout Polynesia for the same species (*Mugil cephalus*), or another species of the same genus. For

some of their most commonly caught fish, however, Māori adopted a name that had previously been used for a different fish, one not present in New Zealand, although usually there was some general similarity in appearance or behaviour. Examples include *tarakihi*, *hāpuku*, *pātutuki* (one of several Māori names for blue cod) and *tāmure* (snapper). The case of barracouta is interesting. The Māori chose to name it *mangā*, which in the Cook Islands and other parts of Eastern Polynesia is the name given to the snake mackerel, rather than *ono*, a very widespread Polynesian name for members of the Sphyrænidae family, which are also very similar in appearance to the New Zealand barracouta.

FISH ZONATION AND OCEAN CURRENTS

As might be expected, the broad ecological zones of the New Zealand fishery depend to a great extent on the basic physiographical structure of the underwater environment around New Zealand (Figure 18). The edge of the continental shelf is normally taken to be the 200 m depth contour, and this identifies seven distinct regions around New Zealand: the main New Zealand landmass, the Mernoo Bank northeast of Banks Peninsula, the Chatham Islands, Bounty Island, the Pukaki Rise between Bounty Island and Stewart Island, the Auckland Islands and Campbell Island. This contour line conveniently separates the inshore or neritic zone and the offshore or oceanic zone (Figure 19).

As one moves away from the continental shelf the sea floor slopes steeply downwards, increasing by about 100 m for each 1.5 km. This area is known as the continental slope. At a depth of about 3,000 m it merges with a more or less level abyssal plain. The upper part of the continental slope from about 800 m to the edge of the continental shelf is a rich fish habitat. Upwelling of nutrient-rich waters from greater depths occurs in this region, and this promotes plankton growth and therefore fish populations. As can be seen in Figure 18 there are several notable areas of sea bottom between 200 and 1000 m around New Zealand, such as the Challenger Plateau, the Chatham Rise, the Bounty Platform, and Campbell Plateau. For unknown reasons the Challenger Plateau carries only limited fish stocks (Armitage *et al.* 1981: 15). The main deep water regions with large fish stocks are the Chathams Rise and the Campbell Plateau.

³ Historical linguists use the form **tanifa* for a word they have reconstructed as the probable form in a proto language. *Taniwha* is an actual word in Māori and other modern Polynesian languages; **tanifa* is the hypothetical ancestral form.

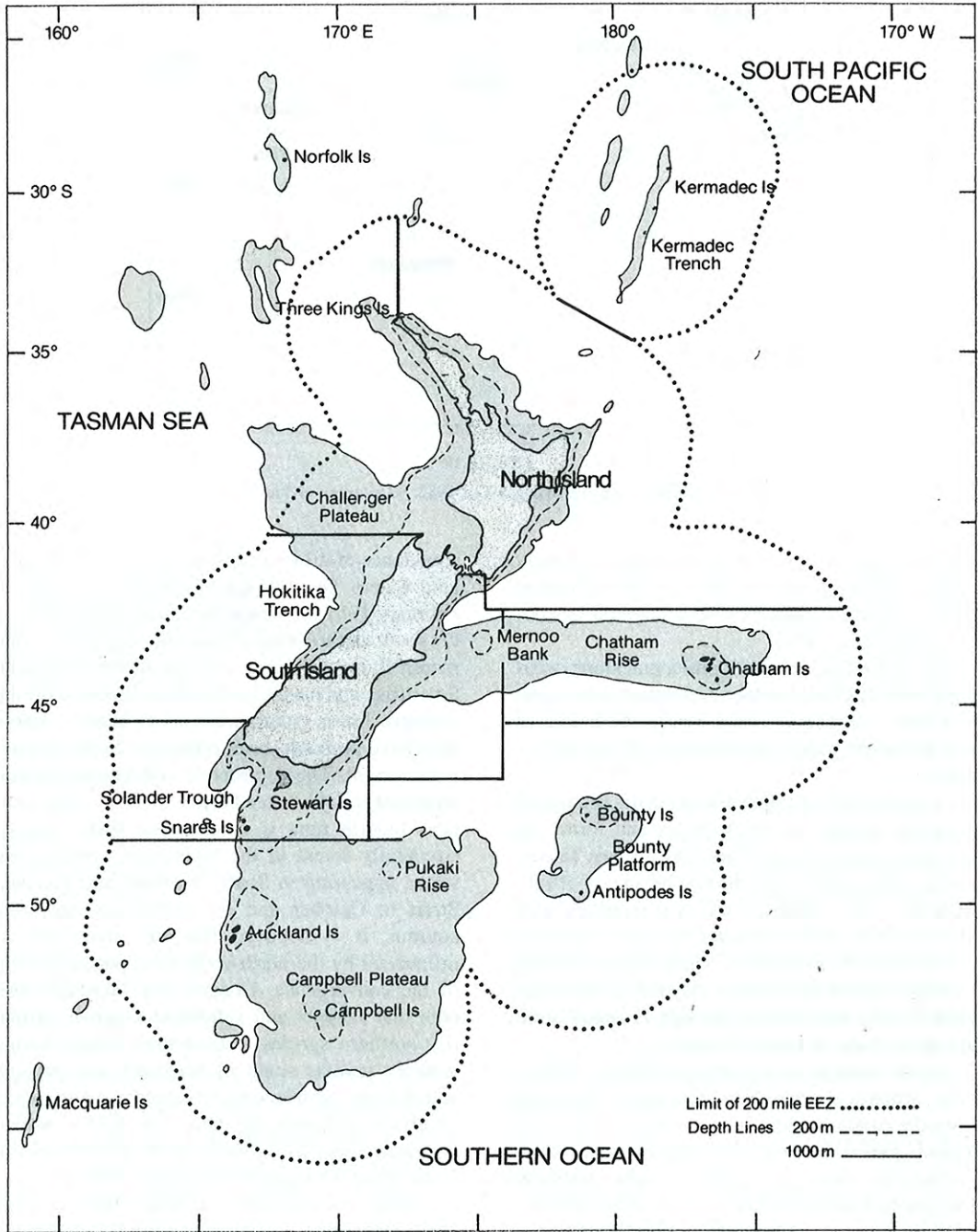


FIGURE 18

The main physiographic features of the New Zealand benthic environment (after Armitage *et al.* 1981: 9, courtesy of the New Zealand Seafood Industry Council).

