

# Retrospective Anthracological Analysis of Two Early Coastal East Otago Polynesian Settlements

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# Abstract

Curated archaeological charcoal assemblages are a significant palaeobotanical resource capable of providing insight into the human-plant interactions of the past. This thesis tests the appropriateness of two early Polynesian coastal east Otago charcoal assemblages, Shag River Mouth and Purakaunui, for retrospective anthracological analysis. The ability to inform on past fuel collection strategies and vegetative impacts is investigated through the taxonomic identification of specimens from within the two assemblages. The environmental impacts are investigated within the context of a modelled Initial Burning Period. Shag River Mouth is largely presented through single fire pit samples and was able to provide evidence of intensive resource depletion synonymous with the Initial Burning Period. Purakaunui provides a contrasting image of more sustainable resource management, distancing it from the trends predicted for early Polynesian vegetation management by the Initial Burning Period model. This research has shown that all curated archaeological assemblages can be revisited, although due consideration should be made as to research aims of such investigations.

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# 1. Introduction

The history of New Zealand archaeology includes the excavation of sites integral to our understanding of Polynesian Colonisation, many of which cannot be re-excavated. The legacy that these excavations leave behind are their assemblages. These assemblages range from the vast to the minimal but all subject to the same practice; curation. The material that is removed during excavation is inevitably the result of some form of field sampling, and further sampling when or if laboratory analysis is performed. The resulting assemblages, merely a fraction of the site's original material, are the inheritance of future researchers.

This thesis investigates the suitability of curated charcoal assemblages for retrospective investigation by anthracology (the study of charcoal). This will be undertaken through the application of appropriate sampling of the existing collections, the identification of specimens and analysis of the generated data.

The validity of curated assemblages will be tested through the investigation of three research questions for the Polynesian colonisation of East Otago:

- Does fuel use change over time?
- Can vegetation impacts be seen through the anthracological record?
- Do vegetative impacts at the site fit within the modelled Initial Burning Period of anthropogenic landscape modification?



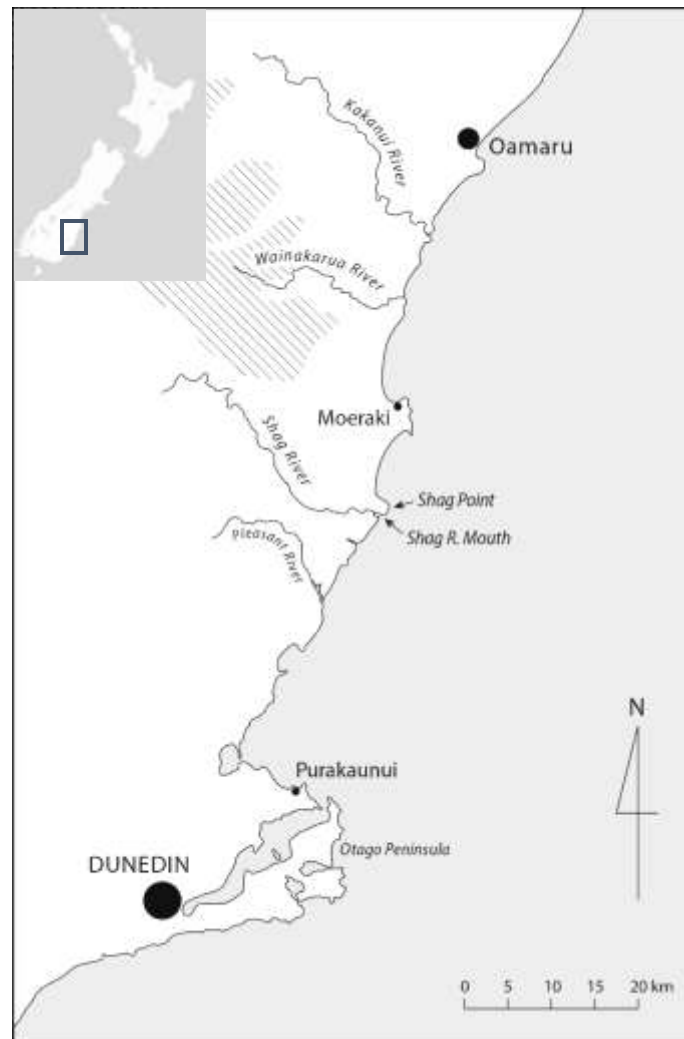


Figure 1. Map of Purakaunui and Shag River Mouth on the east coast of Otago, New Zealand.

I have chosen to focus this investigation on two archaeological midden sites from coastal East Otago, Shag River Mouth and Purakaunui. These two sites represent similar estuarine and coastal environmental regimes and both belong to the early Polynesian settlement period. Shag River Mouth and Purakaunui were also chosen as their curated charcoal assemblages represent two different sampling methods. A comparison between the two different sampling methods will assist in determining the assemblage attributes necessary for sound interpretation.

## 1.1 Problem statement

Defined by Dotte- Sarout *et al.* as “[the study of] wood charcoal macro-remains to provide both palaeoenvironmental and palaeoethnobotanical information” (Dotte Sarout *et al.* 2015, 1) anthracology extends beyond the taxonomic identification of charcoal specimens. Charcoal is

identified within this thesis as a wood that has undergone pyrolysis; “when organic material is heated in the absence of oxygen” (Scott and Damblon 2010, 2).

As with all research based disciplines, anthracology is constantly evolving as technology and techniques develop; the development of light incident microscopy allowing for fast and systematic identifications (Théry-Parisot *et al.* 2010). Recently the increased accessibility to scanning electron microscopes (S.E.M.) allows higher resolution images, a valuable tool for identifying minute anatomical differences (Huebert 2014). As the technology develops methodology develops alongside. The Montpellier school of France has been integral in the development of anthracological methodology, providing guidelines for appropriate sampling, both in the field and laboratory (Chabal *et al.* 1999; Figueiral *et al.* 2000; Scheel-Ybert 2001). Current anthracological practices will be explored further and critiqued within the methodology chapter.

The ubiquitous nature of charcoal in New Zealand’s archaeological record is in part a result of Maori cooking practices. Although there were many methods for cooking in pre-European New Zealand (see Beattie 1994) the most widely recognised in the archaeological record is that of the umu, or earth oven. An umu functions through the heating of stones, which are buried with the food, rather than through direct fire contact. As such, wood fuel is used to heat the stones and as umu are buried there is a lack of readily available oxygen resulting in incomplete combustion or pyrolysis. Charcoal is also found within the archaeological record associated with the practice of land clearing (Williams 2008, 66) (see Introduction; research Scope).

Although the identification of charcoal for radiocarbon dating purposes has been encouraged since the first New Zealand Archaeological Association conference (Golson 1956), the theoretical framework associated with anthracology has been notably lacking. This absence means there have been few examples of systematic and comprehensive field sampling of botanical remains.

Studies specifically focussed on identification of charcoal specimens have been undertaken as part of other large scale investigations, such as those conducted by Wallace on the Shag River Mouth assemblage (Boyd *et al.* 1996). Indeed, much of the work conducted in New Zealand has been undertaken by Wallace (Allen *et al.* 2005; Furey 1998; Lidefeged and Wallace 2009). However these investigations were not undertaken with anthracological analysis as a research goal. Whilst not strictly an aspect of anthracology identification of non-carbonised wooden artefacts has also taken place within New Zealand. The excavation of anaerobic sites, notably Kohika (Irwin 2004) has provided a limited number of wooden artefacts.

The lack of anthracological intent which previous excavations has resulted in assemblages that are curated without consideration for future anthracological research. These curated assemblages

represent the different sampling strategies that were in place on each excavation, as well as further sampling in a laboratory environment. It is the purpose of this thesis to determine how appropriate these assemblages are for anthracological research to be retrospectively applied through the identification and analysis of existing samples.

## 1.2 Research scope

The context for this research is the early settlement of Southern New Zealand by Polynesian colonisers. The chronology of settlement has been a central issue for New Zealand archaeology. It is acknowledged that New Zealand's settlement chronology is relatively short, it being the last major landmass to be settled before the industrial revolution (Anderson 2014). Radiocarbon dates have provided the majority of evidence used in the debates regarding New Zealand's settlement. As the science of radiocarbon dating advanced, it became possible to apply stricter standards to radiocarbon dates. This effectively culled the number of 'acceptable' radiocarbon dates to those that have the lowest risk of effects such as 'inbuilt age' (see Anthracology; radiocarbon dating) as well as results that were used to support the argument for a 'long' chronology (Anderson 1991). Recent investigations have resulted in new radiocarbon dates (Jacomb *et al.* 2014) as well as a systematic analysis of existing radiocarbon dates (Wilmschurst *et al.* 2011), with both investigations placing the earliest securely dated settlement within the early 14<sup>th</sup> Century.

As the chronology of settlement and anthropogenic environmental impacts are the subjects of ongoing debate, a parallel model that can be considered is the Initial Burning Period (IBP). The IBP provides an appealing model for early Polynesian vegetative interactions and advocates for the importance of anthropogenic burning in driving late Holocene deforestation of the South Island. McWethy *et al.* (2014) characterises the IBP as being a "period of deliberate burning" (McWethy *et al.* 2014, 1) targeting the established and "extensive native forests in the South Island" (McWethy *et al.* 2010, 21344). Radiocarbon dating of sediment samples has indicated the IBP was dichronous and occurred "between *ca.* A.D. 1280-1600" (McWethy *et al.* 2010, 21344). The motives for such dramatic landscape change have been theorised to include the encouragement of important carbohydrate sources *Pteridium esculentum* (bracken) and *Cordyline australis* (Cabbage tree or tī) as well as the facilitation of transport across the landscape (McWethy *et al.* 2010). McWethy *et al.* (2009, 2010, and 2014) analysed non-cultural palaeoenvironmental data, namely pollen records and macroscopic charcoal data, from the sedimentary records of "16 small closed-basin lakes" (McWethy *et al.* 2010, 21344) throughout the South Island (see figure 2). The use of palaeoenvironmental

records creates proxies for anthropogenic impacts. This model does not reference the direct archaeological site evidence of charcoal generated as fuel.

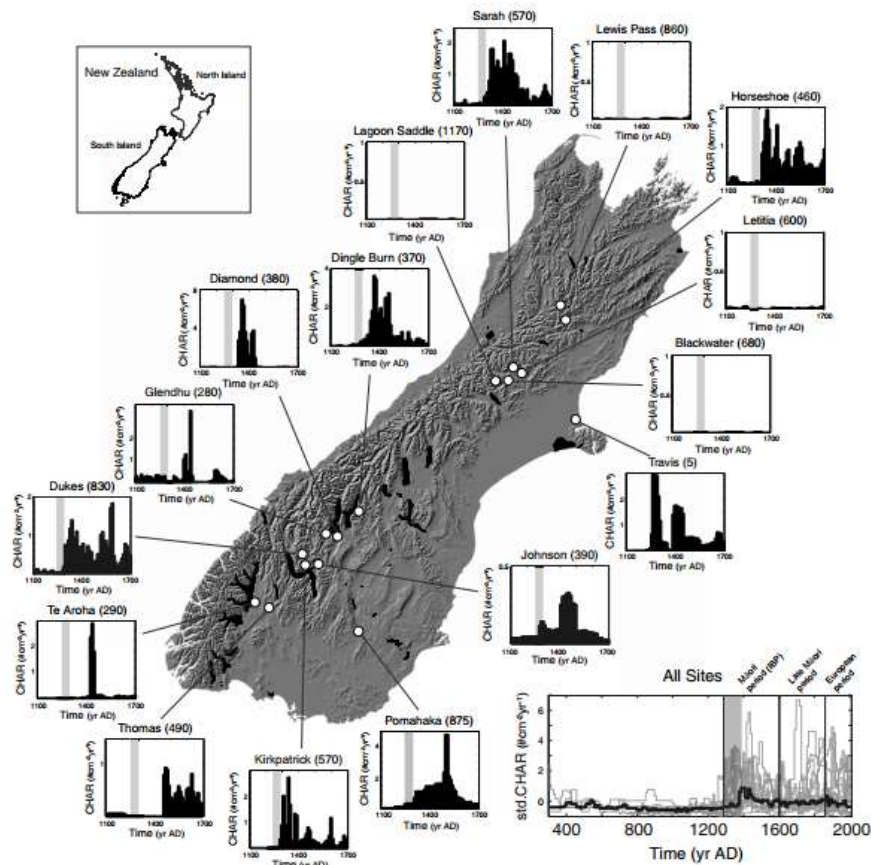


Figure 2. Charcoal accumulation rates (CHAR pieces–1 cm–2 y–1) and location of 16 sites, South Island, New Zealand. Site names above plots and elevations (masl). (McWethy *et al.* 2010, figure 1).

The IBP model is used to explain large-scale landscape modification but does not address how it was implemented at an occupational level. The palaeoenvironmental assumptions can be tested through the analysis of archaeological charcoal assemblages.

The locations of the 16 sampled lakes shows a clear bias towards inland Otago (figure 2). This bias can be addressed through the investigation of coastal Otago, which remains within the dry leeward coast of New Zealand (Anderson *et al.* 2015). Investigation of two coastal sites will also assist in identifying the geographic limitations of the behaviour modelled through the IBP. Purakaunui and Shag River Mouth are within close proximity to the dry coastal forests that are vulnerable to anthropogenic burning activities. McWethy *et al.* (2010) suggested that the drier climate of the East coast of New Zealand would display greater impact as the dry south-eastern region of New Zealand was more prone to natural fires (McWethy *et al.* 2014). In this region the effects of the IBP should be visible within the archaeological charcoal records of sites occupied during the period as a

dramatic reduction in the visibility of large forest species and accompanying increase in shrubland species.

The results of radiocarbon dating places the occupation periods of Shag River Mouth and Purakaunui securely within the earlier period of the IBP. The radiocarbon dating results also provide tightly dated occupation periods for both sites that indicate significant occupation and thus opportunity for deforestation activity. Shag River Mouth has returned radiocarbon dates that place occupation at “a period of perhaps 20-50 years in the 14<sup>th</sup> century AD” (Anderson *et al.* 1996, 67). Purakaunui, although also an early site, is considered to have been occupied for a few decades only “within the general period of the early to middle 15<sup>th</sup> century” (Allen 2013, 13).

The two sites discussed in this thesis represent similar, but not identical, vegetative environments that are the result of their geomorphology. At Shag River Mouth, the Shag River which originates in the Kakanui ranges meets the sea in an open estuary environment. Purakaunui, approximately 35km further south, is a tidal inlet with surrounded by steep hills. The coastal forest and estuarine environments that the two sites represent consist of a well-established series of plants (McEwan 1987; Moore 1963; Wardle 1991). Understanding the contemporary vegetative communities assists in identifying how well the charcoal record represents the vegetation.

## 1.3 Research objective

This research is guided through the application of several research questions, as follows:

1. Are existing curated charcoal assemblages appropriate sources for retrospective anthracological research?

This question will be answered through the analysis and comparison of two sites, an investigation that is guided by the following questions:

2. Can changes in fuel collection be viewed over time?
3. Do changes in fuel collection reflect on potential vegetation impacts at the site?
4. Are anthracological analyses of East Otago archaeological sites consistent with the IBP model for landscape modification?

These questions will ultimately lead to the overall aim of the thesis, which is to create a set of guidelines for future anthracological investigation, manifested in the following question.

5. What attributes render a curated charcoal assemblage suitable for retrospective anthracological research?

## 1.4 Thesis structure

Anthracology has not been extensively integrated within New Zealand archaeology. The history and key concepts are briefly introduced within the first chapter. The applications and limitations of anthracology and several of the key theoretical frameworks are discussed in order to provide a clear explanation for why an anthracological approach has been chosen in this thesis.

The background chapter functions as an introduction to both the archaeological sites Shag River Mouth and Purakaunui, and the associated vegetation regimes. The vegetation communities of the two sites will be described over time and space; and notable taxa discussed. The history of archaeological investigations at both of the sites is explored in order to demonstrate how interpretation of the sites has changed as New Zealand archaeology has evolved. These previous interpretations are also reviewed with the aim of placing both sites within the context of the Polynesian colonisation of the South Island.

The third chapter details both the theoretical and practical methods used in this project. The application of current theory, briefly explored in the previous chapter and expanded here, is detailed. The sampling strategy is explained in relation to the multiple contexts represented within this research. The practical methods include a brief description of the wood anatomy used in identification.

The results are presented for the two archaeological sites investigated. They are separated into the two cultural layers per site and the contexts within. A total of 950 samples were identified over both sites and the results are presented with preliminary interpretations of fuel collection strategies and indications of exploited vegetative environments.

The penultimate chapter discusses the results in relation to the research questions outlined in this chapter. The data for each layer analysed is interpreted, where appropriate, in order to provide information relevant to fuel collection strategies. Further analysis is then undertaken on the suitable assemblages to determine if vegetative impacts can be seen as well as placing these impacts in the wider regional setting of early Polynesian settlement of coastal east Otago.

The concluding chapter outlines the final findings of this research. The appropriateness and applications of each context are summarised and the parameters of an ideal sampling strategy and curation plan suggested.

## 2. Anthracology

In the following chapter I will briefly explore the applications of anthracology in the Pacific, and internationally where appropriate, in order to demonstrate the range of research anthracology can contribute towards.

### 2.1 A brief history

Anthracology as a research approach has its origins in the early 20<sup>th</sup> century, although it did not emerge as a discrete discipline until mid-century. Salisbury and Jane (1940) are considered the first researchers to attempt the large scale identification of wood charcoal with the aim of reconstructing past vegetation. Although their work was instrumental for the discipline it did not take cultural factors into account and thus is of debatable value for current methodology. The groundwork of Salisbury and Jane was continued by Cecilia Western, producing a thesis analysing the wood charcoal from Jericho (Western 1971).

However, it was the research of Jean-Louis Vernet at the University Montpellier that has formed the methodological basis for anthracology as it is practiced today. Students from the French institute have been at the forefront of the discipline with significant contributions towards methodology and theory (Chabal *et al.* 1999; Figueiral and Mosbrugger 2000; Scheel-Ybert 2001). As a result, the field of anthracology has developed substantially within European archaeological research whilst its uptake in Pacific archaeology had been more recent.

### 2.2 Anthracology in the Pacific and Australia

A resurgence in anthracological research has recently occurred in the Pacific, resulting in several publications (Byrne *et al.* 2013; Dotte-Sarout 2011; Huebert *et al.* 2010) as well as post-graduate research at both the University of Otago and the University of Auckland (Allen 2013; Hand 2014; Huebert 2010; Maxwell 2015).



New Zealand and the wider Pacific present a rare opportunity to study human impacts on non-human modified environs. New Zealand was among the last to be settled by humans thus allowing anthropogenic impacts to be identified and investigated with comparative ease due to a shorter chronology. The late settlement also allows for a range of paleobotanical methods, including palynology and starch analysis (Horrocks and Barber 2005; Horrocks and Lawlor 2006; Horrocks *et al.* 2004), to be applied, providing a more comprehensive image of past vegetation as well as the impacts humans have had on the vegetation.

The resurgence in anthracology within the Pacific has centred firmly on the advancement of the theoretical framework. The research being undertaken within the Pacific can be placed in the wider context of adapting the anthracological methodology developed in temperate Europe to tropical climates (Scheel-Ybert 2001). The application of international theories to local environments has been an important focus; in particular understanding the effect of sampling on results (Dotte-Sarout 2011) and building reference collections for the Pacific.

## 2.3 Subsistence

### Plant Management

Anthracological analysis proves a useful tool for identifying and investigating subsistence strategies. Within the Pacific, anthracology has been used to identify the presence, or absence, or introduced Polynesian cultigens (Allen *et al.* 2005; McCoy *et al.* 2010; Millerstrom and Coil 2008). It has also been utilised to identify changing interactions with native species (McWethy *et al.* 2009, 2010 and 2014).

The cultivation of tree species as a food resource, formally known as arboriculture, has been a significant area of study within Pacific archaeology. The introduction of breadfruit (*Artocarpus altilis*) in the Pacific is one example where anthracology has contributed to existing research. Within both the Marquesas and Hawaii, the accepted date for the introduction of breadfruit has been pushed back through the identification and subsequent radiocarbon dating of breadfruit charcoal (Millerstrom and Coil 2008; McCoy *et al.* 2010). The work of Millerstrom and Coil (2008) pushed the accepted date of a breadfruit-centred arboriculture back “several centuries before contact” (Millerstrom and Coil 2008, 346). The introduction of breadfruit in Hawaii has also been subjected to investigation through the carbonised remains of the breadfruit tree. The work of McCoy *et al.* (2010) suggests a new chronology for the introduction of breadfruit in the north-eastern Kohala district of Hawaii (Allen 2004; McCoy *et al.* 2010).

An example from a little closer to home is that of the kopi (*Corynocarpus laevigatus*) on Rekohu, Chatham Islands (Maxwell 2015). The kopi produces carbohydrate rich drupes which require significant processing before becoming safe for consumption. Despite high labour costs, the kopi represented a significant carbohydrate source for the Moriori of the Chatham Islands. The under representation of kopi compared to the expected presence from charcoal records has led Maxwell (2015) to argue for the active management of the kopi. The anomalous representation of an expected species was identified through anthracological analysis, thus identifying cultural practices of plant management.

## Modification of vegetative communities

Anthracology can also be utilised to identify the modification of original, or existing, vegetative communities for subsistence. The accepted boundary of introduced crops in New Zealand is Banks Peninsula (Barber 2004; Furey 2006), resulting in a heavy reliance on native species such as bracken (*Pteridium esculentum*) and cabbage Tree (*Cordyline australis*) as a source of carbohydrates (McWethy *et al.* 2010; 21347) south of this boundary. Unlike the introduced Polynesian cultivars, these southern carbohydrate sources were not actively gardened in general (see Leach and Stowe 2005 for possible exceptions). Instead, their growth was encouraged through the anthropogenic alteration of the vegetative landscape (McGlone *et al.* 2005, 177). Optimal conditions were achieved by “firing stands to reduce woody competition and rejuvenate the underground rhizome network” (McGlone *et al.* 2005, 177; McWethy *et al.* 2010). The identification of dramatic environmental change at sites of human occupation can be undertaken through vegetation reconstruction of stratigraphically distinct contexts.

## 2.4 Architecture

The value of anthracology as an archaeological tool is particularly evident when it is applied to identifying construction materials. Wood requires a narrow range of conditions in order to survive in the archaeological record. Wetland sites, such as swamps or lakes, provide anaerobic conditions. These environments prevent decomposition of the organic wood material. Excavation of water logged sites, such as Kohika (Irwin 2004) provide rare insights into the wooden material culture. On a larger scale, structures can survive when wooden elements, such as posts, have been burnt in-situ. Thus the structural element is preserved both in form, allowing it to be identified as a structural element, and botanically so that it can be identified to taxon.

