Chapter 3: The Shag River Mouth Site and Vertebrate Fauna

The Shag River Mouth site, also known simply as Shag Mouth, is located on the east coast of the South Island of New Zealand, approximately 50 km north of the city of Dunedin (Figure 3.1). The site is extensive, covering an area of about 90 by 300 meters across a spit of land that is bounded by the Pacific Ocean to the east and the Shag River along the north and west (Figure 3.2). Much of the site extends across an extensive dune system with mudflats and swamp along the river's shore to the west.

Shag Mouth has been important in the history of archaeology in New Zealand because of the large sample of faunal and artifactual material recovered from the site. The faunal component, in particular, has played an integral role in interpretations about subsistence change in southern New Zealand. The long history of excavations at Shag Mouth has recently been detailed by Anderson and Smith (1996*b*) and Allingham (1996). In this chapter, I present a summary of this history and a description of the faunal assemblage used in the analyses to follow.

History of Excavations

In 1874, at the request of the landowner, F. D. Rich, Julius von Haast briefly visited the site. He took notes, collected artifacts, and drew sketches of the site layout and the inferred stratigraphy. Haast described extensive middens across the sand dunes that he attributed to both Moa-hunter and Maori origins (Haast 1874). The early Moa Hunter strata were dominated by moa while the later Maori deposits were mainly shell middens. He argued that the Maori 'beds' were separated stratigraphically from those of the Moa-hunters', suggesting that much time must have passed between occupations.

Haast's work at Shag Mouth was followed in 1875 by that of Bayard Booth, who was working for Frederick Hutton, the director of the Otago Museum. Hutton (1875) used Booth's data to argue that Haast's interpretations of distinct Moa-hunter and Maori occupations separated by a long hiatus were incorrect. He noted that moa bones were often found with shells and that shell beds were sometimes found below the moa laden layers, implying that the Moa Hunters and Maori were not temporally or culturally distinct groups of people.

However, according to Booth's excavation notes, which were lost for many years, Haast and Hutton were both right and wrong. In general, moa-rich layers were overlain by shell midden, but some moa bone was found in the shell midden and some shell and fish were recovered from the lower moa layers (Anderson 1989*a*). Thus, the basic trend was indeed from moas to fish and shellfish, but the shift was much less dramatic than suggested by Haast.

The most extensive excavations at Shag Mouth were carried out between 1915 and 1923 by David Teviotdale, a former farmer and gold-miner with no formal training in archaeology. He was a prolific digger, having excavated at nearly all the major sites in Otago. According to his diaries, he could excavate up to 160 cubic feet in a day (Leach 1972:5). During the early part of his excavation career Teviotdale was like most other fossickers or curio-hunters. His goal was to secure artifacts, ignoring context. But in 1920, he met H. D. Skinner, the Curator of Anthropology at the Otago Museum, who encouraged and trained Teviotdale to excavate systematically, and keep extensive notes and detailed maps on his excavations (Anderson and Smith 1996*b*; Leach 1972; Teviotdale 1924).

At Shag Mouth, Teviotdale's excavations were extensive:

> "The digging was done with no system; any likely spot would be dug over, and then I would move on to another, but as time went on the patches became connected, till practically the whole site had been covered. ...nearly three acres of ground have been turned over." (Teviotdale 1924:33).

Teviotdale recorded and mapped many features, as well as Booth's excavations and the trenches that Augustus Hamilton had excavated in the 1890s (Figure 3.3). There are about 36 features identified as fireplaces (designated in Figure 3.3 by a square with an F above), many of which were lined with sandstone slabs or encircled by basalt boulders. Although no postholes were recorded, the fireplaces were interpreted as evidence of habitations.

Like most excavators before him, Teviotdale was interested in the origin of the Moa Hunters (Leach 1972). As such, his notes reflect only those aspects of the excavations that were relevant for addressing this research question. Midden and faunal remains were important only as they were able to shed light on the issue of the relationship of Moa Hunters to either Polynesians or Maoris. As a result, the question of how subsistence changed as moas declined was not investigated.

Shag Mouth was most recently excavated from 1987-1989 as part of the Southern Hunters Project led by Atholl Anderson of the University of Otago. The goal of the project was to re-excavate sites in Otago that had been deemed important in New Zealand prehistory. Shag Mouth was selected because it represented an early occupation, had produced a large sample of faunal remains and artifacts, and had habitation features that were the best example of a prehistoric permanent village (Anderson and Smith 1996*b*). The researchers wanted to re-excavate the site to clarify the stratigraphy and chronology, determine site function, and address environmental and subsistence changes. This

research has provided one of the most comprehensive archaeological monographs on New Zealand prehistory (Anderson, Allingham, and Smith 1996).

Each of the three years of the Southern Hunters project at Shag Mouth had different goals. The first year of excavation consisted of test units across six separate areas of the site (Allingham and Anderson 1996; see Figure 3.4). The goal was to obtain stratigraphic profiles and samples for radiocarbon dating, and to locate areas for further investigation.

The next year, 1988, excavations were concentrated in the high dune and swamp area (Anderson and Allingham 1996). The high dune area was chosen because it appeared that, based on Booth's excavations and the 1987 test excavations, deep undisturbed deposits could be found here. A series of systematic test pits were also excavated in the dune to determine the extent of the midden across the dune (Figure 3.5). The faunal assemblage used in the analysis presented in the following chapters comes from the 1988 High Dune or Area C (SM/C) Dune excavations.

The swamp excavations were selected to obtain datable material to link the swamp area of the site to the dune. Since Teviotdale (1924) had recovered a wooden bowl from the edge of the swamp, the researchers were also hoping to find more wooden artifacts and other perishable items. They found plant material, pieces of wood with adze marks, and a portion of a moa carcass (Anderson and Allingham 1996).

In the final year, the University of Otago field school, led by Ian Smith, conducted excavations in an area near the northwest border of the site (Figure 3.6). Teviotdale (1924) had found a number of fireplaces in the area so the goal was to locate additional evidence of habitation features (Smith 1996*a*). The field school excavations found numerous postholes, oven pit features, and hearths.

1988 High Dune (SM/C) Excavations

The faunal assemblage from the dune excavations was chosen for analysis over other components at Shag Mouth because it contained the largest, well-dated sample of faunal material that had been systematically recovered from a well-stratified moa hunting site. Although there has been a long history of excavations at Shag Mouth, the recovery of material from earlier excavations was not systematic. The 1988 excavations were conducted using modern excavation and recovery methods (Anderson and Allingham 1996). An 8 meter by 10 meter grid unit was laid out over the highest point of the site where test excavations had revealed undisturbed cultural layers capped by more than 1 meter of sterile dune sand. During the areal excavation, this sterile upper layer, Layer 1, was removed with a bulldozer and shovels. Layers 2 through 6 were excavated by trowel, but due to time constraints and safety issues, Layers 7 through 11 were excavated in only a portion of the units. The base of the excavation was 2.5 to 3.0 meters in depth. All excavated material was screened through 1/8" (3.2 mm) mesh.

The stratigraphy of many Moa Hunter sites consists of only two or three layers of material, but the dune at Shag Mouth consisted of eleven strata (Figure 3.7). Two of the strata, Layers 1 and 3, were non-cultural. Layer 1 was a thick layer of loose dune sand that capped the site, while Layer 3 was loose sterile sand located mainly in the NE corner of the excavation. Layers 2 and 4 through 7 were described as being 'rich' in cultural material (Anderson and Allingham 1996). These layers all consisted of charcoal-stained sand with dense midden and numerous pit features. Layer 4 is notable in that it also contained a dense concentration of shells. In contrast with the upper layers, the concentration of cultural material in the lower layers, Layers 8-11, was considerably less.

I also selected the dune sample because it is very well-dated. Forty-eight radiocarbon dates on marine shell, moa bone, rat bone, moa eggshell, and charcoal were obtained for the site during the Southern Hunters project (Anderson, Smith, and Higham 1996). Forty dates were taken from the high dune area alone (Table 3.1). The charcoal, moa eggshell, and marine shell dates for this area span the period from AD 1300 to AD 1500 (Figure 3.8). At two standard deviations, the dates from the top are not significantly different from those at the bottom (Anderson, Smith, and Higham 1996). This series of dates has been interpreted to represent a relatively short, continuous occupation of 20-50 years (Anderson, Smith, and Higham 1996:67).

The moa and rat bone dates, unlike those dates described above, are quite variable and were excluded from Figure 3.8. The reliability of moa bone dates have long been suspect because of the large variability between dates from supposedly similarly aged contexts (Anderson 1991). The variability in dates is often linked to diagenetic effects or the type of pretreatment methods used on moa bone (Anderson 1991; Anderson, Smith, and Higham 1996). Dates from Polynesian rat (*Rattus exulans*) bone have recently come under scrutiny for similar reasons as well (see Anderson 1996*b*; Beavan and Sparks 1998; Ladefoged *et al*. 1997; Smith and Anderson 1998; Sparks *et al*. 1997). The rat bone dates from the Shag Mouth site differ significantly from the tight sequence of dates on other material. Anderson (1996*b*) argues that the radiocarbon dating of rat bones is not accurately reflecting the death of the rat. Rat diet, post-depositional contamination, and laboratory pre-treatment procedures have been identified as possible causes for this discrepancy amongst the dates (Anderson 1996*b*; Ladefoged *et al*. 1997; Smith and Anderson 1998). Until the source of the discrepancies in rat and moa bone dates is

identified, Anderson (1996*b*, Anderson, Smith, and Higham 1996) advises that these dates be viewed with caution.

Summary

The faunal assemblages recovered from the Shag River Mouth site have played an important role in the explanations about southern New Zealand prehistory for the past 125 years. While the samples from the various phases of excavations are numerous they vary significantly along several important criteria: chronological control, sample size, and documentation. The faunal assemblage from the 1988 High Dune excavations was selected for analysis follow because it consists of a very large sample of material from well-dated, well-stratified, and well-documented contexts. In the next section, I present the fish, bird, and mammal data used in the analyses to follow.

Shag Mouth Vertebrate Fauna

The vertebrate faunal assemblage from the dune excavations is among the largest from any New Zealand archaeological site. The assemblage consists of 51,982 specimens of which thirty percent, or 15,784, were identified to the sub-class level. Over 75 species of vertebrates are represented in the assemblage (Table 3.2).

In the sections below I present information relevant to the analyses to follow in Chapters 4 and 5. First, I discuss the identification issues that arose for particular taxa represented within the assemblage. The assemblage has been analyzed previously by various researchers (see Anderson and Smith 1996*a*; Anderson, Worthy, and McGovern-Wilson 1996; McGovern-Wilson *et al*. 1996; Smith 1996*b*); and relevant details of these analyses are provided below. Because there are few published sources on the

identification of osteological material from New Zealand, the specificity of my identifications was heavily dependent on the availability of reference specimens.

In addition, as discussed in Chapter 2, my analysis requires that resources be divided into their appropriate patches. Thus, I provide information on life history and ethnographic Maori capture techniques that will be used in determining where species are likely to have been encountered. Within each class, species are reviewed in taxonomic order.

The Fishes

Unlike the bird and mammal sample, an initial sort of the fish was done in the field (Smith and Anderson 1996). After screening, only the elements felt to be diagnostic were returned to the lab for analysis. These elements were the five mouth parts (premaxilla, dentary, maxilla, articular, quadrate) and a suite of 'special bones' traditionally used in Pacific fish identifications (Leach 1986, 1997). All other fish elements were discarded in the field.

A total of 9886 fish bones were identified to thirteen species and four genera representing twelve families and four orders (Table 3.3). Of those, 7925 were identified by Angela Boocock in an earlier analysis (Anderson and Smith 1996*a*: Table 17.1). This sample of material is not housed at the University of Otago; therefore, I did not re-analyze it. However, I did analyze an additional 1963 specimens from the unidentified and previously unanalyzed material through comparison with the fish osteological reference collection in the Anthropology Department of the University of Otago. The fish taxa in New Zealand are relatively evenly distributed across families, with few species in each of the twelve families represented. At the family level, differences

between taxa are often quite marked. With few species to choose from within each family, identifications were based on size (see Table 3.4) and comparison with the reference collection.

Unlike the situation for birds and mammals, the documentation of the life histories of New Zealand fishes is limited. Most of the information about species' habitats used in this analysis come from sport or commercial fisheries (e.g., Armitage *et al*. 1981; Doogue and Moreland 1960). In addition, except for barracouta and freshwater eels, ethnographic descriptions of Maori fishing in reference to specific taxa are also sparse. Thus, most of the descriptions of fishing techniques described below are those used in modern fishery or sport fishing contexts. Since the information about habitats and procurement techniques are from modern and often commercial sources, it may not accurately reflect either the ethnographic or prehistoric situation.

Angulliformes

Only one angullid specimen was identified in the earlier analysis from Layer 4. There are two freshwater eel species found in New Zealand. The short-finned eel (*Anguilla australis*) reaches 80 centimeters, while the larger longfinned eel (*Anguilla dieffenbachii*) can reach lengths of up to 1.2 meters. Both eels are catadromous, migrating downstream in the fall to breed at sea (Paul and Moreland 1993). Historically, they were taken by traps during their migration or by spears during the rest of the year (Anderson 1994).

Gadiiformes

Two gadiiform species from the Morid family are represented in the Shag Mouth assemblage. Red cod (*Pseudophycis bachus*) is the second most abundant fish species in the assemblage and was recovered throughout the sequence. In addition to its large mouth parts, the rock cod also has large otoliths that are readily identifiable. Only one otolith was identified from Layer 4; however, otoliths may not have been recovered systematically. During historic times, these fish were taken by hook in offshore areas with sandy substrates (Sherrin 1936).

The other morid species is the rock cod (*Lotella auratus*), which is found in rocky areas along the coast (Doogue and Moreland 1960). This species is represented by only 2 specimens in the Layer 2, both were identified in the previous analysis (Anderson and Smith 1996*a*). The mouth parts of the two morids are quite different morphologically (see Leach 1997), making it easy to differentiate between the two species.