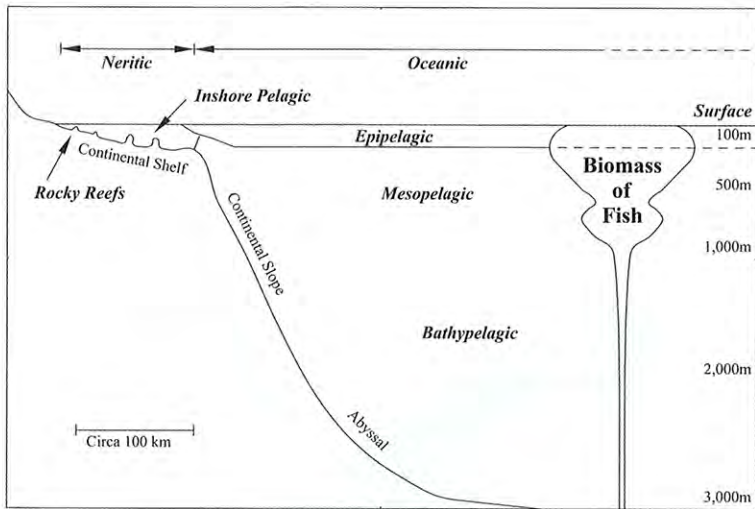


FIGURE 19

Major fish habitats (based on Ayling & Cox 1982: 16, courtesy of Tony Ayling).

The Chathams Rise lies under the same relatively warm subtropical water as the main New Zealand shelf, while the Campbell Rise is covered by cooler subantarctic water.

The richest areas of the continental slope occur along what is known as the subtropical convergence (Figure 20). This is a zone where two bodies of cool and warm waters mix together (Ayling & Cox 1982: 17).

A broad mass of tropical water drifts southward along the eastern part of Australia and forms the East Australian current. When this reaches Tasmania it is deflected towards the east by a body of subantarctic water which flows in a north-easterly direction. This deflected water becomes the South Tasman current, and when it reaches New Zealand, it swings northward to reach beyond Cook Strait. Some of this water passes through Foveaux Strait and up the coast of Otago (Figure 21).

In like fashion, the southward drifting tropical water, when it reaches New Zealand, is deflected down the east coast, and is known as the East Cape current. When it meets the sub-antarctic water coming up from the south it turns eastward towards the Chatham Islands. No doubt part of this deflecting process is caused by the shallower sea bottom between Banks Peninsula and the Chatham Islands, known as the Chatham Rise (Doogue & Moreland 1966: 34).

These currents and the subtropical convergence have a major influence on the presence and

abundance of different species of fish in New Zealand waters. Doogue and Moreland record that in February 1951 the East Cape current penetrated as far south as the Otago Peninsula, and in the same month flying fish were seen off Banks Peninsula. Swordfish and marlin are regularly reported off the southern fiords (south west South Island), where they have probably been riding the South Tasmanian current. The subtropical convergence would represent a cold water barrier to them. The southern bluefin tuna is a temperate water species commonly found in the vicinity of convergence water, appearing in South Westland and Foveaux Strait in October and November, and again in autumn. It is believed that this movement is influenced by the north-south seasonal movement of the convergence. Doogue and Moreland also note that snapper and yellowtail kingfish, primarily northern species, extend their ranges during summer months south of Kaikoura and beyond, and that the subtropical convergence again marks an effective barrier for these fish. In the winter, they range only as far south as the western part of Cook Strait (Doogue & Moreland 1966: 34).

These seasonal effects and the overall position of the sub-tropical convergence can be expected to have had an important influence on prehistoric fishing activities. For instance, even slight changes in the climate regime in New Zealand over the past millennium would have had repercussions in the sea, certainly in surface sea temperatures and pos-

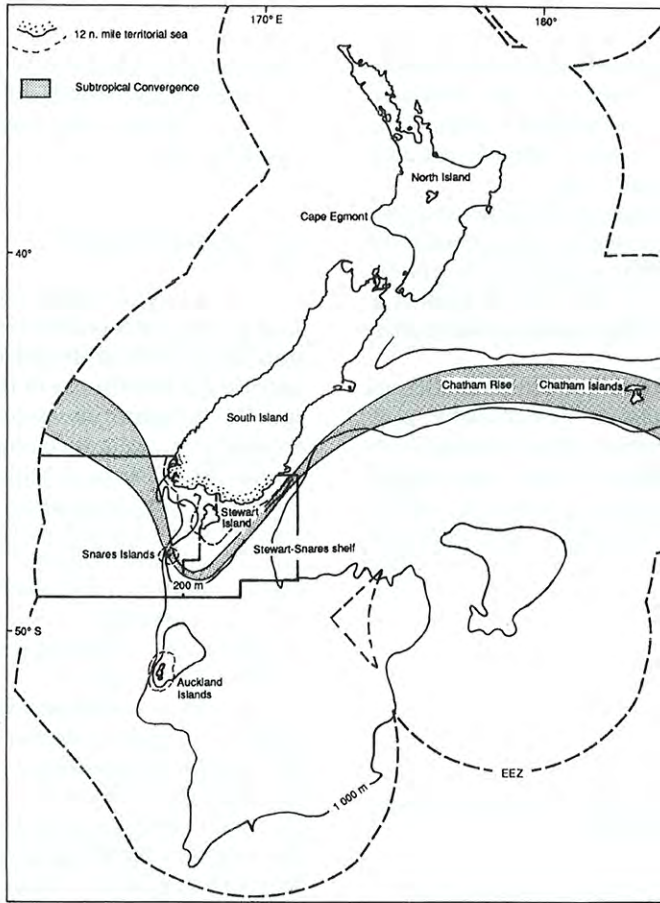


FIGURE 20

Subtropical convergence in New Zealand (from Hurst *et al.* 1990: 6, courtesy of Ministry of Fisheries).

sibly in the positioning of the convergence too. This may explain why, as we shall see in Section 7, snapper are found in archaeological sites very far south, and in the early period of New Zealand prehistory appear to have been rather more common than in later archaeological sites.

Figure 19 indicates the relative biomass of fish in the different zones. This shows that by far the bulk of fish are to be caught in depths above about 300 m, and especially on the continental shelf at less than 200 m. There is another major concentration of biomass in the upper reaches of the continental slope between 1000 and 500 m. This zone was almost certainly beyond the reaches of fishing equipment brought to New Zealand by Polynesians. However, having said that, it must be noted that there is ambiguous early historic evidence of

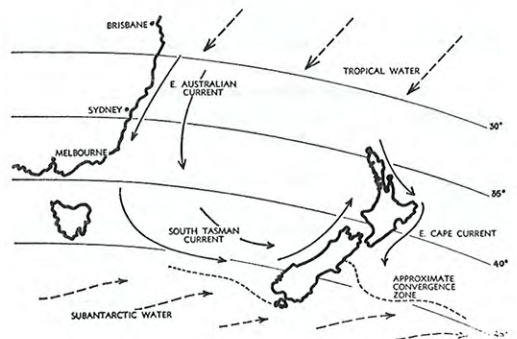


FIGURE 21

The main ocean currents which are responsible for the subtropical convergence in the vicinity of New Zealand (from Doo-
gue & Moreland 1966: 34, courtesy of Eric W. Heath).

deep water fishing in the Pacific for the *Ruvettus* (oil fish), or *palū*, as it is widely known. This is not the place to embark on a discussion about the problem of *palū* fishing, except to say that deep-water fishing (over 200 m) is essentially a modern phenomenon in the Pacific region with the spread of nylon lines and steel fish-hooks.

