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Section 6: The regional character of fishing

INTRODUCTION

Humans have a natural tendency to want to simplify complex cultural or biological information into manageable geographical units. There is an ever-present danger that any such units that might be proposed will later become accepted as *real* and immutable; but these units are not *real*, they are artificial constructs, serving a useful purpose of simplification, which might be quite temporary. This is no less true of cultural, biocultural or biogeographical provinces, and we should try to keep a watchful eye open for this tendency to entrench regional constructs lest they take on a life of their own.

Several kinds of regional boundaries have been imposed on the map of New Zealand. The first attempt to do this for pre-European Māori culture was by Skinner (1921), who proposed a series of *Culture Areas*. In a postscript to his 1921 publication, Skinner noted that he had read a draft of his paper to the New Zealand Institute Science Congress in January that year and that during discussion, the eminent botanist Cockayne had pointed out a remarkable correspondence between Skinner's *Culture Areas* and the *Botanical Provinces* which Cockayne himself had published in the same year (Cockayne 1921). Skinner stated that he had not seen Cockayne's book at that time and had arrived at his geographical construct quite independently. Moreover, after finishing his work he consulted a map of Māori tribal boundaries and observed a close correspondence there too (Skinner 1974: 23). To these constructs we might perhaps add Powell's *Marine Provinces* (1979: 7). This all sounds very convincing and self-reinforcing until we consult the three different maps involved in this discussion. There is actually very little correspondence between Skinner's *Culture Areas* and Cockayne's *Botanical Provinces*, and the idea that either of these is similar to *Tribal Districts* is, well ... stretching things just a bit too far.

Cockayne first put forward his regional classification in 1914 (Cockayne 1921: 378), and commented:

> The major divisions of the region are here designated *botanical provinces*. These are based largely upon climatic change depending on latitude ... the ground is fairly secure for their basis is the stable one of gradual change in species in proceeding from north to south (Cockayne 1921: 378-379).

In contrast to this rather firm opinion of the stability of *Botanical Provinces*, Powell was not so confident about *Marine Provinces*, and warned against "placing too much reliance upon their existence as viable entities" (Powell 1979: 7).

The pivotal concept of any regional entity is that there are some clearly defined characteristics, which tend to be shared within it and tend not to occur outside it. This is, therefore, exactly analogous to other forms of biological classification, indeed any form of classification, including linguistics. This was discussed in some detail in Section 3. The choice of a set of characteristics has a major determining role in the shape of whatever classificatory entities are derived. I first proposed a series of regional entities within which to examine pre-European Māori fish catches in 1993 (Leach & Boocock 1993: figs. 3, 4, 5). These were not based upon any consideration of shared characteristics, and they were certainly not derived from the basic information (fish catches of pre-European Māori). They were simply lines drawn across a map in much the same way as the boundary between Irian Jaya and Papua New Guinea, which is an arbitrary vertical line drawn across the island of New Guinea. For New Zealand, I drew horizontal lines separating arbitrary regional districts called Northern North Island, Southern North Island, Northern South Island, Southern South Island, and Chatham Islands (NNI, SNI, NSI, SSI, Chat). I then looked at the character of the fish catches in those arbitrary regional units, worked out mean values to characterise each, and gave a rough indication of any changes in them through time. This was merely exploratory research. Anderson has described this as "a first approximation of overall characteristics and regional differences in fish catches" (Anderson 1997: 3) and that is quite correct. Using these same arbitrary regional units (although Chatham Islands was omitted), Anderson extended this study. He adjusted the MNI values of these regional entities by adding newly studied assemblages and re-calculated various statistics. It must be emphasised that neither of these studies involved the deduction of regional units, they were merely assumed. What is really needed now as a second step forward is to study the database itself to see if any sets of regionally specific characteristics actually exist.

Although New Zealand is a small country in a large ocean, it has a complex landform, spread over 1,500 km from Spirits Bay in the Far North to the southern shores of Stewart Island. The Far North is sub-tropical, and the islands immediately to the south of the South Island are sub-antarctic. Tropical waters form currents which move southwards and meet sub-antarctic waters moving northwards on both the east and west coasts of New Zealand. Not surprisingly, surface sea water temperatures are variable around New Zealand, and change considerably during the annual seasonal cycle. The implications of this environmental complexity were discussed in Section 3. In particular, it was shown there that there are marked changes in the general abundance of different species of fish from north to south, as well as strong seasonal migrations. I also discussed a study by Francis (1996) in which he examined regional fish diversity and species associations. This led him to propose a series of eight clusters or regional groupings, three of which relate to mainland New Zealand (Figure 31). It might therefore be expected that fish catches by pre-European Māori might also differentiate into regional groups. This possibility will now be examined.

At the outset it must be pointed out that humans are not like mites on an orange, foraging for food using an optimal strategy of maximising gain for minimum effort. If this were so, there would be no place for human culture, and we would expect any groupings of fish catches by humans to follow exactly marine provinces determined entirely by ecological clustering. On the contrary, my expectation would be that marine provinces form only the baseline of choices for humans, not the final outcome. Upon this baseline there will be a complex interaction involving technology, material culture, basic nutritional needs, spiritual and magico-religious practices (such as food avoidance or totemic behaviour), and seasonal abundance. The final character of fish catches for any communities living in different parts of New Zealand and at different times of the year will be an amalgamation of all these interactions. We might therefore expect some gross regional patterning, perhaps following the regional clusters suggested by Francis, but superimposed upon this will be a great deal of variation from site to site.

There are several possible ways of examining our accumulated information on fish catches to see how regionalism is expressed. In this Section I shall explore two – catch diversity, and principal components analysis.