Ophidiiformes

The ling (*Genypterus blacodes*) is a large eel-like fish that inhabits deep offshore water (Coutts 1975; Doogue and Moreland 1960). They were likely taken on long lines with large two-piece bait hooks (Coutts 1975). Ling are common in the Shag Mouth assemblage, and their large mouth parts are distinctive, allowing for easy identification. Of the 141 ling specimens in the assemblage, I identified only 29 specimens.

Scorpaeniformes

There are two scorpaenids represented in small numbers in the upper layers of the Shag Mouth assemblage. Scorpionfish (*Scorpaena cardinalis*) can be found on rocky shores along the coast (Paul and Moreland 1993), and were likely taken by a baited hook.

All scorpionfish specimens were identified in the previous analysis, and are found in the upper layers.

Like the scorpionfish, the sea perch (*Helicolensus papillosus*) also inhabits the rocky shores and was likely taken by hook and line (Coutts 1975). Of the 12 sea perch specimens found in the upper layers, 11 were identified by Boocock (Anderson and Smith 1996*a*); my work added one premaxilla.

Perciformes

Nine perciform families are found in the Shag Mouth assemblage. Each family has only one species represented, except for the latridids and the gempylids, which consist of two species. As discussed above, family level differences in morphology are marked, making identification relatively simple. There are however, notable exceptions, which are discussed below.

Hapuku or gropers (*Polyprion oxygeneios*) are large fish that were taken with two piece bait hooks from canoes (Anderson 1986; Best 1929). They were not common inshore, but may have come in during the summer months (Doogue and Moreland 1960). In the Shag Mouth assemblage, hapuku are found in the upper layers in small numbers. Of the 18 hapuku specimens, I identified only two maxilla and two quadrates. Hapuku have large, distinctive maxilla and quadrates, making identification relatively simple.

The tarakihi (*Nemadactylus macropterus*), blue moki (*Latridopsis ciliaris*), and trumpeter (*Latris lineata*) all inhabit a range of environments from inshore to offshore (Anderson 1986; Paul and Moreland 1993). Today, they are usually caught in gill nets (Anderson 1986 Coutts 1975); early historic accounts, however, describe the use of baited hooks (Anderson 1994; Best 1929). None of these three species are common in

the fish assemblage. Only two specimens of tarakihi were identified from Layer 4 in the previous analysis. Blue moki is represented by seven specimens in Layers 2, 6 and 7, all of which I identified. The most abundant of the three, the trumpeter, is represented in Layers 2 through 7 by 34 specimens, which were identified by Boocock.

Boocock identified the only specimen of yellow-eyed mullet (*Aldrichetta forsteri*) found in Layer 5. Mullet are typically found in estuarine environments and along the coast (Paul and Moreland 1993).

There are several species of black cods in New Zealand water, but distinguishing between species is difficult (Leach 1997), and all specimens were identified only to the generic level (*Notothenia* spp.). Black cods inhabit rocky coastlines, and can be found in shallow water (Anderson 1986; Paul and Moreland 1993). Black cods are found in small numbers throughout the occupation of Shag Mouth. Of the 79 specimens, I identified nine.

The blue cod (*Parapercis colias*) is the third most common fish in the Shag Mouth assemblage. It is found in moderate numbers throughout the Shag Mouth sequence. I identified only 16 of the 245 specimens. Blue cod were probably taken by hook and line in shallow, rocky areas along the coast (Anderson 1986, 1994; Coutts 1975).

There are several species of wrasses in New Zealand that are difficult to distinguish, thus most analysts identify wrasse specimens to the generic level (*Pseudolabrus* spp.). They are found through most of the occupation of Shag Mouth in small to moderate numbers. Labrid elements are easily distinguished from other families. Their pharyngeal plates, in particular, are distinctive and are treated as 'special bones' (see Leach 1997). Wrasses inhabit shallow rocky shore along the coast and can be caught by hook and line (Anderson 1986; Leach and Anderson 1979)

Over 80% of the fish assemblage consisted of barracouta (*Thyristes atun*), making it the most abundant fish and the second most abundant vertebrate in the Shag Mouth assemblage. Barracouta is an open ocean fish that was often caught feeding on the surface.

Ethnographic accounts of barracouta fishing are quite detailed. Barracouta were seasonally abundant, with great numbers taken during the summer and fall (Anderson 1981*a*; Best 1929). When the seas were calm, shoals of barracouta could be seen feeding on the surface. A lure was dragged across the surface of the water to attract the barracouta, which would snap at almost anything when feeding. Once hooked, the fish was pulled into the boat. The fish were then dried and stored (Anderson 1994).

The gemfish (*Rexea solandri*) is another offshore species whose small numbers in southern New Zealand sites suggest that it may have been taken incidentally with barracouta (Anderson and Smith 1996*a*). All five gemfish specimens were identified in the previous analysis. Leach (1997) cautions that the mouth parts of gemfish and barracouta, along with frostfish (*Lepidopus caudatus*) can be difficult to distinguish. Fragments of the toothed portions of dentaries and premaxillae, in particular, look similar. Thus, it is possible that I misidentified these types of fragments as barracouta, when they were in fact gemfish or frostfish.

The two specimens of warehou (*Seriolella* spp.), both from Layer 4, were identified by Boocock. Warehou have been described as being taken on hook and line from a canoe (Best 1929). They inhabit the inshore and offshore to 50 fathoms (Doogue and Moreland 1960).

The Birds

The bird from the Shag Mouth site comprise the largest component of the faunal assemblage. Over 17,000 identified specimens, 13 orders, and 54 species of bird are represented (Table 3.4). Thirty-eight species are endemic to New Zealand, ten of which are now extinct (Table 3.5). Of the extinct species, six became extinct during the pre-contact era, while four were historic extinctions.

In previous analyses, the assemblage was divided into moa and non-moa, also known as small bird, components and analyzed separately. The moa component was identified by Brian Kooyman and Trevor Worthy. Anderson, Worthy, and McGovern-Wilson (1996) note several problems with Kooyman's identifications and advocate the use of Worthy's species designations. Since Worthy is a well known avian paleontologist and the foremost expert on moa identifications (Worthy 1988, 1990), I follow this advice and retain the species identifications he made.

The moa data presented here differ from the previous analysis mainly in the increase in the sample of material identified only to the order Dinornithiformes, or 'moa'. All of these specimens were small fragments that I could not identify beyond 'moa'. The moa sample nearly doubled through the analysis of material from several boxes of unanalyzed midden, and from the re-analysis of the 'residue' material, which consisted of material previously classified as unidentifiable.

The remainder of the bird assemblage, also known as the 'small bird' component, was originally analyzed by Rick McGovern-Wilson (McGovern-Wilson *et al*. 1996) and Fiona Kirk (1989). The data presented in this analysis differs from their work in that a few corrections in identifications were made. Most changes were to anatids, waders, and passeriforms. All specimens of anatids were identified to sub-family level by Worthy, who also identified the majority of passeriform and charadriiform specimens. A number

of these specimens were re-identified by Worthy to extinct species that were not well-represented in the Otago reference collection.

The analysis of the previously unanalyzed material, and the re-analysis of the 'residue' material increased the small bird sample by over 800 NISP, about a 40% increase. Many of the additional small bird specimens were scapulae that had been systematically excluded from the earlier analysis. The identifications were made using the skeletal reference collection in the Anthropology department, University of Otago. Reference collections at the Museum of New Zealand, Wellington, were also used to check the identifications of a few shag (Phalacroracidae) and dotterel (*Charadrius* spp.) specimens.

Moas

Moas are the most speciose of all ratites (Anderson 1989*b*; Cooper *et al*. 1993). During the early decades of moa research, the number of species identified varied from twenty to thirty-seven, with each discovery of a new fossil leading to a new species designation. With an ever-increasing sample of material and more sophisticated morphological analyses, researchers greatly reduced the number of species. Cracraft (1976) defined thirteen species by using multivariate analyses of morphological characteristics. Today, the most widely accepted list is comprised of 11 species across six genera in two families (Table 3.6). Of these eleven species, two are found only on the North Island, four on the South Island, and five across New Zealand. The largest terrestrial vertebrate in New Zealand was *Dinornis giganteus*, which had a back height of 1.8 meters and weighed about 250 kilograms. However, most moas were closer in size to ostriches.

In New Zealand, where the only native terrestrial mammals were bats, birds filled niches normally occupied by mammals, with moas evolving into giant avian herbivores. Duff (1950) suggested that moas were grazers, feeding mainly on grasses. However, based on preserved gullet remains, moas more likely filled the browser niche, feeding on such diverse plant material as seeds, fruits, leaves, and even twigs (Anderson 1989*b*).

Paleoenvironmental information and species distributions derived from paleontological and archaeological contexts provide data to reconstruct the habitats of moa species. Moas occupied a variety of habitats across New Zealand, from coastal forests to subalpine tussock (Worthy 1990). As a group, however, moas comprise three broad assemblages that reflect the different habitat zones from which their remains have been found (Figure 3.9; Worthy 1990, 1991). The *Anomalopteryx* moa assemblage occupied areas that were dense, wet, lowland, mixed podocarp forests, while the *Euryapteryx* assemblage occupied open forests, scrub, and grasslands. The third group of moas utilized the upland-subalpine region, probably on a seasonal basis.

The timing of moa extinctions was a major focus of both early zoological and archaeological research in New Zealand. Claims of historic sightings of moas suggested that there were remnant populations in the remote areas of New Zealand. However, the lack of references to moas in Maori legends testifies to the antiquity of these birds (Anderson 1989*b*). Since their discovery over 150 years ago, the wealth of paleontological and archaeological moa remains from dated contexts indicates that these birds became extinct about 400 years ago (Anderson 1989*a*, 1989*b*). However, the timing of extinction of individual species is not well-established because moa extinction has been approached in terms of the group as a whole.

Both habitat destruction and predation by humans have been identified as causes of moa extinction; however, determining the relative contribution of each is difficult. The role of environmental change in the extinction process requires a tight chronology for paleoenvironmental data that currently does not exist (Anderson and McGlone 1992). Based on charcoal and pollen data, we know that the period between 800-400 BP is one of intense deforestation with a loss of nearly 70% of the native forests by AD 1840 (McGlone 1983) (Figure 3.10). However, because large contiguous tracts of forest may have still existed 800 to 400 years ago, it is not likely that habitat destruction alone caused moa extinction (Anderson and McGlone 1992), and predation probably played a significant role in thsee extinctions. There is much speculation over how moas were hunted with likely methods including the use of spears, traps, snares, clubs, and dogs (Anderson 1989*b*). Regardless of how they were captured, as one of the most common taxa in archaeological middens, moas were obviously an important dietary resource.

Moa was the most abundant vertebrate taxon identified for the Shag Mouth assemblage. The moa specimens, however, were highly fragmented. In the original analysis, Worthy (Anderson, Worthy, McGovern-Wilson 1996) was able to identify only 77 out of a sample of over 8000 specimens to one of five species (*Dinornis giganteus*, *Dinornis novaezealandiae*, *Dinornis torosus*, *Emeus crassus*, and *Euryapteryx geranoides*). Although species identifiability is very low, the size and distinctive bone structure of moas allowed for the small fragments to be identified as moas.

Procellariforms

Three families of procellariforms or tube-noses are represented in the Shag Mouth assemblage, of which the most common by far are the albatrosses (Diomedeidae). New

Zealand has six native species of albatrosses, of which one is endemic. These six species can be differentiated into three size classes with two species in each of those size classes (Table 3.7). The Royal Albatross (*Diomedea epomophora*) and Wandering Albatross *(D. exulans*) are distinctively large species. The Shy Mollymawk (*D. cauta*) and Black-browed Mollymawk (*D. melanophrys*) are of intermediate size. The smallest species are the Grey-headed (*D. chrysostoma*) and Buller's Mollymawks (*D. bulleri*).

Three species (Wandering Albatross, Shy Mollymawk, Buller's Mollymawk) were identified in the original analysis (McGovern-Wilson *et al*. 1996). The *Diomedea* species identifications listed in Table 3.4 are from that original analysis. In my analysis of the unidentified and unanalyzed material, I identified all specimens as *Diomedea* spp. I found that the Otago reference collection was limited in the range and number of albatross specimens. Of the six albatross species, only the Wandering Albatross and Shy Mollymawk were represented by more than two reference specimens. Consequently, it was difficult to differentiate between the two species in each size category, as well as to distinguish between species of different sizes. Much of the material I identified appeared to be from intermediate-sized *Diomedea*, with an occasional large and small specimen. For all analyses presented in the following chapters, I treat all the albatross material as *Diomedea* spp.

Albatrosses are large, oceanic, circum-polar birds that spend most of their time at sea foraging, returning to land mainly to breed on offshore and subantarctic islands (Heather and Robertson 1996). The Shag River Mouth faunas lack juvenile individuals, which would have been easy prey, suggesting that a nesting colony was not being exploited. Since juvenile specimens were identified for other bird species, differential preservation is not likely to be the cause for the absence of juvenile albatrosses in the assemblage.

If albatrosses were not being taken while nesting, then the likely alternative is that they were harvested at sea. A few ethnographic accounts of albatross procurement describe albatrosses being taken during offshore fishing trips (Anderson 1994:165). Best (1942) described albatrosses as being taken on well-baited hooks that presumably were dragged on the surface of the water behind canoes. Another means of obtaining albatrosses was to simply put a stick in a fish and troll it behind the canoe until an albatross took the bait. The stick would lodge in the bird's throat and the bird was then hauled into the boat and clubbed. The by-catch of albatross by the long line tuna fishery attests to the effectiveness of these trolling methods (Brothers 1991; Murray *et al*. 1993). It is unlikely to be coincidence that the common by-catch taxa are Wandering Albatross, Shy Mollymawk, and Black-browed Mollymawk.

The Procellaridae is the second family of procellariformes represented in the Shag Mouth faunas. Three species of procellarids (*Pachyptila turtur*, *Puffinus gavia*, *Pelecanoides urinatrix*) were identified in the Shag Mouth assemblage. The original analyses identified two additional species (*Puffinus griseus*, *Pachyptila vittata*), but these identifications have been revised. The one specimen originally identified as Sooty Shearwater (*P. griseus*), I changed to *Puffinus* spp. because of the lack the University of Otago reference collection lacks comparative material for *Puffinus* species of that size. The three specimens of Broad-billed Prion (*Pachyptila vittata*) were re-identified by Worthy as Fairy Prion (*P. turtur*) or simply as *Pachyptila* spp..