Commercial fishermen and fisheries scientists recognise a series of ecological zones around New Zealand waters, each with its dominant mix of species and other characteristics. Water depth is an important part of this. These zones are summarised in Table 3.

With the exception of the last zone (Oceanic demersal), all these regions were available to the Polynesians who inhabited New Zealand in the pre-European era. Some of the deep water species, such as frostfish, occasionally come into shallow water and wash up on beaches. These species of course became known to the New Zealand Māori through such incidents. However, the main part of

the fishery which was exploited by Māori was confined to coastal waters less than 100 m deep. This is an important point, of considerable interest to modern Māori seeking to assert mana (authority) over the sea and its resources, and will be returned to later.

SEA TEMPERATURES

The surface sea temperature around New Zealand is one of the principal variables which controls the presence or absence of seasonally mobile species, and also the rate of recruitment of juveniles. This is further discussed in Section 4 where snapper recruitment is considered. The interest in this matter for archaeologists is twofold. Firstly, the strong seasonal character of fish presence in inshore waters has important implications for the type of economic system which pre-European Māori could sustain. Secondly, any trends in surface sea temperatures over hundreds of years would have had important implications for people living in New Zealand.

The plot of summer and winter surface sea temperatures in Figure 22 shows the approximate boundary line for the sub-tropical convergence, in summer along the 15°C contour, and in the winter along the 10°C contour. In general terms, seasonal changes in water temperature around New Zealand are represented by a 5°C change from mid-winter to mid-summer. This may not sound very large, but it represents a very large latitudinal shift in temperature contours. For example, on the east coast of New Zealand, the 16°C contour in summer lies about the level of Kaikoura and Chatham Islands, or 44° south latitude. In winter, on the other hand, the 16°C contour lies mostly above North Cape at about 33° south latitude. In other words, the shift is 11 degrees of latitude. Fish are very sensitive to temperature changes, some more so than others, and this large latitudinal shift is an important driving force for migratory movements of fish – species tolerant of cold water moving north in winter, and species intolerant of cold water moving south in summer.

It has been found that coastal surface sea temperatures follow coastal air temperatures quite closely. The daily fluctuations in air temperature are much more marked than those in the sea, as one might expect since the sea acts like a large heat sink, absorbing rapid local changes. However, the two temperature regimes follow each other, as shown by Greig *et al.* (1988: 393) in their study of

Fresh water:	eels, whitebait
Shallow water pelagic:	(near the shore, harbours, etc.) grey mullet, yellow-eyed mullet, garfish (piper)
demersals:	sand flounder, yellowbelly flounder, school sharks, rig (seasonal occurrence), greenbone
Coastal water pelagic:	(near the shore to 200 m depth) kahawai, yellowtail kingfish, blue mackerel, pilchards, sprat and anchovy, trevally, jack mackerel, barracouta (also deeper waters)
demersals clear open bottom	
northern:	snapper, john dory, leatherjacket
southern:	red cod, moki, monkfish, blue warehou, spiny dogfish, elephantfish, sole, lemon sole, turbot, brill
widespread:	tarakihi, red gurnard, rig, school shark, skates
	rough bottom/coastal reefs
widespread:	blue cod, hāpuku, bass groper, bluenose, conger eel
Oceanic waters pelagic:	(200 to 1400 m depth) skipjack, albacore, southern bluefin
demersals:	southern blue whiting, hoki, ling, silver and white warehou, hake, orange roughly, oreo dory, gemfish, frostfish, sea perch, orange perch, alfonsino, lookdown dory, ribaldo, silverside, ghost shark, grenadiers

TABLE 3

Commercial Fish Distributions (after Armitage *et al.* 1981: 13 ff.)
See Appendix 2 for scientific names of fishes.

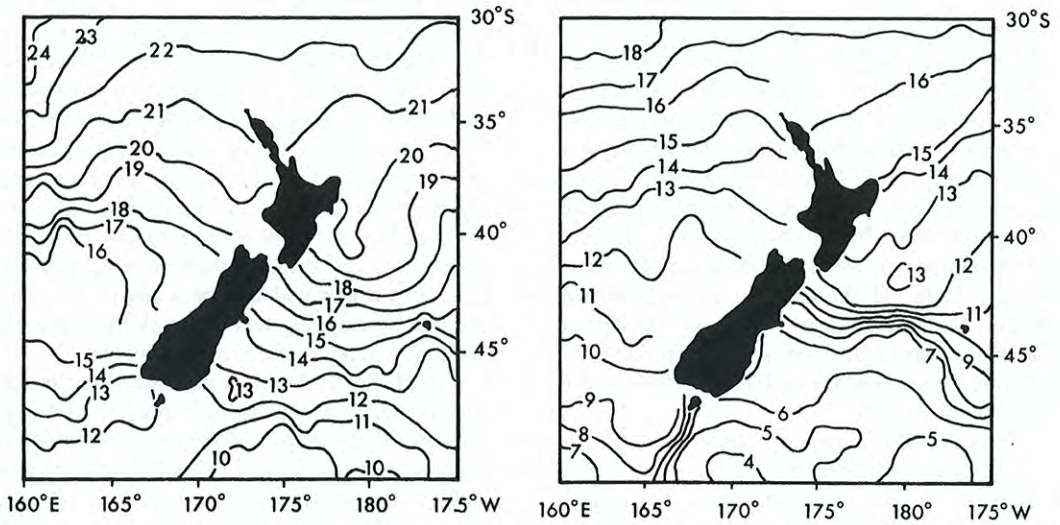


FIGURE 22

Surface water sea temperatures for New Zealand. These plots are close to the extreme values for summer (left) and winter (right), being obtained 8 March 1977 and 21 September 1976 respectively (from Eggleston & Paul 1978: 78, courtesy of Ministry of Fisheries).

16 stations between Bluff and the Leigh Marine Reserve north of Auckland. They found air temperatures to be slightly cooler than the sea on average, and short-term fluctuations of air temperature to be 3-4 times the standard deviation of surface sea temperatures.