Through their anthracological investigation of Tahitian house post remains, Kahn and Coil (2006) have shown a relationship between the species used for construction and the status of the structure. Their study made use of ethnohistoric data to identify which species of trees were “sacred or ritual species” (Kahn and Coil 2006, 319). Their results identify the presence of the Breadfruit tree species, a sacred species, within both ‘specialised houses [...] and the high status dwelling’ (Kahn and Coil 2006, 338). Breadfruit was not present, however, at the “lower status sleeping house” (Kahn and Coil 2006, 338). This allowed Kahn and Coil to recognise a relationship between the inherent value of the tree species and the function and status of the dwelling.

While Kahn and Coil’s investigation utilised anthracological analysis as the central investigative tool, it can also be applied as a complementary approach. A local example can be found in the investigation into the form and construction of the Makotukutuku house in Palliser Bay (Leach *et al.* 1999). The identification of wood charcoal recovered from the charred remain of house posts was undertaken as part of a larger study of the single construction. The species identified included manuka (*Leptospermum scoparium*) and totara (*Podocarpus totara*) (Leach *et al.* 1999). The identification of totara, a species not found in the immediate vicinity, implied that construction materials were brought into the locale. Here, anthracology has contributed to the wide knowledge of the makotukutuku house, suggesting that the building material was introduced (Leach *et al.* 1999).

## 2.5 Radiocarbon dating

As an organic material, plant charcoal is well-suited to the process of radiocarbon dating. The appropriateness of wood charcoal as a dating material becomes less suitable when questioning what event is being dated. A number of large tree species within New Zealand are capable of living for hundreds of years (Wardle 2011; 25). As such the concept of 'in-built age' is applicable. Inbuilt age has been defined as the "difference in age between the death of the sample and the archaeological event dated" (McFadgen *et al.* 1994, 223). In order to avoid such an occurrence, it is considered best practice to use charcoal or wood samples from short-lived species. Short lived species have been considered "those with a potential life span < 100 yr" (McFadgen *et al.* 1994, 224). Recent discussion within Polynesian archaeology has called for stricter regulation of what is considered a 'short-lived' species with Allen and Huebert (2014) calling for a standard of 10 years.

This application of charcoal identification has been in use for several decades within New Zealand archaeology (Higham and Jones 2004). Higham and Jones note that "prior to 1976 [...] wood charcoal was not routinely screened to remove potentially old wood material" (Higham and Jones 2004, 219). The effect of a non-specific selection radiocarbon sample can be seen in the example of the 1978 excavations of Purakaunui. The charcoal samples subjected to radiocarbon dating methods were identified after dating as consisting of *Coprosma ?spp.* and *Podocarpus ?spp.* As a result this date of  $1030 \pm 60$  B.P. was deemed 'suspect' by Anderson who argued instead for a 14<sup>th</sup> century site chronology based on marine shell ages (Anderson 1981, 204).

## 2.6 Non-cultural charcoal

Anthrachology is only applied to culturally produced charcoal. The analyses of naturally produced charcoal is most commonly undertaken in relation to palaeoenvironmental research and has been used to study natural fire events (Scott 2000, 2009), climate change (Power *et al.* 2010) and reconstruction of past environments (Figueiral and Mosbrugger 2000). As McGlone (1983, 1989) and McWethy *et al.* (2009, 2010 and 2014) have demonstrated, non-cultural charcoal can also be used to investigate human actions. The use of non-cultural charcoal to infer anthropogenic actions introduces a bias of environmental data into the archaeological record. This bias is why the model for the IBP can be tested through analysis of culturally-produced archaeological charcoal. Analysis of archaeological charcoal can be used to interpret the rates and nature of anthropogenic deforestation at the level of individual sites. This in turn can be used to provide regional models for burning practices that considers both the chronology and functions of individual archaeological sites.

This chapter functions only as brief introduction to the many applications of anthracology. As a palaeoethnobotanical tool it is a valuable accompaniment to investigations relating to human-environmental interactions. Anthracology informs on both how the people have impacted entire vegetative communities as well as interactions with individual species. The methodology briefly discussed here will be further explored in the following chapter.

### 3. Background

In this chapter I explore the background of the two sites at the centre of this investigation; Shag River Mouth (J43/2) and Purakaunui (I44/21). This background encompasses both the environmental history of the sites and the archaeological work associated with each site. The history of archaeological investigation is considered as the on-site sampling is the first step of the curation process. The current interpretations of the sites are identified to provide a cultural background for the anthracological results.

Understanding the environmental history is fundamental to interpreting the results of the anthracological identifications as it provides a context for the taxa identified and a beginning for the assessment of the charcoal assemblage's suitability for retrospective anthracological analysis. The vegetation that existed during human settlement is reconstructed using palaeobotanical data. Key species from within this reconstruction are described.

#### 3.1 Sites background

Shag River Mouth:

Shag River Mouth is located on the Otago coastline, approximately 70km north of Dunedin (Anderson and Smith 1996a, 1). As indicated by the name the site occupies the mouth of the Shag River as it flows into the Pacific Ocean. As is common with river mouths in New Zealand, an estuarine environment has formed with an accompanying dune system. It is within these dunes that the Shag River Mouth site is located.

The site is one of the most well-known archaeological sites in southern New Zealand, a fact that has resulted in numerous excavations from the late nineteenth century (Anderson *et al.* 1996; Anderson 1989)

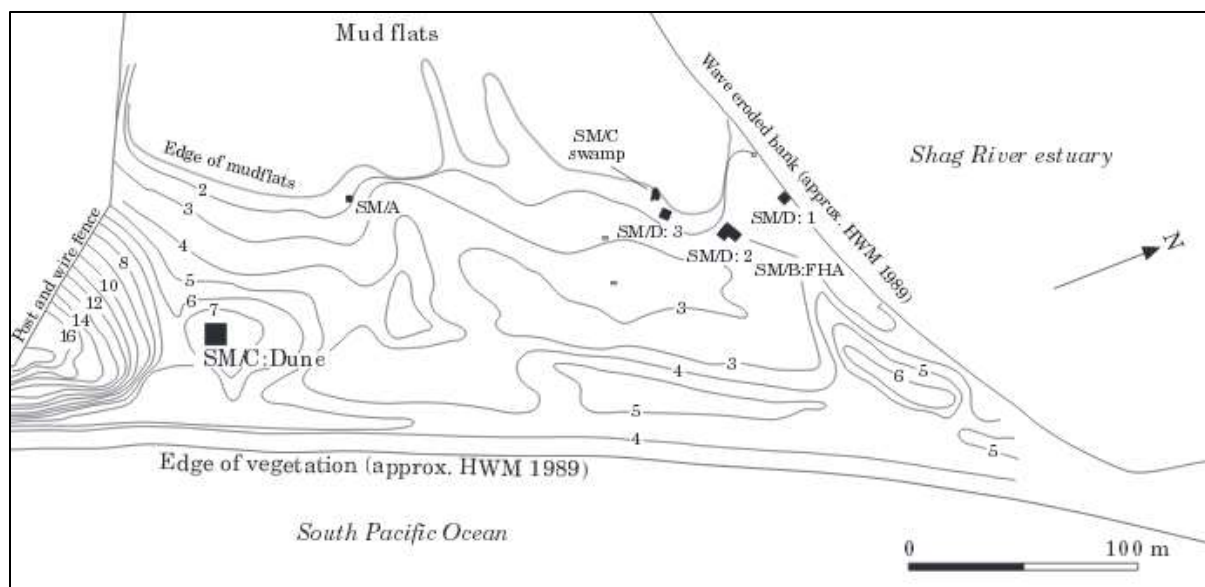


Figure 3. Site plan showing the location of excavations November 1988-1989 (Anderson and Allingham 1996: figure 5.1)

#### Historic excavations

The site's long history of excavation presents a litmus for the changing attitudes towards prehistoric settlement theories. It began its illustrious career in the context of Julius Von Haast's 'Moa Hunter' interpretation, which proposed separate entities of primary moa hunters and later ancestral Maori (Anderson and Smith 1996a, 2). Von Haast had undertaken brief excavations which yielded midden and provided him with material corroborating evidence of distinct midden separations with no moa bone appearing in the upper fish and shellfish middens.

This proposition was in turn debated by the Director of the Otago Museum, Captain Frederick Hutton. In order to provide damning evidence against Von Haast's theory Hutton engaged the services of Bayard Booth to excavate an extensive area of Shag River mouth. The result of Booth's excavation was evidence that the two distinct layers of midden in fact both contained fish, shellfish and moa bone. For Booth this reflected the single 'racial' identity of those who made the midden (Booth in Anderson 1989, 68). This created an impasse between Hutton and Von Haast which remained firmly in place until further excavations (Anderson and Smith 1996a, 4).

Shag River Mouth became a magnet for amateur archaeologists in part due to its fame and the material culture that was being recovered from the site at the time. Among the amateurs was one David Teviotdale, who excavated a significant portion of the site over a period of 26 years. These excavations were focussed largely on the collection of material culture until the involvement of H.D. Skinner, Director of the Otago Museum, resulted in more detailed accounts and records. Teviotdale was not the only antiquarian interested in the site and numerous finds were made by G. Griffen

(Anderson and Smith 1996). The prolonged and variable extraction methods undertaken at Shag River Mouth had resulted in a patchy assemblage of artefacts and information.

#### *Smith and Anderson excavations*

The numerous excavations and less informative fossicking activities that had been undertaken at Shag River Mouth served the dual purpose of highlighting the importance of the site to the chronology of the South Island, and providing a muddled and inconsistent record. Despite the record of site modification it was decided by Ian Smith and Atholl Anderson to test the proposal that surviving archaeology would provide evidence of “a lengthy occupation beginning earlier than in other sites in southern New Zealand and spanning the entire Archaic phase” (Anderson and Smith 1996b, 276).

Preliminary small excavations were undertaken by Anderson in 1987 in order to determine the best location for extensive excavation (Allingham and Anderson 1996). These later excavations resulted in a season of excavations and a field school for the University of Otago archaeology programme (Anderson and Allingham 1996; Smith 1996). The small, initial excavations were located in areas identified by Brian Allingham in 1968 (Allingham and Anderson 1996, 35) and took the form of three small excavations and four test pits (Allingham and Anderson 1996). These test pits and small excavations revealed that there were areas of the site that still contained undisturbed stratigraphy, and thus were suitable for further investigation.

A season of excavation followed in the summer between 1988 and 1989. Two large areas were the focus of the investigations and a programme of test-pits was continued (Anderson and Allingham 1996, 39). The areas that were of particular interest to the excavators were the high dune area and the lower swamp. The high dune area was chosen as it was anticipated that the deep build-up of sand above any cultural material would have resulted in an environment in which excavation was difficult thus protecting it from earlier excavations (Anderson and Allingham 1996, 39). The second area subjected to significant excavation was that of the swamp where earlier excavations by Teviotdale had unearthed a wooden bowl (Anderson and Allingham 1996, 39). The high dune excavations (SM/C:Dune) will be the focus of this research as it is from within this section of the excavation that material is being analysed.

#### *SM/C:Dune high dune excavations*

This supposition of protection by a deep build-up of sand was proven correct when 1988 test trenching revealed upper stratigraphy (Anderson and Allingham 1996). A small bulldozer was employed to remove the loose sand above the stratigraphy, with spades used to clear an 8 x10m



area (Anderson and Allingham 1996). The excavation revealed a total of twelve stratigraphic layers with a depth of up to 2.5 meters (Anderson and Allingham 1996). Despite the depth and number of stratigraphically distinct layers radiocarbon dating on material in SM/C:Dune, where there are “nine cultural layers extending up to 2.5m deep” (Anderson and Smith 1996b, 278) does not identify any statistical significance between the dates for the uppermost and lowest layers.

Atmospheric samples (see table 1) from the radiocarbon dating regime (Anderson, Smith and Higham 1996) were recalibrated using the appropriate terrestrial curve (SHCal 2013) (Hogg *et al.* 2013). A total of eight dates from both plant charcoal and moa eggshell, at 95% confidence, confirm an occupation period within the late 13<sup>th</sup> Century to early 15<sup>th</sup> Century, as seen in figure 4.

Table 1. Conventional radiocarbon ages before present (CRA BP) using OxCal v4.2.4 Bronk Ramsey (2013). SHCal13 atmospheric curve (Hogg *et al.* 2013). Shag River Mouth, SM/C:Dune.

| Lab No. | Stratigraphic context: Layer-unit | Material | CRA      | Identification   | Cal yr. AD. 68% probability (% area)     | Cal yr. AD. 95% probability (% area)   |
|---------|-----------------------------------|----------|----------|--|--|--|
| NZ7757  | 5-D5                              | Charcoal | 537 ± 44 | <i>Hoheria</i> 100%  | 1408-1411                                | 1325-1341 (2.3%)<br>1389- 1461 (93.1%) |
| Wk2416  | 5-E5                              | Eggshell | 600 ± 50 | Moa  | 1321-1349 (24.3%)<br>1386-1428 (43.9%)   | 1301-1365 (38.3%)<br>1375-1444 (57.1%) |
| NZ7756  | 6-C6                              | Charcoal | 670 ± 47 | <i>Hoheria</i> 95%, <i>Myrsine australis</i> 5%  | 1301-1363 (54.4%)<br>1376-1391 (13.8%)   | 1285-1405                              |
| WK2417  | 6-F2/E2                           | Eggshell | 560 ± 45 | Moa  | 1399-1439                                | 1320-1350 (9.9%)<br>1385-1454 (85.5%)  |
| NZ7755  | 7-B7/8                            | Charcoal | 646 ± 47 | <i>Hoheria</i> 99%, <i>Hebe</i> 1%   | 1311-1359 (47.7%)<br>1379-1401 (20.5%)   | 1291-1415                              |
| Wk2589  | 7-B4                              | Charcoal | 630 ± 35 | <i>Hoheria</i> 100%  | 1319-1351 (43.4%)<br>1385-1403 (24.8%)   | 1300-1366 (58.1%)<br>1374-1418 (37.3%) |
| Wk2604  | 8-I3/4                            | Eggshell | 570 ± 45 | Moa  | 1394-1439                                | 1319-1351 (14.5%)<br>1385-1451 (80.9%) |
| NZ7771  | 11-A6                             | Charcoal | 660 ± 46 | <i>Pseudowintera colorata</i> 60%, <i>Leptospermum scoparium</i> 30%, <i>Pittosporum</i> 10% | 1308- 1361 (51.9%)<br>1378- 1395 (16.3%) | 1290-1407                              |

McFadgen *et al.* (1994) identified the genus *Hoheria* as being of medium life expectancy, classified as 100-300 years although noted that “Life span can be much shorter than designated years” (McFadgen *et al.* 1994, 224). This note is pertinent as charcoal from the short-lived *Plagianthus* species was also included. All other identified charcoal samples (*Myrsine australis*, *Hebe*,

*Leptospermum scoparium*, and *Pseudowintera colorata*) are categorised as short lived species with a life expectancy of < 100 years (McFadgen *et al.* 1994). Moa eggshell is a preferred radiocarbon dating material as it has minimal inbuilt age and is resistant to contamination (Higham 1994; Jacomb *et al.* 2014). These dates are considered in the site interpretation.

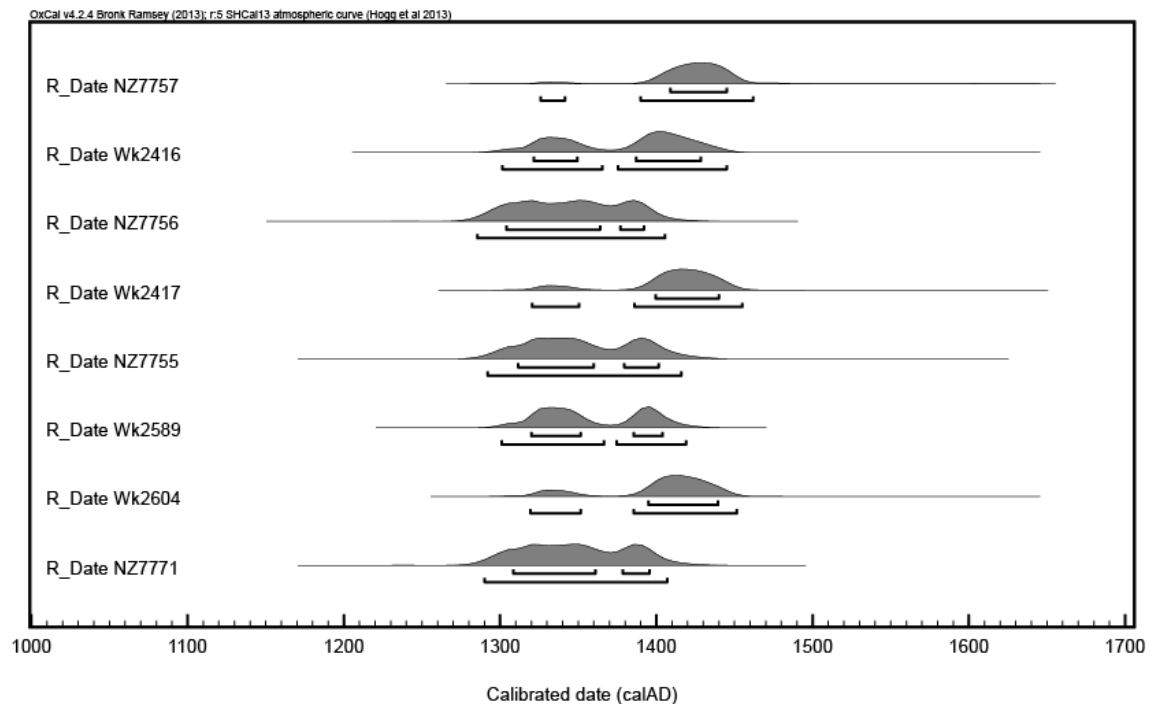


Figure 4. Calibrated ages for SM/S:Dune terrestrial  $^{14}\text{C}$  dates after OxCal v4.2.4 Bronk Ramsey (2013). SHCal13 atmospheric curve (Hogg *et al.* 2013).

As this anthracological analysis is focussed on only two of the early layers a full summary of the stratigraphy will be replaced with a more detailed description and comparison of the relevant layers, 11 and 7, with a full summary of the stratigraphy found in the Shag River Mouth publication (Anderson, Allingham and Smith 1996).

The first layer to be examined is layer 11. This was the lowest cultural layer, although there was relatively little cultural material aside from a small number of flaked chalcedony and silcrete tools (Smith *et al.* 1996). Despite the lack of material culture layer 11 had a significant number of oven features (Anderson and Allingham 1996). The ten oven features, as seen in figure 4 ranged in size, with faunal remains including various moa species (*Emeus* and *Euryapteryx*) (Anderson, Worthy and McGovern-Wilson 1996) as well as a range of mammal; rat (*Rattus exulans*), fur seal (*Arctocephalus forsteri*), sea lion (*Phocarctos hookeri*) and dog (*Canis familiaris*) (Smith 1996). The high occurrence of New Zealand quail (*Coturnix novaezelandiae*) within the small bird assemblage indicates that open

grassland or swampy grass was accessible from the earliest period of occupation at Shag River Mouth (McGovern-Wilson *et al.* 1996).

The stratigraphic relationship between the oven features suggested a complex pattern of site re-use, a theme reflected in the identification of 'Upper' and 'Lower' aspects within the single layer. The charcoal assemblages recovered for layer 11 were all sourced to units that are identified on the figure below (figure 4) as firescoops or associated matrix. Firescoops, as primary contexts, are not suitable for vegetation reconstruction however the sampling of firescoops is not uncommon and must be considered in the assessment of curated charcoal assemblages.

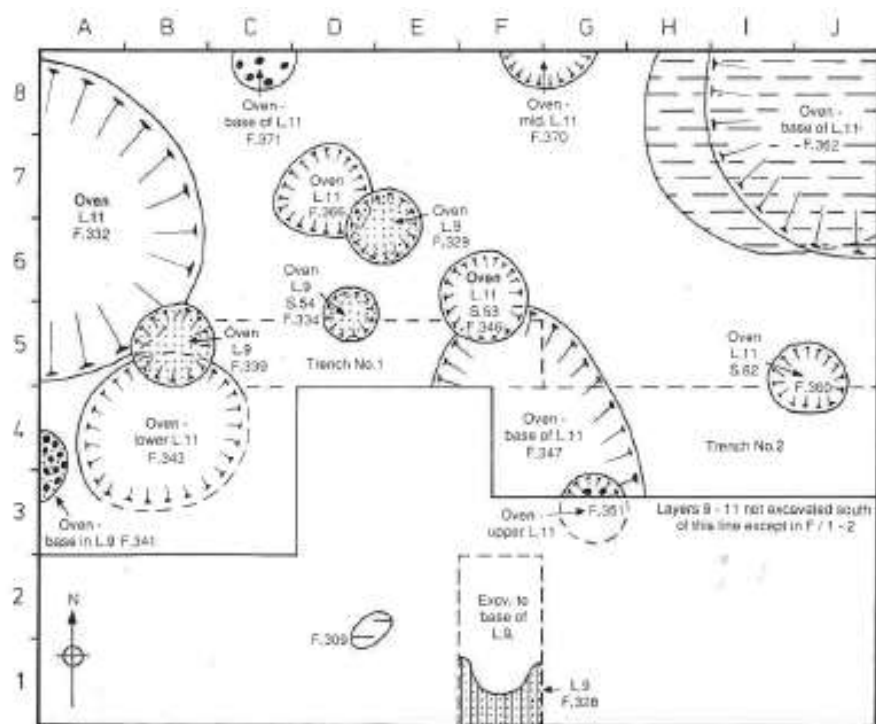


Figure 5. Excavation plan of SM/C:Dune, layer 9-11. (Anderson and Smith 1996, figure 5.10)

Although layer 11 is the lowest, and therefore oldest layer of the SM/C:Dune site it is not suggested that it represents the earliest evidence of human occupation at Shag River Mouth by Polynesian colonisers. The results of the programme of radiocarbon analysis show little statistical difference between the oldest and youngest dates from across the site (Anderson, Smith and Higham 1996). The short occupation of the site (Anderson, Smith and Higham 1996, 67) makes it difficult to distinguish the chronological relationship between the excavated units. Although SMC:Dune layer 11 is no doubt related to early occupation at the site it cannot be unequivocally stated to be the representation of first vegetative interactions.

The second layer selected for sampling and analysis was layer 7. This layer is described as a “cultural layer of charcoal darkened sand, rich in cultural material” (Anderson and Allingham 1996, 47). This thin layer was relatively undisturbed by subsequent occupation, however it did contain a number of oven scoops in the north and west portions of the excavation area. It is one of these oven scoops that has provided the charcoal material for this layer.

All of the available material for layer 7 is excavated from feature 302. Identified on figure 6, feature 302 was classified as a ‘large oven’ and thus was “certainly used more often” (Anderson and Allingham 1996, 48) than the smaller ovens scattered across the excavation. Therefore it can be reasonably argued that feature 302 was a multi-use oven. A subsampling strategy was applied to this feature in order to ensure a more representative sample.