REGIONAL CATCH DIVERSITY

At a gross level, examining catch diversity against changes in latitude would be a logical first step. Francis found strong correlation here, with 228 species in Norfolk island declining to only 6 as far south as Macquarie Island (r=-0.86). When he removed four outliers (Kermadecs Islands, Three Kings Islands, NW North Island, NW South Island) from his 16 original groups, the correlation increased to -0.99 (Francis 1996: 38, fig. 1). This effectively leaves for consideration here Regional Group III minus the Three Kings Islands; Regional Group IV minus NW North Island but including SW North Island between Cape Egmont and Cape Farewell; and the southern and eastern part of Regional Group V (excluding NW South Island). I have also excluded Francis' Fiordland region north of Puysegur Point (Francis 1996: fig. 1). As it happens, the database (Appendix 1) has relatively few archaeological sites in the omitted areas on the west coasts of both islands (more on this point below). The sample from the database is reduced from 126 sites to 104 (24 in Region III, 30 in Region IV, and 50 in Region V), but it is still a reasonable sample with which to test these pre-European fish catches against the observed natural fish diversity in these regions. Two measures of diversity in fish catches were considered: number of families of fish represented at these archaeological sites and the value of Shannon's H, using the MNI values in Appendix 1. The results are given in Table 10.

Fish Family Statistics			
	Region III	**Region IV**	**Region V**
No. Species in Region	170	115	89
No. Familes in Region	58	51	42
No. Sites Studied	24	30	50
Range No. Families	2 to 15	1 to 25	1 to 21
Mean	7.6 ± 0.8	10.2 ± 1.2	6.8 ± 0.5
SD	3.9 ± 0.6	6.7 ± 0.9	3.7 ± 0.4
Coeff. Variation	51.1 ± 7.4	65.5 ± 8.55	5.1 ± 5.5
Student's t values			
	Region IV	**Region V**	
Region III	1.7, 52, NS p=.05	0.9, 72, NS p=.05	
Region IV	--	2.5, 78, S p=.05	
Shannon's H statistics			
	Region III	**Region IV**	**Region V**
No. Sites	24	30	50
Range H values	0.3 to 2.6	0.0 to 3.7	0.0 to 2.8
Mean	1.6 ± 0 .1	2.2 ± 0.2	1.6 ± 0.1
SD	0.6 ± 0.1	1.0 ± 0.1	0.7 ± 0 .1
Coeff. Variation	40.1 ± 5.8	44.4 ± 5.7	41.4 ± 4.1
Student's t values			
	Region IV	**Region V**	
Region III	2.8, 52, S p=.05	0.5, 72, NS p=.05	
Region IV	--	2.7, 78, S p=.05	

TABLE 10

Analysis of Fish Catch Diversity by Francis' Regions.

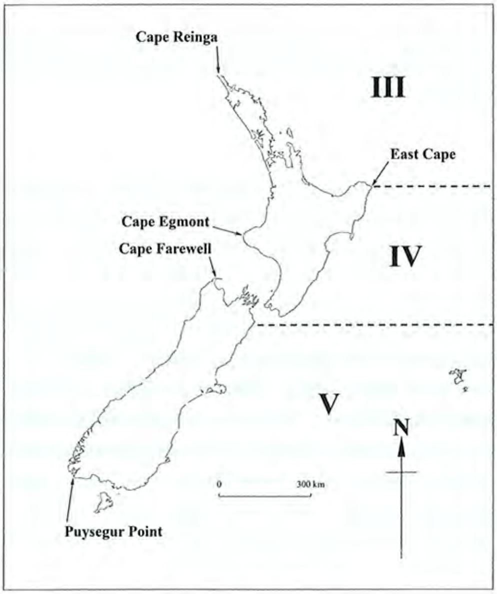

FIGURE 80

Three remaining regional groups suggested by Francis (1996), which show a very strong correlation of decreasing fish diversity with increasing latitude (see text). Archaeological sites between Cape Farewell and Cape Egmont are included in Region IV. The remaining sites on the west coast of New Zealand are excluded from Regions III and V.

The pattern of results in Table 10 is quite complex, reflecting human cultural variation as well as environmental change. Archaeological sites are formed from a variety of activities; some relate to villages, while others relate to specialised food harvesting sites, which take advantage of seasonal abundances. The latter can be expected to illustrate low catch diversity. Nevertheless, assuming that these sites are drawn without bias, they should also reveal any underlying regional patterns, and there are indeed some interesting results here.

For example, Table 10 shows a significant fall in the number of fish families represented in sites from Region IV (Cook Strait to East Cape) to Region V (South Island east coast and Chatham Islands). This pattern is illustrated in Figure 81. This result would be even more dramatic if the Waihora site (WAIH) in the Chatham Islands were removed from consideration. The average number of families has fallen from 10.2 to 6.8. However, it should be noted that there is also a significant rise in the number of fish families represented in sites from Region III to Region IV.

Of special note in Region IV are the catches from Mana Island North Settlement (MAN2), Washpool Village (WASH), Rotokura (ROTO),

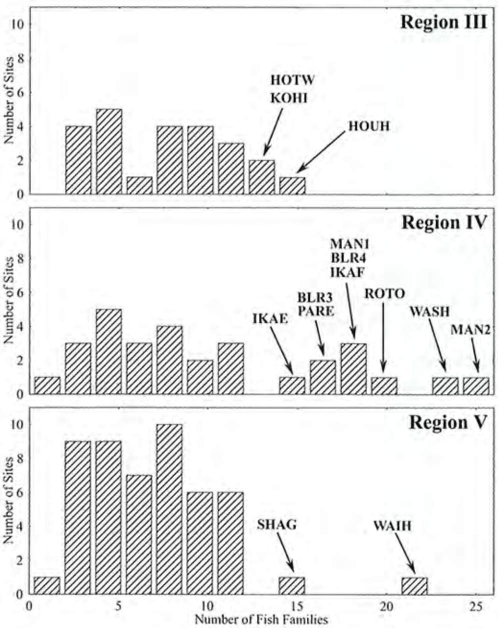

FIGURE 81

The number of fish families in sites represented in the regions shown on Figure 80. The site abbreviations are given in Appendix 1. Sites in Region IV show wide-ranging fishing activities.