The temperature of shallow bays and gulfs reflects the local climate very closely; the primary influence here is direct solar gain and winds passing over warm or cold land or sea. In these cases, the dominant influence is atmospheric. On the other hand, oceanic temperatures follow the thermal patterns of large water masses and currents as well as long-term and large-scale climatic events. The surface sea temperatures of coastal waters between these two extremes are influenced by both atmospheric and oceanic events (Paul 1978: 70). In an analysis of historical trends in surface sea temperatures, Paul found evidence of cyclical patterns repeating every three or four years, and that “coastal air temperatures in northern New Zealand, when considered in terms of months and years rather than days, are a reasonable measure of sea surface temperatures” (Paul 1978: 71). Since there are far better historical records of air temperature than sea temperature in New Zealand, Paul examined these records as a guide to possible long term changes which might have prevailed in

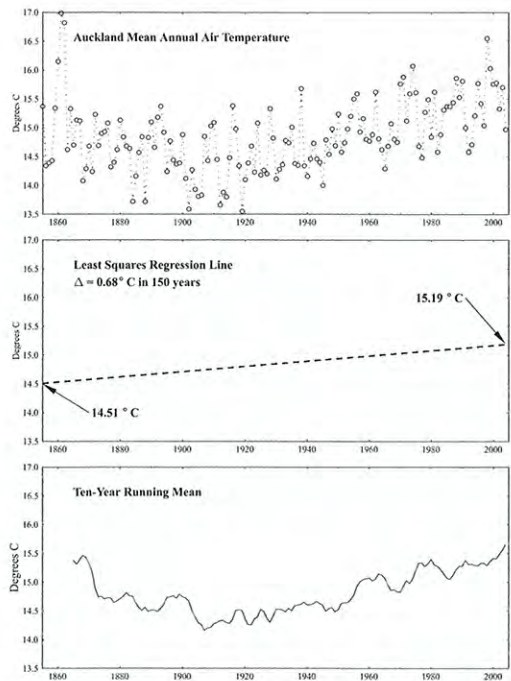


FIGURE 23

Historical trend of mean annual air temperature at Auckland (10 year running mean). An overall rise of more than 1°C has occurred over the period 1910 to 1996 (based on data provided by Paul 1997: pers. comm.; see also Paul 1978: 72-73).

coastal waters (Figure 23). His analysis shows an overall rise of more than 1°C from 1910 to 1977, with somewhat higher temperatures before that. In Figure 23, the data range has been extended to 1996, and when least squares analysis is carried out on this, it shows that there has been a rise in temperature of 1.41°C over this period. Folland and Salinger conclude that nearby ocean surface temperatures have warmed by about 0.7°C since the beginning of the 20th century (Folland & Salinger 1998: 1195. See also Salinger 1991a, 1991b). Such a change will have influenced abundance figures for various fish species over the same period, but the historical details of this are not well studied.

Unfortunately, there is very little direct evidence of sea water temperatures for any part of New Zealand for the pre-European period, but there is information about changing air temperatures from both speleothem studies and patterns of glacial advance and retreat. This is discussed further in Section 7, but it can be noted here that there is increasing evidence of significant changes in climate during the last thousand years, and these changes would have had an effect on surface sea water conditions, and in turn the abundance and recruitment rate of different fish species.

SEA CONDITIONS

When Polynesians arrived in New Zealand they experienced sea conditions quite different from those of their homeland, and these would have influenced fishing activities. One important difference is the disadvantage that underwater visibility is much less than in the tropics. This is very important for people used to diving and spearing underwater. It is also important when spearing surface predators from a canoe, or using a hoop net amongst seaweed. A less obvious advantage, however, is the possibility of using stationary set nets or gill nets in New Zealand. Before the advent of nylon, such nets were effectively absent in the Pacific region. In fact, some Pacific islanders visiting New Zealand and seeing a local fisherman place a set net simply do not believe that it could ever catch fish, until of course the net is retrieved full of fish, captured by the gills. Nets made from sennit (coconut fibre) in the tropical Pacific are highly visible under water and fish simply swim away from them, rather than trying to swim through them and getting caught by the gills.

The concept of gill net selectivity therefore may not have been part of the fishermen's pool of knowledge when they arrived in New Zealand. Set nets, which capture by the gills, are commonly used in New Zealand for a number of species, and were fully effective when cotton line was employed in their manufacture. They are even more effective with nylon. It is an interesting issue to try and establish when gill nets developed during the course of New Zealand prehistory. Before this time, seine nets would have been employed to capture fish by dragging them through the water and essentially trapping the fish with the net.

Greatly reduced underwater visibility is not the only change from the tropical regions. Although islanders in the tropics experience conditions of large swell and occasional violent storms, the temperate waters around New Zealand have far more days per year when it would be difficult or impossible to put to sea in a small craft such as a canoe. The main factor here is surface swell, caused by local winds. This varies throughout New Zealand, but on the whole sea conditions progressively deteriorate towards the south. In Cook Strait, there is nearly always a slight sea running, and even in summer, calm periods seldom last for longer than 10 days (Anderson 1973: 96). After a detailed analysis of the modern marine environment and local midden sites at Black Rocks, Palliser Bay, Anderson concluded that fishing and shellfish gathering on the nearby exposed coastal waters must have been confined to about 120 days per annum (Anderson 1973: 120). Turbulent sea conditions constitute the principal limiting factor. These are caused by frequent local winds and also by the dominant southerly oceanic swell, which can be generated from far afield. Thus, poor sea conditions can prevail during periods of locally fine weather (Figure 24). This severely limits the ability to procure marine foods for at least one third of the year.

Although people living near sheltered bays would not be hampered in the same way as those living at Black Rocks, such a situation is by no means confined to Palliser Bay. Much of the east coast of New Zealand is unprotected from these wind-generated swells. On the west coast, the prevailing northwest wind has a similar effect. This is particularly hazardous in the Northland region where numerous sailing ships were wrecked in the nineteenth century, unable to keep to windward. Captain Cook, with characteristically good seamanship, kept well away from the Northland coast when he travelled down the west of the North Island.

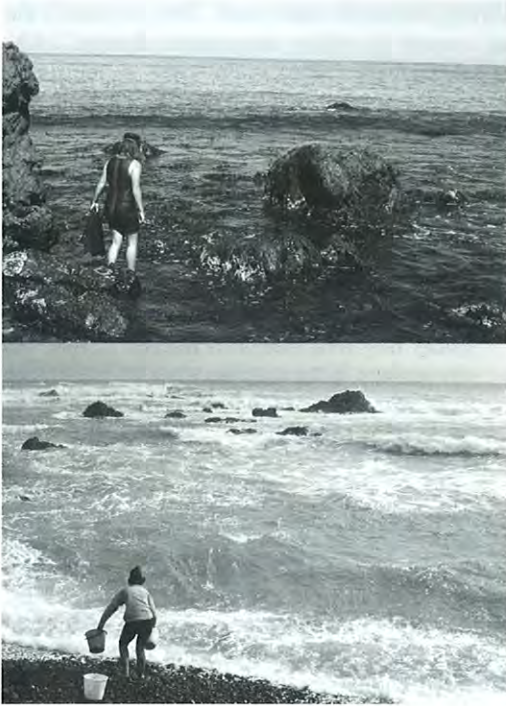


FIGURE 24

Black Rocks in Palliser Bay showing the contrast between a calm sea (upper) and during a typical moderate southerly blow (lower). It is impossible to put to sea in a canoe in such windy conditions, which might last for weeks on end (courtesy of Atholl Anderson).