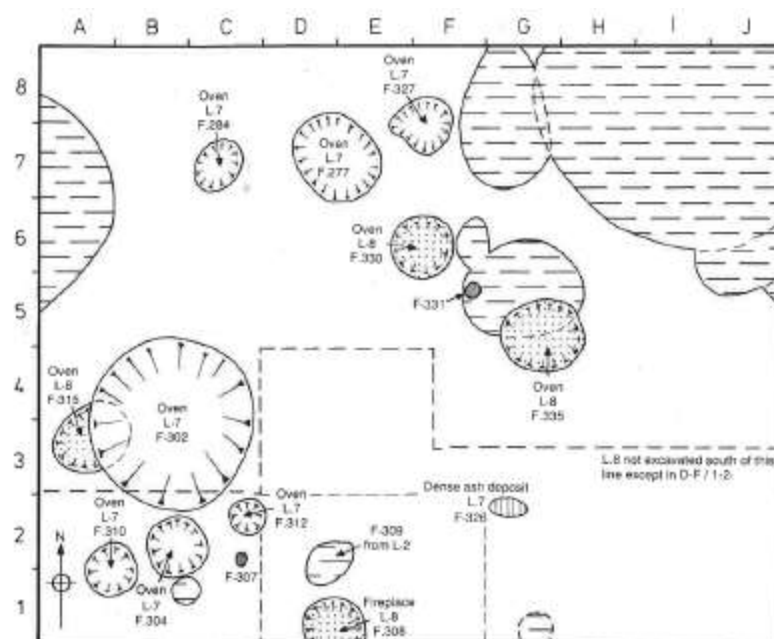


Figure 6. Excavation plan of SM/C:Dune, layer 7-8. (Anderson and Smith 1996, figure 5.9)

#### *Summary of site interpretation*

The interpretation of the site marked a considerable development in the archaeology of Polynesian settlement in southern New Zealand. Prior to the investigations of Anderson and Smith (1996) it had been hypothesised that the archaeological site represented at Shag River Mouth was one of a lengthy occupation; the diversity of artefacts and sheer number of hearths suggesting occupation over a significant portion of the Archaic period (Anderson and Smith 1996; Davidson 1984, 7). The systematic excavation at the site, the analysis of excavated material, and the use of radiocarbon dating provided evidence of an alternative site use. Anderson and Smith surmised that the supposedly long occupied site instead “represented a brief occupation during the 14<sup>th</sup> century” (Anderson and Smith 1996, 276). This is supported by the recalibrated dates (see figure 4).

Although described as ‘brief’ the occupation at Shag River Mouth was hypothesised to be a period of up to 50 years (Anderson and Smith 1996). The central element of the site’s interpretation is that it was considered to have been *continuously occupied* within this approximate 50 year period. This creates a marked difference between the seasonally utilised settlements that are typical of the ‘Archaic’ period in southern New Zealand (Anderson and Smith 1996c; ) A lack of significant weathering on faunal remains between stratigraphic layers at SM/C:Dune (Anderson and Smith 1996, 278) suggests that no significant periods of exposure, and thus abandonment, occurred. It is also suggested that Shag River Mouth village was a base camp for a more extensive settlement system (Anderson and Smith 1996).

Material submitted for radiocarbon dating was sourced from 14 of the total 25 cultural layers identified site-wide with a further seven layers through association (Anderson and Smith 1996, 278). The results of the radiocarbon dating programme presented mean charcoal dates which “gives a 1 $\sigma$  range between AD. 1330-11346 [...] and 1393-1408” (Anderson, Smith and Higham 1996, 67). In this thesis I follow the interpretation that Shag River Mouth was occupied for no more than 50 years during the 14<sup>th</sup> century AD (Anderson and Smith 1996).

The radiocarbon results for SM/C:Dune shows that through the 2.5 metres of stratigraphy “there is no statistically significant variation between the dates for the uppermost and lowest layers” (Anderson and Smith 1996, 278).

It is not suggested that the entire village site was simultaneously occupied for the duration of occupation. The layout of the village site includes several distinct areas of specialised function. SM/C:Dune, the source of the material analysed in this research, was defined as a ‘butchery, cooking and midden’ area (Anderson and Smith 1996). The faunal remains found within the stratigraphy of SM/C:Dune show an early reliance on big game (fur seals and moa) which disappears after layer 6 and is replaced with an increase in both finfish and shellfish (Anderson and Smith 1996). This transition in subsistence strategies was hypothesised to be the result of resource depletion, and ultimately a potential reason for the abandonment of the site (Anderson and Smith 1996, Nagaoka 2002). Changing resource use is also visible in the small bird assemblage with the incidence of quail within the faunal record increasing over time, with Kirk (1989) noting that quail “increased from 15% [of the total sample] in layer 11-6, to 31% [of the total sample] in layer 5-0” (Kirk 1989, 38). Such an increase indicates that the quail’s open grassland habitat has become more prevalent.

This interpretation of the archaeological site has ramifications for what is expected in the anthracological record. This is manifested largely through two aspects; the vegetation at the time of occupation and the patterns of fuel collection. The reconstruction of vegetation was well established

at the site through pollen core analysis and is discussed later within this chapter ( see Background; palynological reconstruction). The patterns of fuel collection however must be considered in relation to the expected results of the anthracological analysis.

Key to this interpretation is the assertion of a 'continuous' settlement. A continuous occupation at the site, although for no more than 50 years, will result in a more significant and sustained human impact on the surrounding vegetation. As the site is continuously occupied the initially available woody resources close to the site will be exhausted and vegetation from further afield will be targeted for fuel collection. This can be expected to be displayed in the anthracological record as a transition from high fuel value species within the "dense, salt-tolerant shrubbery" (Anderson and Smith 1996, 285) species found immediately around the village to species with a lower fuel value.

## Purakaunui

First investigated by Anderson in 1978 (Anderson 1981), Purakaunui is located on a dune system at the mouth of the Purakaunui Inlet approximately 15km northeast of Otago harbour. The dune system sits upon a boulder bar that was visible along the western edge of the dune (Anderson 1981).

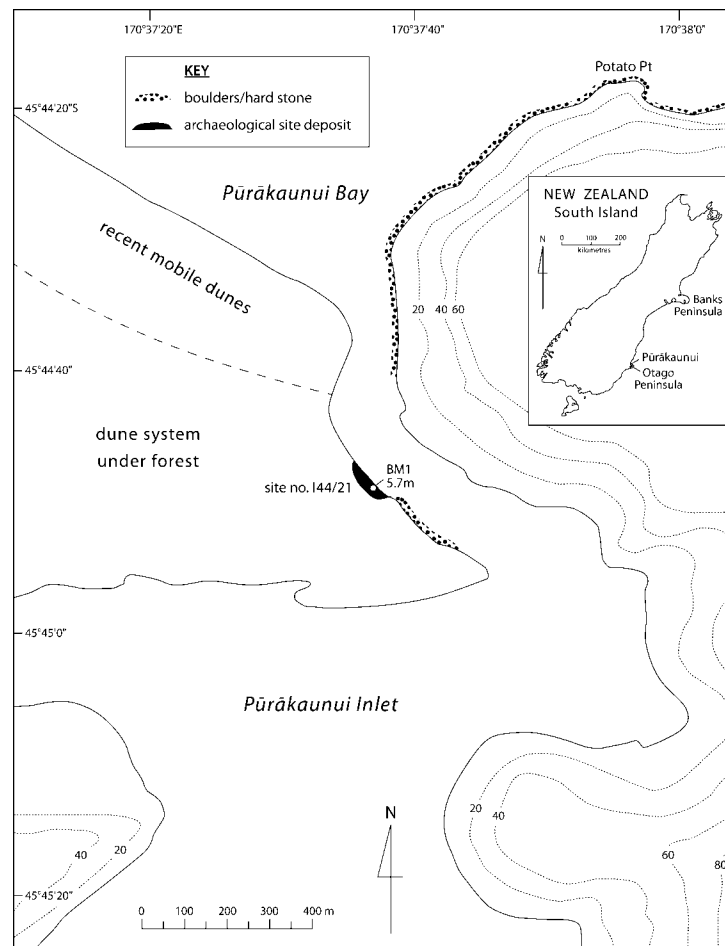


Figure 7. Map of Purakaunui

### Anderson excavations, 1978

Atholl Anderson's attention was drawn to Purakaunui through concerns for the site's stability as significant erosion to the dune had been noticed. A staff member at the University of Otago at the time, Anderson was well placed to investigate the local site, which had been recently planted with Pines (*Pinus radiata*). An initial survey of the site by Anderson deemed the Northern area (see figure 8) at a higher risk of erosion, consequently his excavations were focussed there in order to preserve, in record, as much as possible of the site. Several test-pits were placed over in the Southern area as

well (Anderson 1981). . As a result of a comparison of the northern and southern aspects Anderson came to the conclusion that they were “stratigraphically unconnected” (Anderson 1981, 203).

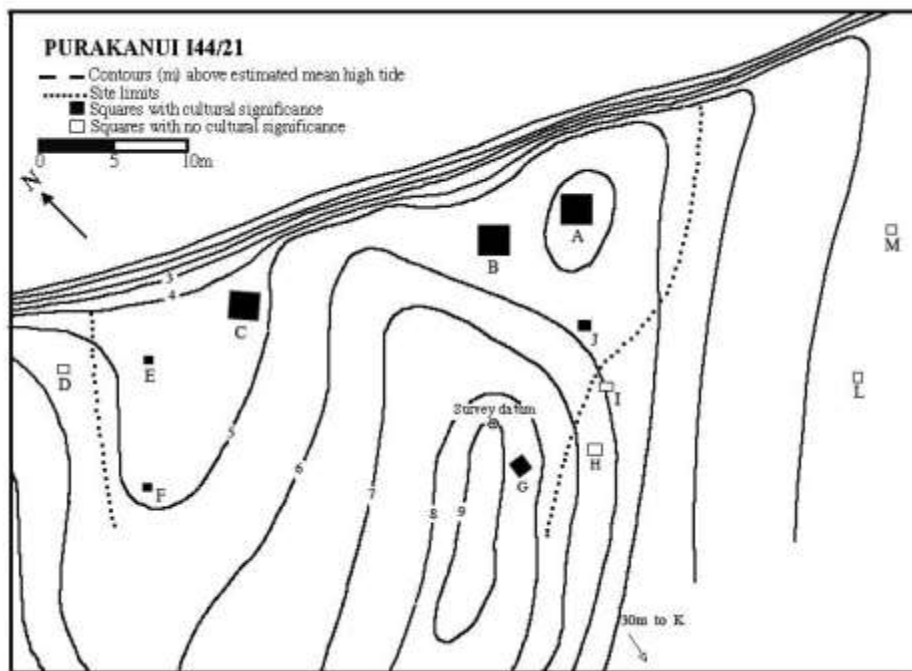


Figure 8. Plan of S164/18, northern area, showing excavated squares (A-C) and test pits (D-M). (Anderson 1981: figure 2).

Within the high dune Northern area, Anderson opened three excavation units (see figure 8). The stratigraphy was largely uniform through the three excavation units and was as follows;

Layer 1: Sterile dune sand

Layer 2: A mixture of unburnt midden and blackened sand

Layer 3: A dense, heavily burnt shell midden

Additional features and layers were found in individual excavation layers including a further layer of unburnt midden (layer 5) in unit B and a compact lens of the same material in unit A (layer 2A). An oven feature had been cut into unit C from layer 2 (Anderson 1981, 204).

Anderson suggested that “any hiatus in occupation more than a few months would be stratigraphically observable as a barren sand layer or lens” (Anderson 1981, 214). As such layers were easily observed it could be implied that three briefly separated occupations had occurred at the site. Further analysis of the shellfish was undertaken in order to determine the patterns of occupation. It was suggested that the three occupation periods were “separated by no more than a matter of months in each case and all within the space of several years” (Anderson 1981, 217). The purpose of occupation was determined through the estimation of meat weights from the various



fauna identified in the midden. It was found that fish represented the greatest dietary contribution to the data which in turn led Anderson to his interpretation that “fishing was the principal function of the settlement” (Anderson 1981, 217).

These findings of Anderson were an important development for South Island prehistoric archaeology. Previously, specialised fishing camps were thought to have been a development of the later classic period of Maori settlement (Anderson: 1981, 219). The radiocarbon dates returned for the site suggest it was occupied in the earliest ‘Archaic’ period as defined culturally and chronologically at the time (Davidson, 1984).

#### *Barber and Walter, 2000s*

The site was once again the subject of investigation in the early 2000s when an increased rate of erosion prompted another archaeological assessment. Several inspections were conducted in 2000 by Ian Barber and Richard Walter where “evidence of [...] substantial site erosion” (Barber and Walter 2001) supported the commencement of a series of excavations in order to preserve the site through record. Permission was granted by the relevant bodies and salvage excavation was scheduled in order to function as the excavation component for the University of Otago field school paper ANTH405 (Archaeological excavation).

#### *Field school excavations*

Excavation was undertaken for three field seasons between 2001 and 2003, by Barber and Walter. Their work was carried out to the north and south of the high dune ridge identified as the northern site area by Anderson, and in particular the “small and clearly threatened eastern bench remnant” (Barber and Walter, 2001, 5).

During the first year a total of 6 square meters were excavated, however this was not a “sufficiently large area [...] to identify, sample, screen and assess the horizontal relationship of layers and features” (Barber and Walter, 2001, 7) and excavations were continued over the next two years. The area south of the dune ridge was excavated during all three field seasons, the discovery of pit features fuelling interest in this area. A smaller northern excavation was opened in 2002.

At the cessation of the field schools, a total of 28 square meters had been excavated, yielding a significant amount of midden and material culture. A significant portion of the recovered material has been incorporated into the course work aspect of the field school paper and also utilised for postgraduate research (Bull 2002; Gay 2004; Latham 2002, 2005; Lawrence 2012; Mitchell 2010).

Barber (pers. Comm. 2015) continued further excavations and sampling at the site outside of the field school excavation periods, and between 2003 and 2005.

### *Stratigraphy*

The northern side of the dune ridge, as excavated by Walter, had a dissimilar stratigraphy to that uncovered by Anderson. A single layer of cultural material was found and labelled layer 2 (Latham 2005). This cultural layer consisted of midden within which several fractured umu stones were found (Latham 2005, 43).

The southern excavation had a similar stratigraphy to Anderson's, with two distinct cultural layers. The stratigraphy as described by Barber and Walter (2002: 161-162) follows (see also figure 9);

Layer 1: A topsoil layer of wind deposited dune sand with light brown soil of varying depths, generally deeper than 10cm.

Layer 2: The uppermost cultural layer visible in the stratigraphy. It consists of shell and bone midden in a matrix of dark grey-black sand (see figure 9).

Layer 3: Positioned between the two cultural layers, scattered charcoal is found with over stones and midden within a greyish brown sand layer.

Layer 4: The oldest of the cultural layers, a discontinuous layer that again consists of midden and evidence of cooking including oven stones and "occasional umu" (Barber and Walter 201, 162). As this layer represents the oldest cultural horizon of the stratigraphy it is the earliest record of the environmental interactions of the inhabitants of Purakaunui.

Layer 5: The natural horizon of sterile light brown sand.

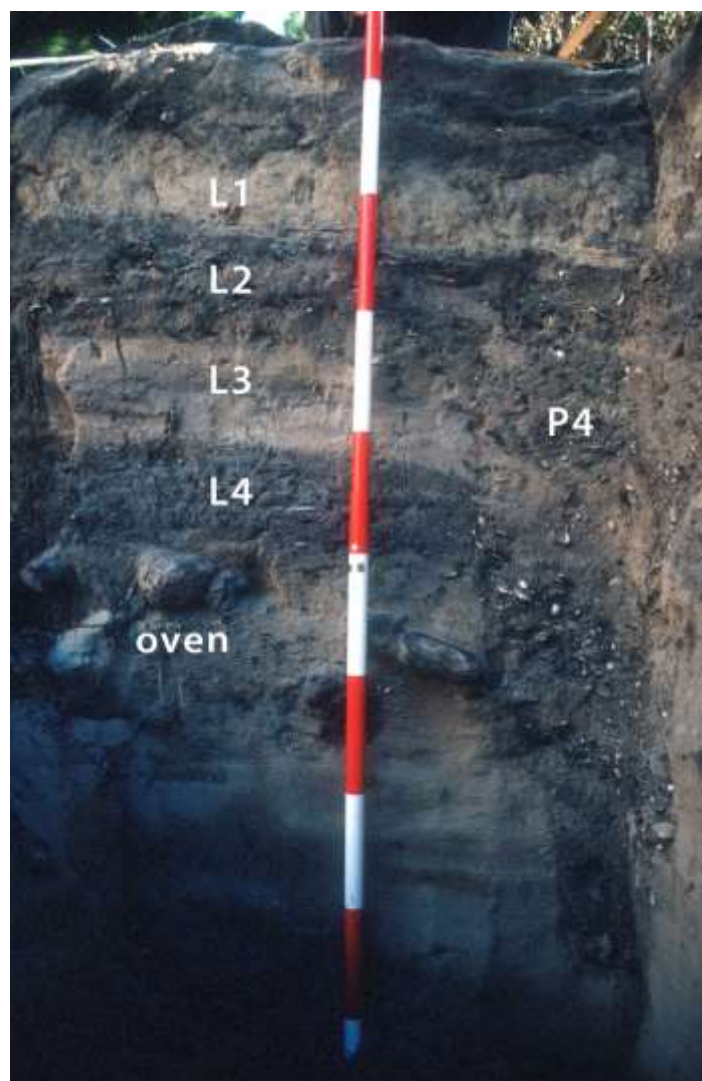


Figure 9. Photograph of southern area stratigraphy showing numbered layers and pit feature (P4) as discussed in text (western view, north-south section, mid-J5). Ian Barber, April 2003.

Radiocarbon dates for Purakaunui were generated as the result of the 2001-2003 excavation. The two distinct cultural Layers 2 and 4 were dated using both pipi (*Paphies australis*) (Latham 2005, 41) and plant charcoal. The more reliable and consistent short-life plant charcoal results are presented in table 2. These radiocarbon results are presented with the permission of Barber (pers. comm., August 2015). Each sample dated by AMS is a single carbonized plant fragment from a reasonably short-lived species (McFadgen et al. 1994). An outlier can be seen in sample Wk37501, which was a *Melicytus lanceolatus* stem.

The results of the radiocarbon dates indicate occupation occurred during the earlier 15<sup>th</sup> century, as visible in figure 10 below. This securely places Purakaunui as later than Shag River Mouth in the New Zealand chronology.

Table 2. Conventional radiocarbon ages before present (CRA BP) and calibrated age ranges (CAL AD) using OxCal v4.2.4 Bronk Ramsey (2013). SHCal13 atmospheric curve (Hogg et al. 2013).

| Context | Lab No.  | CRA BP | Identification                  | Cal yr. AD. 68% probability (% area)   | Cal yr. AD. 95% probability (% area)   |
|---------|----------|--------|---------------------------------|--|--|
| L2      | Wk-37504 | 492±22 | <i>Pseudopanax crassifolius</i> | 1435-1453                              | 1420-1460                              |
|         | Wk-37505 | 488±22 | <i>Melicytus ramiflorus</i>     | 1435-1455                              | 1420-1464                              |
| L4      | Wk-37501 | 655±20 | <i>Melicytus ?spp.</i>          | 1319-1351 (57.1%)<br>1384-1391 (11.1%) | 1301-1365 (71.8%)<br>1375-1399 (23.6%) |
|         | Wk-37502 | 542±21 | <i>Leptospermum scoparium</i>   | 1415-1436                              | 1404-1444                              |
|         | Wk-37503 | 521±20 | <i>Pseudopanax crassifolius</i> | 1424-1444                              | 1413-1450                              |

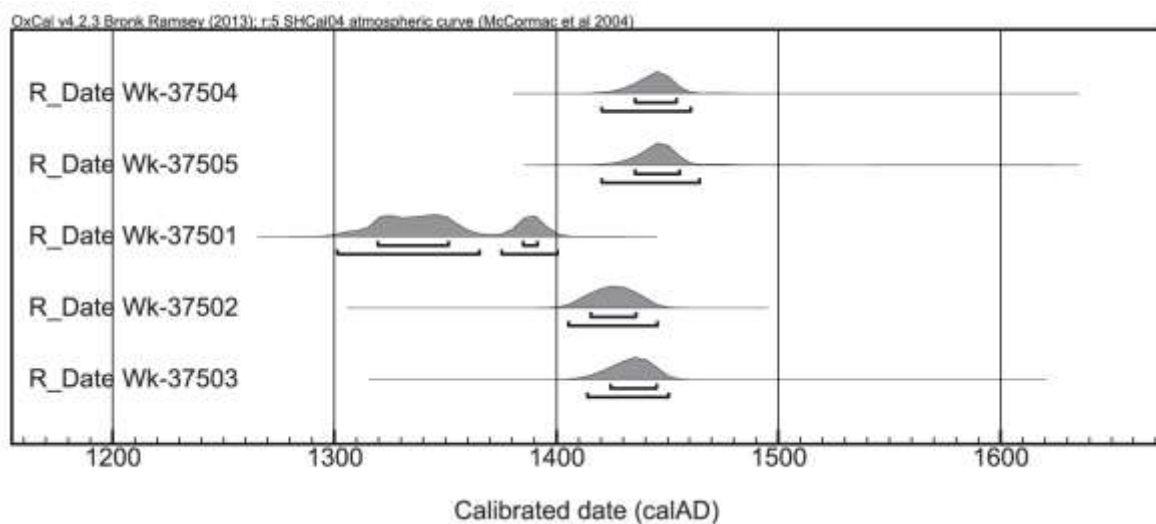


Figure 10. Calibrated atmospheric plant charcoal ages for Purakaunui <sup>14</sup>C dates.

An important outcome of the Southern area investigation is the identification of a series of archaeological features cut into the archaeological midden deposit. These were identified as ‘pits’. The features were not all completely excavated, with the exception of the largest pit feature (P3, see figure 19). P3 extends over a large portion of the excavated southern surface “between K and G to D4 at the eroding dune edge” (Barber and Walter 2002, 163). This large pit was an unexpected feature. Its attributes suggest an excavated below-ground storage structure. The presence of a noticeably straight edge along one side of the pit within the “mobile sand environment” (Barber and Walter 2002, 163) suggests that P3 was lined. In addition, postholes extend below the base of P3 and P2 at least which suggest the presence of supportive structures and a cover. Radiocarbon dates Wk-37504 and Wk-37505 are from layer 2. This layer caps P3 and P4 at least, so as to provide a secure 15<sup>th</sup> century chronology for the cut feature (Barber and Walter 2002).

The stratigraphy found in association with P3 has been classified as sub-layers of layer 2. Layer 2a is the upper pit fill of very dark grey-black sand with scattered shell midden or discrete shell midden lenses (Barber and Walter 2001, 161). Contained within this sub-layer were historic period cultural materials such as clay pipe and glass fragments (Barber and Walter 2002, 163). Layer 2b is the lower feature fill. It consists of shell midden and abundant fish bone in a dark sand substrate. The presence of joined shellfish valves and articulated fish bones are evidence of primary coastal processing.