The modern distribution of all three procellarid species has been severely affected by introduced predators; these birds currently exist only on islands that do not have Polynesian rats (*Rattus exulans*). However, it is likely that their prehistoric range included the South Island. Evidence from North Otago and Canterbury owl roost sites

show the presence of *Puffinus* spp. and *Pelecanoides* spp. inland during prehistoric times (Worthy 1997*b*).

The only procellarid that is commonly discussed in relation to human foraging is the Sooty Shearwater. They were, and still are, taken as fat nestlings before they leave their burrows. However, direct access to the breeding areas of these and other procellarids is apparently not needed. At night, they can be heard flying overhead as they go to and from their nests. By placing fires along their flight pathways on misty nights, they can be lured down and captured. This is a technique still used by ornithologists to trap petrels (Worthy pers. comm.).

The third family of procellariforms represented in the assemblage is Hydrobaitidae. A single specimen was originally identified as a White-faced Storm Petrel (*Pelagodroma marina*). However, given the limitations of the comparative material to distinguish between the four genera and seven possible species found in New Zealand, I re-identified the specimen at the family level.

Penguins

Four species of penguin were represented in the assemblage. I used non-metric traits identified as diagnostic by Worthy (1997*a*) to differentiate between the three larger species: Yellow-eyed Penguin (*Megadyptes antipodes*), Fiordland-crested Penguin (*Eudyptes pachyrhynchus*), and Erect-crested Penguin (*Eudyptes sclateri*). When it was not possible to distinguish between the three, the element was identified as *Megadyptes*/*Eudyptes*. Remains of the Little Blue Penguin (*Eudyptula minor*) were easily identified because of its significantly smaller size. In the original analysis two

specimens were identified as Snares-crested Penguin (*Eudyptes robustus*), however, they have been re-identified by Worthy (pers. comm) as *Eudyptes* cf. *pachyrhynchus*.

The Little Blue Penguin is most abundant penguin species in the assemblage. This native species is largely sedentary and lives in burrows and small caves or crevices along the coast. They leave their burrows during the day to forage at sea and return at night. This pattern is so predictable that there is a tourist attraction at Oamaru, 20 miles north of Shag Mouth, where people watch these bird return to their burrows in the evening.

Like the Little Blue, the Yellow-eyed Penguin is sedentary, returning to its nest after feeding offshore. But instead of utilizing burrows, the Yellow-eyed nests in scrub or forested areas on steep slopes along the coast. Conversion of its nesting grounds into pasture has made this species the most endangered penguin in the world. Only 1500 breeding pairs are estimated to exist (Heather and Robertson 1996). In recent years, several episodes of die offs, possibly due to biotoxins, have severely reduced the population.

Both the Fiordland-crested and Erect-crested Penguins are dispersive and possibly migratory (Marchant and Higgins 1990*a*). The Fiordland-crested currently has breeding colonies on the southwest coast of the South Island. Like the Yellow-eyed Penguin, they nest on steep slopes near the coast. The Erect-crested penguin breeds on rocky coastlines on subantarctic islands, although they are sometimes sighted along the east coast of the South Island during the fall when they moult.

Based upon these life histories, all four penguin species are classified as coastal resources. The Little Blue and Yellow-eyed Penguins were most likely taken in or around their nests. The small sample of Erect-crested and Fiordland-crested Penguins

suggest that they were not taken at breeding grounds, but harvested whenever sighted along the coast.

Shags and Cormorants

Three species of shags were identified from Shag Mouth: Stewart Island Shag (*Leucocarbo chalconotus*), Spotted Shag (*Stictocarbo punctatus*), and Little Pied Shag (*Phalacrocorax melanoleucos*). Most of the identifications were made using the Otago reference collection. A few, however, were made using the collections from the Museum of New Zealand. In particular, these collections were used to re-examine the six specimens originally identified as Pied Shag (*Phalacrocorax varius*) because the Otago collection only contained two partial Pied Shag reference specimens. Five of the Pied Shag specimens from Shag Mouth were reidentified as Stewart Island Shag; one tibiotarsus was reidentified as Spotted Shag.

The Stewart Island Shag, the largest of the three shags, is a sedentary marine species that lives in colonies on small islands or sea cliffs on the southeast coastline of the South Island (Heather and Robertson 1996). The Shag River area marks the northern extent of the distribution of modern populations.

The Spotted Shag is a common, endemic marine species. These shags have colonial nesting grounds that are located on coastal cliffs throughout the South Island, and parts of the North Island. There is a large colony on the Otago peninsula that resides alongside a Stewart Island Shag colony. After breeding, individuals disperse from the colonies, but congregate to roost on offshore stacks and islands located across New Zealand. Many individuals can be seen roosting on the stacks off of Shag Point located at the north entrance to the Shag River.

Unlike the Spotted and Stewart Island Shags, Little Pied Shags (*Phalacrocorax melanoleucos*) live in estuaries and sheltered coastal waters throughout New Zealand. They breed in colonies in trees that overhang freshwater. After breeding, they disperse and congregate around good roosting or feeding areas (Heather and Robertson 1996). Little Pieds are significantly smaller in size than either Spotted or Stewart Island Shags (Table 3.7).

The Stewart Island and Spotted Shags were taken throughout the occupation of the site. Only three specimens of Little Pied Shag were recovered in the upper layers. Juveniles were identified for both Spotted and Stewart Island Shags, suggesting that at least some of these birds were being taken at the nesting sites. There are ethnographic accounts that Maori took both young and old shags at night by clubbing them in their colonies (Anderson 1994:165). Pied shags were also described as being taken by snares on perches over the water (Best 1942:403). Apparently, shags made tasty meals. Early accounts, including those from Captain Cook's voyages, describe shags as "excellent" or "very good eating" (Best 1942:406).

Anatids

Since it is often difficult to distinguish different species of ducks even with an extensive reference collection, all anatids were sent to Trevor Worthy for identification. He identified 8 species from the 72 anatid specimens. New Zealand Shoveller (*Anas rhynchotis*) had been identified in the previous analysis, however Worthy re-identified all four specimens involved as Brown Teal (*Anas chlorotis*).

Of the 8 anatid species represented in the assemblage, 2 are now extinct. The New Zealand Swan (*Cygnus sumnerensis*), represented by one distal right humerus fragment,

became extinct prior to European colonization. This species may be related to the Australian Black Swan (*Cygnus atratus*), but was much larger and robust, weighing about 13.5 kilograms (Gill and Martinson 1991) compared to the 5 to 6 kilograms for Black Swans.

The other extinct species found in the Shag Mouth assemblage is the Auckland Island Merganser (*Mergus australis*). Prehistorically, this merganser was found across New Zealand, but by historic times, it could only be found on the subantarctic Auckland Islands. In the early 1900s, it became extinct. The Auckland Island Merganser had a few unusual qualities. Its wings were reduced, but it could still fly. It had the largest bill of all mergansers, yet was the smallest species (Gill and Martinson 1991). It is represented in the Shag Mouth assemblage by one proximal left femur.

Paradise shelducks (*Tadorna variegata*) are goose-sized waterfowl that live in open grasslands and tussocks near freshwater. They are a common sight in New Zealand today because the creation of pastureland has produced favorable habitats for them (Heather and Robertson 1996). However, since extensive open grasslands are a recent phenomenon, it is likely that shelducks were much less common prehistorically.

There are three species of dabblers present in the Shag Mouth assemblage: Brown Teal (*Anas chlorotis*), Grey Teal (*Anas gracilis*), and Grey Duck (*Anas superciliosa*). All three species were once found in wetlands and estuaries throughout New Zealand. After a period of decline, Grey Teal populations are now doing well due to recent conservation efforts and natural migrations from Australia (Heather and Robertson 1996). The Grey Duck is still common throughout New Zealand, but, its numbers are declining because of habitat loss and interbreeding with the introduced Mallard (*Anas platyrhynchos*). The

endemic Brown Teal has been hardest hit by habitat loss and is now restricted mainly to Fiordland on the west coast of the South Island and the far north of the North Island.

The New Zealand Scaup (*Aythya novaeseelandiae*) is the only diver represented in the assemblage. This species prefers deep freshwater lakes that can be found from the coast to the mountains. They were once more widespread, but habitat alteration (e.g., draining of lowlands for pastureland), introduced predators, and hunting have reduced their numbers (Marchant and Higgins 1990*b*). Currently, the New Zealand Scaup is found mainly on the west coast of the South Island and a few areas on the North Island.

Ethnographically, anatids have been described as being taken during their moult when they could be chased down in canoes while in groups on the water and taken in bulk (Anderson 1996:165, 337). They were also known to have been taken with dogs and by snares. Although a number of birds could be captured at one time, they did not store as well as other birds because of their low fat content (Anderson 1994:344).

Raptors

Two raptor species are represented in small numbers in the Shag Mouth midden. The endemic New Zealand Falcon (*Falco novaeseelandiae*) is represented by one element recovered from Layer 4. Falcon populations have been affected historically by the clearing of lowland native forest, although their numbers probably were not very high prehistorically (Heather and Robertson 1996). The other raptor species is represented by one ungal phalanx. It was large enough to be identified by Trevor Worthy as possibly coming from Eyles' Harrier (*Circus eylesi*). This extinct endemic species is much larger than the Australian Harrier (*Circus approximans*); females are estimated to weigh as much as 3 kilograms (Gill and Martinson 1991). Very little is known about the bird

because it was only discovered in 1953, and the sample of specimens acquired since then has been quite small. Eyles' Harriers probably lived in grassland-shrub-forest mosaics, which meant that their distribution likely extended from the coast to subalpine areas (Worthy pers. comm.).

Ethnographic descriptions of Maori use of raptors are sparse. The falcon was not taken often because it was too fast and could not be baited without live prey (Anderson 1994:168). Since Eyles' Harrier became extinct prehistorically, there are no historic descriptions of its procurement. However, the Australasian Harrier may have been taken by snares on perches, possibly for their feathers (Anderson 1994; Best 1942).

Gamebirds

The New Zealand Quail (*Coturnix novaeseelandiae*) is the only native phasianid in New Zealand. After moas, quail is the most common bird taxon in the assemblage. It is relatively common in archaeological sites, having been recovered from both coastal and inland sites (McGovern-Wilson 1986).

Now extinct, the New Zealand Quail lived in areas of open grassland. According to ethnographic accounts, Maori captured quail by placing snares amongst the grass along tracks formed by the quails (Anderson 1994:169; Best 1942:237). At the time of European contact, they were abundant in open country grassland across New Zealand, but were extinct by the mid-1800s. Disease, habitat loss, introduced predators, and, particularly, hunting are identified as causes for the quail's extinction (Turbott 1967).

Rails

Two species of rails, Weka (*Gallirallus australis*) and Banded Rail (*Rallus phillipensis*), were identified from the Shag Mouth assemblage. Both species are found in small numbers in the upper layers of the site. Wekas are flightless birds that live near water around edges of forests, grasslands, and estuaries. This endemic species was once found throughout New Zealand, but now has a spotty distribution. On the South Island, they had been extirpated from the east coast by the 1920s, and are now found mostly in the northwest and southwest corners of the island (Heather and Robertson 1996; Marchant and Higgins 1993). Their decline is attributed to the conversion of native habitat to farmland, use of poison baits for eradicating possums (*Trichosurus vulpecula*), and possibly the introduction of predators (Heather and Robertson 1996; Marchant and Higgins 1993). The Maori are said to have hunted Weka with dogs (Anderson 1994).

The Banded Rail is a native species that inhabits wetland areas. Like the Weka, they were once common across New Zealand. On the South Island, they are now restricted to the north end of the island. Their limited distribution is due to the loss of habitat and the introduction of mustelid predators (Heather and Robertson 1996).

Waders

Four families and ten species of waders are present in small numbers throughout much of the occupation of the site. There is one species of oystercatcher found in the Shag Mouth assemblage. The Pied Oystercatcher (*Haematopus ostralegus*), also known as the South Island Pied Oystercatcher or SIPO, is found along coastal North Island and throughout the South Island except Fiordland. They breed inland along braided riverbeds, dispersing after breeding to estuaries and sandy beaches along the coast.

Four species of charadriids were identified from the assemblage. The Banded Dotterel (*Charadrius bicinctus*) lives in wetlands throughout New Zealand, breeding along beaches and braided river beds. Only four specimens, all from Layer 4, were identified. Most of the specimens originally identified as Banded Dotterel were re-identified by Worthy as New Zealand Dotterel (*Charadrius obscurus*), which is a smaller species. New Zealand Dotterel were once found throughout New Zealand prior to the mid 1800s when they were extirpated from the South Island. They live along shore and estuarine regions. On the South Island, they used to breed along braided rivers, after which they moved to the coast (Heather and Robertson 1996).

The two other charadriid species, Wrybill (*Anarhynchus frontalis*) and Shore Plover (*Thinornis novaeseelandiae*), were also identified by Worthy from specimens that were previously identified as Banded Dotterel. The Shore Plover was one of the more common waders in the assemblage, but was recovered only from the upper two layers. The Wrybill is represented by only one specimen in Layer 4. A few specimens could only be identified as *Anarhynchus*/*Thinornis*.

The Wrybill is unique in that its bill bends to the right as much as 20 degrees. The bent bill is used to take invertebrates from under rocks and sieve small prey from the surface of the water (Marchant and Higgins 1993). The Wrybill breeds along braided rivers, moving to estuaries and sheltered coasts during the non-breeding season. During historic times, the largest populations were found on eastern coast of the South Island. But because of hydro-electric projects, irrigation, and the introduction of exotic plants, Wrybill numbers have declined to about 5000 individuals (Heather and Robertson 1996).