It has been noticed that there is a positive correlation between the general storminess of coastal waters in different parts of New Zealand and the relative abundance of labrid fishes in archaeological sites, and an inverse correlation with the relative yield of kūmara crops (Leach & Anderson 1979a: 11). This suggests that in places where there is the greatest pressure to harvest marine resources, and where it is most difficult to do so, labrids become important in the local pre-European economy, because they can be caught from the shore even in the most adverse conditions. However, as will be seen in Section 8, people could not maintain a healthy diet on fish alone. In the far north, where kūmara were more plentiful, people did not have to rely on labrids in bad weather to anything like the same extent (Figure 25).

Not all of New Zealand is subject to poor sea conditions by any means. There are numerous sheltered bays with excellent fishing. Notable areas with intensive human settlement in the pre-European period are Parengarenga harbour, the Bay of Islands, Whangarei Harbour, and Hokianga Harbour (Figure 26), all in the far north. It is interesting that neither Wellington Harbour nor the myriad of protected areas in the Marlborough Sounds appear to have had large populations of people. This region marks the boundary between groups of people in the north who had a successful horticultural economy, and those in the south who were hunter-gatherers. Cook Strait is a transitional zone in many respects.

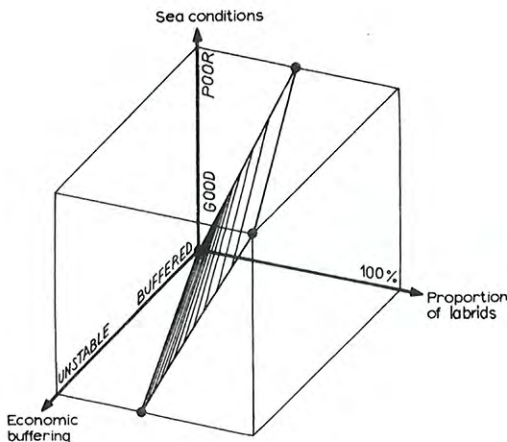


FIGURE 25

Labrid fishes are particularly abundant in archaeological sites where people experienced adverse sea conditions (from Leach & Anderson 1979a: 12).



FIGURE 26

The entrance to Hokianga Harbour in Northland with somewhat hazardous waters to negotiate. The inner harbour during pre-European times would have been a rich fishing ground. The outer area has some rocky headlands and excellent coastal fishing too (courtesy of Geosmart Ltd. Negative #27126, White's Aviation).

SEASONALITY

The seasonal change in sea water temperatures is one of the main driving forces for the movement of various fish species into and away from shallow inshore waters, and also from one part of New Zealand to another. These movements are very complex, partly depending on spawning requirements and partly on the quest for food. Generally speaking, the best time to go fishing in New Zealand is in the summer, but fish can be caught all year round. During the summer months a number of species come into shallow waters to spawn and they may then be caught in large numbers. Snapper is a good example of this. However, there are many species which inhabit rocky weedy areas and are present all year round, such as labrids, blue cod, solitary snapper, greenbone, etc.

As an example of changes in seasonal abundance, the commercial landings of blue mackerel and elephantfish are shown for different months of the year in Figure 27. These show a preponderance during the summer months. One has to be careful about how one interprets these commercial catch figures, which after all document fishing behaviour, not fish behaviour. However, in the case of these two species there are other observations which reinforce the change in abundance suggested by Figure 27. Large numbers of mackerel are seen in late spring and summer near Whangarei and Auckland. The fish apparently undertakes coastal migrations southwards in October and northwards in April and May (Leach 1979a: 116).

Elephantfish is primarily a southern species, and large numbers are caught in the Canterbury Bight, but it is sometimes seen as far north as the Bay of Plenty. It very rarely takes a baited hook since it feeds on crustaceans and shellfish, and it has specially adapted mouth parts for crushing these animals. It can be obtained in beach seines in the Canterbury area. The fish appears to migrate into deeper water when cold weather sets in, and during these months very large specimens can be hooked well offshore. At one time they were plentiful in Otago Harbour in summer from November through March. The change in abundance illustrated in Figure 27 shows a summer peak in catches.

Greenbone has been mentioned as a species present all year round. The information about this species is somewhat ambiguous. Fyfe (1982: 175) states "They are only to be found in shallow water during warm months between November and April,

leaving before the water cools. They frequently die as a result of sudden temperature changes". Although Graham (1956) is not cited as the direct source of this observation, it does appear to derive from this book. What Graham actually said is:

Greenbone only came into the Otago Harbour at intervals during warm weather. They were the first fish to suffer from a sudden change or lowering in the temperature which is sufficient to kill them, when they could be picked up on the shore. When a gale in the harbour caused the water to become muddy they soon died. This reaction to cold was also apparent in the aquarium when the temperature of the incoming sea water had to be brought up several degrees in temperature if Greenbone were to be kept alive (Graham 1956: 268).

These observations should not be interpreted as implying that greenbone are not present in coastal Otago waters or coastal waters elsewhere in New Zealand at times other than summer. Graham is describing greenbone coming inside the Otago harbour, which would not normally be a favoured habitat for greenbone, in the summer. The areas at the entrance of Otago Harbour are rich in seaweed and therefore provide suitable cover and food for this species, which are present all year round. Fyfe's comments about the seasonal movement of this species only concerns this special harbour occurrence. Greenbone occur throughout New Zealand, but are more common south of East Cape. The marked seasonal pattern of catches, evident in Figure 27, illustrates that fishermen leave them alone in preference to far more profitable returns from rock lobster fishing. The low point in the rock lobster catch in April is due to the mating, and the second low point in August is when they are moulting (Armitage *et al.* 1981: 189).