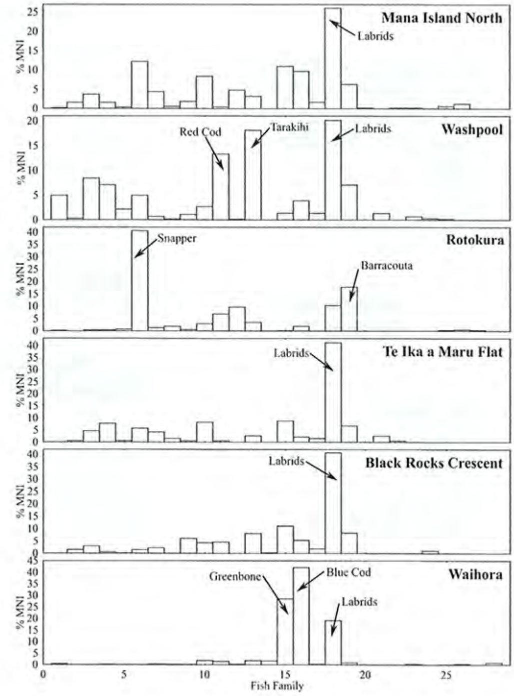

FIGURE 82

The proportions of different fish families at sites in the vicinity of Cook Strait. A few of the most abundant fish species are labelled. The Waihora site in the Chatham Islands is added at the bottom (see text).

Mana Island South Midden (MAN1), Black Rocks Crescent Midden (BLR4) and Black Midden (BLR3), Paremata (PARE), Te Ika a Maru Base of Pā (IKAF) and Eastern Flat (IKAE). These sites are all on the shores of Cook Strait, and the people at them were harvesting fish from 15 to 25 different families. The proportions of fish families at some of these sites are plotted out in Figure 82, and the Waihora site in the Chatham Islands is added at the bottom for comparison. People at this site harvested 21 different families of fish, which is a large number compared with sites elsewhere in New Zealand (see Figure 81); however, the site exhibits low diversity in the catch compared to other sites, as should be clear in Figure 82. Only three taxa were caught in any great abundance – greenbone, blue cod and labrids.

By comparison, the Cook Strait fishermen were wide-ranging in the fish they targeted. Figure 82 shows this clearly. Even at these sites, though, one or at most three fish families still dominate. For example at Mana Island North, Te Ika a Maru Flat and the Black Rocks Crescent midden, labrids stand out well above other fish types in abundance. At Rotokura it is a combination of barracouta and snapper which stands out. At the Washpool, three fish types are quite abundant – red cod, tarakihi and labrids. These catch-frequency diagrams are also interesting for the fish types which are unexpectedly low. For example, snapper has low abundance at all but Rotokura in the Cook Strait sites. This is a matter discussed further in Section 7, but it is noted here that snapper were highly variable in Cook Strait catches. Other sites in Cook Strait have very high abundance of snapper, but since they exhibit very low catch diversity, they are not shown in Figure 82. An example is the site at Foxton.

In the case of the diversity statistic, Shannon's H, there are also two statistically significant inter-regional comparisons. Moving southwards from Region III to Region IV, there is an increase in diversity from 1.6 to 2.2. This is followed by decreasing diversity moving further south from

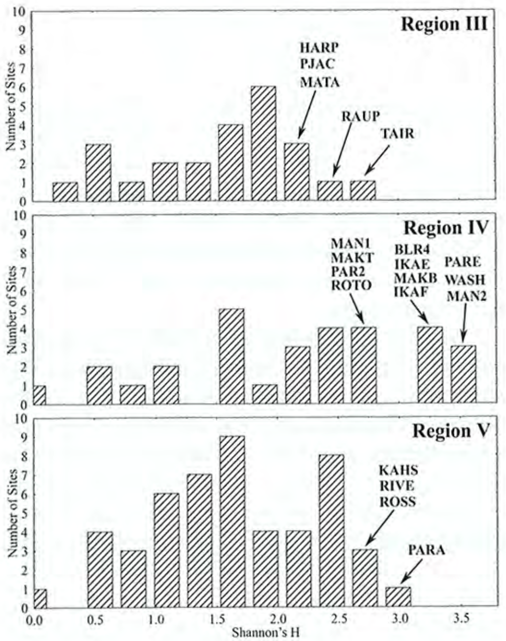

FIGURE 83

The diversity of fish catches in three regions of New Zealand shown on Figure 80, using Shannon's H statistic. The site abbreviations are given in Appendix 1. Archaeological sites in the vicinity of Cook Strait show the greatest diversity.

Region IV to Region V (2.2 back down to 1.6). The diversity pattern is illustrated in Figure 83. Seven sites in the Cook Strait area show particularly high diversity. Six of these were also high in the number of families represented (Figure 81). Rotokura is not among them; the addition is Makara Beach (MAKB).

As far as catch diversity is concerned, pre-European Māori catches did not follow the environmental groupings suggested by Francis (1996) in any clear manner. This shows that even when humans are confronted with uniform environmental opportunities they do not always approach their food quest in the same way. To some readers this will appear a truism, hardly worth mentioning; but there is considerable interest amongst archaeologists in documenting the relationship between predation opportunities and the resulting harvests. Some are convinced that many human communities, particularly hunter-gatherers, follow a food-gathering strategy dubbed 'optimal foraging', whereby they gain the greatest energy benefit from the least energy input. If this were the case for pre-European Māori, we would expect their fish catches to have a reasonably close relationship with the natural groupings of the marine environment. No such simple relationship exists. Instead, we see here the complex hand of human culture. This subject is returned to in Section 9.