#### *Summary of site interpretation*

The interpretations of the archaeological site represented by Purakaunui has altered between the primary excavations by Anderson (1981), Barber and Walter (2002) and recent research (Barber, pers. comm. 2015). Anderson provided a simple interpretation of a seasonal fishing camp; encouraged by evidence of extensive fishing (Anderson 1981) as well as significant sand build-up between the cultural layers (Anderson 1981).

This interpretation of a simple seasonal fishing camp was challenged by the results of the 2001-2005 excavations. Primary among them is the excavation of pit-features which suggest a less transient occupation. The presence of cut and lined (Barber and Walter 2002, 163) pits is highly suggestive of a storage function which in turn indicates a longer period of occupation. The AMS radiocarbon data for layer 2 provide strong evidence that the pit was filled and capped during the 15<sup>th</sup> Century AD.

## 3.2 Environmental History of Coastal East Otago

Though several disciplines can inform on past vegetation, the discipline that is most commonly applied in New Zealand is palynology. Palynology is the identification of pollen grains from sediment samples. Palynological investigations have been widely applied in New Zealand to ascertain information on both past vegetation and the changes it undergoes, specifically anthropogenic change such as large-scale burning practices (McWethy *et al.* 2009, 2010, 2014; Williams 2009).

The environmental history of coastal east Otago has been revealed through several palynological investigations. The most relevant investigation was undertaken in association with the 1988-1989 excavations at Shag River Mouth (Boyd *et al.* 1996). These cores revealed a series of vegetative shifts indicative of human modification and environmental adaption. Two further palynological investigations are consulted for vegetation reconstruction; the Glendhu drainage basin (McGlone and Wilmshurst 1999b) and the Ajax swamp (Johnson, Mark and Bayliss, 1977)

### Palynological reconstruction

The Palynological samples taken at Shag River Mouth included two cored samples (Waihemo A and Waihemo B, see figure 11) as well as a third sample recovered from the baulk of an excavated test pit (Boyd *et al.* 1996). As well as providing palynological data the three cores also provided information on the geomorphology of the region. The core closest to the archaeological site, identified on figure 11, below, as Shag Mouth core comprised of “organic peaty sand deposits” (Boyd *et al.* 1996, 257). These deposits are “associated with the sand and clay deposits of the Shag Mouth sand spit and the Shag River estuary” (Boyd *et al.* 1996, 257). The

The two inland pollen cores, Waihemo A, and Waihemo B, provide soil and environmental information on the catchment area above the archaeological site. This combined second sequence “comprises organic peaty and carbonaceous spring outflow sediments in a small valley which drains into the Shag River estuary near the archaeological site” (Boyd *et al.* 1996, 257). Together the three pollen cores provide information for the reconstruction of the environment around Shag River Mouth.

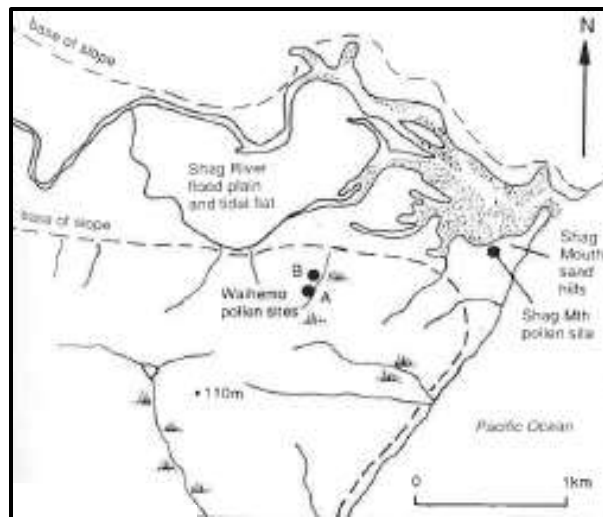


Figure 11. Location of Shag River Mouth pollen cores.

The results from the Shag Mouth core show four distinct periods of change. The first, and oldest, period was described as;

“A dense scrubland, with *Coprosma*, *Myrsine*, *Muehlenbeckia*, *Rubus* and various *Asteraceae* prominent covered the immediate environs of the salt marsh. [...] forest [...] was certainly abundant and diverse. We envisage a partly-deforested landscape, characterised by complex patterns of forest, scrubland, fernland and grassland” (Boyd *et al.* 1996; 262)

Anthropogenically induced change is seen in the second period;

“destruction of local scrub vegetation by fire, [...] an expansion of seral, fern dominated communities in the wake of destruction of forests and scrub.” (Boyd *et al.* 1996; 263).

As this research is utilising samples from the earliest layers of occupation (Layers 11 and 7) only the first two zones of vegetation from the Shag River Mouth palynological investigation are of relevance as the third zone includes the presence of exotic *Pinus* pollen, indicating the arrival of European settlers (Boyd *et al.* 1996, 263). The first and second zones represent the first interactions and anthropogenically induced changes to the pre-colonisation vegetation.

Although Purakaunui is not directly represented through a palynological investigation the Boyd *et al.* (1996) investigation can serve as a proxy as the environments the two sites occupy are comparable. The two sites are both situated in close proximity to both estuarine environments and established podocarp forests and thus share access to similar species, although Purakaunui is probably adjacent to the podocarp forest. This is supported by preliminary anthracological identifications which have indicated a number of species were present at both sites. These species include; *Podocarpus* ?spp.,

*M. australis*, *L. scoparium*, *P. crassifolius*, *K. robusta*, *M. ramiflorus*, *M. lanceolatus*, *S. microphylla*, and *P. taxifolia* (Allen 2013). It is noted however that the individual geographic settings differ as Shag River Mouth is located within an open estuary environ whilst Purakaunui is set in a more narrow valley-like inlet.

The mosaic of “forest, scrubland, fernland and grassland” (Boyd *et al.* 1996, 262) is explored in greater detail below to determine which species were likely to be present in each, and identify their ecological niches.

## Vegetation regimes

The composition of the forest as indicated in the Shag River pollen cores (Boyd *et al.* 1996) would have been dominated by conifer and broadleaf species.

The upper canopy of such forests consist of large trees that would break above the lower canopy and includes conifer species such as rimu (*Dacrydium cupressinum*), kahikatea (*Dacrydiodes dacrycarpus*) and totara (*Podocarpus ?spp.*). The composition of these large tree species would depend on environmental factors such as micro climates or the moisture of the soil, with species such as kahikatea preferring a damper soil (Wardle 1991, 21).

Beech trees (*Nothofagus spp.*) can also be found in the upper canopies of coastal forests. The lower canopies consists of species with medium to low light demands such as manuka (*Leptospermum scoparium*), kanuka (*Kunzea robusta*) and lancewood (*Pseudopanax crassifolius*). Non-woody species are also found on the forest floor and lower canopies but as they preserve poorly in the anthracological record will be considered only briefly (Asouti and Austin 2005).

Although coastal forest can be found as low as the high tide mark in southern New Zealand (Wardle 1991, 140), the drier climate of coastal Otago resulted in a mix of vegetation types. Scrubland and fernlands filled the intermediate land between the forests and the marine environment. These coastal scrublands consisted of species such as coprosmas (*Coprosma spp.*), toro (*Myrsine salicina*), mapou (*Myrsine australis*), Muehlenbeckia and various Asteraceae (Boyd *et al.* 1996).

As both sites are located immediately within dune environments coastal forest woods would have been the closest and most easily available fuel source. There are few woody species that can be found in dune environments, the salinity of the soil requiring specialisation. Saltmarsh ribbonwood (*Plagianthus divaricatus*) is often found at the fringes between estuarine and scrubland (Johnson 1998, 11).



The key taxa are discussed below with both their ecological niches and cultural uses by Māori considered.

Key indicator species:

Large trees:

*Matai (Prumnopitys taxifolia)*

Another member of the genus *Podocarpaceae*, matai is comparable with totara, capable of growing up to 25m high, although with a narrower trunk (Salmon 1980). Matai shares a similar distribution to totara, being found amongst the lowland forests of the North and South islands from sea level to around 600m above sea level (Wardle 2011). Although a combination of matai and totara is common in South Island podocarp forests matai has higher fertility needs, preferring environs such as “fertile alluvial soils” (Wardle 2011, 33).

Matai was used as a food source, the dark berries being seasonally available in summer and early autumn (Crowe 1990). The sap of the tree, sometimes called matai beer, was also consumed both as a medical tonic to “check advance of consumption” (Brooker *et al* 1987, 83) and as a refreshing beverage (Crowe 1990).

Matai wood was used in the manufacture of tools, with the excavations of waterlogged artefacts at Kohika (Irwin 2004) recovering the following artefacts fashioned out of matai: plank, bowl fragments, stakes and a shaft end knob on a digging implement (Irwin 2004).

*Totara (Podocarpus totara)*

Totara is among the largest of the native gymnosperms, reaching approximately 30m (Salmon 1980). Totara represents one of the giants of the conifer-hardwood forest, occupying the emergent canopy along with other members of *Podocarpaceae* and *Dacrydium*. Although a large tree, totara is not confined to inland forests but can be found from sea-level through to 600m (Salmon 1980). As totara is highly tolerant of dry conditions it has a widespread distribution throughout mainland New Zealand.

Traditionally totara was regarded as a valuable tree, both culturally and practically. It provided not only wood once felled, but a number of resources that could be harvested without killing the tree. These resources were small edible berries (Crowe 1990, Wardle 2011) as well as strips of bark that were used as a building material (Best 1934, 230). As totara was a tall tree with an upright trunk it was considered an ideal building material for large structures such as houses (see Anthracology;

construction; Best 1934; Leach *et al.* 1999) and waka (Irwin 2004; Tipa 2015). Totara was also used in the manufacture of smaller artefacts such as wakahuia, potaka and bowls (Irwin 2004). The usefulness of totara also extended to a number of medical uses, namely “to cure *paipai* (a cutaneous disease) and venereal disease in women” (Goldie 1999, 116).

## Medium trees:

### *Kanuka (Kunzea robusta)*

Kanuka is in many ways similar to Manuka; they share the same ability to quickly establish themselves in open spaces as well as that of an adaptive form. Although, like manuka, kanuka can grow as either a tree or a shrub its tree form is significantly larger than manuka's, up to 20m in height (Wardle 2011). Kanuka is also less tolerant of poor quality or wetter soils, preferring more fertile conditions. Both species are highly adept at colonising new scrubland, although their high light demands prevent them from regenerating so prolifically once under a forest canopy (Wardle 2011).

The leaves of kanuka, as well as manuka, can be brewed into a tea (Crowe 1990). Infusions of both tea-tree's are used for a wide variety of medicinal purposes (Brooker *et al.* 1987, Crowe 1990).

Kanuka also shares manuka's high quality as a fuel source (Wardle 2011). As well as a source of fuel, kanuka was a suitable material for the manufacture of utensils such as bird spears (Irwin 2004, 253).

Kanuka has recently been reclassified from a single species (*Kunzea ericoides*) to ten regionally specific sub-species (de Lange 2014). *K. robusta* is the only sub-species present on the eastern coast of Otago and thus all kanuka identifications can be considered *K. robusta*.

### *Kowhai (Sophora microphylla)*

One of the most distinctive of New Zealand trees, common kowhai is easily identified through the small feathery leaves and seasonal displays of yellow flowers. A divaricating shrubby plant when juvenile the species grows to a small or medium sized tree, with the upper limits of growth being 10-12 m (Wardle 2011).

Kowhai is distributed throughout the North and South Islands and can commonly be found within “coastal, lowland [...] forest margins [...] and in second-growth successional forest” (Wilson and Galloway 1993, 159). The species has high light demands and so although well suited to successional growth it will not flourish once the tall trees of the later stages of succession are established.

As with many of the species examined here, kowahi was considered to have medicinal uses including “an infusion of the bark [...] for internal pains, [and] for pains of the back or side. The inner bark of

kowhai is used for *hakihi* (itch).” (Goldie 1999, 113). The wood was also of such quality to be used in the manufacture of tools (Wardle 2011).

#### *Ngaio (Myoporum laetum)*

Ngaio can grow in a variety of forms, the most common being a medium sized tree. Ngaio can grow to approximately 10m in height, or conversely can survive as a low growing shrub (Wardle 2011). In optimal conditions ngaio can grow quickly, allowing it to be among the first colonisers, although high light demands place it with kanuka and manuka in its inability to regenerate under established forest.

Ngaio is found throughout New Zealand, although Dunedin is an approximate southern limit (Wardle 1991). Ngaio is typically a coastal plant, capable of tolerating coastal winds and a wide range of well-drained soil types (Wardle 2011). It can be found growing among sand dunes (Wardle 1991) as well as “almost down to high tide mark [...] on coastal cliffs or in lowland coastal forest” (Wardle 2011, 348). The uses of ngaio were largely medicinal, such as an aid against toothache as well as an insect repellent (Goldie 1999).

Although the fruit and berries of Ngaio are toxic (Crowe 1990), there are reports that the berries were consumed by Maori (see Crowe 1990 for more information).

#### Small trees and shrubs:

##### *Manuka (Leptospermum scoparium)*

Manuka is one of the most widespread New Zealand native trees (Wardle 2011) being commonly found in areas of vegetative succession. The success of manuka is in part due its ability to adapt to highly varied environmental conditions. It can vary from a tree between 4 to 8m in height (Salmon 1980; Wilson and Galloway 1993) to a more prostrate form “creeping and matted” (Wardle 1991, 27). When favourable conditions are present, such as when forest clearance has occurred, manuka and associated plant kanuka, are able to quickly establish themselves forming a mixed scrub that acts as a nursery for successive plants (Wardle 2011).

As well as playing an important role in forest succession manuka was used for a number of other purposes. Goldie (1903) lists the medicinal uses of the plant as “applied to scalds [and] to cositive infants. It is also taken by adults to allay coughing. An infusion of the bark is used [...] as a sedative. A decoction of the bark relieves diarrhoea and dystentry” (Goldie 1999, 114). As previously mentioned with kanuka, the young leaves are also used as a tea (Crowe 1990).

Expanding beyond medical uses, manuka is “much prized as a firewood” (Salmon 1980, 162) as well as being used for tool manufacture. Manuka was identified as the fabric of several artefacts recovered from Kohika (Irwin 2004) including: potaka (spinning tops), javelin darts, and ko (Irwin 2004).

#### *Mapou (Myrsine australis)*

Also known as red matipo, or simply matipo, *M. australis* is a small tree capable of growing from 3-6m in height (Wardle 2011).

Dispersed from coastal to low alpine environments mapou is found throughout the North Island, South Island and Stewart Island. The environmental niche inhabited by mapou is that of the forest margin as well as within open scrubland (Salmon 1980). It has been known to form a “solid wind-scrub” (Moore and Adams 1963).

As well as a fuel species, mapou was used medicinally as an infusion (Wardle 2011); the leaves were boiled and used as a treatment for toothache (Brooker *et al.* 1987).

#### *Olearia species*

Within New Zealand the genus consists of approximately 38 species (Wardle 2011) and they vary between woody shrubs and small trees. It is extremely difficult, and outside the technological limitations of this investigation, to identify between the *olearia* species on an anatomical level, hence the genus being treated as a cohesive whole. The *Asteraceae* family to which *olearia* belongs is represented ubiquitously throughout New Zealand and occur in “almost all major plant communities” (Wardle 2011, 309). Wardle (1991) notes that “on southern coasts woody composites with broad tomentose leaves in the genera *olearia* [...] can be abundant or dominant” (Wardle 1991, 72).

Some species which are likely to be present within the locale include; *Olearia lineata*, *O. bullata*, and *O. solandri*.

#### *Saltmarsh ribbonwood (Plagianthus divaricatus)*

This species is one of the few saline resistant species from the South Island that has a stem woody enough to be present in the anthracological record. The species can grow to a shrub approximately 1-2m in height (Wilson and Galloway, 1993) with “flexible, interlacing branchlets” (Wilson and Galloway 1993, 273). Saltmarsh ribbonwood’s distribution throughout New Zealand is strictly coastal where it is often found, as the name suggests, on the fringes of saltmarshes and estuaries (Wilson and Galloway 1993).

## Soil profiles

Although Purakaunui and Shag River Mouth share many environmental similarities they both possess distinct soil profiles. The soil profiles, as assembled using Landcare Research online soil classification database, show that despite both sites occupying dune environments the underlying soil variations are particular to their respective environments (Bonnington *et al.* 1964). Shag River Mouth can be characterised through three soil types. The first type is that found on the steep norther aspect of the estuary and is classified as 'Firm Brown' which indicates a very stable environment that could be associated with established forest. The dune site, although clearly coastal sand, has an underlying layer of calcareous rocks. Finally, the saltmarshes are classified 'Perch-grey Pallic' which refers to their slowly permeable nature and tendency to waterlogging.

Purakaunui, in contrast with Shag River Mouth, is located on a dune system identified as well drained coastal sand. The steep hill on the East of the tidal inlet was identified as 'fragile pallic' which means pale subsoils, that are susceptible to erosion. The tidal inlet itself consists of a young land surface commonly associated with flowing water. With the exception of the tidal inlet all of these soils can support plant growth.

The 'firm brown' soils of the sloping northern aspect of the Shag River Mouth estuary and the 'fragile pallic' soils are capable of supporting significant vegetative growth. Purakaunui particularly, provided sufficient stability for an established podocarp forest.

Shag River Mouth and Purakaunui present a twofold opportunity for investigation. The anthracological analysis of the two curated charcoal assemblages provides the opportunity to investigate a methodological problem. Analysing how the field sampling affects the scope of retrospective anthracological investigation provides insight into how curated charcoal assemblages can be best utilised for retrospective anthracological investigation. The analysis of the two assemblages, and subsequent interpretation, provides information on the vegetative interactions of two early coastal East Otago Polynesian communities; which species were chosen for fuel, and why, as well as illustrating how people were impacting their vegetative communities. Ultimately both sites provide an opportunity to understand human actions in the past, and their repercussions.

## 4. Methodology

This chapter addresses the theoretical and practical methodological considerations. The first part focusses on the application of current anthracological theory within this research, specifically that regarding sampling strategy and understanding the taphonomic filters that affect the assemblages. The latter half of the chapter describes the practical laboratory procedure as well as the process of identification.

### 4.1 Theoretical analysis

#### Primary and secondary contexts

Although the phrases ‘primary context’ and ‘secondary context’ are well established terms within the archaeological literature (Diogo Montiero 2012; Dotte-Sarout *et al.* 2015 ), when applied to anthracological research, and the recovery of charcoal, they have specific meanings.

Diogo Montiero describes primary contexts as “hearths or other type of structures that [...] reveal the charcoal is *in situ* and related with an activity” (Diogo Montiero 2012, 35). As a hearth represents a single fire event the range of taxa within it will be limited. Depending on the size and function of the fire the taxa will be subject to restrictions, for example a small fire require a smaller amount of fuel and thus potentially a single taxa.

In contrast, secondary contexts are the result of numerous firing events and can be typified as the general charcoal scatter through midden deposits. As secondary deposits represent the remains of a range of firing events they can contain a higher number of contributing species.

Charcoal is also found within the archaeological record associated with the practice of land clearance (Williams 2008, 66) (see Introduction; research scope). These may be considered examples of secondary contexts when there is clear evidence that the charcoal is associated with cultural activity.

## Vegetation reconstruction

If the research focus is on vegetation reconstruction it has been widely agreed (Théry-Parisot *et al.* 2010; Dotte-Sarout 2011; Asouti and Austin 2005) that sourcing samples from *both* primary and secondary context will provide the most accurate representation of species present. Théry-Parisot *et al.* (2010) established a set of criteria that must be met in order for an assemblage to be 'palaeoecologically representative', criteria that were also suggested earlier by Asouti and Austin (2005). These criteria can be summarised as follows:

1. Charcoal samples must represent a domestic context
2. The context must be the result of long-term activities
3. The recovered samples must number sufficient to allow for meaningful statistical analysis. In the last regard, Théry-Parisot *et al.* (2010) suggest a "minimum of 250-400 charcoal specimens [from] each archaeological layer" (Théry-Parisot *et al.* 2010, 143).

In order to meet these criteria careful consideration is needed in field to ensure that excavation procedures allow for appropriate sampling (see Methodology; sampling and sample recovery).

## Taphonomy

In addition to understanding the contexts from which charcoal is recovered it is also necessary to consider the processes affecting it prior to archaeological excavation. Taphonomy is the series of processes acting upon a material during its burial. This original definition is expanded in archaeology to include;

"the cultural choices and gestures which have an impact on the plant, animal or human materials, from their natural environment to their fossilization" (Théry-Parisot *et al.* 2010, 142).

It is not always possible to identify these 'choices' and 'gestures' as they are all intrinsically linked in past human actions. Within anthracology these past human actions are identified by Théry-Parisot *et al.* (2010) as filters, a series of transformations undertaken by woody vegetation as it is converted from past vegetation to anthracological data. The filters that are applied before the charcoal is excavated and recovered by the archaeologist are identified as 'societal filters', 'combustion filters' and 'depositional filters', all of which cannot be affected by the archaeologist (Théry-Parisot *et al.* 2010). The filters applied during and post-excavation are within the control of the anthracologists with field practices and laboratory processing affecting the eventual assemblage. It is through the

control of these post-depositional filters that anthracologists can draw accurate and relevant conclusions about the pre-depositional filters.

### Societal filters

While anthracology may have a strong focus on vegetation reconstruction as a research goal, understanding the cultural ‘choices’ and ‘gestures’ of past peoples is also a particular focus of research. Théry-Parisot *et al.* (2010) identifies six central actions under the ‘societal filter’ heading; wood selection, taboos and preferences, gathering modalities, storage, hearth type and maintenance, and cleaning (Théry-Parisot *et al.* 2010, 143).

The first, and arguably one of the most important, transformations is that of fuel selection. As wood is removed from the natural vegetation biases in selection result in over or under-representation of species within the anthracological record. Théry-Parisot (2002) investigates the potential factors affecting the gathering of firewood through the application of ethnography; identifying how different selection criteria affect the charcoal record. An important consideration raised through ethnographic studies is that of the concept of species. Although anthracology is based on the taxonomic identification of samples the same criteria of identification may not be applied during the collection process (Théry-Parisot 2002). The selection criteria used to categorise wood can be varied, dependant on characteristics that could allow two botanically distinct species to be considered the same ‘type’ (Théry-Parisot 2002, 244). This can be seen through the recent reclassification of *Kunzea ericoides* (kanuka, tea tree) into 10 distinct species of *Kunzea* (de Lange 2014), with the dominant and most widely spread species renamed *Kunzea robusta*.