Also illustrated in Figure 27 is the pattern of catches of barracouta for two ports of landing. The seasonal habits of this species are discussed in further detail in Section 4, but it is noted here that the pattern shown for Port Chalmers of a strong summer appearance in the commercial landings is a fair reflection of their relative abundance in inshore waters at that time of year in the Otago region. The apparent winter predominance of catches landing in Wellington may also fairly represent a higher abundance at this time of year in the Cook Strait region. Hurst notes that the pronounced seasonal peaks in late winter to spring are based on known spawning areas. Most

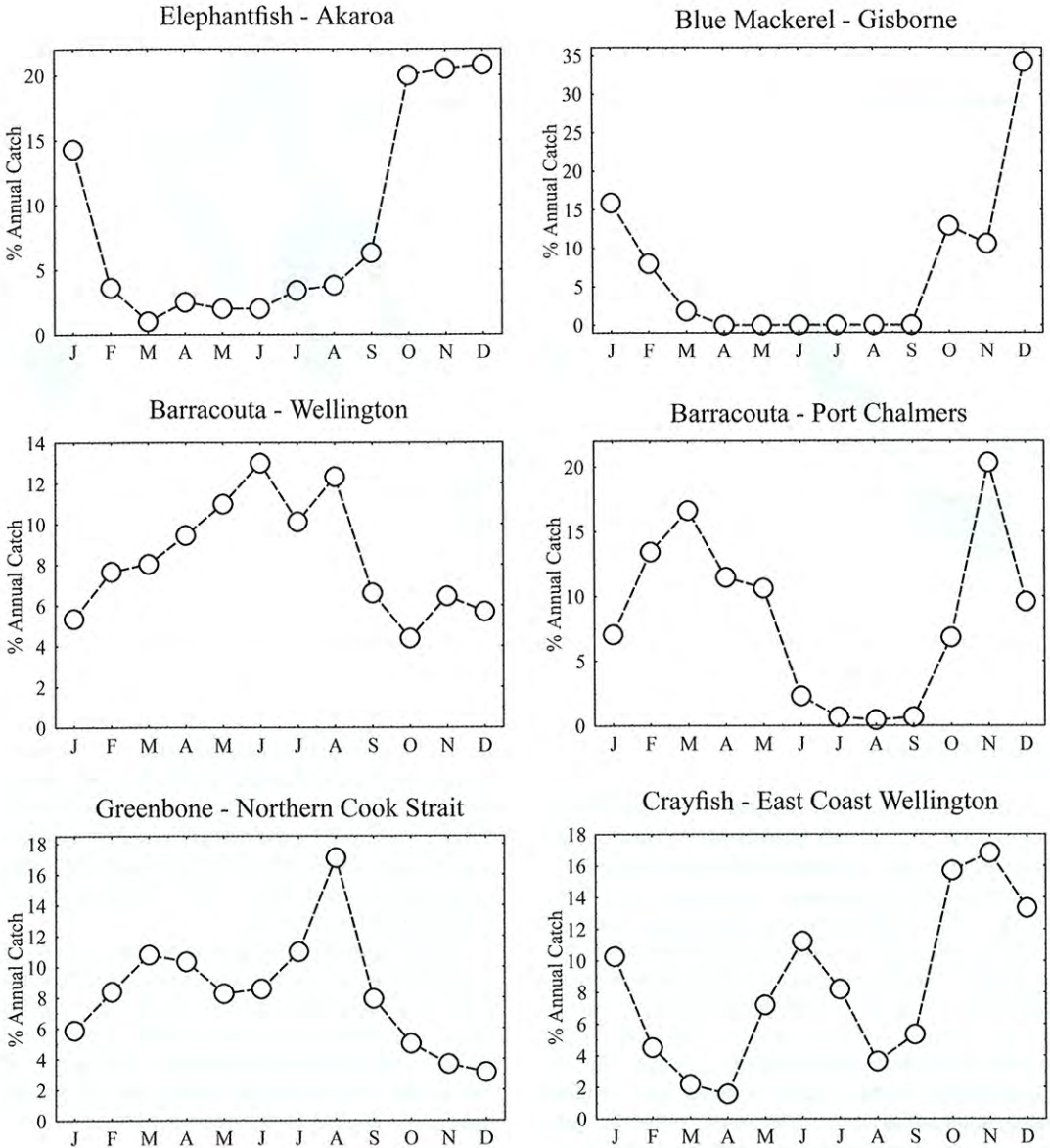


FIGURE 27

Some New Zealand fish are more abundant in inshore waters in the summer and others in the winter. These graphs show the commercial landings of several species (from Leach 1979a). The greenbone figures reflect fishing behaviour, not fish behaviour.

of the spawning appears to take place between August and December around the North Island and north-east and west coasts of the South Island (Figure 28). The fishing patterns, evident in this figure, suggest that there is a southward move-

ment in early summer to feeding areas in the Canterbury Bight and around the Snares Islands. There is some evidence to suggest that barracouta are scarce in northern areas outside the spring spawning season (Hurst 1988: 36).

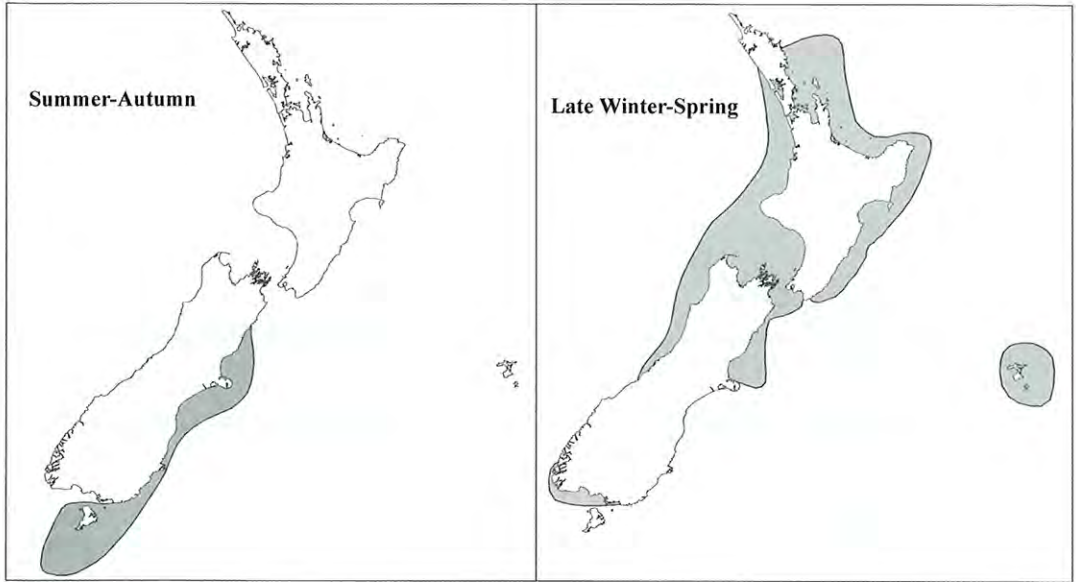


FIGURE 28

The general seasonal pattern of barracouta catches in New Zealand waters (based on Hurst 1988: 38, courtesy of Ministry of Fisheries).

MARINE REGIONS

The islands of New Zealand are distributed across nearly 1600 km from north to south, and there are therefore substantial differences in climate and marine environment associated with this spread. The far north is sub-tropical and the far south is sub-antarctic. With such diversity of climate it is hardly surprising that pre-European Māori had completely different life-styles and economic systems at the two ends of the country. In the far north the people had an economy rich in horticultural produce, able to build and sustain large populations. In the far south, however, the people were hunter-gatherers, with low population density.