The current situation of the Shore Plover is even more tenuous. It is found only on the South East Island of the Chatham Islands, where the population is estimated to consist

of less than 150 individuals (Heather and Robertson 1996). The extent of the plover's distribution in the past is uncertain. It is known to have occurred on both the North and South Island, but records are spotty. To confound matters, Buller (Turbot 1967) presents conflicting reports of the bird's abundance during the late 1800s.

The New Zealand Snipe (*Coenocorypha aucklandica*) is the only scolopacid recovered from the Shag Mouth site. It is represented by four specimens from the upper two layers. Snipes live in a broad range of vegetation types such as tussock grasslands, sedges, ferns, that provide cover for them (Higgins and Davies 1996). Like many of the other waders, the New Zealand Snipe populations have been on the decline. As a ground-nesting bird, they are particularly susceptible to predators. They can now be found only on subantarctic islands lacking predators. Prehistorically, there is evidence for them in Canterbury and central Otago, indicating that their range was much broader (Worthy and Holdaway 1996; Worthy 1997*b*, 1998)

Larids are the most common waders in the assemblage. The Black-backed Gull (*Larus dominicanus*) is the largest of them and is now common across all three major islands. On the South Island, they breed mainly on braided riverbeds. During winter they move to coasts, along estuaries and harbours (Heather and Robertson 1996). In the Shag Mouth assemblage, Black-backed Gulls are represented in small numbers in Layers 4 through 7.

There are two other gulls possibly represented in the assemblage. The Black-billed Gull (*Larus bulleri*) and Red-billed Gull (*Larus novaehollandiae*) are of similar size and are very difficult to distinguish. Thus, specimens were identified as Red/Black-billed Gull. Black-billed Gulls are widespread and common, breeding on the coast and offshore islands, but can be found from coast to inland subalpine zones across New Zealand

(Higgins and Davies 1996). The Red-billed Gull is also common, but is found mostly along the coast. They nest in colonies along rocky headlands, sandspits, and boulder banks (Heather and Robertson 1996).

The Black-fronted Tern (*Sterna striata*) is the only species of tern represented in the assemblage. It is one of the more common waders in the assemblage. In the original analysis, one specimen of White-fronted Tern (*Sterna albostriata*) was also identified. However, this specimen was re-identified by Worthy as the much smaller Black-fronted Tern. This locally common species breeds on the riverbeds of eastern South Island, moving to the coast after breeding. It also has a spotty coastal distribution on North Island and Stewart Island (Heather and Robertson 1996).

Pigeons

The New Zealand Pigeon (*Hemiphaga novaeseelandiae*) is the only endemic pigeon in New Zealand. It is also one of the more common birds in the Shag Mouth assemblage and is found throughout the occupation of the site. The species is large, reaching up to 800 grams, double the weight of the introduced Rock Pigeon (*Columba livia*).

New Zealand Pigeons favor the lowland podocarp-broadleaf forests found throughout the North and South Islands. They feed on the fruits and berries of native trees. During historic times, pigeon numbers have declined due to deforestation and hunting. As the only bird large enough to eat the larger fruits of native trees, pigeons have a direct impact on the health of native forests (Heather and Robertson 1996).

Ethnographically, there are numerous descriptions of elaborate snares used to catch pigeons (e.g., Best 1942: 279-312). Sometimes, fowlers would creep up as close as possible to a roosting pigeon to spear them. Pigeons were usually taken in abundance

during the late summer to late fall when the trees were fruiting and the birds were the fattest (Turbott 1967). The birds would be stored and preserved in their own fat for future use.

Parrots

Of the six native species of parrots in New Zealand, five are endemic. The Shag Mouth assemblage contains two taxa. One specimen of the Kaka (*Nestor meridionalis*) was recovered from the Shag Mouth assemblage. The Kaka is a large forest parrot that was common across North and South Islands during the prehistoric and early historic periods (Heather and Robertson 1996; McGovern-Wilson 1986). By the early 1900s, however, their populations had declined to localised flocks. It is no longer found on the east coast of South Island.

The Kaka was commonly taken by Maori fowlers either by spearing or snaring, sometimes with a tame Kaka used as a decoy (Best 1942). The decoy parrot was set out on a perch with food. The fowler held on to a string attached to a leg ring made of bone or greenstone that was slipped over the bird's foot. When the string was pulled, the decoy would screech and attract wild parrots to the perch (Buck 1950:97). Sometimes, when Kaka were fat from gorging on berries, they would be taken by spears as they sat on a branch since they were not as easily attracted to the food at perches (Best 1942: 241-242).

There are two possible species of parakeets represented in the Shag Mouth assemblage: Red-crowned (*Cyanoramphus novaezelandiae*) and Yellow-crowned (*C. auriceps*) Parakeet. The two species are difficult to distinguish osteologically, and given that there were very few individuals in the reference collection, I identified all specimens

as *Cyanoramphus* spp. Their remains are common throughout the occupation of the Shag Mouth site.

Parakeets can be found in podocarp and beech forests. Populations of both species have been severely impacted by predators on the main islands because both Red-crowned and Yellow-crowned Parakeets forage on the ground and nest in holes close to the ground (Heather and Robertson 1996).

Owls

Three Laughing Owl (*Sceloglaux albifacies*) specimens, identified by Worthy, were recovered from the middle layers at the Shag Mouth site. Laughing Owls lived in small crevices formed by rock outcrops in open country such as that found in Central Otago. The faunal deposits of Laughing Owl caves have been important for paleofaunal reconstructions of regions of the South Island (Worthy 1997*b*; Worthy and Holdaway 1996). Laughing Owls were once found across New Zealand, but became extinct by the 1920s. Introduced disease, introduced predators, the decline of their major food source, Polynesian rats, and museum collecting have been identified as causes of their extinction (Heather and Robertson 1996).

Passerines

Because of the limited collection of passerine reference material in the Otago collection, most of the passerine specimens were sent to Trevor Worthy for identification. Seven species representing five families were identified.

The New Zealand Pipit (*Anthus novaeseelandiae*) is one of the more common passerines represented in the Shag Mouth assemblage. This species inhabits a variety of

open habitats, except pure pastureland, from the coast to subalpine tussockland (Turbot 1967). Pipits may have originally benefited from the creation of open country through clearing of forests, but as pastureland developed, they declined (Heather and Robertson 1996; Turbot 1967). They are still distributed widely across New Zealand, but their distribution is patchy. Of the 32 specimens, nine were originally identified as Bellbird (*Anthornis melaneura*) and subsequently re-identified by Worthy. The thirteen specimens in Layer 6 appear to represent one individual.

The New Zealand Robin (*Petroica australis*) was not identified in the earlier analyses. Of the four specimens from Layer 4 Worthy identified to this species, three were originally identified as Bellbird, and one specimen was identified as Fairy Prion. The New Zealand Robin lives in mature native forests, and is found on all the main islands today, but is not common on the eastern coast of South Island. Historic declines are due to the introduction of mustelids and habitat clearance (Heather and Robertson 1996).

Bellbirds and Tuis (*Prosthemadera novaeseelandiae*) are nectar and fruit feeders. They are common in forest and scrub areas of both native and introduced species across most of New Zealand. Tuis tend to feed on fruits more than Bellbirds, and are one of the main dispersers of medium sized fruit of native trees. The Tui is the most common passerine in the Shag Mouth assemblage and was recovered from most layers. Only two specimens of Bellbird were identified, from Layers 4 and 6.

The family of birds called wattlebirds consists of only three species, all of which are endemic to New Zealand. Two species, the Kokako (*Callaeas cinerea*) and the Saddleback (*Philesturnus carunculatus*) are present in small numbers in the Shag Mouth

assemblage. The third species, the extinct Huia *(Heteralocha acutirostris*), was not found on the South Island (Gill and Martinson 1991).

The Kokako is a forest bird that feeds on fruits and leaves of mature native podocarp trees (Heather and Robertson 1996). It was extirpated from the South Island and can only be found in small concentrations of native forest on the North Island. They are currently endangered because forest clearing has reduced habitat and food resources. The identification of the one Kokako specimen was made in the original analysis and confirmed by Worthy.

Saddlebacks were once widely distributed in the forests of the main islands and many offshore islands. Their numbers and distribution have been greatly reduced because of such introduced predators as cats, rats, and mustelids. They nest low to the ground in tree holes, rock crevices, and tree fern crowns making them susceptible to these predators (Heather and Robertson 1996; Turbot 1967). They are currently found mainly on offshore islands. Two specimens originally identified as Saddleback were re-identified as Tui by Worthy, who also confirmed the identification of other five specimens.

Worthy also identified the two specimens of the Piopio (*Turnagra capensis*), one of which was previously unidentified; the other had been identified as a Saddleback. Piopio is a forest bird that was common across New Zealand prehistorically. During historic times its population was drastically reduced due to introduced predators and possibly avian disease. Buller described Piopio as very tame (Turbott 1967). This behavior, coupled with its foraging on the forest floor, made the Piopio very vulnerable to cats and mustelids (Turbot 1967). They are believed to be extinct since the last confirmed sighting was in 1902 (Heather and Robertson 1996).

The Mammals

The mammal assemblage consists of 3699 specimens identified to sub-class or higher (Table 3.8). The sample was identified using the reference collections at the University of Otago. The collection was previously analyzed by Ian Smith (1996*b*). As with the other classes, the data presented here differs from Smith's analysis because of the addition of the unanalyzed material and a re-analysis of the specimens identified as 'residue'. Except for the cetaceans, the taxa represented in the Shag Mouth assemblage are discussed according to families.

Cetaceans

I was only able to identify one mandible fragment from the assemblage as cetacean. Twenty other specimens were identified as sea mammal, which may include cetaceans. In New Zealand waters, there are 35 species of whales, dolphins and porpoises (Table 3.9; Baker 1983). While it has been suggested that cetaceans were actively hunted (Anderson 1994:333), it may be more likely that beached individuals were harvested because of the high incidence of beach cast cetaceans each year (Baker 1981).

Leporids

Two species of leporids (*Oryctolagus cuniculus* and *Lepus europaeus*) were introduced into New Zealand by sailors and colonists as early as Captain Cook's voyage in 1777 (Gibb and Williams 1990). The Otago reference collection has few leporid specimens, so no attempt was made to differentiate between the two species. The few bones found in the Shag Mouth assemblage are mainly from Layer 2 and are likely to be intrusive through burrowing.

Murids

There are four murid species of in New Zealand, three of which (*Rattus norvegicus, R. rattus, Mus musculus*) are European introductions. The third, the Polynesian rat or *kiore* (*R. exulans*), was introduced by the Polynesians who colonized New Zealand, although it has been recently proposed that Polynesian rats may have colonized on their own (Anderson 1996*a*).

In the original analysis, all rat specimens were identified as *Rattus exulans*. Since this sample was not housed with the rest of the collections, I was unable to examine the specimens. The specimens identified as *Rattus exulans* in Table 3.7 are from this earlier analysis. In contrast, I identified all specimens from the unanalyzed and unidentified material as *Rattus* spp. It is difficult to distinguish post-cranial material of the three species other than by size, and the reference collections at hand only contained domestic rats (*Rattus* spp.) as specimens. Although most of the material is likely that of *Rattus exulans,* I limited my identifications to the generic level.

The Polynesian rat is a commensal species. Throughout the Pacific, they are often found in and around human habitations, although they seem to inhabit a variety of environments (Williams 1973; Wodziki and Taylor 1984). In New Zealand, they are mainly described as forest animals, but they can also be found in grasslands and near human habitations as well (Roberts 1991; Roberts and Craig 1990). The presence of rat gnaw marks on a small percentage of bone in the Shag Mouth assemblage indicate that rats were living in and around the occupation at the site.

While it is possible that some of the rat specimens in the Shag Mouth assemblage arrived there naturally, there is also evidence that rats were actively procured. According

to ethnographic accounts, the Polynesian rat was caught by the Maori in traps along trails through the forest or grass (Best 1942; Buck 1950). They were cooked and preserved in their own fat, much like pigeons, and were considered to be "rich and very palatable food, nourishing ...served to build up vigorous bodies" (Best 1942:435).

Phocids

The remains of elephant seals (*Mirounga leonina*) and leopard seals (*Hydrurga leptonyx*) are commonly found in small amounts in New Zealand middens (Smith 1985). At Shag Mouth, however, only the elephant seal is present, and only in small quantities, throughout the sequence. Most of the specimens were distinguished from leopard seal based on size and shape of the element. The majority of the sample consisted of teeth and long bone elements, mainly from juveniles. Elephant seals have small incisors, peg-like post-canines, and large canines. Leopard seal post-canines are quite distinctive, with large ornate cusps (King 1983), while the canine is smaller than those of elephant seals. The long bones of juvenile elephant seals are much larger and robust than the single adult leopard seal specimen available.

Elephant seals are very large animals. Females reach 2.5 meters and 400 kilograms, while males can be ten times heavier than the females and reach over 5 meters in length (Crawley 1990*c*). They are usually found on sandy beaches fairly close to shore since their large bulk and caterpillar locomotion makes traveling significant distances difficult.

The presence of elephant seal remains throughout much of the sequence at Shag Mouth suggests that these animals were regular visitors to New Zealand coasts as they are today. Lone female elephant seals have been documented pupping on the South Island, especially on the southeast coast (Crawley 1990*c*). However, the archaeological

evidence does not suggest that elephant seals ever had rookeries in New Zealand (Smith 1985).

Otariids

There are two species of otariid commonly found on New Zealand shores and in prehistoric middens. New Zealand fur seals (*Arctocephalus forsteri*) are the most abundant mammal and the third most common vertebrate in the Shag Mouth assemblage. Hooker's sea lions (*Phocarctos hookeri*) are much less abundant in the assemblage, but are found throughout the occupation of the site. Many of the specimens that could only be identified as otariid were from pups or juveniles. The diagnostic features which are used to differentiate the sea lions from fur seals are not fully developed in younger individuals. Thus, it can be difficult to distinguish between species, especially given that the Otago reference collections had few juvenile specimens.