Another line of enquiry is that concerned with the firing properties of different species or ‘types’ of fuel. Théry-Parisot (2002) addresses this issue with the acknowledgement that despite each species having distinct burning qualities, what is far more pertinent are the “levels of humidity, the morphology of the log (size and diameter) and its physiological state (fresh or altered)” (Théry-Parisot 2002, 244). In the 2013 investigation into the charcoal record of the Weld Valley, Australia Byrne *et al.* (2013) found evidence that although fuel was collected in tandem with other subsistence practices “they were selective in their choice of species [that were] known to produce poor fuel” (Byrne *et al.* 2013, 104). Within New Zealand, there is little evidence for selective processes, with the exception of Moriori forest management (Maxwell 2015).

### Combustion filters

Combustion is the first natural filter and one that is difficult to quantify. Charcoal is formed through the process of pyrolysis “when organic material is heated in the absence of oxygen” (Scott and Damblon 2002, 2). During this process there are several factors that can affect the resulting



assemblage, most importantly mass loss and fragmentation (Asouti and Austin 2005; Théry-Parisot *et al.* 2010). Both of these factors can affect the ‘representativeness’ of an assemblage and are considered further in section 4.4. Quantification.

Research into the factors affecting mass loss and fragmentation (Chabal 1990; Théry-Parisot *et al.* 2010) suggests that the number of factors that affect wood during combustion pushes the “limits of the experimental approach” (Théry-Parisot *et al.* 2010, 147). Research into the factors affecting fragmentation rates has produced a series of observations however which show that “the anatomical structure of the different tested wood taxa has a significant impact on the mechanical properties of charcoal” (Chrzaszvez *et al.* 2014, 39). However, in the same research, Théry-Parisot *et al.* found that “the sum of all combustion biases affecting a plant species, during successive fires, tends to minimise frequency distortions in the sample recovered during field work” (Théry-Parisot *et al.* 2010, 147). This supports the necessity to recover charcoal from contexts that represent long-term activities.

### Depositional filters

The depositional filter is the last filter to affect the charcoal assemblage prior to excavation and anthracology-associated filters. The primary considerations are the anthropogenic agents of taphonomy: the human ‘choices’ and ‘gestures’ that dictate how the charcoal enters the archaeological record.

The absence of a pottery or metal working tradition in pre-European Maori culture rules out charcoal assemblages associated with kilns or forges. This categorises the most common contexts for pre-nineteenth century archaeological charcoal as; within an oven feature, or the in-situ remains of a burnt structure (primary context) or as the result of several oven events incorporated within general midden scatter (secondary context). Within each of these contexts, and these are simply examples of the most common, a series of anthropogenic actions are represented. In the case of general midden scatter this may include the cleaning or sweeping out of successive fire features, while the burnt structures may be the result of either intentioned or accidental destruction.

Further from the anthropogenic actions are the natural processes affecting buried material. Théry-Parisot *et al.* (2010), in a review of the available literature surmised that despite there being evidence of effects such as root systems, atmospheric or water transport affecting wood charcoal (Clark 1988; Stein 1983; Wood and Johnson 1978) “when post-depositional processes homogeneously affect the charcoal deposits inside each layer, they do not affect the palaeoecological signature” (Théry-Parisot 2010, 148).

## Archaeological and anthracological filters

The archaeological and anthracological filters mark the first set of taphonomic filters upon which archaeologists and anthracologists can exert some control. These filters are related to how archaeologists excavate and recover the charcoal, how sites are sampled and results quantified. In the following sections I will discuss each of the aforementioned biases with reference to both existing or previous field practices as well as proposed 'ideal' charcoal recovery and sampling.

## 4.2 Curation

Curation is not explicitly considered in the consulted literature, an omission that is perhaps reflective of the variation in cataloguing practice. This variance can result in problems of record variability and archival inconsistencies.

As anthracology continues to become more of a focus within New Zealand one can expect that it will be added to the standard repertoire of investigative techniques applied to archaeological sites and excavation assemblages. Previously excavated sites leave a physical legacy in the form of stored excavated material, especially those excavations associated with educational facilities including the University of Otago, Department of Anthropology and Archaeology. The two assemblages associated with this research, Shag River Mouth and Purakaunui, were both the focus of University of Otago field schools, with some of the subsequent analysis of excavated material performed by students (Latham 2002, 2005; Lawrence 2012; Mitchell 2010; Higham 1990; Kirk 1989). These assemblages provide a valuable resource for student based research which allows for investigation into a variety of aspects. The potential for future research for any of these curated assemblages is tempered by the potential for negative effects such as loss of provenance, contamination or unrecorded sampling, especially when the material in question, charcoal, may be seen to be of little importance.

The previously discussed practice of sampling charcoal solely for radiocarbon dating purposes has not only resulted in poor field-sampling practices but also a poor written record of curation processes. Purakaunui's excavated assemblage, as predominantly bulk samples, contain a range of archaeological material including faunal, lithic, and botanical. As a result some bags have been subjected to several screening processes. The viability of each individual sample bag was assessed on the presence of sufficient charcoal of varying sizes, and other residue materials to indicate that, despite screening, no material has been discarded.

The other element of curation that may affect an assemblage's potential for retrospective anthracological research is a reliable record of provenance. Ideally this would consist of a written record of excavation provenance that can be matched to information available on the bag itself. In

many cases, this information is readily available, but where not it is often only possible to match the provenance information available on the bag with information from publications, as was the case with several of the sample bags from Shag River Mouth (see Methodology; field sampling and sample recovery).

Thus charcoal sampling and recording strategies should be considered as carefully as for any other important archaeological material.

## 4.3 Sampling and sample recovery

The high concentration of charcoal within the New Zealand archaeological record, when considered with the time and effort associated with charcoal identifications sampling presents a daunting task. Restricting the number of samples identified through sampling is both a practical necessity and a theoretical consideration. The first of these filters is the recovery of charcoal samples in the field; a combination of field sampling and field recovery methods.

### Field sampling and sample recovery

The first consideration for sampling is that which occurs in the field. Due to practical restraints and the destructive nature of archaeological excavation it is unlikely that the entirety of a site's charcoal assemblage would ever be recovered (Orton 2000). As such, field sampling must be undertaken in order to recover appropriate samples. The appropriateness of a sample is dependent on the research aims of the anthracological analysis, with primary and secondary charcoal deposits informing on different activities.

When charcoal has been considered within a larger field sampling strategy it has often been with the intention of sourcing suitable material for radiocarbon dating. This has encouraged a focus on concentrated deposits, such as fire pits, as they represent culturally associated fire events suitable for radiocarbon dating.

This targeting of concentrated charcoal deposits can be seen in the material available from Shag River Mouth. The charcoal assemblages recovered for layer 11, the oldest cultural layer excavated in the High Dune context, are all provenanced to units that are identified in figure 12 as firescoops or associated matrix. The parent bags were not clearly labelled as either firescoops or matrix and so cannot securely be considered either. This is an excellent example of both the hazards of long-term curation (labels that once made sense lose meaning) and selective field sampling.

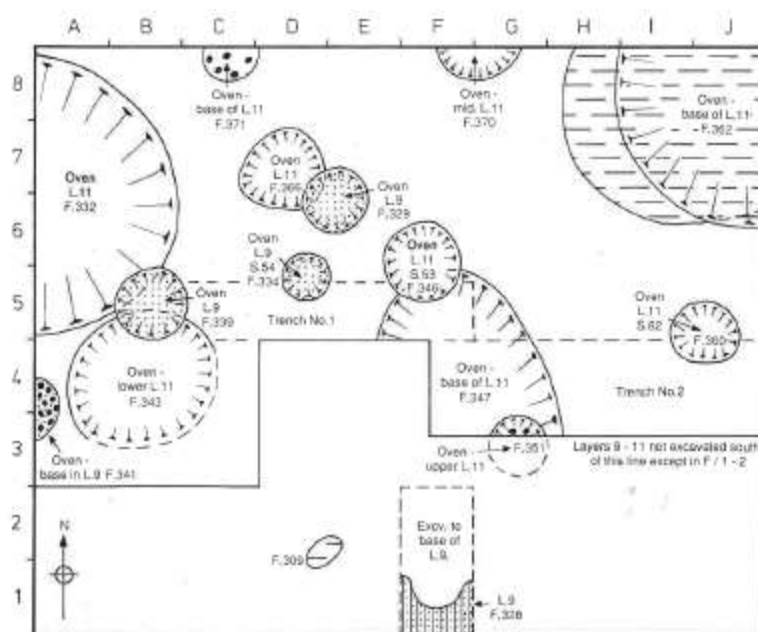


Figure 12. Excavation plan of SM/C:Dune, layer 9-11. (Anderson and Smith 1996, figure 5.10)

The literature available on the sampling strategies employed at Shag River Mouth (Smith and Anderson 1990) identifies the ‘general collection policy’ as inclusive of all material, with the exception of fire cracked rock. Material was “either hand-picked from the matrix while trowelling, or extracted through the screening of excavated sediments through 1/8 inch (3.175mm) sieves” (Smith and Anderson 1990, 70). It is also clarified that un-sieved bulk samples were collected from every ‘major’ stratigraphic layer in each area, although these bulk samples were not located at the time of this research.

As seen in the above description of material recovered from Shag River Mouth; there is no material present which can be positively identified as originating from a secondary context. The material identified as ‘matrix’ carries a potential bias as it is unclear if it was collected through hand selection. As such available samples are inappropriate for vegetation reconstruction and fuel selection (see Methodology; vegetation reconstruction). If samples are obtained in order to inform on past vegetation then sampling should follow the three criteria outlined by Théry-Parisot *et al.* (2010) and Asouti and Austin (2005) (see Methodology; vegetation reconstruction).

In contexts where the research focus is on specific fire events such as the investigation of building materials (Kahn and Coil 2006; Leach *et al.* 1999) the primary context represented by the burnt remains of the structure are an appropriate context for the collection of samples.

Once appropriate samples have been identified their recovery should follow appropriate practices in order to maintain a representative sample. There is agreement in the current literature (Byrne *et al.* 2013; Dotte-Sarout *et al.* 2015; Huebert 2014; Maxwell 2015; Pearsall 2000) that, where possible,

floatation of excavated material should be carried out at site as “floatation schemes recover more complete archaeobotanical assemblages” (Huebert 2014, 142). However, in circumstances where floatation is not possible on site, such as when the matrix is ill suited (Dotte-Sarout 2011), or the site is sufficiently isolated to prevent easy access to water (Maxwell 2015), substitute methods may have to be used. These other methods include the wet sieving of sediment off-site, dry sieving and bulk sampling. In such cases as material is sieved or screened the anthracologists must consider the size of material recovered as the literature recommends the identification of samples down to 2mm diameter (Dotte-Sarout *et al.* 2015; Byrne *et al.* 2013). Bulk samples may be taken in order to confirm that sampling was appropriate at site providing an un-sampled comparison data set for comparison as well as preserving archaeobotanical assemblages for more controlled sample recovery in a laboratory environment.

Much of the material identified from Purakaunui was located from bulk samples. These bulk samples were taken from layers 2 and 4 of the southern excavation of the 2001-2003 seasons of excavation (see Background; Purakaunui). This is in comparison with the samples identified from Shag River mouth, which almost exclusively represent single oven contexts. The comparison of identified species, in both number and range, between these two different sampling strategies is a fundamental research goal for this investigation.

### Sampling from curated contexts

Although the assemblages represented in this research were not randomly sampled, but were instead assessed with the most appropriate samples selected for further identification, it is important to consider alternative collection strategies. This is explored in Orton’s (2000) work, which although focussed on large-scale museum collections, includes concepts and terminology that are applicable to archaeological collections stored in other facilities. An example of this can be seen in the definition of the word ‘collection’ which Orton defines as “an administrative unit within the overall collection” (Orton 2000, 193). This ‘administrative unit’ when related to archaeological collections is most appropriately presented as that of a particular excavation.

### Subsampling

Once samples have been recovered from the field, or collections, they may necessitate subsampling. Subsampling occurs when the samples are too large to identify all specimens, with the intention of retaining a palaeoecologically representative sample. Chabal *et al.* (1999), as well as other anthracological methodological investigations (see Asouti and Austin 2005; Scheel-Ybert 2002) suggest that 100-250 fragments should be analysed from each stratigraphic layer. In contrast, Dotte-Sarout *et al.* (2015) suggests a much higher number of identifications, 200-400, when analysing assemblages from biologically diverse tropical locations.

In the absence of an established identification protocol for New Zealand flora it was decided that, where possible, the most conservative recommended number of identification (200-400) would be attempted, but the overall sampling strategy would be a combination of cumulative sampling and sampling to redundancy (STR). STR requires the equal splitting of the total sample into smaller subsamples; these smaller subsamples are then incrementally identified until new identifications become 'redundant'. This is visually represented when the identified samples are plotted against the total number of samples with redundancy represented by an asymptotic curve (Leonard 1987).

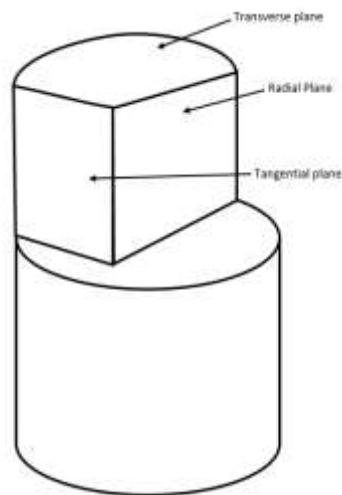
This subsampling strategy was achieved through the selection of appropriate parent bags available for each layer. Subsamples were then taken from each parent bag in batches of 50 specimens, randomly selected from the total parent bag assemblage. The identified samples were then plotted against total number of samples after each 50 identification to determine when a layer had been sampled to redundancy.

## 4.3 Identification

### Wood structure

Anthracoology is the identification of woody plant remains. Although other pieces of plants can be preserved, such as seeds and occasionally leaves or other fibres, it is the woody component that is targeted. Though there are three orders of plants which have wood, only angiosperms and gymnosperms are considered within this thesis. Gymnosperms, or softwoods, include the family podocarpaceae, whilst the angiosperms (hardwoods) consist of both monocotyledons and dicotyledons. Within New Zealand the monocotyledon group is made up of ferns and some tree species such as cabbage tree (*Cordyline australis*) and palms. Dicotyledons are the hardwoods, a diverse range of trees and shrubs.

The anatomy of gymnosperms and angiosperms differs greatly but shares some characteristics. The xylem structure that forms the support structure for the wood is found in both, with the axial system transporting nutrients and water up and down the system whilst the radial system carries the same products from the outer aspect of the stem or trunk to the centre. An exception is found in monocotyledons which house a much simpler system in which vascular bundles consisting of xylem, phloem and rigid fibres are surrounded by parenchyma tissues. The anatomical features that are used in identification are viewed in three distinct planes; the transverse plane (TS), tangential longitudinal plane (TLS) and the radial plane (RS) as illustrated in figure 13 below.



*Figure 13. The three planes of wood identification.*

The transverse plane reveals a cross section of the vessels, axial parenchyma and fibres as well as a lateral view of ray cells. Vessels are cells that facilitate the transport of nutrients and water across the axial system. The arrangement of the vessels in hardwoods are classified into several categories on the basis of vessel porosity (Esau 1977); ring porous, where there are distinct growth rings, semi-ring porous, a growth ring is visible but not defined, and diffuse porous, where vessels are evenly distributed. Gymnosperms do not have vessels, instead relying on tracheids for the transport across the axial system (Esau 1977). The attributes of axial parenchyma are also used in identification, namely how they are associated with vessels, individual shape and, when present, the thickness of continuous bands of axial parenchyma. Rays are viewed in both the transverse and tangential longitudinal sections. The lateral view of the rays available in the transverse section allows for identification through ray width, with uniserate (a single cell wide) and multiserate rays (many cells wide), as well as the individual ray cell characteristics. The tangential longitudinal view provides a cross section of the ray parenchyma cells whilst the radial plane reveals an additional longitudinal view of the ray cells (Esau 1977).

Gymnosperms, although sharing the same fundamental anatomy, differ from angiosperms and thus other anatomical features are relied upon for identification. Growth rings, as visible on the transverse plane, are defined as distinct to indistinct whilst axial parenchyma are noted as present or absent. The radial plane provides some of the more identifiable features with the cross-field pitting varying in size, shape and frequency between species (Esau 1977).

Although the anatomical features for many of the species are distinct, there remains a certain level of individual variation between individual species (see Patel 1995, 1995a for examples). Such variation is accounted for by the creation of a comprehensive reference collection, as is discussed in a following section.

## Reference material

The anatomical features which make each species, or genera, distinct are subject to variation. This variation can manifest itself as either simple variation amongst individual specimens to variation due to the stage of growth when the charcoal sample was created. A twig specimen will differ from a specimen taken from the trunk of a mature tree.

This variation can, at times, lead to similar features present between two species. In such cases the available literature used to assist identifications (Meylan and Butterfield 1978; Patel 1973, 1978, 1986, 1995, 1995a) can prove insufficient in providing identifications as only single 'typical' samples are pictorially represented. In such cases, and as standard good practice, reference should be made to wood slide samples.

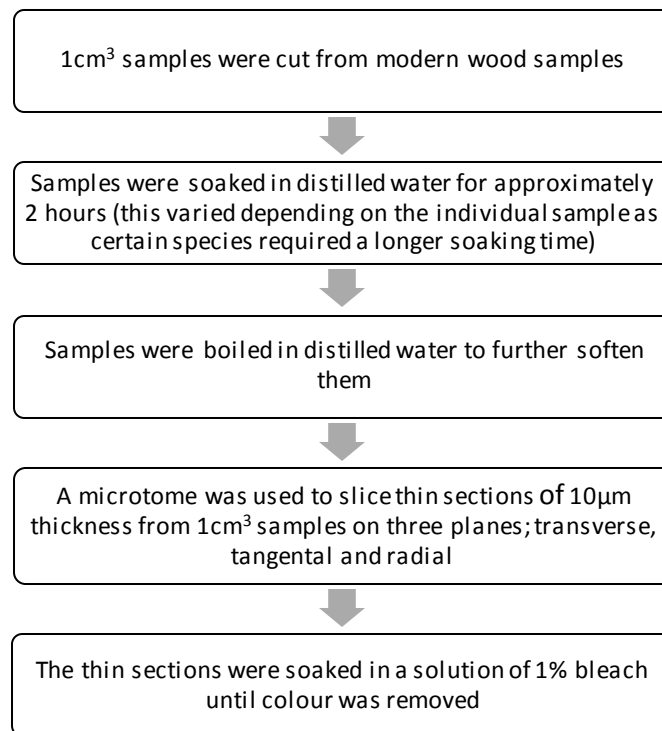
Wood reference samples consist of thin sections of modern wood samples mounted on slides to allow for viewing of anatomical features through a light incidence microscope. The three views used in identifications (transverse, tangential longitudinal, radial longitudinal) are represented within the reference collection to allow for viewing of all features. The samples are ideally taken from branch wood, matured beyond the twig growth phase so to ensure that anatomical features would be clearly visible.

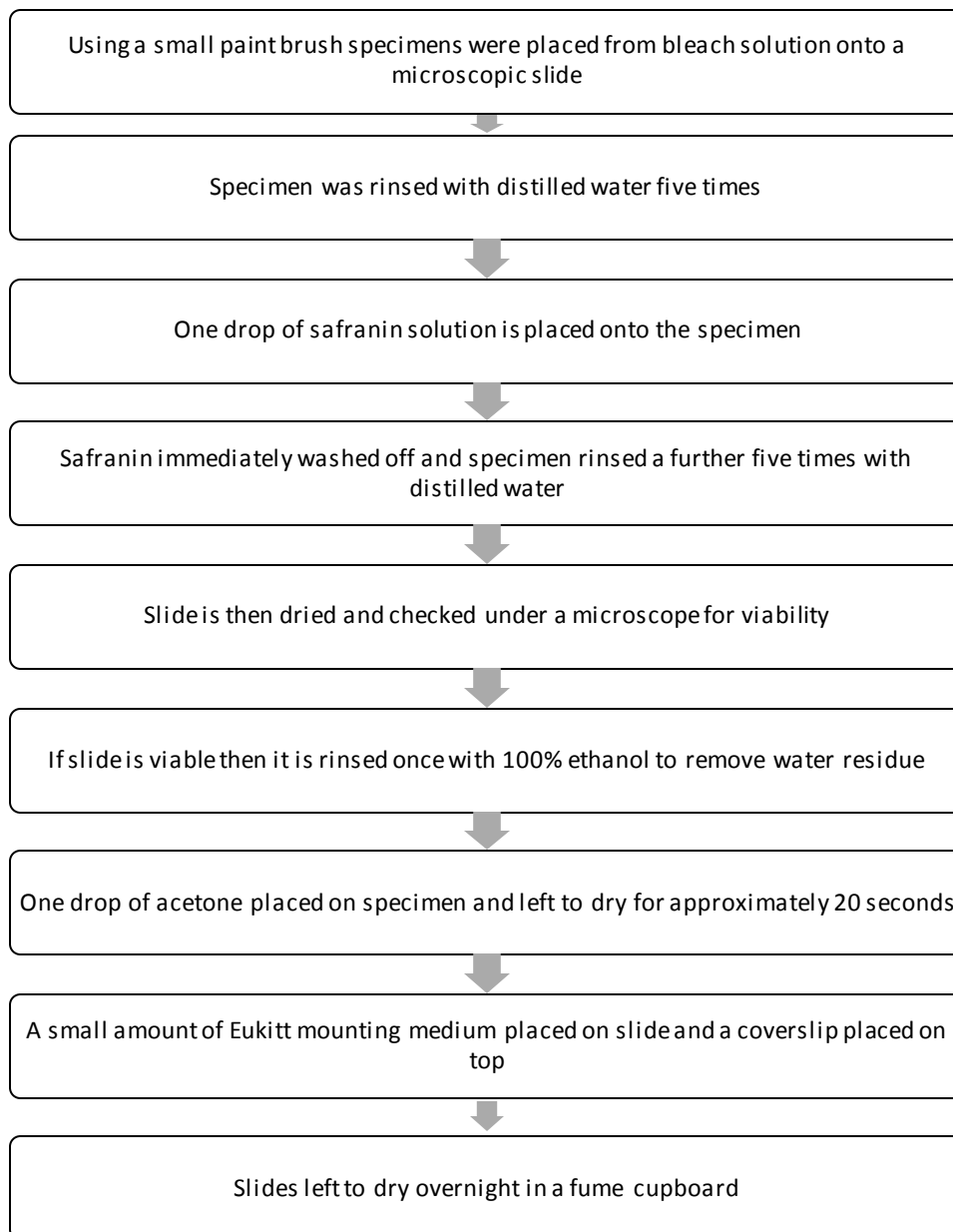
As the practice of charcoal identifications is a developing area of research within the Archaeology programme at the University of Otago the wood reference collection has been under constant renovation. A number of species were represented only by twig specimens which, as previously mentioned, are not suitable for reference as the anatomical features can be difficult to identify. These species, many of which were conifers, were added to the reference collection with the kind assistance of Rod Wallace from the University of Auckland Archaeology Department.

Samples were sourced from both the Dunedin Botanic Gardens (with kind permission) and privately owned residences.