The types of fishing which could be carried out in different parts of the country were also determined by the large latitudinal spread of the New Zealand coastline.

The latitudinal ranges of common New Zealand fishes are indicated in Figure 29. This shows a steady loss of some species as one moves progressively southwards, and the steady appearance of different species at the same time. A few species, such as groper, spotty, tarakihi, and butterfly perch, have ranges which cover the whole of New

Zealand. Even these appear in reduced abundance at one end of New Zealand or the other. We should therefore expect that pre-European fishermen in different parts of New Zealand would harvest the sea by somewhat different techniques and that their catches would vary as well. This is discussed in more detail in Section 6.

These latitudinal ranges raise the subject of whether there are significant groupings of species into marine regions or provinces. The most useful discussion of this is by Francis (1996), who carried out an analysis of the geographic distribution of reef fishes in New Zealand waters. He divided the region into a series of 16 areas as follows:

- | | |
|-------------------|---------------------------------|
| 1 Norfolk Is. | 9 NE South Is. |
| 2 Kermadec Is. | 10 NW South Is. |
| 3 Three Kings Is. | 11 SE South Is. |
| 4 NE North Is. | 12 Fiordland |
| 5 NW North Is. | 13 Stewart Is. |
| 6 SE North Is. | 14 Snares Is. |
| 7 SW North Is. | 15 Auckland and
Campbell Is. |
| 8 Chatham Is. | 16 Macquarie Is. |

He found that reef fish diversity (number of species) dramatically decreased with latitude, ran-

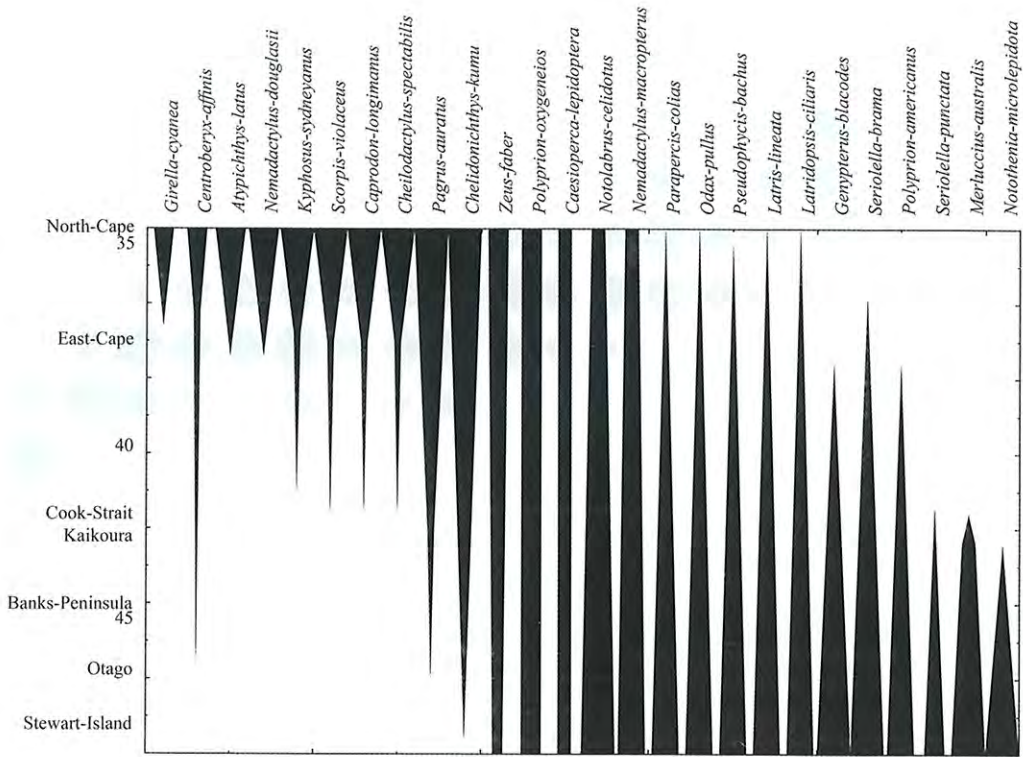


FIGURE 29

Distribution of common New Zealand fishes (after Leach & Anderson 1979a: 9, based on data from Waugh 1973: 257).

ging from 228 species in Norfolk Island to only 6 species in Macquarie Island. There are four outliers, departing from a linear relationship with latitude, all of which have considerably less than the expected number of species. These are areas 2, 3, 5 and 10. It is interesting that the Kermadecs should be depauperate in species, even compared with the northeast North Island of New Zealand. Scheil *et al.* (1986: 532–533) suggest that this is a product of geological history and isolation, noting that no major currents flow through these islands, and that most of the landform probably appeared as recently as the Pleistocene. The other three areas with lower than expected diversity run down the west coast of New Zealand from the Three Kings Islands and the northwest North Island to the northwest South Island. Francis suggests that the exposure of this coastline to the prevailing westerly wind and swell results in little sheltered reef habitat, and that this is probably the reason for low species diversity (Francis 1996: 43).

In an attempt to identify groups of species which share similar distributional patterns, Francis used principal components analysis, and found seven clusters of 375 species represented. The regional distribution of these is shown in Figure 30. This shows a steady change southwards as one might expect. For example, in Otago waters (region 11), 83 reef species are present. Of these, most are from the 'Cool Temperate' cluster, slightly fewer from the 'Widespread' cluster, and a few from the 'Subantarctic' cluster. The list of species occurring in each cluster is provided by Francis in an appendix (Francis 1996: Appendix 1).

Francis also examined the distributional information to see if significant groupings of the original 16 regions could be found. Once again, principal components analysis was employed. This yielded eight clusters as follows (original regions in brackets):