New Zealand fur seals are much smaller than Hooker's sea lions. Male fur seals can reach 2.5 meters and 185 kilograms, while females are less than 70 kilograms and 1.5 meters (Crawley 1990*a*). In contrast, sea lion males can be as large as 3.25 meters and over 400 kilograms; females are much smaller at 1.9 meters and 230 kilograms. (Crawley 1990*b*). Although both can be found along the coast, fur seals prefer rocky, exposed coastlines, while sea lions are usually found on sandy beaches and dunes (Crawley 1990*a*, 1990*b*).

By aging and sexing fur seal remains from archaeological sites around New Zealand, Smith (1985) found that fur seal distributions had changed significantly during prehistoric times. Fur seal breeding colonies were once widely distributed throughout coastal New Zealand, but by about AD 1500, fur seals had disappeared from the North

Island. On the east coast of the South Island, breeding colonies were replaced by non-breeding colonies during the late prehistoric times, about AD 1500-1700 (Smith 1985, 1989). When European sealers arrived in the late 1700s, fur seal breeding colonies were confined to the South Island's remote south and west coasts.

One behavioral aspect of fur seals may have encouraged their decline. Fur seals tend to return every year to the same rookery (King 1983; Reidman 1990). The males arrive first, staking out territories, and then wait for the females to arrive. While site fidelity increases the predictability of where males should wait for arriving females, it also increases the predictability of where human foragers can find fur seals. Site fidelity is often so strong that even extensive predation pressure may not deter fur seals from returning to the same rookery. For example, the Russian and American harvest of Northern fur seals (*Callorhinus ursinus*) in the Bering sea was extensive over several decades in the late 1800s to the 1950s, yet fur seals returned to the same place year after year.

Prehistorically, sea lions were found across New Zealand, but in much smaller numbers than the fur seal (Smith 1985), and there is no archaeological evidence for prehistoric sea lion rookeries either (Smith 1985). Today, they are found mainly at haul outs on the southern end of the South Island. They currently breed on the subantarctic islands and do not have rookeries on the main islands of New Zealand.

Fur seals were taken on land by hitting them on the nose with a short club (Anderson 1994:156). Their flesh was an important source of meat, but it seems their skins were not often used. Instead, the fur seal meat was cooked with the skin left attached (Anderson 1994:333, 476).

Sea lions were described as being harder to kill than fur seals. A longer club was needed since the larger sea lions have a longer striking distance (Anderson 1994:156). Unlike fur seals, the first blow to the nose of a sea lion usually just stunned the animal and more strikes were required to kill one.

Canids

The only canid in New Zealand, and in much of the Pacific, is the Polynesian dog (*Canis familiaris*). Of the three Polynesian domesticated animals (pigs, dogs, chickens), only the dog is found in New Zealand. The Maori dog or *kuri* is the second most abundant mammal in the Shag Mouth assemblage. As the only canid in New Zealand, it was relatively easy to distinguish dog from other taxa. The exceptions are vertebral fragments and ribs that could have been either juvenile fur seal or adult/juvenile dog. These specimens could only be identified to the Pinniped/Canid category.

The Maori dog became extinct through breeding with European dogs in the mid 1800s before its morphology or behavior was adequately described. Skeletal remains show the kuri to have been a small breed with an estimated height ranging from 17-28 centimeters and weight from 8 to 25 kilograms (Clark 1997). In historical accounts, it has been described as a short version of an Australian dingo (Anderson 1981*b*).

Based on coprolite studies and ethnographic accounts, dogs in New Zealand appear to have been fed fish, or at least eaten fish (Anderson 1981*b*). Carnivore markings are on bones from middens, including those at Shag Mouth (Anderson 1981*b*; Trotter and McCulloch 1989), suggesting that dogs may not have had a significant effect on the destruction of bones at the site.

As in the rest of Polynesia, dogs were likely a reliable food source (Allo Bay-Peterson 1979). Demographic studies of archaeological dog remains show that most individuals were culled as juveniles (Smith 1996*b*). In addition to being a source of food, the skins of dogs were used for cloaks and mats (Anderson 1994:476).

Dogs may also have been important in hunting birds, especially moas (Anderson 1981*b*). Stories of hunting dogs were recorded ethnographically, but these records occurred long after the breed was lost, and it is not clear if this is a pre- or post-European phenomenon (Trotter and McCulloch 1989).

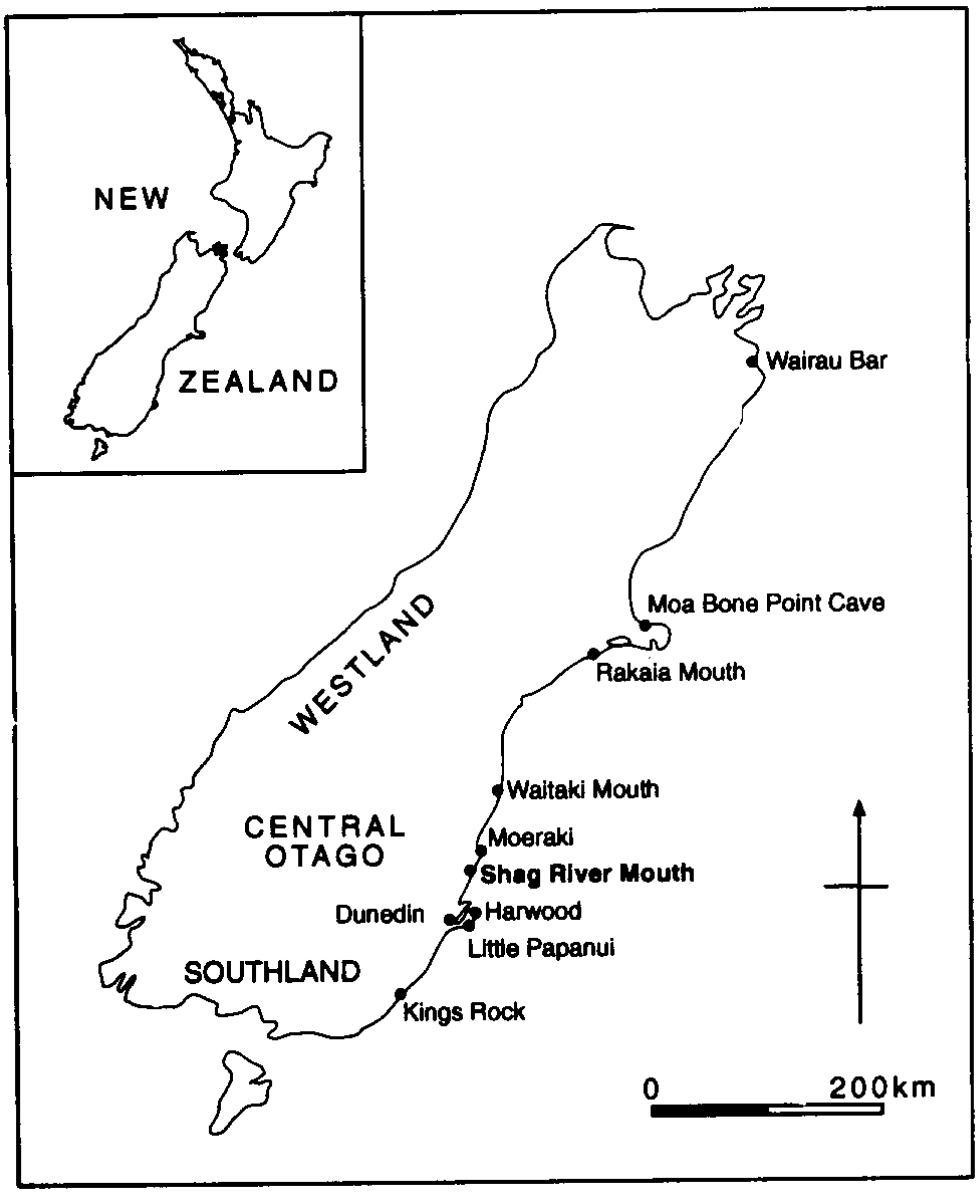

Figure 3.1. Map of New Zealand showing the location of the Shag Mouth River site (from Anderson et al. 1996).

Figure 3.2. Photo of the Shag Mouth site looking north across the High Dune excavations (Anderson et al. 1996).

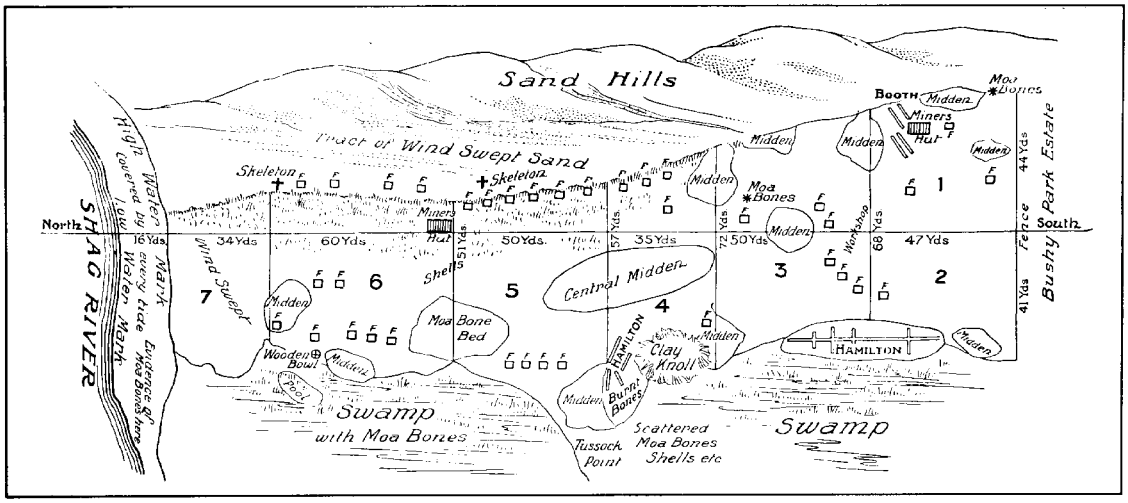

Figure 3.3. Plan map of the Shag Mouth site showing the location of features documented by Teviotdale, including Booth's and Hamilton's trenches (from Teviotdale 1924).

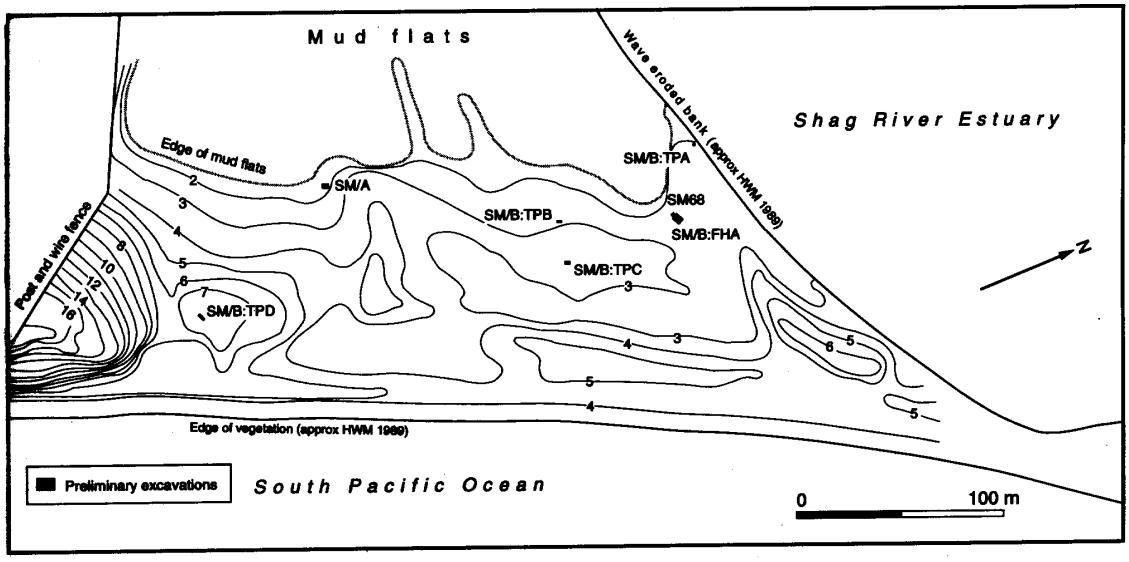

Figure 3.4. Site map of the 1987 test excavations of the Southern Hunters project. Also shown is the 1968 test excavation (SM68) by Brian Allingham. Contour intervals in meters above mean sea level (from Anderson et al.1996).

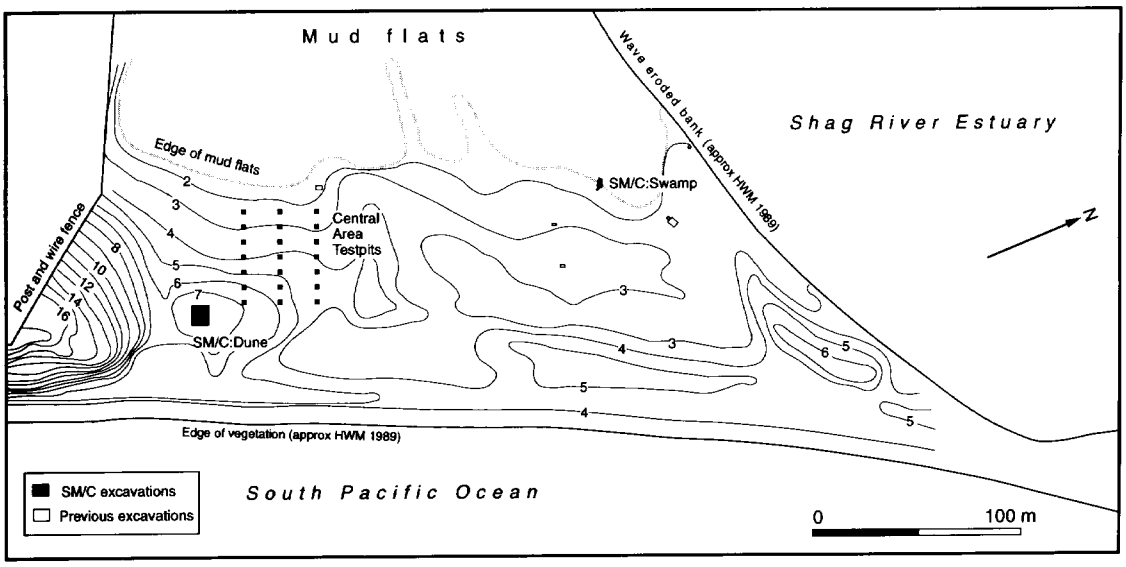

Figure 3.5. Site map showing the 1988 High Dune and Swamp excavations (from Anderson et al. 1996).