MULTIVARIATE ANALYSIS OF THE ARCHAEOLOGICAL SITES

Francis employed Principle Component Analysis (PCA) to derive his suggested regional groupings, and this can also be used on the pre-European fish catches to see if any regional or other clusters can be determined. For this purpose it is desirable to consider only the highest quality data, which in this case effectively means the largest fish catches, and also to focus attention on the main species being caught. The complete database in Appendix 1 has 126 sites and 36 fish families, totalling 40,433 MNI. I decided to select only sites where the MNI was greater than 100, and then to select only the most abundant 10 fish families[1]. This resulted in a data matrix with 55 archaeological sites and 10 fish families, totalling 35,176 MNI (87% of the original database). This data set should reveal any coarse patterns, which if necessary could be further refined with other data sub-sets. MVSP Version 6.20 was used[2] for the analysis.

The MNI data were first converted into Z-scores[3], which is a more convenient form for multivariate analysis. In the process of doing this any outliers are identified. In this case, outliers are examples of archaeological sites where far higher (or lower) than expected catches of particular species are encountered. These are listed in Table 11. For example, the value of the Z-score of 3.7 for blue cod at the site of CHA in the Chatham Islands indicates that the relative abundance of blue cod at this site is 3.7 standard deviations above the mean value for all other sites being considered. These outliers are all potentially important results and there may be a quite different explanation in each case for their far higher than expected abundances.

[1] All manipulation of the data in Appendix 1 was carried out using programs personally written in Borland's MS-DOS Turbo Pascal version 5.0, 1988.

[2] Kovach's Multivariate Statistical Package (MVSP Plus) version 6.20, 1993, is an MS-DOS based program.

[3] Z-scores are also known as 'standard normal variate', 'standard normal deviate', and 'standard scores'. This is a method of transforming a data set so that the final data has a mean of zero and a standard deviation of unity. This is a more convenient form for carrying out multivariate analysis. $z = (x - \mu)/\sigma$ (Snedecor & Cochran 1967: 35–36).

Main species in Family	Z-Scores	Archaeologial Site
Blue cod	3.7	CHA
	3.3	CHB
Red cod	4.4	Fox River
	3.0	Appleby
Greenbone	4.3	Waihora
	3.8	CHB
Tarakihi	6.2	Kahiti South
Ling	6.1	Tiwai Point
Leatherjacket	3.0	Cross Creek
	6.2	Hahei
Mackerel	5.2	Matakana
	4.9	Kohika

TABLE 11
Unusually (High) Z-score Found during Multivariate Analysis.

Some notable examples should be commented on. For example, the very high proportion of blue cod in the two Chatham Islands sites, CHA and CHB, may be partly a reflection of the great abundance of this species in the Chatham Islands. Fabulous stories are told about these and other fish in the Chatham Islands, and most are probably apocryphal; but one which I can personally verify took place during archaeological fieldwork there with some students in 1973. During a lunch break it was decided to try and spear some fish with a sharpened stick, as no lines and hooks were available. The fish could be seen darting about in knee deep water, but were too fast for the students. They then tried throwing rocks at them to no avail. Finally, an old man gathered a few sea eggs and broke them with his hands in a few inches of water by the beach. The blue cod rushed into the shallows to devour the ripe gonads from the sea eggs and the old man easily kicked them out of the water and on to the beach. As many large specimens as were needed were gathered and the small ones returned to the sea.

The same explanation is offered for the high proportion of greenbone at Waihora and CHB, again two Chatham Islands archaeological sites. This species is super-abundant in the weed-rich rocky coastline along the south-west corner of the main Chatham Island where these sites are located.

Kahiti South, another Chatham Islands site, on the eastern side of the main island, shows an unusually high proportion of tarakihi. An even higher proportion is present at the nearby site of Kahiti North, but the total MNI there is only 95, which is less than the cut-off point of 100 which is being used for the multivariate analysis. It is not easy to find a simple explanation for why so many tarakihi were caught at these two sites. The coastline at these sites is a coarse sand, high energy beach, shelving quickly into relatively deep water. It is not an easy place to fish with nets. The entrance to Te Whanga Lagoon, approximately 8 km to the north, is a possible area where the tarakihi may have been caught.

Another notable feature in Table 11 is the high number of mackerel at Kohika and Matakana. The latter site is on an island on the outer edge of the Tauranga Harbour in the Bay of Plenty, in an area where there is high seasonal abundance of mackerel (Leach *et al.* 1994a), so this is perhaps not surprising. Kohika is on the mainland in the Bay of Plenty about 3 km inland, and therefore within easy access to coastal fishing resources. What is surprising is that other species, so abundant in the Bay of Plenty, such as snapper, have low abundance at these two sites.

Red cod features very highly at both Fox River on the west coast of the South Island and Appleby in Tasman Bay. Red cod spawns in the coldest months of winter in deep water (Ayling & Cox 1982: 142), and they are well known for schooling and migrating seasonally but irregularly. Paul suggests that these irregular movements may relate to their breeding requirements and the changing distribution of food (Paul 2000: 57). In former times, red cod were known to be especially abundant in the Otago harbour in summer months, but local fishermen relied upon their catch of the species outside the harbour in winter (Graham 1956: 168). Commercial landing figures for red cod at Akaroa and Timaru show greatest abundance in winter (Leach 1979a: 114), and at Wellington between May and July. Although Otago and Canterbury are a long way from Tasman Bay and the west coast where the Appleby and Fox River sites are located, these observations do suggest that low water temperature may be one of the triggers determining changes in local abundance. It is sugested that these high numbers of red cod at these two sites might be because sea water conditions at the period they were occupied were somewhat colder than normal. It might also be noted that barracouta, a late winter to early spring visitor to the west coast and western Cook Strait areas (see Figure 28), is also reasonably abundant at these two sites being considered, again showing that cold water conditions are bringing this species inshore. This is a topic returned to in Section 7.