The process for the creation of wood reference sample slides was as follows;





## Identification

Identification of charcoal samples was achieved through the observation of particular anatomical features, as discussed in earlier in this chapter. Guidance was given through the assistance of both Dr Justin Maxwell, and Dr Rod Wallace.

Samples were chosen at random from the previously sorted sample and weighed. All samples were observed using a Zeiss Axio 40A1m dark field microscope under magnifications 50X, 100X and 200X. Samples were snapped using tweezers and placed within a small tray of sand on the microscope's stage to first observe the transverse plane. This plane was assessed to make a preliminary identification, initially gymnosperm or angiosperm and then using Meylan and Butterfield (1978) to narrow down potential species. Once a preliminary identification was made the sample was further snapped in order to observe the tangential longitudinal plane and the radial plane. Reference material, both charcoal and wood, was referred to in order to make a positive identification.

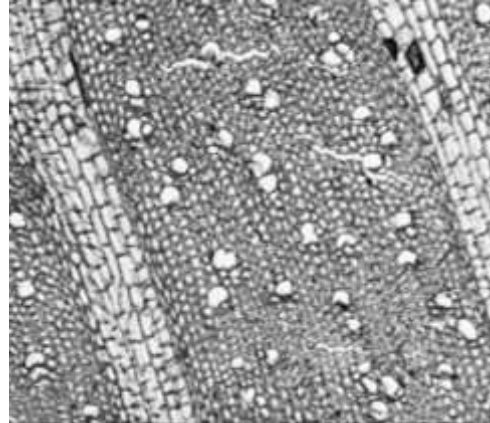
Angiosperms were identified largely from the transverse and tangential longitudinal planes. The transverse plane was examined to determine the vessel size and arrangement, as well as the degree of porosity and ray shape. Once possible species had been identified the tangential longitudinal plane was observed and numerous features used to determine a positive identification.

The identification of gymnosperms was conducted through the observation and assessment of anatomical details described in both Patel (1967a, 1967b, 1968) and material provided by Dr Wallace. These anatomical details were first assessed on the transverse plane where growth rings, tracheid cell thickness and the presence or absence of axial parenchyma were observed. These traits were tallied in order to rule out unlikely species. Further observations were made on the tangential longitudinal plane with regard to the ray height and presence or absence of tangential wall inter-tracheid pits. Finally the cross-field pitting on the radial plane was examined and assessed in order to make a taxonomic identification.

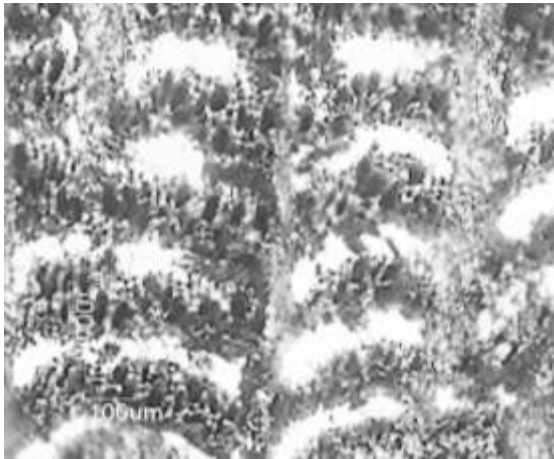
A selection of the diagnostic anatomical features are shown in the above figure, figure 14. A species key used during the identification of specimens can be found in appendix 1.



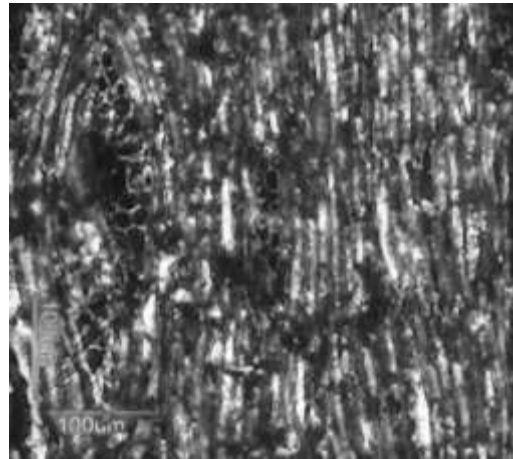
*L. scoparium*, transverse view, 50X magnification. Oblique patterning of vessels shown.



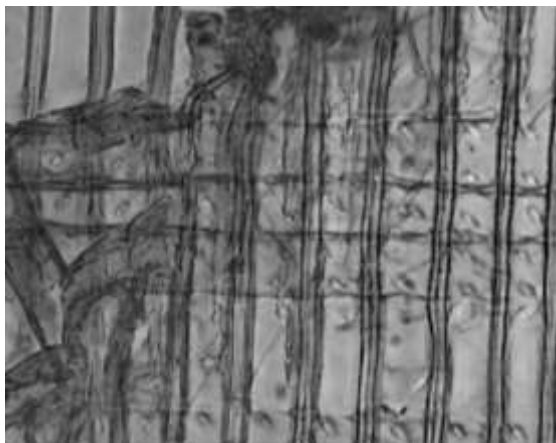
*M. australis*, transverse view, 50X magnification.



*P. divaricatus*, transverse view, 50X. Concentric banding shown.



*S. microphylla*, tangential view, 100X. Storied axial parenchyma shown.



*P. totara*, radial view, 500X magnification. Small, cupressoid cross field pits shown.



*P. taxifolia*, radial view, 200X magnification. Large, cupressoid cross field pits shown

Figure 14. Diagnostic anatomical features of a selection of species identified within this research.

## 4.4 Quantification

Quantification is the final filter between the original vegetative communities. As discussed briefly in Methodology; combustion filters, fragmentation and mass loss experienced by wood during the combustion filter can affect how the identified results are interpreted. Translating the identified samples into appropriate results involves the quantification of samples. Within anthracology this is largely encompassed within the debate of fragment count versus weight. The investigations, largely based in the Montpellier school have shown that fragment counts provide the most palaeoecologically representative sample (Asouti and Austin 2005; Chabal 1990; Théry-Parisot *et al.* 2010). As a result of the previously mentioned research a set of parameters have been suggested in order to ensure the most representative results (Asouti and Austin 2005). These parameters can be summarised as the following:

- Appropriate sample practices that target long-term deposits (for more detail see Methodology: vegetation reconstruction)
- The sampling of multiple sites for comparison and pattern identification.
- An understanding of existing vegetation and modern ecology, comparing species ratios with those generated from anthracological data.
- When available, alternative palaeoenvironmental studies that complement charcoal analysis should be consulted. Asouti and Austin (2005) suggest palynological studies, land snails or macrobotanical analysis.

The application of fragment counts over weight counts is also a more appropriate quantification method when many studies have shown that the factors affecting mass loss in wood samples are too numerous to reproduce under experimental conditions (Théry-Parisot *et al.* 2010).

Although weights and counts are the most commonly utilised quantification methods there are several others that may be suitable. Huebert (2014) suggests both relative percentages and ubiquity analysis as alternatives. Relative percentages are calculated “by dividing the sum of counts of a given taxon and dividing by the total amount of material in a given sample” (Huebert 2014, 131). There is a benefit to this approach as it “even[s] out variation in density between samples, and effectively inform[s] on the changing use of plant materials over time” (Huebert 2014, 131). The other alternative suggested, ubiquity analysis, is useful for “illustrating broad-scale changes in the use of a particular resource” (Huebert *et al.* 2010). Ubiquity analysis is performed quite simply on the presence or absence of individual taxa across a range of units or assemblages. These occurrences set the relative value of individual taxa for the overall assemblages or total units (Huebert *et al.* 2010).

For example, a taxon that was present across half the assemblage would have a ubiquity value of 0.5 whilst a taxon present in only one of ten units would have a ubiquity value of 0.1.

As this investigation is focussed on assessing the viability of curated assemblages as the subject of retrospective anthracological analysis fragment counts will be made in order to identify trends or patterns in the taxa identified. Although an interesting concept, ubiquity analysis has been deemed unsuitable for this research due to the limited number of investigated contexts as only two occupation periods are analysed for each site.

The methodology outlined above was utilised to generate the anthracological data that was then subject to interpretation. Understanding the processes that have affected the charcoal assemblage from the collection of fuel, to the excavation of charcoal allows us to understand the limitations affecting each assemblage can be recognised. These limitations are explored further in the following chapters as they impact how each identified assemblage can be interpreted.

## 5. Results

The results are presented for each stratigraphic layer investigated. In order to ensure the most representative sample specimens were taken from multiple contexts in increments of 50 until the identified species had reached saturation on an exponential graph (see Methodology; quantification, and figures 15, 16, 20 and 22). Contexts are identified with reference to both their nature as a primary or secondary context, their unit of excavation (a unit being a 1mx1m square) and feature type if applicable. All percentage values are by fragment count, following the literature (see Methodology; quantification).

The results here are presented in three categories; large trees, medium trees, and small trees or shrubs. This broad categorisation allows for the grouping of species that fulfil similar environmental roles. The categories also assist with the identification of large-scale environmental change as well as indications of the vegetative communities targeted for fuel. Individual species will be discussed when they function as indicators of particular environments.

### 5.1 Shag River Mouth

#### Layer 11 SMC:Dune

The assemblage of parent bags for layer 11 was the largest of the Shag River Mouth charcoal assemblage; a total of 7 bags were available for subsampling. As the lowest stratigraphic layer, layer 11 represents early interactions. Many of the available samples were from excavation units that are considered primary contexts including firescoops and ovens. In order to mitigate the effects of primary samples and ensure results were more representative of general fuel selection strategies, samples were taken from five different excavation units. These squares were identified in the order of F8, C8, J5, F4 and D7 with a total of 50 identified specimens from each sample.

The context represented by layer 11 is that of a domestic area, with radiocarbon dates placing occupation in the 14<sup>th</sup> century (see figure 15 below).

Units C8, F4 and D7 are all identified as firescoops while units F8 and J5 are matrix. Though the firescoop units are primary contexts, together they represent multiple fire events. Secondary contexts represented by units F8 and J5 assist in identifying diversity from multiple fire events.

Within the layer 11 subsample a total of 250 specimens were identified. The incremental identifications were plotted against the cumulative taxa to determine when the sample could be

considered representative. Within the identifications a total of ten taxa were identified to a species level with a further five genera and three e family level identifications (see table 3). A total of 28 specimens, 11.2% of the total sample, were unable to be identified, due to the condition of the charcoal. The density of the charcoal led to incomplete snaps and unidentifiable anatomical features.

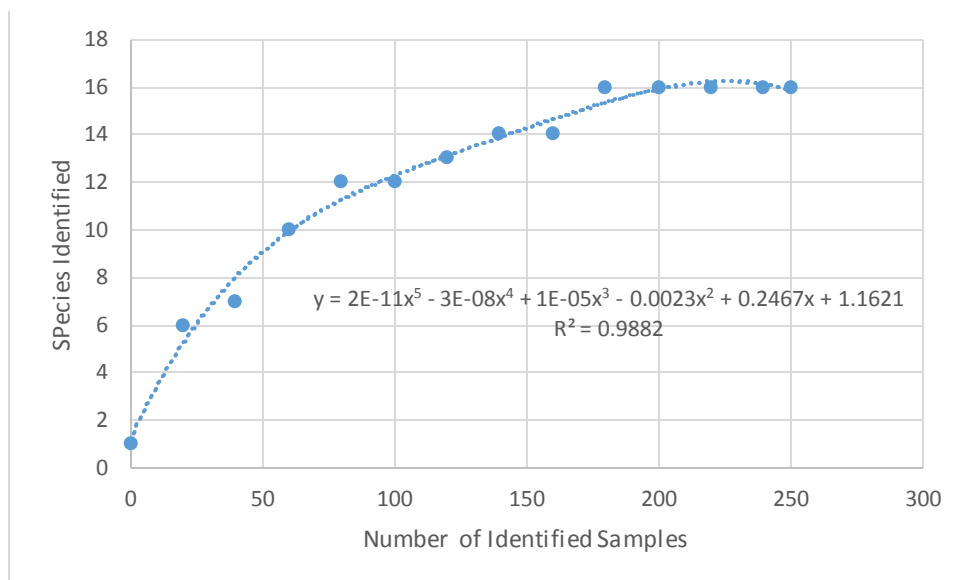


Figure 15. Incremental identifications plotted against cumulative data. Shag River Mouth, layer 11 High Dune Excavations



Table 3. Summary of wood charcoal identifications from Shag River Mouth layer 11.

| Context                        | F8<br>N. Baulk | C8 | J5 | F4 | D7 | Total Nisp. | Percentage total |
|--------------------------------|----------------|----|----|----|----|-------------|------------------|
| <i>Plagianthus divaricatus</i> | 7              |    | 7  | 1  | 1  | 16          | 6.4              |
| <i>Olearia ?spp.</i>           | 5              | 11 | 5  | 5  |    | 26          | 10.4             |
| <i>Myrsine australis</i>       |                | 6  |    | 2  |    | 8           | 3.2              |
| <i>Coprosma ?spp.</i>          | 1              |    | 1  |    | 1  | 3           | 1.2              |
| <i>Discaria toumatou</i>       |                |    |    | 1  | 1  | 2           | 0.8              |
| <i>Hebe ?spp.</i>              |                | 1  | 1  |    |    | 2           | 0.8              |
| <i>Pittosporum ?spp.</i>       | 1              |    |    |    |    | 1           | 0.4              |
| <i>Myoporum laetum</i>         |                |    |    | 1  |    | 1           | 0.4              |
| <i>Kunzea robusta</i>          | 3              | 9  |    | 2  |    | 14          | 5.6              |
| <i>Leptospermum scoparium</i>  |                | 5  |    | 4  |    | 9           | 3.6              |
| <i>Sophora microphylla</i>     | 27             |    | 13 | 17 | 9  | 66          | 26.4             |
| <i>Coraria arborea</i>         |                | 1  |    |    |    | 1           | 0.4              |
| <i>Pseudopanax ?spp.</i>       |                | 3  | 1  | 3  |    | 7           | 2.8              |
| <i>Myrtaceae ?sp.</i>          |                | 2  | 1  | 1  |    | 4           | 1.6              |
| <i>Malvaceae ?sp.</i>          |                |    | 2  |    |    | 2           | 0.8              |
| <i>Podocarpus totara</i>       |                |    | 13 | 5  | 35 | 53          | 21.2             |
| <i>Prumnopitys taxifolia</i>   |                |    | 3  | 1  | 1  | 5           | 2                |
| <i>Podocarpaceae ?sp.</i>      | 1              |    |    | 1  |    | 2           | 0.8              |
| <i>Unidentified</i>            | 5              | 12 | 3  | 6  | 2  | 28          | 11.2             |

### Large trees

Two species of large tree were identified within the assemblage; these were *Podocarpus totara* and *Prumnopitys taxifolia*. The least taxonomically distinct identification made was of the family Podocarpaceae.

Within the category of 'large trees' *P. totara* was the most dominant, by a significant margin. It also represents a significant percentage of the total sample (see Table 4). Identifications of totara were made within three of the four sampled excavation units but are concentrated in the firescoop context of unit D7. This concentration equals 70% of the material from unit D7 and is indicative of a large piece of *P. totara* being used as fuel.

*Prumnopitys taxifolia* was identified within the same excavation units although at 2% of the total sample it represents a much smaller portion. The relative abundance of *P. totara* in contrast to the abundance of *P. taxifolia* suggests that the large trees were being opportunistically taken as remnants of previously intact forest, such as driftwood.

The presence of both *P. totara* and *P. taxifolia* is an indication of established podocarp forest within the larger catchment for the Shag River. This conclusion corresponds to the palynological research conducted at the site (Boyd *et al.* 1996) which identified both *P. totara* and *P. taxifolia* within the pollen record.

#### *Medium trees*

Within the medium trees category three species were identified; *Myoporum laetum*, *Kunzea robusta* and *Sophora microphylla*. The family Myrtaceae was also included when identification to a species level was not possible on specimens presenting anatomical features present in both *Leptospermum scoparium* and *Kunzea robusta*.

*Myoporum laetum* represents only a single identification, from the firescoop in unit F4, a reflection of the importance of large sample sizes.

The *Sophora microphylla* identifications dominate both the medium tree category and the total layer 11 assemblage comprising 26.4% of the total sample. Present in both primary and secondary units, the relative abundance of *S. microphylla* suggests that it was routinely used for fuel. As a tree with high light demands *S. microphylla* would have been found growing on the fringes of established forest or within seral vegetation.

When considered with the relatively low abundance of *L. scoparium* and *K. robusta*, both of which are indicators of seral vegetation, it suggests that fuel is being collected from areas of relatively open forest margins and scrubland. The palynological reconstruction of Shag River Mouth indicates an environment “characterised by complex patterns of forest, scrubland, fernland and grassland” (Boyd *et al.* 1996, 262).

#### *Small trees or shrubs*

This third category is unsurprisingly the most diverse. Identifications to a species level were possible for the following; *Plagianthus divaricatus*, *Myrsine australis*, *Discaria toumatou*, *Leptospermum scoparium*, and *Coraria arborea*. The least taxonomically specific identification was of two specimens to the Malvaceae family where positive identification as *P. divaricatus* could not be confirmed. The lack of species-specific anatomical features led to the identification of five genera; *Olearia*, *Coprosma*, *Hebe*, *Pittosporum*, and *Pseudopanax* within the sample.

The diversity of this category is reflected in the low percentage values of these identifications. As the species included within this category typically represent a smaller mass when entering the

archaeological record, they are the most vulnerable to loss through taphonomic processes. This potential for 'invisible' species is a significant factor for appropriate sampling. The presence of a single-identification taxon (*Coraria arborea*) indicates that the taxonomic diversity of the sample is closer to being truly representative.

*Olearia* is the most often reported identification at 10.4% of the total sample (see Table 4). As *Olearia* could only be identified on a generic level it is highly likely that a number of species are identified. Although numerous species are represented within the generic identification, the high percentage indicates that the open, scrubby environment most common to the genus was being exploited.

The estuarine environment is clearly indicated as a source for fuel through the presence of *P. divaricatus*. Although this species would have grown exceptionally close to the occupation site it is not overtly present within the sample making up only 6.4% of the total layer 11 sample.

## Layer 11 overview

The results of the layer 11 identifications show an even spread between the three categories (see figure 16 below). The balance of the three categories suggests that a range of environments are represented within the results rather than a single environment dominating the assemblage. Estuarine scrub and associated coastal dune are clearly visible within the 'small tree and shrub' category, while open forest margins are represented through the 'medium tree' category.

The variation between individual firescoops also supports the interpretation of multiple environment exploitation. The D7 firescoop is dominated by *Podocarpus totara*, considered to represent driftwood whilst the F4 firescoop has high amounts of *S. microphylla*, potentially indicating forest margins, and a diverse combination of both coastal dune shrubs and *P. totara*.

These results indicate that fuel collection was taking place over a wide range of environments around the Shag River Mouth settlement. The opportunistic inclusion of large tree species from remnant wood is visible in combination with small shrubs sourced from the immediate dune vegetation and possible forest margins.

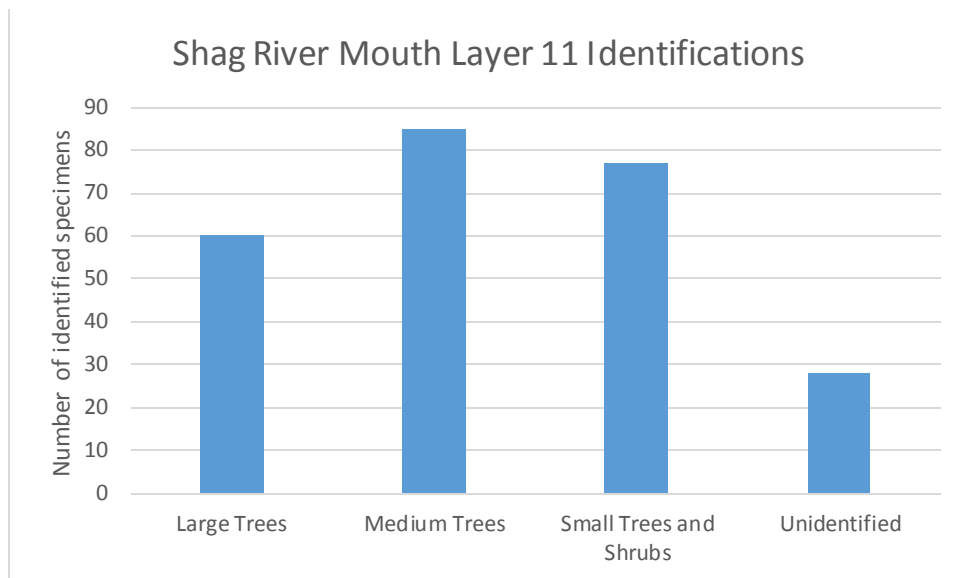


Figure 16. Comparison of identification categories for layer 11, Shag River Mouth

## Layer 7 SMC:Dune

Layer 7 differs from layer 11 as all the samples are from the same feature, numbered 302.

Although it has been suggested that it was a multi-use oven (see background; Shag River Mouth) the nature of feature 302 as a primary context necessitates it being interpreted as a single fire event. In order to maximise the range of fuel woods identified, samples were taken from different locations within the large feature. These locations are labelled as excavation units B4, C4 and stakes 3 and 4.

A total of 200 specimens from the feature were subject to identification. As seen in figure 17 below, this sample size was considered appropriate through the plotting of incremental identifications against cumulative taxa. A total of 10 specimens were unable to be identified through the degradation of the charcoal. Four species were identified; *Plagianthus divaricatus*, *Sophora microphylla*, *Myrsine australis*, and *Prumnopitys taxifolia* (see table 4).

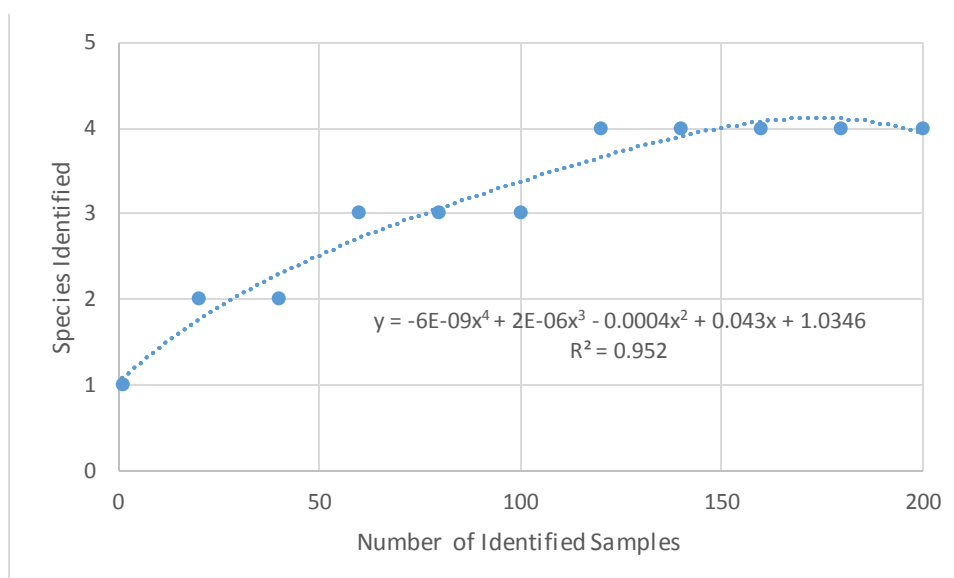


Figure 17. Incremental identifications plotted against cumulative data. Shag River Mouth, layer 7 High Dune excavations.