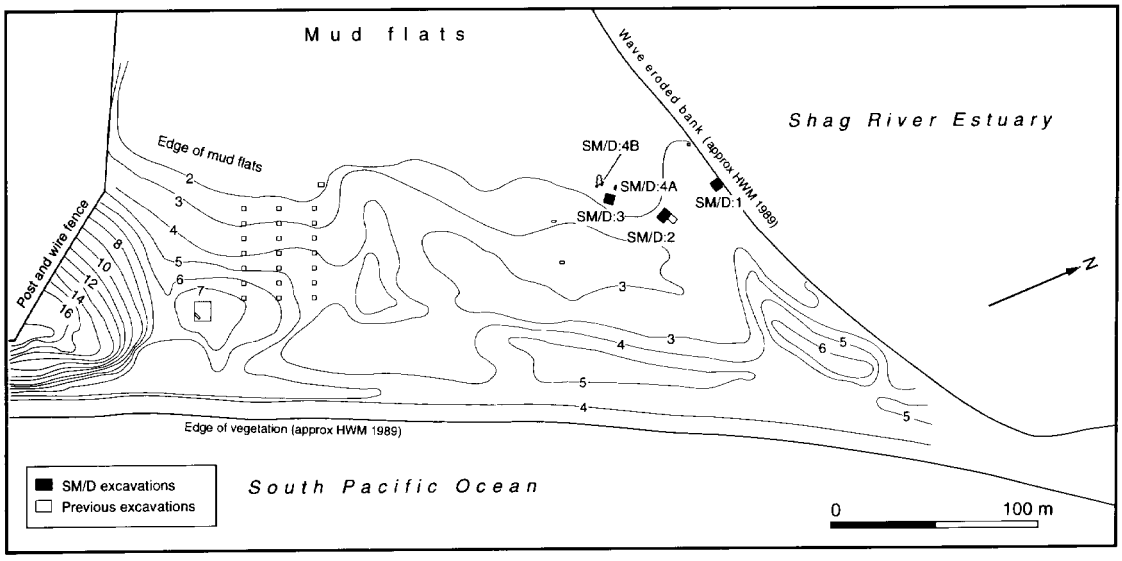

Figure 3.6. Site map of the 1989 Field School excavations (from Anderson et al. 1996)

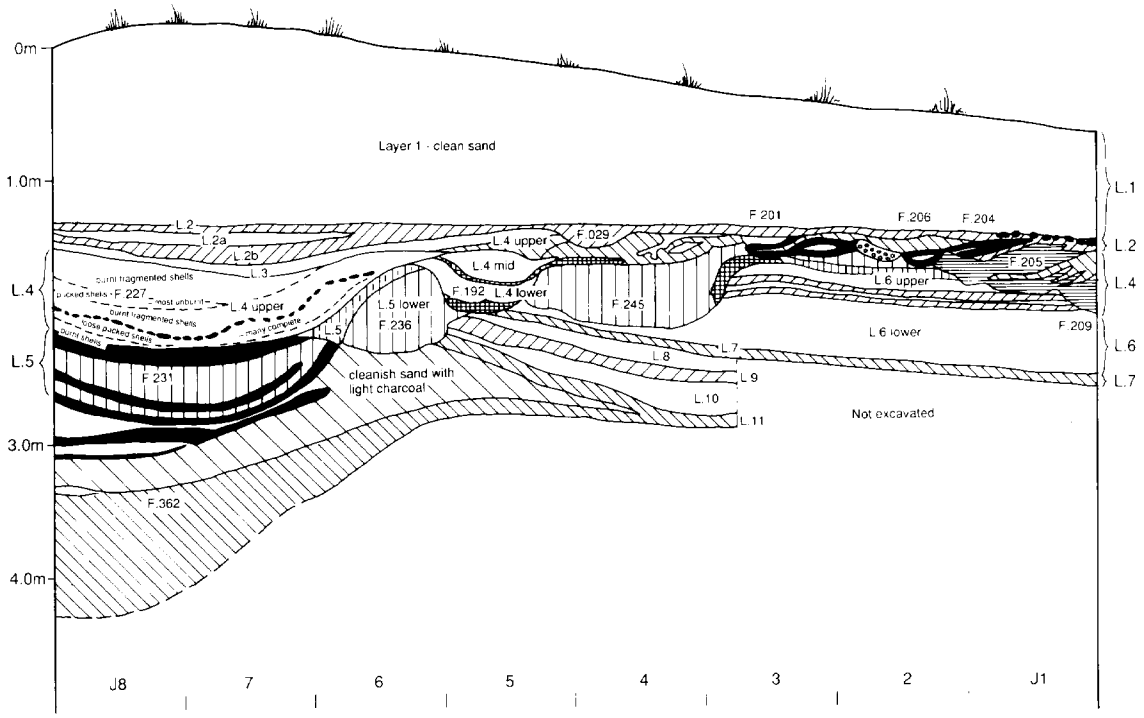

Figure 3.7. Stratigraphic profiles of Units J1-J8, east wall, High Dune excavations (SM/C) (from Anderson and Allingham 1996).

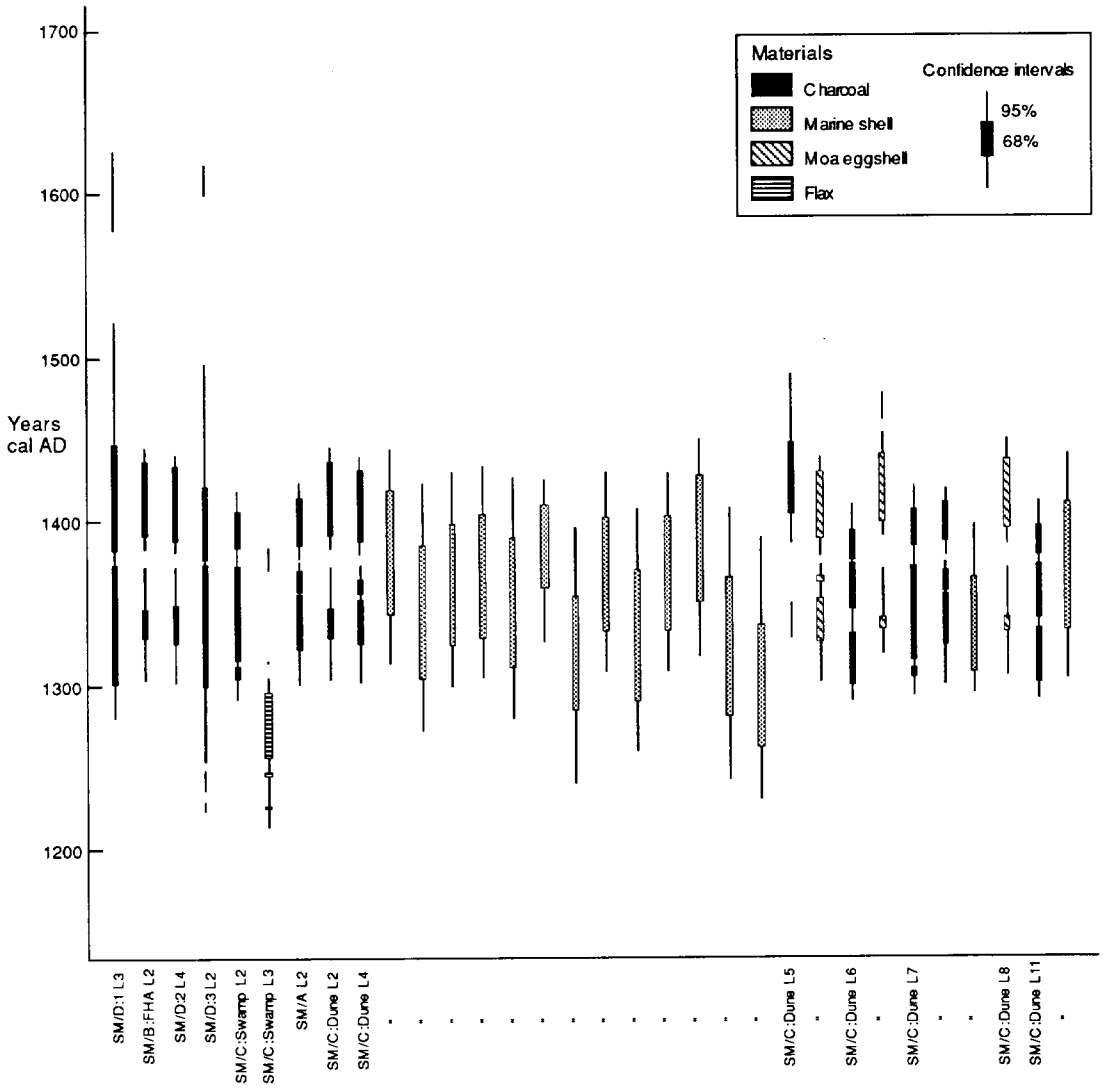

Figure 3.8. Plot of the radiocarbon dates on shell, charcoal, flax, and moa eggshell from the Shag Mouth site (from Anderson 1996).

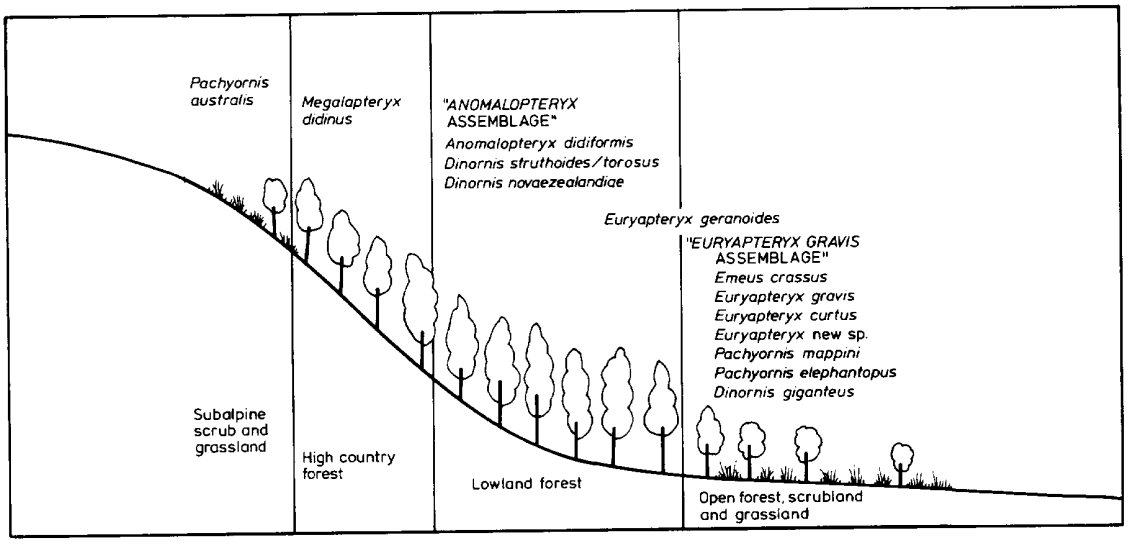

Figure 3.9. Distribution of moa species across habitats (from Anderson 1989).

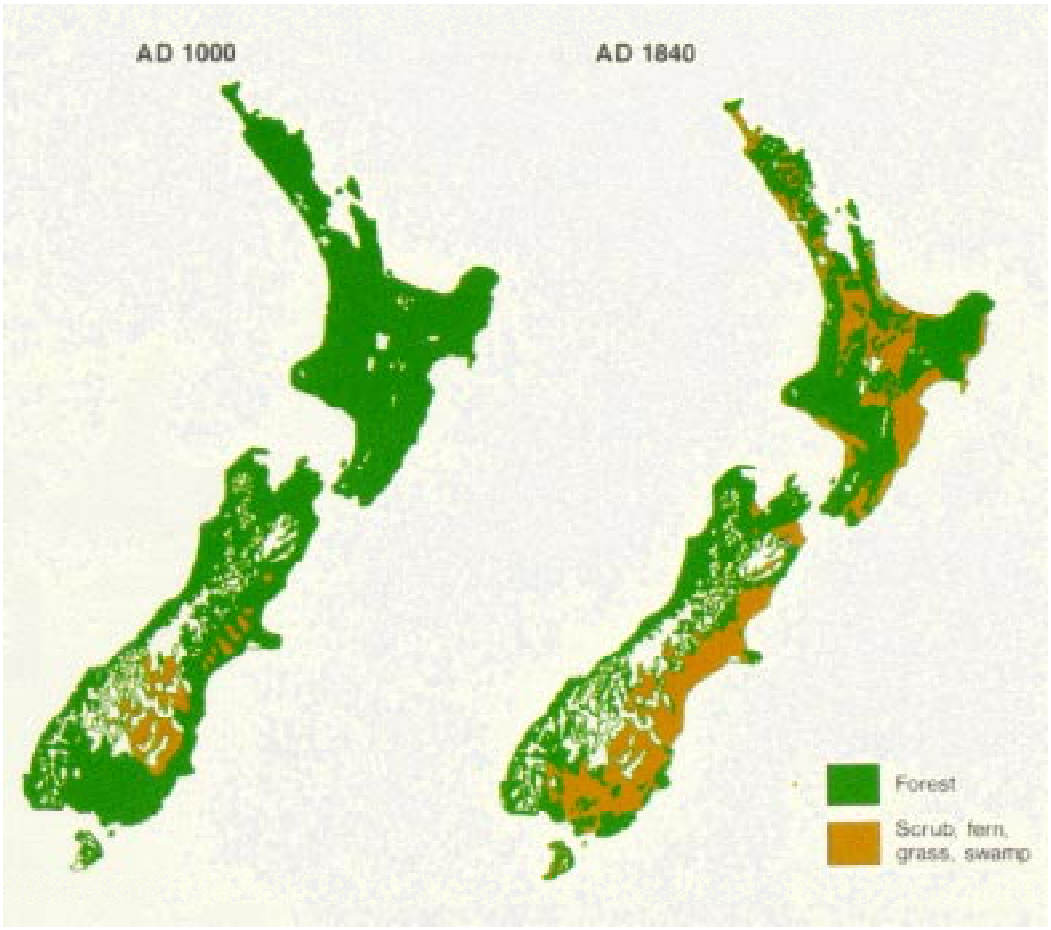

Figure 3.10. Changes in distribution of forest in New Zealand over time (from Trotter and McCulloch 1989).