When Principal Components Analysis (PCA) was carried out on these Z-scores (Q-Mode analysis[4]), the top 10 families of fish produced eigenvectors whose statistics are given in Table 12, and plotted out in Figure 84. The first two eigenvectors extract far more of the total variance than others and, as will be seen on the left of Figure 84, there is a pronounced 'scree-shape' at the third vector, although the total amount of variance captured is not as high as one would wish (52%). This indicates that these are complex data, not easily fully captured in three principal components. On the right of Figure 84 I plot the archaeological sites using the first two eigenvectors. This shows some loose clustering, which is perhaps a little clearer on the three dimensional plot using the first three principal components (Figure 85).

Eigenvector	Eigenvalue	Percent of Total	Cumulative Percent
1	12.9	22.2	22.2
2	11.0	19.0	41.2
3	6.5	11.1	52.3
4	6.0	10.4	62.6
5	5.9	10.1	72.8
6	5.3	9.1	81.8
7	4.7	8.1	90.0
8	4.2	7.2	97.2
9	1.6	2.8	100.0
10	0.01	0.001	100.0

TABLE 12

Eigenvector Statistics from Principal Components Analysis of Fish Assemblages.

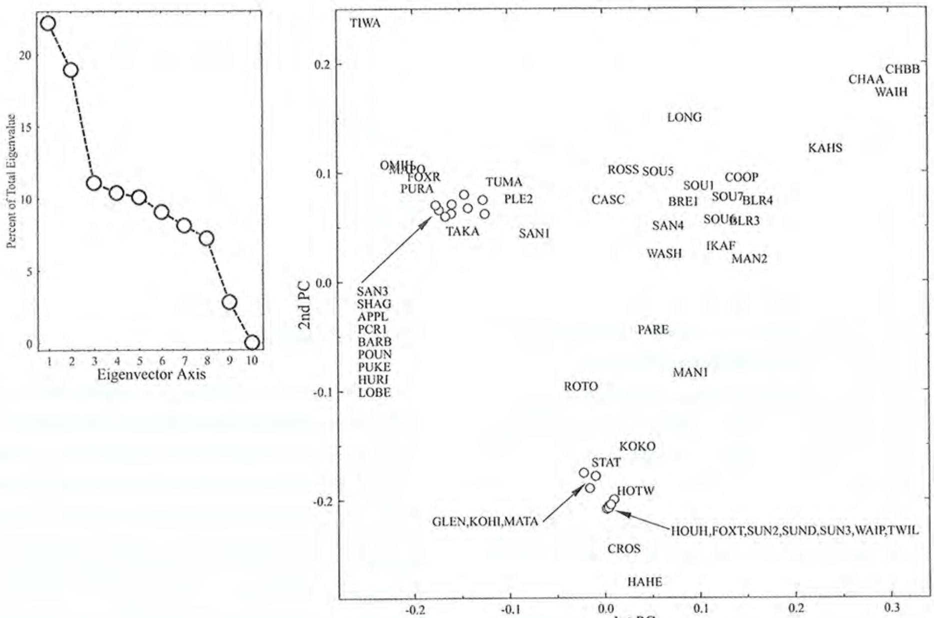

FIGURE 84

Results of principal component analysis (PCA) of fish remains of the 10 most numerous fish families from 55 sites with MNI>100. This sample has 87% of all fish remains studied. Left: scree-test of eigenvalues. Right: plot of archaeological sites, using the first two principal components. Site abbreviations are listed in Appendix 1.

[4] Multivariate analysis may be carried out from at least two points of view, named Q-mode and R-mode (or Q and R techniques). The primary focus in Q-mode analysis is to understand the resemblance and classification of the individual cases in the data matrix (in this case archaeological sites); whereas in R-mode it is the classification of characters or attributes which is the focus (in this case the families of fish). This distinction between Q-mode and R-mode is common to many forms of multivariate analysis (Miller & Kahn 1962: 293–294; Sneath & Sokal 1973: 115–116).

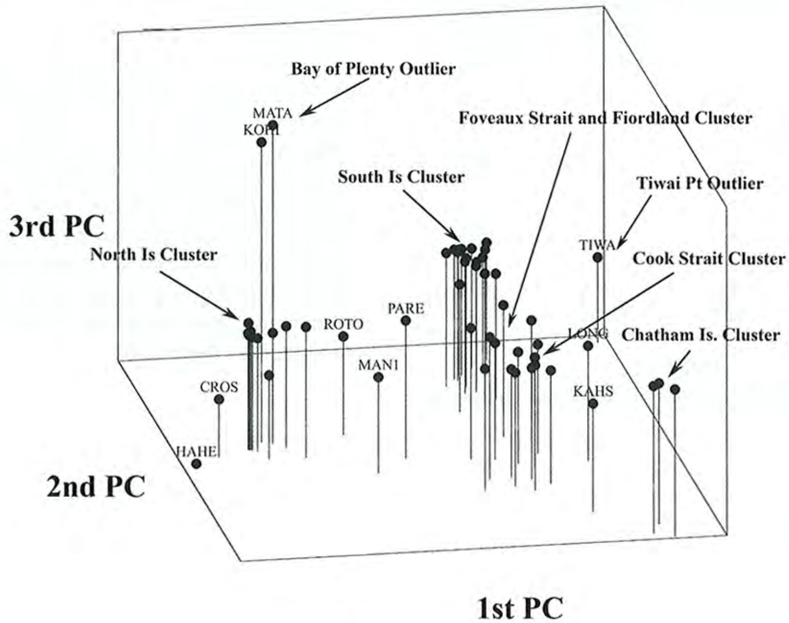

FIGURE 85

Three-dimensional plot of the first three principal components of Q-mode analysis, showing several loose clusters of archaeological sites. To avoid clutter, only sites which are outside the main clusters are labelled.