Table 4. Summary of wood charcoal identifications from Shag River Mouth, layer 7 identifications.

| Context                        | Stake 3 | Stake 4 | B4-7 | C4-7 | Total Nisp. | Percentage total |
|--------------------------------|---------|---------|------|------|-------------|------------------|
| <i>Plagianthus divaricatus</i> | 43      | 43      | 37   | 27   | 150         | 75               |
| <i>Sophora microphylla</i>     | 4       | 1       | 3    | 19   | 27          | 13.5             |
| <i>Myrsine australis</i>       |         |         | 4    |      | 4           | 2                |
| <i>Prumnopitys taxifolia</i>   |         | 5       | 4    |      | 9           | 4.5              |
| Unidentified                   | 3       | 1       | 2    | 4    | 10          | 5                |

#### Large trees

A total of nine specimens were identified from the layer 7 sample that belong to 'large tree' species *Prumnopitys taxifolia*. These identifications were in both unit B4 and the stake 4 sample. The small percentage, less than 5% of the total, and the remaining identifications suggests that the *P. taxifolia* was driftwood that was collected in the same estuarine environment as the *P. divaricatus*

#### Medium trees

*Sophora microphylla* was the only species identified from the 'medium tree' category. *S. microphylla* comprise a total of 27 identifications within the assemblage, the second most abundant species at 13.5% of the sample. The majority of *S. microphylla* identifications, 19 from a total 27, were from the C4 unit of excavation. This localisation of the taxon within the oven suggests that a single piece, or small amount, of *S. microphylla* was represented.

### *Small trees and shrubs*

The 'small trees and shrubs' category is the most diverse category of feature 302 with two species identified. The first species, *Plagianthus divaricatus*, is the most prominent of the layer making up 75% of the total sample for the layer. The second shrub species identified was *Myrsine australis*, of which a total of four identifications were made from excavation unit B4.

The dominance of *P. divaricatus* is an extremely strong indicator of the environments from which fuel has been sourced. As *P. divaricatus* is a salt-tolerant species it can be found growing very close to the marine and estuarine environments. At the time of this research *P. divaricatus* can still be seen growing amongst the dunes, and close to the estuary at Shag River Mouth. The high percentage of a species that grows close to the occupation site suggests that the fuel collection took place within the immediate environment of the site.

This is a similar result to the charcoal analysis undertaken by Wallace (Boyd *et al.* 1996), in which 53.1% of the samples identified were *P. divaricatus*.

### Layer 7 overview

The dominance of *P. divaricatus* is a strong indicator of the fuel collection strategy represented by feature 302. The single-fire event appears to have been fuelled almost exclusively on the coastal shrub, which would have been growing in close proximity to the site and thus would have been easily accessible. The supplementary species are indicated by their relative abundance to have occurred in small amounts and may represent driftwood.

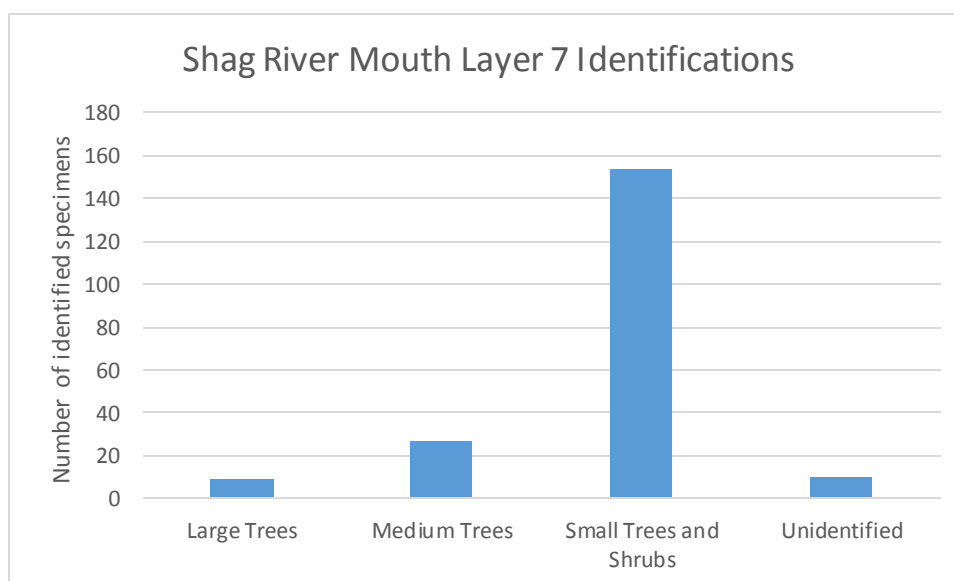


Figure 18. Comparison of identification categories for layer 7, Shag River Mouth

## 5.2 Purakaunui

### Layer 4

Layer 4 was the lowest cultural layer of the southern excavation. It consists of a general midden scatter with some intact umu inclusions. None of the units chosen for subsampling included single umu. The radiocarbon dates, including a twig sample, place occupation in the earlier 15th Century.

Specimens were sourced from three units, and where a unit was sampled twice, separate spits were sourced. The units were: K5, M10 and J5 (figure 19). A total of 22 specimens were unable to be identified. Through analysis a total of 12 species were identified with a further four genera and one family.

A total of 250 specimens were identified through the subsampling. A sufficient sample size was ensured through sampling to redundancy, as illustrated in figure 20.

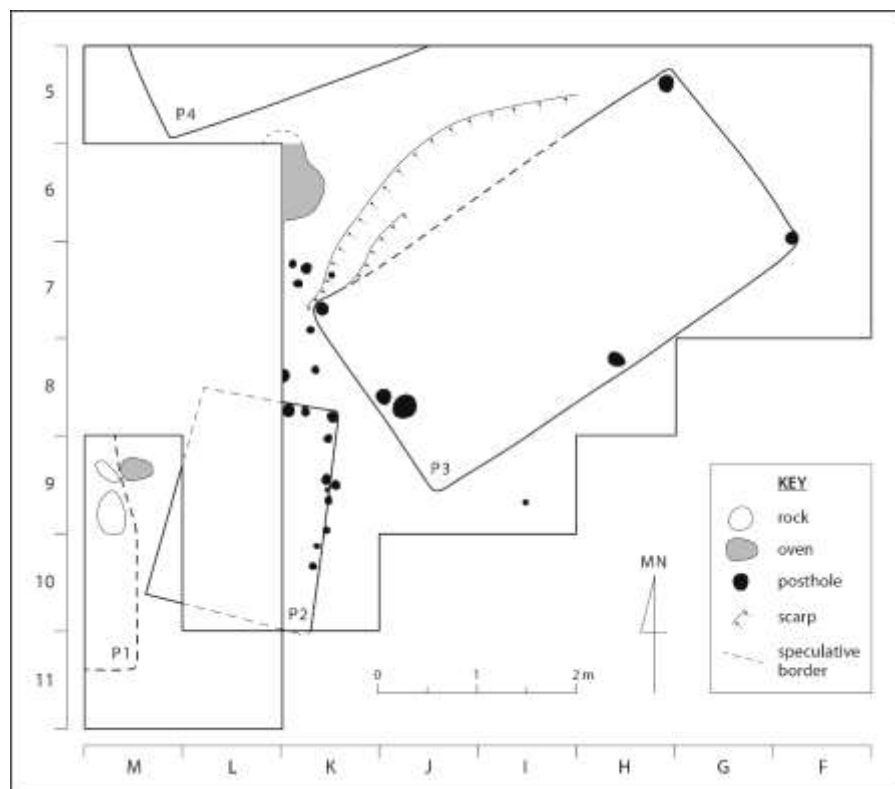


Figure 19. Barber Southern excavation area and plan showing excavation units and numbered pit features, Purakaunui 144/21.

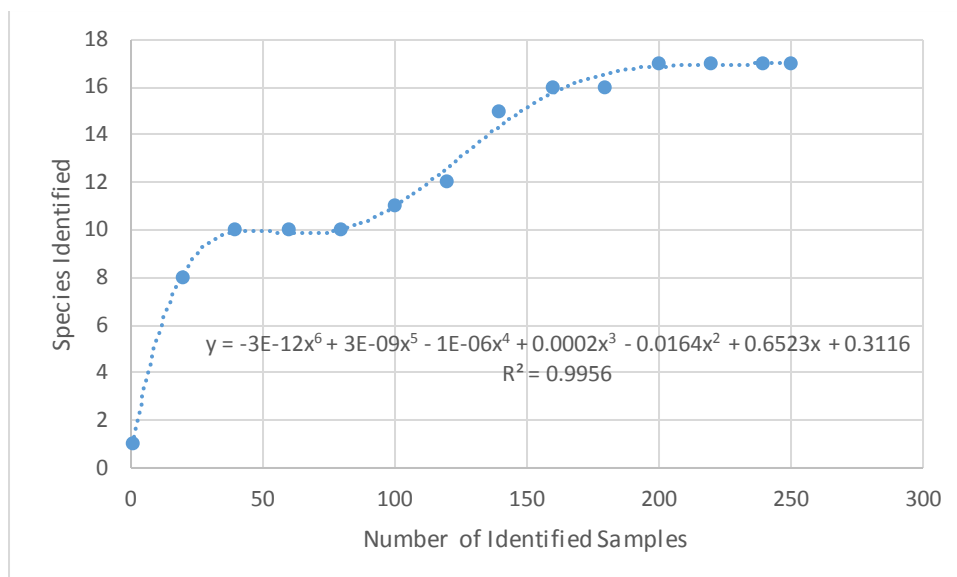


Figure 20. Incremental identifications plotted against cumulative data. Purakaunui, southern excavation, layer 4

Table 5. Summary of wood charcoal identifications from Purakaunui, southern excavation, layer 4.

| Context                         | K5-4-ii | K5-4-ii<br>NEQ | J5-4-ii | J5-4- N.<br>baulk | M10-4-ii | Total Nisp. | Percentage<br>total |
|---------------------------------|---------|----------------|---------|-------------------|----------|-------------|---------------------|
| <i>Myrsine australis</i>        | 2       | 1              |         | 2                 | 2        | 7           | 2.8                 |
| <i>Coprosma</i> ?spp.           | 1       | 5              | 1       | 2                 | 3        | 12          | 4.8                 |
| <i>Pennatia corymbosa</i>       |         |                | 2       | 5                 | 2        | 9           | 3.6                 |
| <i>Hebe</i> ?spp.               |         |                | 1       |                   | 1        | 2           | 0.8                 |
| <i>Myrtaceae</i> ?sp.           | 4       | 1              | 1       | 1                 | 1        | 8           | 3.2                 |
| <i>Leptospermum scoparium</i>   | 5       | 14             | 4       | 5                 | 6        | 34          | 13.6                |
| <i>Pseudopanax</i> ?spp.        |         | 1              | 1       | 1                 | 1        | 4           | 1.6                 |
| <i>Pseudopanax crassifolius</i> |         |                |         | 1                 |          | 1           | 0.4                 |
| <i>Streblus heterophyllus</i>   | 1       |                |         |                   |          | 1           | 0.4                 |
| <i>Kunzea robusta</i>           | 3       | 1              | 2       | 2                 | 2        | 10          | 4                   |
| <i>Sophora microphylla</i>      | 1       |                |         |                   | 1        | 2           | 0.8                 |
| <i>Melicytus lanceolatus</i>    |         |                | 1       |                   |          | 1           | 0.4                 |
| <i>Myoporum laetum</i>          |         | 2              | 1       |                   |          | 3           | 1.2                 |
| <i>Metrosideros</i> ?spp.       | 2       |                |         |                   |          | 2           | 0.8                 |
| <i>Metrosideros umbellata</i>   |         |                | 2       |                   |          | 2           | 0.8                 |
| <i>Podocarpus totara</i>        | 13      | 15             | 18      | 10                | 7        | 63          | 25.2                |
| <i>Prumnopitys taxifolia</i>    | 12      | 5              | 12      | 18                | 20       | 67          | 26.8                |
| Unidentified                    | 6       | 5              | 4       | 3                 | 4        | 22          | 8.8                 |



### *Large trees*

Three species of large tree were identified within this category, the largest percentage of the layer. *Podocarpus totara* and *Prumnopitys taxifolia* dominated both the layer and the category, comprising over 50% of the total sample. A further two identifications were made of *Metrosideros umbellata* and for two samples where species specific anatomy was not visible, the genus *Metrosideros*, although given the geographic location of the site it is most likely that they are *M. umbellata*.

The extremely high proportions of *P. totara* and *P. taxifolia* are strong indicators of a well-established forest being directly accessed for fuel. Given the large size of both species it is most likely that fuel wood would have taken the form of branches or surplus from construction. The presence of *M. umbellata* also suggests the targeting of coastal forest for fuel.

### *Medium Trees*

This category has both the lowest diversity and percentage count, consisting of only 6.4% of the total sample. The five identified species were; *Streblus heterophyllus*, *Sophora microphylla*, *Kunzea robusta*, *Melicytus lanceolatus* and *Myoporum laetum*. All of these tree species grow along forest margins although their limited presence suggests that they were not targeted for fuel collection but may have been taken opportunistically either as smaller branches or driftwood.

### *Small trees or shrubs*

Small trees and shrubs was the most diverse category for this layer. A total of four species were identified with three genera where individual species could not be distinguished and one family, Myrtaceae. This category makes up just over 30% of the total sample.

*Leptospermum scoparium* was the most frequently identified species in this category comprising 13.6% of the total species. As a colonising species with high light demands *L. scoparium* will quickly take advantage of recent clearings and could represent forest margins or scrubland. Forest margins are also suggested by the relative abundance of *Coprosma* species which often form the understory of established forests.

## Layer 4 overview

The results of the layer 4 identifications show a clear prevalence of large trees within the subsample. This is essentially the dominance of two species, as discussed, which indicates the presence of a large matai and totara forest. The understory and margins of this forest can be seen in the identifications of *Coprosma* species as well as *L. scoparium*. Identifications of *P. corymbosa* and *S. heterophyllus* encourage the interpretation of a forest understory being accessed for fuel.

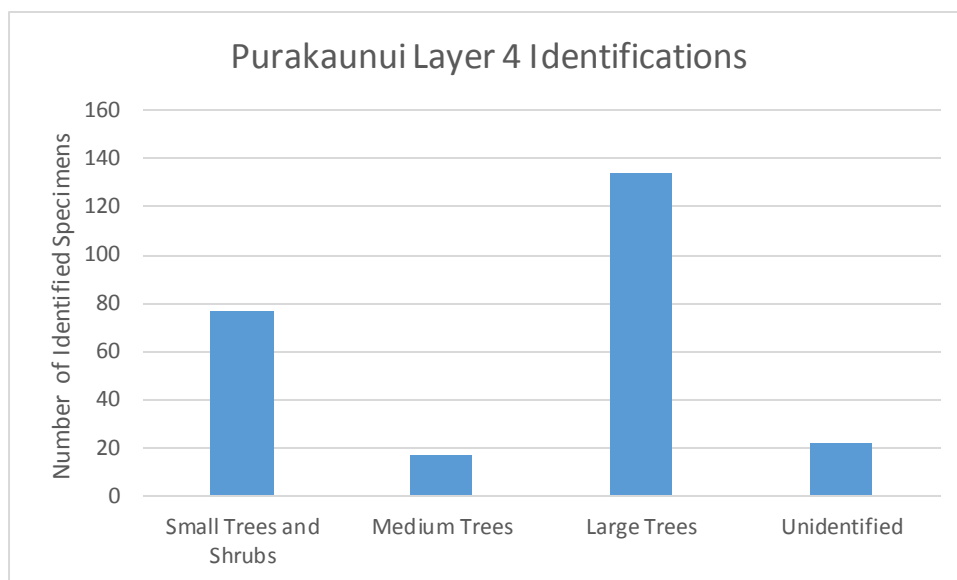


Figure 21. Comparison of identification categories for layer 4, Purakaunui.

## Layer 2

Layer 2 represents the youngest cultural layer of the southern excavation. As described in the background chapter it consists of bone and shell midden in a matrix of dark grey-black sand. As layer 2 represents a secondary charcoal context, that of a general midden scatter, it is suitable for vegetative reconstruction. There is no statistical difference between the radiocarbon dates from layer 4 and layer 2 at 95% confidence (Barber pers. comm. 2015) other than for basal *Melicytus* outlier (Wk 37501).

The layer caps the pit features, however only units outside the pits were sampled. A total of 250 specimens were identified from four units. These units were; J5, L12, M10 and M9 (see figure 19). Unit M9 was sampled twice, from spits iv and v.

A total of 29 specimens were unable to be identified due to either being too small or the condition of the charcoal not allowing for appropriate snaps. Within the identified specimens 13 species were identified with a further five genera and two families identified where identification to a species level was not possible.

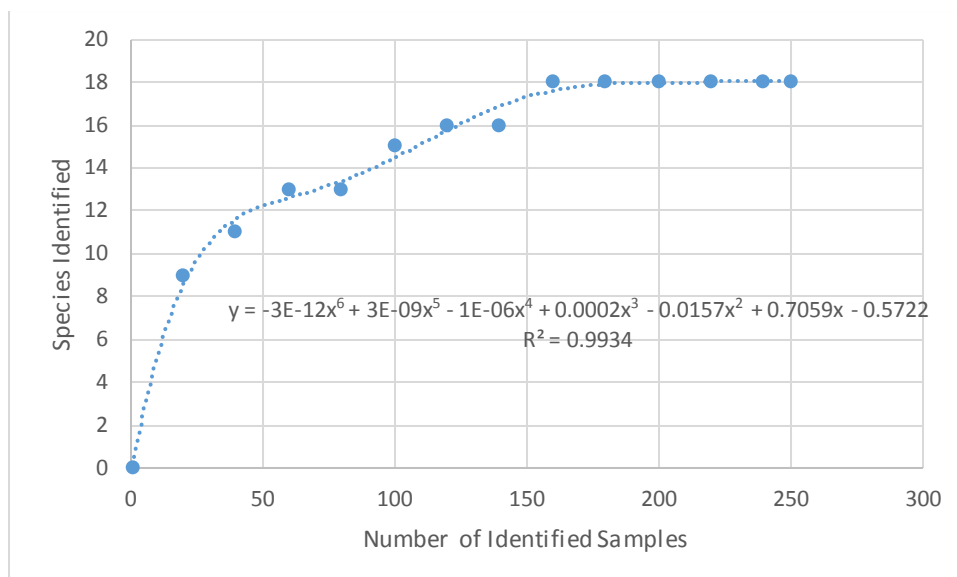


Figure 22. Incremental identifications plotted against cumulative data. Purakaunui, southern excavation, layer 2.

Table 6. Summary of wood charcoal identifications from Purakaunui, southern excavation, layer 2.

| Contexts                        | J5-2-ii | M9-2-v | M9-2-iv | L12-2-i | M10-2-i | Total Nisp. | Percentage total |
|---------------------------------|---------|--------|---------|---------|---------|-------------|------------------|
| <i>Pittosporum</i> ?spp.        | 1       |        | 1       |         |         | 2           | 0.8              |
| <i>Myrsine australis</i>        | 1       | 6      | 4       | 1       | 16      | 28          | 11.2             |
| <i>Coprosma</i> ?spp.           | 3       | 2      |         | 1       | 4       | 10          | 4                |
| <i>Pennatia corymbosa</i>       |         |        | 2       |         | 3       | 5           | 2                |
| <i>Hebe</i> ?spp.               |         |        | 1       |         |         | 1           | 0.4              |
| <i>Myrtaceae</i> ?sp.           |         |        |         | 1       | 1       | 2           | 0.8              |
| <i>Leptospermum scoparium</i>   | 4       | 5      | 4       | 8       | 4       | 25          | 10               |
| <i>Pseudopanax</i> ?spp.        |         | 1      |         | 3       | 6       | 10          | 4                |
| <i>Pseudopanax crassifolius</i> |         | 1      | 6       |         | 1       | 8           | 3.2              |
| <i>Streblus heterophyllus</i>   | 1       |        |         | 2       |         | 3           | 1.2              |
| <i>Kunzea robusta</i>           | 3       | 5      | 3       | 5       | 3       | 19          | 7.6              |
| <i>Sophora microphylla</i>      | 4       | 4      | 1       |         |         | 9           | 3.6              |
| <i>Melicytus lanceolatus</i>    | 2       | 1      |         |         | 2       | 5           | 2                |
| <i>Melicytus ramiflorus</i>     | 3       | 2      | 1       |         |         | 6           | 2.4              |
| <i>Myoporum laetum</i>          | 3       | 3      | 2       | 1       | 4       | 13          | 5.2              |
| <i>Metrosideros umbellata</i>   |         | 2      |         |         |         | 2           | 0.8              |
| <i>Podocarpaceae</i> ?sp.       |         | 2      | 1       |         |         | 3           | 1.2              |
| <i>Podocarpus totara</i>        | 6       | 6      | 10      | 3       |         | 25          | 10               |
| <i>Prumnopitys taxifolia</i>    | 9       | 7      | 7       | 19      | 2       | 44          | 17.6             |
| <i>Nothofagus</i> ?spp.         |         |        |         | 1       |         | 1           | 0.4              |
| Unidentified                    | 10      | 3      | 7       | 5       | 4       | 29          | 11.6             |

### *Large trees*

Three species were identified within the category of 'large tree'; *Podocarpus totara*, *Prumnopitys taxifolia* and *Metrosideros umbellata*. A further identification of the genus *Nothofagus* was restricted to a single sample which due to its small size was unable to be identified to a lower taxonomy. The identification of 'Podocarpaceae' was made when distinguishing anatomical features were not visible.

*P. taxifolia* is the most represented within the context with 44 identifications, almost twice as many as *P. totara*. Whilst present in all contexts, almost half the *P. taxifolia* specimens were concentrated in unit L-12-2-i. Although still present in significant amounts *P. totara* is not nearly as abundant as *P. taxifolia*. The relative abundance of both species suggests that, while present, large trees are either not the focus of fuel collection strategies, or are not readily available.

The smaller quantities of a larger range of 'large tree' species is indicative of driftwood or fallen material from coastal forests being included in fuel collection strategies.

### *Medium trees*

Identifications to a species level was possible for six species in this category; *Myoporum laetum*, *Melicytus ramiflorus*, *Melicytus lanceolatus*, *Sophora microphylla*, *Kunzea robusta*, and *Streblus heterophyllus*.