Table 3.1. Radiocarbon dates for the High Dune excavations, Shag River Mouth site.

Charcoal

Lab No.	Provenience	Radiocarbon Years B.P.	Calibrated Dates, 2σ
NZ-7758	Unit F3-4, Layer 2	580±47	1303-1372 (.37) 1383-1444 (.63)
NZ-7761	Unit E7, Layer 4	600±50	1301-1374 (.50) 1379-1438 (.50)
NZ-7757	Unit D5, Layer 5	537±44	1328-1350 (.08) 1379-1438 (.92)
NZ-7756	Unit C6, Layer 6	670±47	1289-1409
NZ-7755	Unit B7-8, Layer 7	646±47	1293-1416
Wk-2589	Unit B4, Layer 7	630±35	1300-1374 (.65) 1377-1418 (.35)
NZ-7771	Unit A6, Layer 11	660±46	1291-1411

Shell

Lab No.	Provenience	Radiocarbon Years B.P.	Calibrated Dates, 2σ
NZ-7804	Unit F2, Layer 4	747±38	1473-1636
Wk-2751	Unit F7, Layer 4	960±45	1313-1433
Wk-2410	Unit F7, Layer 4	1020±50	1272-1423
Wk-2411	Unit F7, Layer 4	990±45	1299-1429
Wk-2412	Unit F7, Layer 4	980±45	1304-1433
Wk-2362	Unit G8, Layer 4	1010±50	1280-1426
Wk-2367	Unit G8, Layer 4	1160±50	1111-1309
NZ-7805	Unit H8, Layer 4	965±26	1327-1425
Wk-2508	Unit H8, Layer 4	1060±45	1240-1396
Wk-2632	Unit J5, Layer 4	980±40	1308-1429
Wk-2633	Unit J5, Layer 4	1070±80	1156-1433
Wk-2752	Unit J5, Layer 4	1040±45	1259-1407
Wk-2856	Unit J5, Layer 4	980±40	1308-1429
Wk-2857	Unit J5, Layer 4	950±45	1317-1449
Wk-2440	Unit J5, Layer 4	1050±50	1242-1407
Wk-2441	Unit J5, Layer 4	1070±45	1231-1391
NZ-7806	Unit A2, Layer 7	1022±29	1295-1398
NZA-1175	Unit C-D/7-8, Layer 11	1022±29	1295-1398

Moa Eggshell

Lab No.	Provenience	Radiocarbon Years B.P.	Calibrated Dates, 2σ
Wk-2416	Unit E5, Layer 5	600±50	1301-1374 (.50) 1379-1438 (.50)
Wk-2417	Unit F2/E2 Layer 6	560±45	1318-1369 (.21) 1386-1453 (.76) 1460-1477 (.03)
Wk-2604	Unit I3/I4 Layer 8	570±45	1305-1371 (.29) 1385-1449 (.71)

Table 3.1. (continued)

Moa Bone

Lab No.	Provenience	Radiocarbon Years B.P.	Calibrated Dates, 2σ
NZA-781	Unit E2-3, Layer 2	630±82	1277-1460
NZ-7743	Unit H8, Layer 4	1201±38	788-974
NZ-7737	Unit D6, Layer 5	1170±70	719-739 (.01) 766-1028 (.99)
NZ-7736	Unit D7, Layer 6	624±58	1288-1417
NZA-780	Unit A7, Layer 7	509±72	1315-1347 (.05) 1390-1635 (.95)
NZ-7666	Unit ?, Layer 11	787±72	1067-1072 (<.01) 1128-1132 (<.01) 1160-1401 (.99)

Rat Bone

Lab No.	Provenience	Radiocarbon Years B.P.	Calibrated Dates, 2σ
NZA-5719	Unit I4, Layer 4	1487±82	427-771
NZ-5936	Unit D7, Layer 5	2040±68	180 BC-AD 192
OxA-5780	Unit F2, Layer5	900±55	1020-1240
OxA-6020	Unit E7, Layer 6	930±65	990-1240
NZA-5926	Unit E8, Layer 6	1578±88	356-688
NZA-5720	Unit J5, Layer 11	1892±86	26-411

Table 3.2. List of vertebrate species identified for the Shag Mouth assemblage.

FISH

Anguiliformes

Anguillidae (Freshwater Eels)

Anguilla sp.

Gadiformes

Moridae (Morid Cods)

Pseudophycis bachus (Red Cod)

Lotella auratus (Rock Cod)

Ophidiiformes

Ophidiidae (Cusk-eels)

Genypterus blacodes (Ling)

Scorpaeniformes

Scorpaenidae

Scorpaena cardinalis (Scorpionfish)

Helicolenus papillosus (Sea perch)

Perciformes

Percichthyidae (Temperate Basses)

Polyprion oxygeneios (Hapuku)

Cheilodactylidae (Morwongs)

Nemadactylus macropterus (Tarakihi)

Latrididae (Trumpeters)

Latridopsis ciliaris (Blue Moki)

Latris lineata (Trumpeter)

Mugilidae

Aldrichetta forsteri (Yellow-eyed Mullet)

Nototheniidae (Cod Icefishes)

Notothenia sp. (Black Cods)

Mugiloididae (Sandperches)

Parapercis colias (Blue Cod)

Labridae (Wrasses)

Pseudolabrus sp. (Wrasses)

Gempylidae (Snake Mackerels)

Thyristes atun (Barracouta)

Rexea solandri (Gemfish)

Centrolophidae (Medusafishes)

Seriolella spp. (Warehou)

BIRDS

Dinornithiformes

Dinornithidae

Dinornis giganteus (Giant Moa*)

Dinornis novaeseelandiae (Large Bush Moa*)

Dinornis torosus (Slender Bush Moa*)

Anomalopterygidae

Euryapteryx geranoides (Stout-legged Moa*)

Emeus crassus (Eastern Moa*)

Sphenisciformes

Spheniscidae - Penguins

Eudyptula minor (Little Blue Penguin)

Megadyptes antipodes (Yellow-eyed Penguin)

Eudyptes pachyrhynchus (Fiordland-crested Penguin)

Eudyptes sclateri (Erect-crested Penguin)

Procellariformes

Diomedeidae - Albatrosses

Diomedea bulleri (Buller's Mollymawk)

Diomedea cauta (Shy Mollymawk)

Diomedea exulans (Wandering Albatross)

Procellaridae - Petrels, Prions,Shearwaters

Pachyptila turtur (Fairy Prion)

Puffinus gavia (Fluttering Shearwater)

Pelecanoides urinatrix (Diving Petrel)

Pterodroma sp. (Petrels)

Hydrobatidae - Storm Petrels

Table 3.2. (continued)

Pelecaniformes
Phalacrocoracidae - Cormorants, Shags
Leucocarbo chalconotus (Stewart Island Shag)
Stictocarbo punctatus (Spotted Shag)
Phalacrocorax melanoleucos (Little Pied Shag)

Anseriformes
Anatidae - Ducks, Geese, Swans
Anas chlorotis (Brown Teal)
Anas gracilis (Grey Teal)
Anas superciliosa (Grey Duck)
Aythya novaeseelandiae (NZ Scaup)
Tadorna variegata (Paradise Shelduck)
Mergus australis (Auckland Island Merganser**)
Cygnus sumnerensis (NZ Swan*)

Falconiformes
Falconidae - Falcons
Falco novaeseelandiae (NZ Falcon)
Accipitridae - Kites, Hawks, Harriers
Circus eylesi (Eyles' Harrier)

Galliformes
Phasianidae - Gamebirds
Coturnix novaezelandiae (NZ Quail**)

Gruiformes
Rallidae - Rails
Gallirallus australis (Weka)
Rallus philipensis (Banded Rail)

Charadriiformes
Haematopididae - Oystercatchers
Haemantopus ostralegus (Pied Oystercatcher)
Charadriidae - Plovers, Dotterels
Charadrius bicinctus (Banded Dotterel)
Charadrius obscurus (NZ Dotterel***)
Anarhynchus frontalis (Wrybill)
Thinornis novaeseelandiae (Shore Plover)
Scolopacidae - Snipes, Godwits, Curlews
Coenocorypha aucklandica (NZ Snipe***)
Laridae - Gulls, Terns
Larus bulleri (Black billed Gull)
Larus novaehollandiae (Red billed Gull)
Larus dominicanus (Black backed Gull)
Sterna albostriata (Black fronted Tern)

Columbiformes
Columbidae - Pigeons, Doves
Hemiphaga novaeseelandiae (NZ Pigeon)

Psittaciformes
Psittacidae - Parrots
Cyanoramphus sp. (Red/Yellow crowned Parakeet)
Nestor meridionalis (Kaka)

Strigiformes
Strigidae - Owls
Sceologlaux albifacies (Laughing Owl**)

Table 3.2. (continued)

Passeriformes

Motacillidae - Pipits

Anthus novaeseelandiae (NZ Pipit)

Eopsaltriidae - Australasian Robins

Petroica australis (NZ Robin)

Meliphagidae - Honeyeaters

Anthornis melanura (Bellbird)

Prosthemadera novaeseelandiae (Tui)

Callaeidae - Wattlebirds

Callaeas cinerea (Kokoko***)

Philesturnus carunculatus (Saddleback)

Paradisaeidae - Bowerbirds, Piopio

Turnagra capensis (Piopio**)

*Pre-European extinction; **Post-European extinction; ***Extirpated from the South Island

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MAMMALS

Cetacea

Lagomorpha

Leporidae (Rabbits/Hares)

Rodentia

Muridae

Rattus exulans (Polynesian Rat)

Carnivora

Phocidae (True Seals)

Mirounga leonina (Elephant Seal)

Otariidae (Eared Seals)

Arctocephalus forsterii (NZ Fur Seal)

Phocarctos hookeri (Hooker's Sea Lion)

Canidae (Dogs)

Canis familiaris (Domestic Dog)

Table 3.3. Numbers of identified fish specimens per taxon by layer.

Taxon	Layers 2	4	5	6	7	8	9	10	11	Total
Anguilliformes										
Anguillidae - Freshwater Eels										
Anguilla sp.					2					2
Gadiformes										
Moridae-Morid Cods										
Pseudophycis bachus (Red Cod)	103	990	41	7	5	1			1	1148
Lotella auratus (Rock Cod)	2									2
Ophidiiformes										
Ophidiidae-Cusk Eels										
Genypterus blacodes (Ling)	27	92	19	2			1			141
Scorapaeniformes										
Scorpaenidae-Scorpionfish										
Scorpaena cardinalis (Scorpionfish)	3	13	2							18
Helicolensus papillosus (Sea Perch)		4	8							12
Perciformes										
Percichthyidae-Temperate Basses										
Polyprion oxygeneios (Hapuku)	4	13	1							18
Cheilodactylidae-Morwongs										
Nemadactylus macropterus (Tarahiki)		2		2						4
Latrididae-Trumpeters										
Latridopsis ciliaris (Blue Moki)	1			3	3					7
Latris lineata (Trumpeter)	2	10	6	5	11				1	35
Mugilidae-Mullets										
Aldrichetta forsteri (Yellow-eyed Mullet)			1							1
Nototheniidae-Cod Icefishes										
Notothenia spp. (Black Cods)	3	51	9		15		1			79
Mugiloididae-Sandperches										
Parapercis colias (Blue Cod)	39	70	44	55	31	4	2			245
Labridae-Wrasses										
Pseudolabrus spp. (Wrasses)	26	94	30	19	13	4				186
Gempylidae-Snake Mackerels										
Thyristes atun (Barracouta)	1305	5751	757	90	67	8	5			7983
*Rexea solandr*i (Gemfish)		5								5
Centrolophidae-Medusafishes										
Seriolella spp. (Warehou)	2									2
Identified fish	1517	7095	918	183	147	17	9	0	2	9888
Unidentified fish	3037	22509	1400	1060	654	68	48	7	23	28806
Total fish	4554	29602	2318	1243	801	85	57	7	25	38694

Table 3.4. Size of fish taxa by weight and length.

Species	Weight	Length
Anguilla sp.		Up to150 cm
Pseudophycis bachus	1.5-2.5 kg	40-80 cm
Lotella auratus		25-40 cm
Genypterus blacodes	5-20 kg	80-150 cm
Scorpaena cardinalis		25-45 cm
Helicolenus papillosus	0.4-0.6 kg	25-35 cm
Polyprion oxygeneios	3-20 kg	80-150 cm
Nemadactylus macropterus	1.8 kg	30-60 cm
Latridopsis ciliaris	2.3-10.0 kg	55-80 cm
Latris lineata		50-120 cm
Aldrichetta forsteri	0.5 kg	20-30 cm
Notothenia sp		30-40 cm
Parapercis colias	1.0-3.0 kg	30-45 cm
Pseudolabrus spp.		20-35 cm
Thyristes atun	1.0-3.0 kg	60-180 cm
Rexea solandri	2.5-4.5 kg	60-90 cm
Seriolella spp.	2.5-6.0 kg	45-60 cm

Table 3.5. Numbers of identified bird specimens per taxon by layers.