Cluster 1: Sites in the Foveaux Strait and Fiordland area form a loose cluster in between the Cook Strait and South Island clusters.

Cluster 2: Sites in the Cook Strait area form a cluster, possibly with some affiliation with both Chatham Islands and Foveaux Strait and Fiordland.

Cluster 3: Sites in the Chatham Islands plot some distance away from other sites except the Cook Strait cluster.

Cluster 4: There is a pronounced cluster of sites in the northern North Island (the North Island cluster), with some sites in Tasman Bay intermediate between the North Island and Cook Strait Clusters.

Cluster 5: There is a tight cluster of sites in the South Island. These are sites on the east coast from Kaikoura to South Otago.

Cluster 6: Two sites in the Bay of Plenty (Matakana and Kohika) form a cluster by themselves.

Cluster 7: Tiwai Point in Southland plots a long way from anything else.

MULTIVARIATE ANALYSIS OF THE FISH FAMILIES

In Section 4, where I considered the species most often caught by pre-European Māori, I produced a series of maps showing the relative amount of each of these species at all the archaeological sites surveyed. These maps appear to show huge changes in the abundance of individual species from one part of New Zealand to another. They largely reflect the imprint of nature on the map of New Zealand, and one might be tempted to use this as the basis for cultural regional entities; but this would be a mistake. In looking at these maps, it is obvious, for example, that barracouta occur in far greater abundance in the east coast of the South Island, and the map in Figure 34 reflects this change in natural abundance by latitude. Similarly, the map in Figure 41, showing snapper abundance in sites, is heavily biased towards sites from Cook Strait northwards. In short, all of these maps in Section 4, focused as they are on individual species, clearly show regional patterns in archaeological fish catches. Would these regional patterns be an adequate basis for defining meaningful regional entities in this Section? Not really. Although they look compelling at a very gross level, as soon as we examine more than single species, the maps unfortunately become a great deal more complex. It would be quite misleading to characterise east coast South Island pre-European communities simply as *barracouta fishermen*. The regional clusters of archaeological sites in Figure 85 are based on 10 families of fishes, and are a much more realistic portrayal of the regional character of pre-European fishing in New Zealand. It is complex, blending as it does human technology and cultural preferences, on top of the natural distribution of fishes.

An alternative perspective on this is the way in which the human communities in the past have caught groups of these ten families of fish in association with each other. That is, do the catches of fish show that some species are more frequently taken together? Principal Components Analysis was performed again, on the same data set (55 sites and 10 fish families), but this time in R-mode, to examine the underlying covariance of these ten fish families in the archaeological sites. As before, this is a blend of human activity and natural abundance. The results appear in Figure 86.

There are two obvious clusters of fish here, and three outliers.

The first cluster is composed of barracouta (Gempylidae), red cod (Moridae) and ling (Ophidiidae). These are the fishes that are especially common in the South Island cluster of sites.

The second cluster is composed of tarakihi (Cheilodactylidae), labrids (Labridae), greenbone (Odacidae) and blue cod (Mugiloididae). These fishes are associated with two of the clusters, notably archaeological sites in the Cook Strait region and the Chatham Islands.

Snapper (Sparidae) appears in the plot a considerable distance from these two clusters, with leatherjacket (Balistidae) being the closest fish. Snapper is the main species associated with the North Island sites, with leatherjacket characterising the outliers of Hahei and Cross Creek.

Finally, mackerel (Carangidae) also plots well away from all other fishes, and is associated with the two sites of Kohika and Matakana Island in the Bay of Plenty.

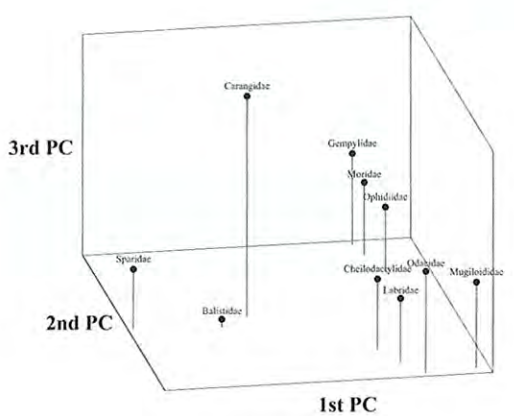

FIGURE 86

Three-dimensional plot of the first three principal components of R-mode analysis, showing several loose clusters of fish families.

THE CHARACTER OF REGIONAL CLUSTERS

It is now possible to make some comments about the character of the regional clusters identified in these complementary forms of multivariate analysis. The first point which needs to be made is that these regional clusters are not completely constrained geographically. The best example of this is the fact that archaeological sites in three of the clusters (Cook Strait, Foveaux Strait and Fiordland, and the Chatham Islands) share more in common with each other than they do with other parts of New Zealand. These three areas are each characteristically rocky shore habitats with diverse seaweed floras supporting a rich biomass of pāua, kina, crayfish, and further up the food chain a mixed population of solitary resident species such as labrids, greenbone and blue cod. In a sense, these three clusters are really one, and might be termed a biocultural rather than regional cluster. That is, there are underlying biological reasons for the character of the fish catches, but with a strong cultural component on top of this.

I separated out the archaeological sites in each of the seven 'regional' clusters, and then examined the fish catches, one cluster at a time, to try and identify common features. One way of revealing this is by looking at the mean percentage of each of the ten major fish families and how this varies within and between clusters. This information is presented in Table 13, and illustrated without standard errors in Figure 87.

Although the mean percent of a type of fish in any one of these clusters is a helpful guide to what pre-European Māori were catching in each of these regions, it is important also to take note of the standard error. This enables a rough assessment of the statistical significance of any observed differences between one region and another.