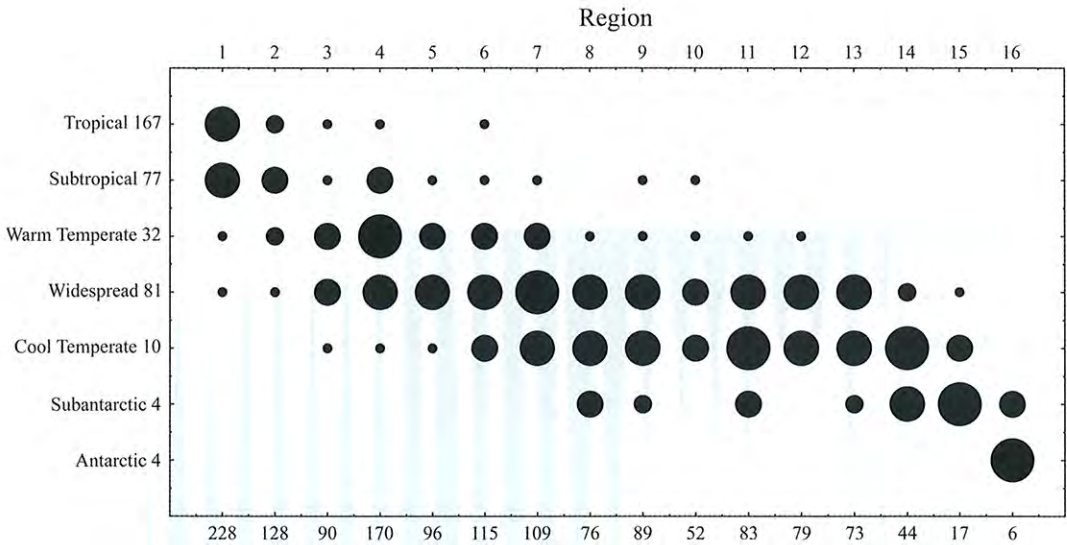


FIGURE 30

The reef fishes in the New Zealand region can be grouped into seven clusters which share similar regional distributions. The number of species in each cluster and region is indicated by the figures in the column on the left and along the bottom of the graph. The size of each circle indicates the percentage in each cluster occurring in each region (based on Francis 1996: 39).

- I Norfolk Island (1)
- II Kermadec Islands (2)
- III Three Kings Islands and NE North Island (3, 4)
- IV West coast North Island and East Coast North Island south of East Cape (5, 6, 7)
- V Chatham Islands and all of the South Island (8, 9, 10, 11, 12, 13)
- VI Snares Island (14)
- VII Auckland and Campbell Islands (15)
- VIII Macquarie Island (16)

The groups which are appropriate to coastal mainland New Zealand are shown in Figure 31. The high diversity of fishes in region III is due in part to the presence of tropical and subtropical species, deriving from the warm East Auckland current. East Cape is also confirmed as an important biogeographical boundary, something which has been proposed many times previously. Francis notes that the reason for the existence of this bound-

ary is not so easy to detect. He also identifies Cook Strait as the southern limit for many warm temperate water fishes, and the northern limit for several cool temperature species. However, unlike the East Cape boundary, in this case there is considerable overlap, and it is therefore not such a marked boundary.

Francis' paper is an important step forward in identifying clusters of New Zealand reef fishes and regional groupings; however, he falls short of naming these natural groupings as biogeographical provinces, partly because apart from the North Cape and East Cape boundaries he sees the lines as blurred rather than sharp distinctions (Francis 1997: pers. comm.). He has expressed similar reservations in his study of fish distributions in the southwest Pacific (Francis 1993: 148). Despite this reservation, the regions identified in Figure 31 are convenient areas against which to view the archaeological data on fishing.

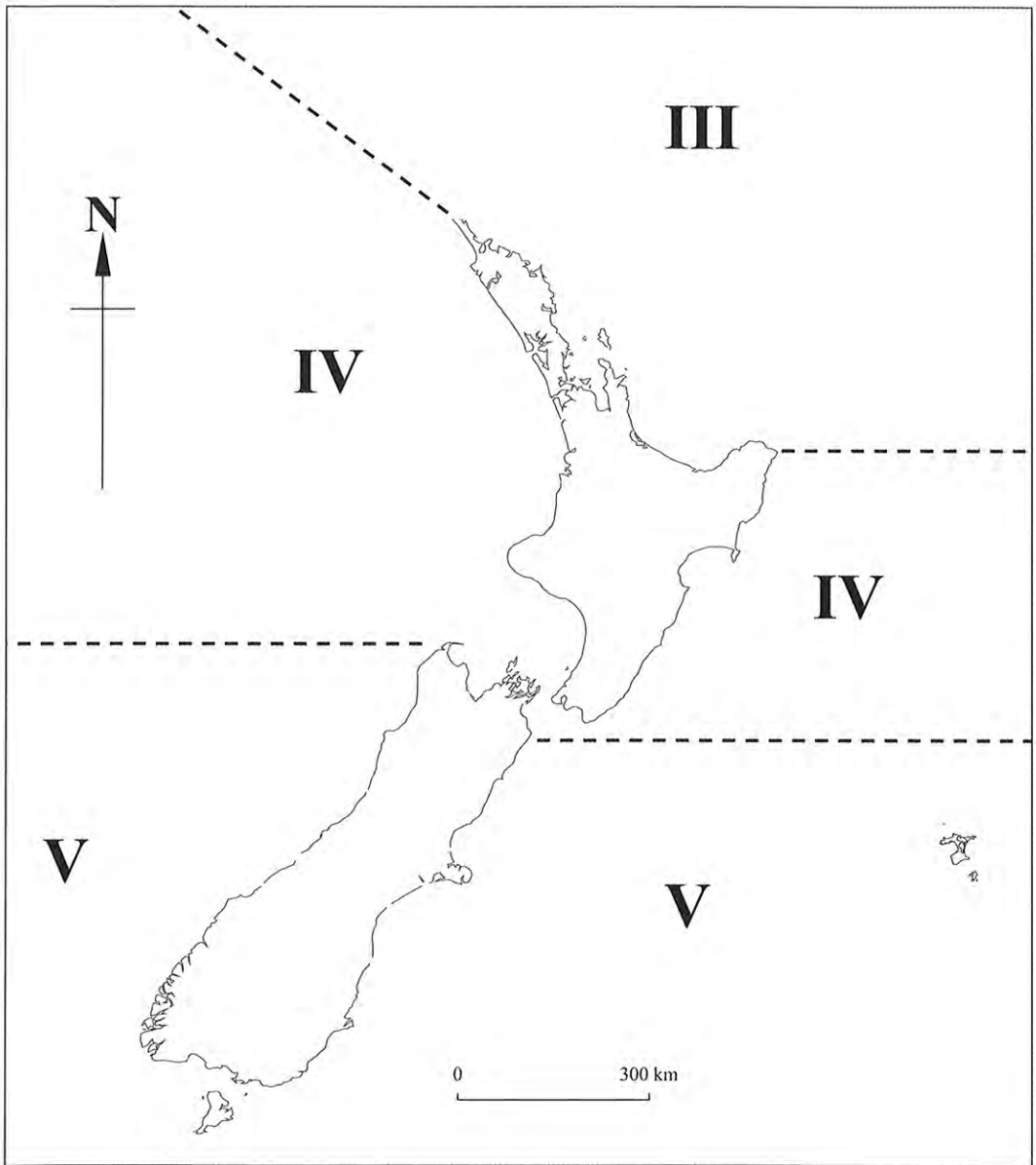


FIGURE 31

Eight regions can be identified in the vicinity of New Zealand which contain similar groups of species. Three are shown in this illustration. The other five are to the north or south of this map (based on Francis 1996: 40).