Taxon	Layers 2	4	5	6	7	8	9	10	11	Total
DINORNITHIFORMES	539	1387	1374	1751	1528	559	764	89	59	8050
Dinornithidae										
Dinornis giganteus (Giant Moa)		2								2
Dinornis novaeseelandiae (Large Bush				1						1
Dinornis struthoides (Slender Moa)			1							1
Emeidae	1	3	2	6	4		1		1	18
Emeinae			2	1						3
Euryapteryx geranoides (Stout-legged Moa)		2	3	17	3		2			27
cf. *Euryapterxy geranoides*					2		1			3
Emeus crassus (Eastern Moa)			16	5			2			23
Dinornis/*Pachyornis*							1			1
PROCELLARIFORMES										
Diomedeidae - Albatrosses										
Diomedea bulleri (Buller's Mollymawk)		2								2
Diomedea cauta (Shy Mollymawk)	46	176	9	4	3	1				239
Diomedea exulans (Wandering Albatross)		1			3					4
Diomedea sp.	79	234	9	7	2					331
Procellaridae - Petrels, Prions,										
Pachyptila turtur (Fairy Prion)	1	153	1		1					156
Pachyptila cf. *turtur*	1									1
Pachyptila sp.	1	12	1							14
Puffinus gavia (Fluttering Shearwater)	2	42		1						45
Puffinus sp.		6								6
Pelecanoides urinatrix (Diving Petrel)	1	19	1	2						23
Pterodroma sp.					1					1
Hydrobatidae		1								1
SPHENISCIFORMES										
Spheniscidae - Penguins										
Eudyptula minor (Little Blue Penguin)	17	36	56	70	121	30	5	2	5	342
Megadyptes antipodes (Yellow-eyed Penguin)		1	4	8	2	6	2		1	24
Eudyptes pachyrhynchus (Fiordland crested Penguin)		4			2					6
Eudyptes cf. *pachyrhynchus*		3								3
Eudyptes sclateri (Erect crested Penguin)			2			1				3
Eudyptes sp.		1			1					2
Eudyptes/*Megadyptes*		2	1		1	1				5
PELECANIFORMES										
Phalacrocoracidae - Cormorants, Shags		1		1						2
Leucocarbo chalconotus (Stewart Island	5	10	7	5	4	7	8	1	10	57
Stictocarbo punctatus (Spotted Shag)	6	7	4	13	6			1	2	39
Phalacrocorax melanoleucos (Little Pied	1	1			1					3
ANSERIFORMES										
Anatidae - Ducks, Geese, Swans		5								5
cf. Anatidae		1								1
Anas chlorotis (Brown Teal)		5								5
cf. *Anas chlorotis*		1								1
Anas gracilis (Grey Teal)	2	2	1							5
Anas superciliosa (Grey Duck)	6	12	4		1	2				25
Anas cf. *superciliosa*		4								4

Table 3.5. (continued)

Taxon	Layers 2	4	5	6	7	8	9	10	11	Total
Anas sp.	1	13			1					15
Aythya novaeseelandiae (NZ Scaup)		1								1
cf. *Aythya novaeseelandiae*		1								1
Tadorna variegata (Paradise Shelduck)	1							2		3
Mergus aucklandica (Auckland Island Merganser)			1							1
Cygnus sumnerensis		1								1
FALCONIFORMES										
Falconidae - Falcons										
Falco novaeseelandiae (NZ Falcon)			1							1
Accipitridae - Kites, Hawks, Harriers										
Circus cf. *eylesi* (Eyles' Harrier)						1				1
GALLIFORMES										
Phasianidae - Gamebirds										
Coturnix novaezelandiae (NZ Quail)	161	470	199	13	50	5	2		1	901
GRUIFORMES										
Rallidae - Rails										
Gallirallus australis (Weka)	2	5	2							9
Rallus philipensis (Banded Rail)		1								1
CHARADRIIFORMES										
Haematopididae - Oystercatchers										
Haemantopus ostralegus (Pied Oystercatcher)	1	3								4
Charadriidae - Plovers, Dotterels										
Charadrius bicinctus (Banded Dotterel)		3	1							4
Charadrius cf. *bicinctus*	1									1
Charadrius obscurus (NZ Dotterel)		15	1		2					18
Anarhynchus frontalis (Wrybill)		1								1
cf. *Anarhynchus*		1								1
Anarhynchus/*Thinornis*		3								3
Thinornis novaeseelandiae (Shore Plover)	4	14								18
Scolopacidae - Snipes, Godwits, Curlews										
Coenocorypha aucklandica (NZ Snipe)	1	3								4
Laridae - Gulls, Terns										
Larus bulleri (Black billed Gull)			1	1						2
Larus novaehollandiae (Red billed Gull)		2	3	5						10
Larus bulleri/*novaehollandiae*	1	2	3	6	2	2				16
Larus dominicanus (Black backed Gull)		5	1	9	3					18
Larus sp.			1		1					2
Sterna albostriata (Black fronted Tern)		17	5	2	1					25
Sterna cf. *albostriata*	1									1
COLUMBIFORMES										
Columbidae - Pigeons, Doves										
Hemiphaga novaeseelandiae (NZ Pigeon)	30	127	29	4	10	2		1		203

Table 3.5. (continued)

Taxon	Layers 2	4	5	6	7	8	9	10	11	Total
PSITTACIFORMES										
Psittacidae - Parrots										
Cyanoramphus sp. (Red/Yellow crowned Parakeet)	12	42	36	1	9	1				101
Nestor meridionalis (Kaka)			1							1
STRIGIFORMES										
Strigidae - Owls										
Sceloglaux albifacies (Laughing Owl)			1	1	1					3
PASSERIFORMES										
Motacillidae - Pipits										
Anthus novaeseelandiae (NZ Pipit)		8	5	13	2	2			2	32
Eopsaltriidae - Australasian Robins										
Petroica australis (NZ Robin)		4								4
Meliphagidae - Honeyeaters										
Anthornis melanura (Bellbird)		1		1						2
Prosthemadera novaeseelandiae (Tui)	6	24	3	3		1	1			38
Callaeidae - Wattlebirds										
Callaeas cinerea (Kokako)		1								1
Philesturnus carunculatus (Saddleback)	1	2	1		1					5
Paradisaeidae - Bowerbirds, Piopio										
Turnagra capensis (Piopio)		1	1							2
Identified Bird	931	2907	1794	1951	1769	621	789	96	81	10939
Unidentified Bird	494	1573	224	99	174	40	55	7	5	2671
TOTAL	1425	4480	2018	2050	1943	661	844	103	86	13610

Table 3.6. Distribution and estimated weight (kg) of moa species. (after Cooper *et al*. 1993)

Taxon	Distribution	Estimated Weight
Emeidae		
Megalapteryx didinus	South Island	25-60
Anomalopteryx didiformis	NZ wide	25-60
Pachyornis elephantopus	South Island	60-200
Pachyornis australis	South Island	50-100
Pachyornis mappini	North Island	15-60
Emeus crassus	South Island	25-120
Euryapteryx geranoides	NZ wide	30-150
Euryapteryx curtus	North Island	15-50
Dinornithidae		
Dinornis giganteus	NZ wide	180-270
Dinornis novaezealandiae	NZ wide	110-200
Dinornis struthoids	NZ wide	50-115

Table 3.7. Size, weight, and distribution information for small birds in the Shag Mouth assemblage (M=male, F=female).

Species	Distribution	Weight	Length
Eudyptula minor	endemic	40-45 cm:	1.1 kg
Megadyptes antipodes	endemic	56-78 cm	M: 5.5kg F: 5.2 kg
Eudpytes pachyrhynchus	endemic	55-60 cm	M: 3.7kg F: 3.4 kg
Eudyptes sclateri	endemic	60-67 cm	M: 4.9 kg F: 4.1 kg
Diomedea bulleri	endemic	76-81 cm	2.4-3.1 kg
Diomedea cauta	native	90-100cm	M: 4.0-4.4 kg F: 3.4-3.8 kg
Diomedea exulans	native	110-135 cm	6.0-11.0 kg
Pachyptila turtur	native	25 cm	90-175 g
Puffinus gavia	endemic	32-37 cm	230-415 gm
Pelecanoides urinatrix	native	20-25 cm	110-150 g
Leucocarbo chalconotus	endemic	65-70 cm	2.5 kg
Stictocarbo punctatus	endemic	64-74 cm	0.7-1.2 kg
Phalacrocorax melanoleucos	native	55-65 cm	410-880 g
Anas chlorotis	endemic	48 cm	M: 600 g F: 500 g
Anas gracilis	native	43-48 cm	M: 525 g F: 425 g
Anas superciliosa	native	47-60 cm	M: 1100 g F: 1000 g
Aythya novaeseelandiae	endemic	40 cm	M: 700 g F: 600 g
Tadorna variegata	endemic	63 cm	M: 1.7 kg F: 1.4 kg
Mergus aucklandica	extinct endemic	58 cm	900 g
Cygnus sumnerensis	extinct endemic		~3.5 kg
Falco novaeseelandiae	endemic	40-50 cm	M: 240-350 g F: 410-640 g
Circus eylesi	extinct endemic		up to 3 kg
Coturnix novaezelandiae	extinct endemic	22 cm	M: ~220 g F: ~200 g
Rallus philipensis	native	30-33 cm	130-230 g
Gallirallus australis	native	53 cm	M: 1000 g F: 700 g

Table 3.7. (continued)

Species	Distribution	Weight	Length
Haemantopus ostralegus	native	46 cm	550 g
Charadrius bicinctus	endemic	18-21 cm	60-80 g
Charadrius obscurus	endemic	26-28 cm	130-170 g
Anarhynchus frontalis	endemic	20 cm	47-71 g
Thinornis novaeseelandiae	endemic	20 cm	60 g
Coenocorypha aucklandica	endemic	21-24 cm	90-120 g
Larus bulleri	endemic	35-38 cm	M: 300 g F: 250 g
Larus novaehollandiae	native	36-44 cm	M: 300 g F: 260 g
Larus dominicanus	native	49-62 cm	M: 1050 g F: 850 g
Sterna albostriata	endemic	29 cm	95 g
Hemiphaga novaeseelandiae	endemic	51 cm	600-700 g
Cyanoramphus sp.	native	23-28 cm	M: 50-80 g F: 40-75 g
Nestor meridionalis	endemic	45 cm	M: 575 g F: 500 g
Sceloglaux albifacies	extinct endemic	38 cm	600 g
Anthus novaeseelandiae	native	19 cm	40 g
Petroica australis	endemic	18 cm	35 g
Anthornis melaneura	endemic	20 cm	M: 34 g F: 26 g
Prosthemadera novaeseelandiae	endemic	30 cm	M: 120 g F: 90 g
Callaeas cinerea	extirpated endemic	38 cm	230 g
Philesturnus carunculatus	endemic	25 cm	M: 80 g F: 70 g
Turnagra capensis	extinct endemic	26 cm	unknown

from Heather and Robertson 1996; Marchant and Higgins 1990, 1993; Higgins and Davies 1996.

Table 3.8. Number of identified mammalian specimens per taxon by layer.

Taxon	Layers									Total
	2	4	5	6	7	8	9	10	11	
Cetacean				1						1
Cetacean/Pinniped		4	1	2	8	6		1	1	23
Leporidae (Rabbits/Hares)	10				1					11
Rattus exulans (Polynesian Rat)	67	194	50	67	58	38	89		100	663
Rattus sp.	14	16	4	5	2	3	1		1	46
Pinniped (Seals)	2	1			3					6
Phocidae (True Seals)				2	1	2		1	1	7
Mirounga leonina (Elephant Seal)	1	1	2	5	2	3	3			17
cf. *Mirounga leonina*			2	1		1				4
Otariidae (Eared Seals)	19	31	46	52	71	17	24	2	10	272
Arctocephalus forsterii (NZ Fur Seal)	136	144	305	301	504	95	92	24	25	1626
Phocarctos hookeri (Hookers Sea Lion)		2	2	3		3	6	8	4	28
cf. *Phocarctos hookeri*		1			2			1	1	5
Pinniped/Canid (Seal/Dog)	46	122	101	91	115	5	4	4	1	489
Canis familiaris (Maori Dog)	87	291	39	35	25	5	5	4	10	501
Identified Mammal	382	807	552	565	792	178	224	45	154	3699
Unidentified Mammal	64	162	174	160	349	64	93	3	9	1078
Unidentified Vertebrate	411	679	503	726	818	171	117	2	111	3438
TOTAL	858	1648	1229	1452	1960	413	434	50	174	8218

Table 3.9. List of cetaceans found in New Zealand waters.

Order Cetacea	
Balaenopteridae (Rorquals)	
Balaenoptera musculus	Blue Whale
Balaenoptera physalus	Fin Whale
Balaenoptera borealis	Sei Whale
Balaenoptera edeni	Bryde's Whale
Balaenoptera acutorostrata	Minke Whale
Megaptera novaeangliae	Humpback Whale
Balaenidae (Right Whales)	
Balaena glacialis	Right Whale
Caperea marginata	Pygmy Right Whale
Ziphiidae (Beaked Whales)	
Berardius arnouxi	Arnoux's Beaked Whale
Tasmacetus shepherdi	Shepard's Beaked Whale
Mesoplodon layardi	Strap-toothed Whale
Mesoplodon bowdoini	Andrews' Beaked Whale
Mesoplodon grayi	Scamperdown Whale
Mesoplodon hectori	Hector's Beaked Whale
Ziphius cavirostris	Goose-beaked Whale
Hyperoodon planifrons	Bottlenose Whale
Physeteridae (Sperm Whales)	
Physeter macrocephalus	Sperm Whale
Kogia breviceps	Pygmy Sperm Whale
Kogia simus	Dwarf Sperm Whale
Delphinidae (Marine Dolphins)	
Globicephala malaena	Long-finned Pilot Whale
Globicephala macrorhynchus	Short-finned Pilot Whale
Pseudorca crassidens	False Killer Whale
Orsinus orca	Killer Whale
Grampus griseus	Risso's Dolphin
Steno bredanensis	Rough-toothed Dolphin
Tursiops truncatus	Bottlenose Dophin
Stenella caeruleoalba	Striped Dolphin
Stenella attenuata	Spotted Dolphin
Delphinus delphis	Common Dolphin
Lagenorhynchus obscurus	Dusky Dolphin
Cephalorhynchus hectori	Hector's Dolphin
Peponocephla electra	Melon-headed Whale
Lissodelphis peronii	Southern Right Whale Dolphin