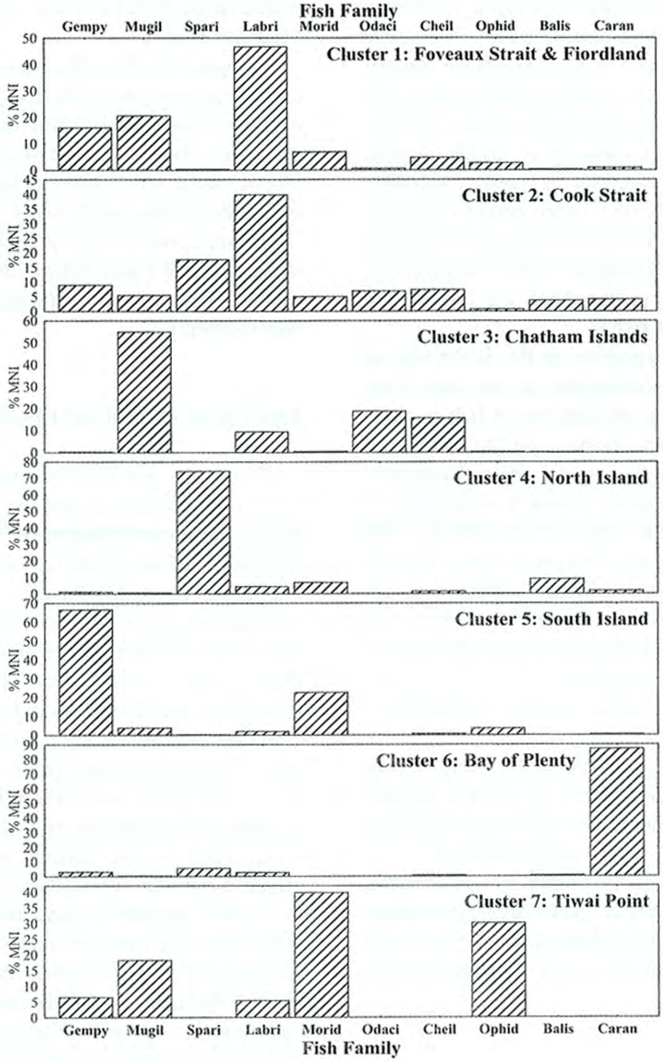

FIGURE 87

The mean percent abundances of the ten main families of fish in each of the biocultural clusters revealed by multivariate analysis.

1. *Foveaux Strait and Fiordland.* Labrids are high in abundance at sites in this cluster, averaging about 47%, with blue cod and barracouta also making a sizeable contribution to catches. The catch diversity in these sites is similar to the Chatham Islands and the outlier of Tiwai Point. It was noted in Section 3 (see Figure 28) that barracouta are winter visitors along this coast.

2. *Cook Strait:* Although Figure 87 shows that labrids are the most common fish represented in these sites, there is greater diversity of catch in this region than in any other. No doubt this is due to the complex rocky shore environments so typical of this region. Sites in Cook Strait that are located along sandy beaches, such as Foxton, clustered with the North Island group. Rotokura in Tasman Bay occupies a position in the multivariate analysis between the North Island and Cook Strait clusters. This site is in an area where snapper were once abundant (more on this point in Section 7), but the nearby rocky shore supported a wider range of fishes than is typical elsewhere in eastern Tasman Bay.

3. *Chatham Islands:* Sites in the Chatham Islands exhibit large numbers of blue cod, 55% on average, with greenbone, tarakihi and labrids also important. I have already alluded to the remarkable abundance of blue cod right up to the shoreline along the rocky coastline of these islands. These areas have a dense forest of seaweeds, which like Cook Strait, Foveaux Strait and Fiordland, supports rich resources of pāua, sea eggs and crayfish.

4. *North Island:* The North Island cluster of sites shows super-abundance of snapper, on average about 74% of MNI. This is in keeping with the large number of sandy open beaches north of Cook Strait on this island where this species is mainly located. Leatherjacket shows up as a secondary species. Several sites in the South Island clustered with these North Island sites, notably Fox River on the west coast, and three sites in Tasman Bay (The Glen, N26/214 and Appleby). This is due to the abundant snapper in these sites. Two sites on the Coromandel Peninsula are outliers to the North Island cluster: Hahei and Cross Creek. This is due to the higher abundance of leatherjacket and labrids in these sites.

5. *South Island:* Barracouta is the pre-eminent fish in this cluster of sites, averaging 67% of the MNI, with red cod also abundant at 23%. Other species have only marginal importance in terms of their abundance. As seen in Figure 28, barracouta are summer visitors along the eastern side of the South Island, which is where the largest number of sites in this cluster are located. Interestingly, the fish catch at Ross's Rocks in north Otago clustered with sites in the Foveaux Strait and Fiordland group rather than with other South Island sites. Conversely, two sites in the Foveaux Strait/Fiordland area clustered out of their geographic location and in the South Island group. These are the Port Craig Cave, and the Sandhill Point 3 site.

6. *Bay of Plenty:* Unfortunately, there are only two sites in the Bay of Plenty with information on fish catches and both are very unusual, with high abundance of mackerel. It is very surprising that neither of these sites has snapper in any number. There are significant snapper stocks in the Bay of Plenty.

7. *Tiwai Point:* Finally, the site at Tiwai Point must be considered an outlier from all these clusters. It has an unusually low abundance of barracouta for a site in eastern Foveaux Strait. The high representation of red cod will be due to the position of this site at the entrance of a large estuary. Red cod are well known for entering estuaries at certain seasons and can be very numerous at times. Another unusual feature of the catch at this site is the large

					Mean Percent of MNI					
	Gempy	**Mugil**	**Spari**	**Labri**	**Morid**	**Odaci**	**Cheil**	**Ophid**	**Balis**	**Caran**
Cluster 1	16.1	20.6	0.3	46.6	6.9	0.7	4.8	2.7	0.3	0.9
Cluster 2	9.0	5.5	17.7	39.8	5.0	6.9	7.4	0.8	3.8	4.1
Cluster 3	0.2	54.9	0.0	9.4	0.4	18.8	15.7	0.3	0.2	0.1
Cluster 4	1.1	0.6	74.3	4.4	6.8	0.1	1.5	0.2	9.0	1.9
Cluster 5	66.6	3.8	0.2	2.0	22.6	0.0	0.7	3.5	0.0	0.4
Cluster 6	3.0	0.4	5.5	2.7	0.0	0.0	0.7	0.0	0.7	87.0
Cluster 7	6.5	18.3	0.0	5.4	39.8	0.0	0.0	30.1	0.0	0.0
					Standard Error[†]					
	Gempy	**Mugil**	**Spari**	**Labri**	**Morid**	**Odaci**	**Cheil**	**Ophid**	**Balis**	**Caran**
Cluster 1	6.2	3.7	0.2	6.0	1.9	0.3	1.6	0.8	0.1	0.7
Cluster 2	2.0	1.2	5.5	6.8	2.1	2.0	2.5	0.3	1.9	1.5
Cluster 3	0.2	7.0	--	4.0	0.4	6.5	13.0	0.2	0.1	0.1
Cluster 4	0.6	0.3	8.8	1.4	6.5	0.1	0.6	0.1	5.4	0.8
Cluster 5	5.7	1.4	0.2	0.6	5.1	--	0.3	0.8	--	0.3
Cluster 6	1.6	0.4	4.3	2.0	--	--	0.7	--	0.7	2.5
Cluster 7	--	--	--	--	--	--	--	--	--	--

[†] NB: where there was insufficient data to calculate a standarad error, this is shown as (--)

TABLE 13

The Main Characteristics of the Identified Regional Clusters

The clusters are described in the text above. Column abbreviations are: Gempy = Gempylidae, Mugil = Mugiloididae, Spari = Sparidae, Labri = Labridae, Morid = Moridae, Odaci = Odacidae, Cheil = Cheilodactylidae, Ophid = Ophidiidae, Balis = Balistidae, Caran = Carangidae.

number of ling, about 30% of the catch. Compared with all other sites in New Zealand, the Z-score for ling at this site is 6.1, which is very high. Ling does occur in smaller numbers in sites, particularly in the South Island. Although ling are primarily a deep water species, most common in the depth range of 300–500 metres (Paul 2000: 64) and are taken during modern groper fishing, Graham records them venturing into Otago Harbour at times (Graham 1956: 337 ff.). It is therefore possible that the ling at Tiwai Point were taken in Bluff harbour.

DISCUSSION

The purpose of this Section was to examine what is known of pre-European Māori fish catches to see if they differentiate into meaningful regional groupings. I explored this question from two points of view. The first approach was to use Francis's regional entities, which were derived from modern distributional data of different fish species throughout New Zealand, and to see if the archaeological data conformed in any way to these existing marine groupings. The second approach was to see if any regional entities could be derived directly from the archaeological catches themselves.

Francis's regional schema provides a good starting point for any discussion about regionalism in fish catches. His regional entities were established from multivariate analysis of fish distributional data. His major finding was that diversity is highly correlated with latitude, becoming increasingly depauperate as one moves further south. When the archaeological data were examined using his regional groupings, it was found that catch diversity increased significantly from the northern to central New Zealand areas, and then decreased significantly from there southwards. This does not conform to expectations. Using these very broad regional groupings, it is clear that fishing was a more specialised activity in the northern and southern parts of New Zealand, and more generalised in the central region, especially around Cook Strait. To over-simplify a very complex picture – pre-European Māori fisherman in northern New Zealand were after snapper, southern fishermen were after barracouta, and those in between were after a much broader range of fish types.

In the second approach taken, I attempted to derive clusters of archaeological sites using multivariate analysis of the catch data, and then to see if these exhibit regional characteristics. Only the most reliable data were used for this purpose; that is, sites with an MNI greater than 100, and the 10 most abundant fish families. Seven clusters were found and each of these is essentially a regional entity. Of considerable interest is the finding that three of these clusters –Cook Strait, Chatham Islands, and Foveaux Strait and Fiordland– show shared characteristics, and to some extent merge into each other. Several archaeological sites fall into clusters which are not their correct geographical locations, and this is a clear sign that there is similarity in the characteristics of these three clusters.

The attempt to derive meaningful regional entities in this Section, although moderately successful, is not without problems. One is that the basic information on fish catches is very unevenly distributed around New Zealand and there are huge gaps with no information at all. A glance at Figure A.1 in Appendix 1 will reveal the full extent of this problem. On the west coast of the North Island I have information from only one archaeological site (Aotea) between the Hokianga and Horowhenua. This is a huge gap in the knowledge base. The west coast of the South Island is almost equally bad with only two sites (Fox River and Bruce Bay) between Tasman Bay and Fiordland. Information is only available for two sites in the Bay of Plenty; and between Whakatane and Palliser Bay only one collection exists, from Tiromoana. Each of these gaps represents an enormous deficiency, and it is hoped that in the future they will be filled. The second problem inherent in this quest for regional groupings is that it takes no heed of changes through time[5] (the subject of the next Section), let alone of issues concerning site function, like specialised seasonal camp sites or permanent villages. Catches from different periods are simply lumped together, as are all sites of different functional status. This analysis therefore is unashamedly broad-brush in approach.

Despite these deficiencies, it is abundantly clear that there are significant changes in fish catches from one region to another in New Zealand, and while these partly reflect natural abundance, they also reflect human culture. For this reason, the clusters which were derived are probably best referred to as biocultural regions.

[5] It should be noted that using modern distributional data on fish types for archaeological purposes necessarily suffers from exactly the same problem, in that natural and human-induced changes in relative abundance of fish types over time are ignored.