The relative abundance of *K. robusta* suggests that relatively open environments were being accessed for fuel collection. This interpretation is encouraged through the identification of *S. microphylla* and both *Melicytus* species which are commonly found on forest margins or partially cleared land.

### *Small trees and shrubs*

Small trees and shrubs represent both the most diverse and largest category for this layer, making up a 36.4% of the total sample. Within this category four species were identified with a further four identifiable only to genus level and for some small samples it was possible only to confidently assign them to the family Myrtaceae.

Within this sample two species are present in significant portions; *Myrsine australis* and *Leptospermum scoparium*. Together they represent over 20% of the total sample. A large percentage of the identified *M. australis* was isolated to the sample recovered from unit S-M10-2-i and may be more representative of a single fire. *L. scoparium* however was distributed evenly throughout the total sample which suggests it was a commonly sourced fuel.

The relative abundance of *Coprosma* ?*spp*, is commonly associated with forest understories and when considered in combination with the range of small tree and shrub species identified suggests that forest margins and their easily accessible species were targeted for fuel collection.

## Layer 2 overview

Interpretation of the complete results of layer 2 identifications indicate that fuel collection is taking place in a forest environment. The relative abundance of *P. totara* and *P. taxifolia* suggest that they make up the upper canopies of the forest. The species that were found on the margins of the forest and in the under canopies consist of a mosaic of, among others, *M. australis*, *Coprosma*, *L. scoparium* and both *Melicytus* species. While driftwood may make up a portion of the identifications it can be considered restricted to the small amounts of large tree species, notable *Nothofagus*.

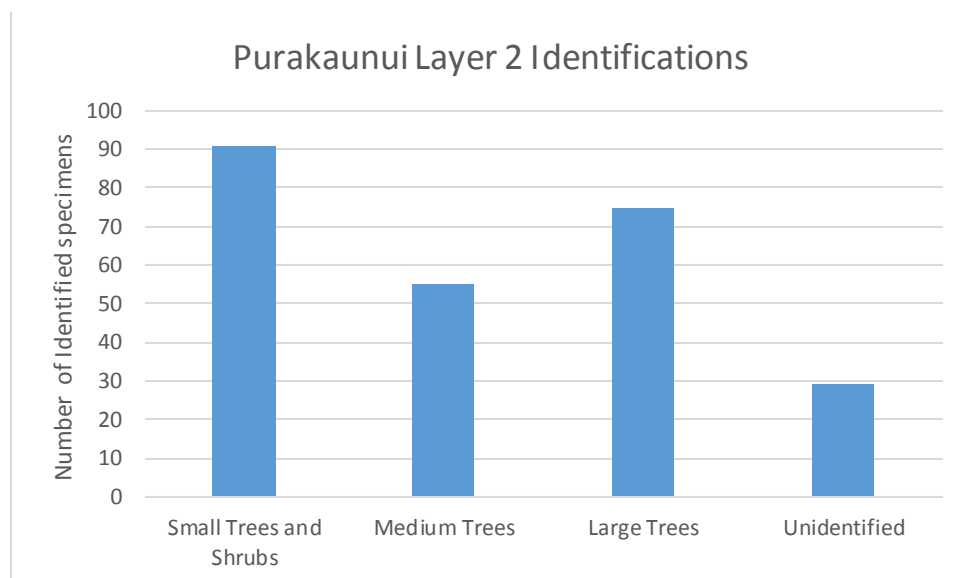


Figure 23. Comparison of identification categories for layer 2, Purakaunui.

These results represent the preliminary findings for each of the contexts individually. They provide the first indications of which vegetative environments were being targeted for fuel collections. The results also indicate how representative each identified charcoal assemblage is, with the applications for further interpretation explored in the following chapter.

## 6. Discussion

The research questions posed in the introduction are an attempt to quantify the potential anthracological value of existing, curated, charcoal assemblages. The results, as discussed in the previous chapter, have indicated the environments targeted for fuel collection. In this chapter I untangle these results and apply the research questions guiding this investigation through comparison of the two archaeological sites.

### 6.1 Site comparison

The two archaeological sites investigated within this thesis were chosen on the weight of both their similarities and differences.

The physical proximity of the two sites places them both on the east coast of Otago, and thus within the same dry climate and similar vegetative communities. The temporal proximity of the sites is two-fold; first Purakaunui was occupied up to 50 years after Shag River Mouth, and secondly they were occupied for similar durations with Shag River Mouth being occupied for approximately 50 years and Purakaunui for < 100 years. The differences presented by the sites include their specific environmental niches and functions. One of the most important differences is presented, not through the sites themselves, but the archaeological processes undertaken during excavation. This is primarily concerned with the on-site sampling of charcoal, with the curation of excavated material also considered.

#### Environmental

The climates and geographic locations of the sites means that they share a comparable range of flora. The similarities are extended to include the coastal nature of both sites, as well as their proximity to a range of environments including established coastal forest and open scrubland. It is the differences separating the sites that need to be considered as they become visible in the anthracological record.

Shag River Mouth occupies the open dune environment adjacent to the mouth of the Shag River. This provides the site with access to both the estuary and associated saltmarshes as well as flat shrublands to the south of the site. The open vegetation behind the site has been indicated through palynological analysis (Boyd *et al.* 1996) to be that of a shrub and scrubland. The northern aspect of the estuary consists of moderately steep exposed rock faces (see figure 24).



*Figure 24. Northern aspect of Shag River Mouth. Visible is the estuary mouth and large sandbank with a large amount of driftwood. Photo taken May 2015.*

In contrast, Purakaunui is located adjacent to a coastal inlet. This site is located on a dune system, on the northern aspect of the inlet, currently planted with pines. The soil consists of loamy sand typical of coastal dunes. The environment on the southern aspect of the inlet is steep hill, with some exposed rock and boulder beach deposits at the inlet mouth. This area is now occupied as the modern settlement of Purakaunui. As with Shag River Mouth, the dune system is mobile and subject to coastal erosion. Barber and Walter (2002) calculated that the coastline has, in parts, retreated as much as 25m since the late 19<sup>th</sup> century.



*Figure 25. Eastern aspect of tidal inlet mouth (Photo taken July 2013). .*

## Chronology

Radiocarbon dating has shown that in both instances, the sites were occupied within a period of 100 years (see Background chapter for full list of radiocarbon dates). Shag River Mouth has an approximate occupation period of up to 50 years in the mid to late 14<sup>th</sup> century (Anderson and Smith 1996c). The two cultural layers at Purakaunui represents a timespan of <100 years around the early to mid-15<sup>th</sup> Century (see Background; Purakaunui). This closeness in occupation time and span at both sites provides a rare opportunity for comparison through anthracological analysis. The differences between the two sites, as explored in this chapter, highlight many facets of both vegetation interactions of the period of early Polynesia colonisation and their representation in the anthracological record.

## Settlement patterns

Although occupation has been shown to have occurred at similar times the patterns of settlement and occupation are less comparable. Shag River Mouth was hypothesised to represent relatively sustained occupation. Faunal analysis showed continued environmental impacts over time as moa are common in layers 6-11 of the SM/C:Dune excavation but relatively scarce in younger layers (Anderson and Smith 1996b; McGovern-Wilson *et al.* 1996). Fish, shellfish and small birds all become more abundant in the upper layers (Anderson and Smith 1996b). The environmental impact of sustained occupation has also been illustrated in the palynological record. Pollen analysis showed large scale landscape clearing and the replacement of shrubland with open seral fern dominated vegetative communities. This is discussed further in the chapter.

Purakaunui was initially interpreted by Anderson (1981) as a seasonal fishing camp. The subsequent investigations of Barber and Walter (2002) show that although fishing was the primary activity undertaken at the site, it is part of a wider subsistence strategy. Analysis of fauna suggests that a wide range of coastal species including coastal birds (notably *Diomedea*) were targeted, with Kuri (*Canis familiaris*) presenting the only significant terrestrial contribution (Mitchell 2010). The discovery of a storage pit complex suggests a more complex site occupation history (Barber and Walter 2002).

The differences in the settlement patterns of both sites is reflected in the palaeobotanical record. This is largely through anthracological analysis at Purakaunui and palynology at Shag River Mouth. Although, as discussed within this chapter, the two records can complement each other to form a more cohesive image of vegetative impacts.



## Methodology

### *Sampling strategy*

The anthracological contexts represented in this research range from a single oven feature, to generalised midden scatter, as well as a combination of both. The sampling strategies represented by these contrasting contexts highlight how much information can be retained or lost.

As has been discussed previously, the sampling strategy at Shag River Mouth can be largely classified as targeting firescoops and other distinct fire events. This focus of firescoops and ovens has resulted in the representation of a single fire event, feature 302, for layer 7. Layer 11 is more representative with three individual fire events. It must be noted that this was not the exclusive method of sampling as some samples (layer 11 units F8 and J5) represent general midden scatter which means that layer 11 is a more representative unit.

In contrast, excavation at Purakaunui included the bulk sampling of general midden scatter in most, if not all, excavation units. Thus, each sampled unit represents multiple fire events making Purakaunui the more representative assemblage.

The second consideration is the curation of the above mentioned samples. Another similarity of both sites is their excavation in association with the University of Otago; a fact which has resulted in the storage of all excavation material within the University's archaeological laboratories. This simple fact has resulted in material from both excavations being included in numerous student dissertations and theses, the writer's included (Allen 2013; Bull 2008; Gay 2004; Higham 1990; Kirk 1989; Latham 2002, 2005; Lawrence 2012; Mitchell 2010). In this aspect, the charcoal assemblage from Shag River Mouth is at a disadvantage as its earlier excavation has resulted in a longer period of investigation and thus a potentially increased incidence of curation interactions. Curation interactions include laboratory processes such as washing, sorting or removal of material, as well as activities such as re-labelling or simply moving parent bags.

It is acknowledged that the available parent bags for subsampling from both sites may not accurately represent the full spectrum of material excavated. However this 'availability' of samples has been considered a reflection of the vulnerabilities of curation.

The bulk samples that represent the sampling strategy at Purakaunui are the most appropriate form of sampling if onsite floatation or subsampling for botanic research is not undertaken. Bulk sampling preserves an accurate representation of the charcoal assemblage, most importantly small diameter specimens and can thus avoid introducing bias into the anthracological record.

Collection strategies that hand-select for large pieces of charcoal result in a heavily biased assemblage. This is illustrated in the charcoal identifications from feature 302. As visible in the table 7 below the mean weight of *P. divaricatus* specimens was larger than any of the other species identified. Hand selection of specimens from the primary context (notably the ‘stake 3’ and ‘stake 4’ parent bags) may have resulted in the reduced abundance of these already poorly represented species.

Table 3. Mean weights of specimens from feature 302, layer 7, Shag River Mouth.

| Species                        | Total nisp. | Mean weight of samples (g) |
|--------------------------------|-------------|----------------------------|
| <i>Plagianthus divaricatus</i> | 150         | 0.22                       |
| <i>Myrsine australis</i>       | 4           | 0.15                       |
| <i>Sophora microphylla</i>     | 27          | 0.12                       |
| <i>Prumnopitys taxifolia</i>   | 9           | 0.08                       |
| Unidentified                   | 10          | 0.13                       |

Together these contexts, and their accompanying sampling methods have illustrated the limitations of retrospective anthracological research on curated assemblages. The relative ‘appropriateness’ of a sample is determined primarily through the intended focus of the research; studies concerned with fuel collection should sample charcoal from a large number of primary contexts originating within secure stratigraphic contexts while studies interested in vegetation reconstruction and anthropogenic impacts require samples from secondary contexts.

## 6.2 Fuel collection

As all samples included in this research represent charcoal generated through cultural activity they are all suitable for providing information on fuel collection. Fuel collection is not to be confused with fuel selection. Fuel selection strategies are concerned with the preference and targeted collection of specific, valued, species or ‘types’. Instead fuel collection is concerned with general practices surrounding the collection of fuel wood.

Limitations on the information gathered are introduced when the number of fire events are considered. The larger the number of fire events, the more the anthracological record informs on general fuel collection patterns rather than a single collecting event. As with vegetation reconstruction, secondary contexts are preferable as they are the result of multiple fire events. The description of a single fire event, such as feature 302, provides evidence of one fire event among the

hundreds, if not thousands, that would have occurred during the site's 50-year occupation period (Anderson and Smith 1996b).

The single fire event represented by feature 302 from layer 7 of the Shag River Mouth high dune excavations contained only four species of wood. Analysis of 200 individual specimens yielded highly concentrated identifications of a single species (*P. divaricatus*). Without comparison to fire events from the same stratigraphic layer it is difficult to determine if the fuel collection strategy represented by feature 302 is typical or anomalous. The high concentrations of *P. divaricatus* may reflect on a persistent fuel collection pattern that targeted the close and easy to collect saltmarsh species. Conversely it may also represent a single incidence whereby the size of the oven, or any of several reasons, resulted in the collection of fuel that deviated from normal practice.

Analysis of the single fire event of feature 302 does not provide a comprehensive picture of fuel collection practices. The dominant species, *P. divaricatus*, or coastal ribbonwood, is a salt-tolerant shrub that would have been found in the immediate vicinity of the site and is still present today. The wood value as fuel however is not very high as the wood is not very dense. The inclusion, and concentration of *P. divaricatus* suggests that the fuel attributes of ease of collection was of primary concern. The low relative abundance of the supplementary species; *M. australis*, *S. microphylla* and *P. taxifolia* suggest that their inclusion relied on much smaller amounts of available fuel, such as could be represented by driftwood.

The limitations placed on data generated from primary contexts can be circumvented in part through the analysis of multiple primary contexts. The fuel collection data that is represented by the layer 11 samples from Shag River Mouth show the results of three single fire events (units D7, C8 and F4) as well as the numerous fires represented by the general midden scatter (units F8, and J5). This provides a much more secure dataset for fuel collection trends during the occupation period that layer 11 represents.

The increased representativeness of layer 11 is immediately apparent with the identification of ten species, five genera and three families. This increase from layer 7 clearly indicates that the inclusion of multiple fire events creates a more diverse and representative anthracological dataset. Analysis of the layer 11 dataset reveals the exploitation of several vegetative environments as well as how relative abundances can vary between fire events.

As briefly discussed in the previous results chapter, the identifications from layer 11 reveal no single species dominates the assemblage, but rather a range of environments are represented. The saltmarsh environs are still present with the identification of *P. divaricatus*, although at a moderate abundance of 6.4%. Open scrubland and possible dune vegetation is well represented with species

such as *Olearia ?spp*, *Hebe ?spp*. and *D. toumatou* making up approximately 12% of the total sample. The most abundant species is *S. microphylla*, which when considered with other coastal forest margin species (*M. australis*, *M. laetum* and *Pittosporum*) suggests that this environment was a common location for fuel collection. The use of forest margins rather than open seral vegetation is suggested by the relatively low abundances of *L. scoparium* and *K. robusta*, both of which are highly suggestive coloniser species (Wardle 1991). The second most abundant species is *P. totara*, although as this is concentrated in the firescoop represented by unit D7. The otherwise low abundance of *P. totara* and other large trees suggests that they represent fuel that was taken opportunistically from remnant wood, likely driftwood, rather than sourced from the forest.

The above results are indicative as the sample size is small. However the inclusion of several fire events, as well as some secondary contexts, illustrates the benefit of appropriate sampling methods.

The most representative fuel collection dataset is generated from secondary contexts as these contexts represent multiple fire events. The Purakaunui assemblages as secondary contexts represent the fuel collection practices for the two stratigraphically distinct occupation periods.

The fuel collection data from layer 4 shows a clear domination of the two identified podocarp species: *P. totara* and *P. taxifolia*. These two species provide over 50% of the total sample. The remaining portion of the sample suggests that the understory and forest margins are also being targeted due to the relative abundance of *Coprosma ?spp*. (4.8%), *P. corymbosa* (3.6%) and *L. scoparium* (13.6%). The high abundance of podocarp species, both of which are large trees, suggests that fuel was collected from an established forest. The form this collection may have taken, such as collection of smaller branch wood, as surplus from construction, or other cultural activities, is unknown as it is highly unlikely trees were being felled for the sole purpose of fuel.

The younger layer 2 reveals a slightly altered fuel collection pattern. The amount of podocarps has decreased to approximately 30% of the total sample but is still the most abundant identification. In other respects the environments indicated as fuel collection zones are the same as in layer 4. Forest margins and understories are still represented with the following species present in marginally increased amounts; *M. australis*, *P. crassifolius*, *S. heterophyllus*, and *K. robusta*. The potential reasons behind this are discussed in the following section.

## 6.3 Vegetation impacts

How and why is vegetation reconstruction (and impact) possible?

Identifying anthropogenic impacts in vegetation communities is one of the central themes of anthracological research. The vegetative communities within which past peoples were living can be identified through vegetation reconstruction and through the investigation of change over time we can understand how people in the past are shaping the vegetative environment around themselves. Ultimately, anthracology is an archaeological tool to inform on the lives of people in the past.

Identifying anthropogenically induced change is possible when representative samples from different stratigraphic layers are compared. The change in relative abundances of species present in both, or all, the compared samples as well as loss of species and introduction of new species all indicate changes in vegetative communities. In this thesis, the anthropogenically induced change that is considered is that of the burning practices associated with the IBP model. The IBP model predicts the rapid removal of dense forest environments on the dry East coast of Otago through intentional anthropogenic firing by early Polynesian colonisers (McWethy *et al.* 2009, 2010, 2014). The IBP model is supported through the analysis of palaeoenvironmental data recovered from inland lakes. Through the analysis of archaeological charcoal assemblages this thesis tests the assumption of dramatic vegetation change at an occupational level.

Analysing secondary contexts over time

Bulk samples from secondary contexts at Purakaunui provide representative samples of the vegetation allowing for suitable vegetation reconstruction. Comparison of these two cultural assemblages and the vegetation they represent allows for an interpretation of change over time in the surrounding vegetation. The older layer 4 assemblage is associated with early occupation in the area and thus vegetation is relatively unaffected by human interaction. Layer 2 represents occupation within 100 years after layer 4 and thus has the opportunity for anthropogenic modification.

The results from layer 4 all indicate that an established matai and totara forest was within close proximity to the site. The high abundance of both podocarp species in combination with a number of understory species identified (*Coprosma* ?*spp*, *P. corymbosa*, *Hebe* ?*spp*, and *C. arborea*) strongly indicates that fuel wood was taken from within the forest environment (for more in-depth analysis see Results: layer 4). Layer 2 is largely comparable to layer 4 with many of the same species present in both assemblages. The central difference between the two assemblages appears when the relative abundances of shared species are compared.

The layer 4 assemblage is dominated by podocarps. Over 50% of the total sample is identified to two podocarp species; *P. totara* and *P. taxifolia*. Within the younger layer the relative abundance of podocarps has markedly decreased and they now only make up 28.8% of the total sample. The reduction in podocarps by itself can be interpreted as a result of changing fuel collection practices, or reduced access to the species. In order to determine which reason is more likely, nuanced changes between the non-podocarp species are considered.

The taxa that are considered 'coloniser' species, due to their inclusion in seral vegetation and high light demands include; *L. scoparium*, *K. robusta*, *Hebe* ?spp., *S. microphylla*. A marked increase in these species would suggest that open areas are more commonly being accessed for fuel collection. There is only a minor increase within two species with *S. microphylla* increasing 2.8% and *K. robusta* by 3.6%. This does not suggest that the existing forest has been impacted sufficiently to encourage significant seral vegetation. Instead, increases are seen in the species that form the understories and forest margins; *Pseudopanax* ?spp (5.2% increase), *Melicytus* ?spp. (4% increase) and *M. laetum* (4% increase). Fuel that was originally sourced from podocarps is substituted with species that are growing within the fringes of the forest. In short, the changes in fuel collection are indicative of vegetative impacts. The impact seen at Purakaunui over the possible course of decades is not largescale landscape modification but an encroachment into established forest.

### The Initial Burning Period

The vegetative changes visible at Purakaunui help to understand the relative resilience of some New Zealand forests and also assists in the creation of a more nuanced record of environmental impacts during early Polynesian colonisation on the East coast of Otago.

McWethy *et al.* (2009) suggest that the widespread burning which characterizes the IBP was initially coastal before moving inland. They also indicate that the IBP occurred between 1270AD and 1600AD (McWethy *et al.* 2010, 21344). The chronology of Purakaunui fits comfortably within this timeframe. However at least a century after first occupation, the Purakaunui data shows that podocarp forest is persisting on the dry east Otago coast.

McWethy *et al.* (2009), as well as other investigations (McGlone 1983, 1989; McGlone and Wilmshurst 1999; McWethy *et al.* 2010, 2014; Perry 2012; Williams 2009) assert that during the IBP widespread land clearance occurred through the burning of forest environments. The reasons behind this land clearance are suggested by Williams (2009) to be a result of the subsistence strategies adopted by the Polynesian colonisers of temperate New Zealand. As the climate of southern New Zealand is too cold to support the agricultural practices transplanted from the Pacific, namely the cultivation of taro (*Colocasia esculentum*) and kumara (*Ipomea batatas*), the southern colonisers

adopted a transient lifestyle (Anderson and Smith 1996c; Walter *et al.* 2006; Williams 2009). Such a transient lifestyle required two attributes from the vegetative communities. The first was ease of travel as “early Māori would have travelled across the landscape to target other non-local resources” (Williams 2009, 182). The second attribute is the availability of carbohydrate rich plant species. Outside the limits of cultivation, two native species were targeted as a source of carbohydrate: tī (*Cordyline australis*) and bracken (*Pteridium esculentum*). These two species were not subject to active gardening practices but their growth could be encouraged through the extension of suitable environments. Firing established forests provides the open, environment that bracken and tī are best suited to (Leach 2003).

Had the forest environment around Purakaunui been subjected to the practices of the IBP then the relative abundances of the podocarp species would have been dramatically reduced as the established forests were burnt. The result of forest loss is an increase in open seral vegetation where light-demanding species such as *S. microphylla*, *K. robusta*, and *L. scoparium* greatly increased. The anthracological record at Purakaunui recognises a reduction in the abundance of podocarps over time but not in sufficient amounts to indicate land clearance and the accompanying increase in seral species is not identified. Instead the anthracological record has shown the persistence of an established podocarp forest through an occupation period that has been securely dated as <100 years. This small scale change is contrasted to the high impact, fast moving landscape alteration suggested by McWethy *et al.* (2009).

Despite its geographic setting in coastal East Otago among established forest and occupation during the early Polynesian colonisation, all factors which suggest inclusion in the IBP model, Purakaunui does not fit the IBP model. Instead of largescale landscape modification for the purposes outlined above, the local vegetation has been left in a relatively intact state. The identification of Purakaunui as an outlier highlights the value of a more nuanced interpretation of landscape change available when archaeological assemblages are analysed.

Whilst the limitations presented by the nature of the Shag River Mouth contexts precludes them from being used for vegetation reconstruction the anthracological dataset can be compared to the existing palynological data. Through comparison it is possible to determine if they correlate with the environmental changes indicated from the pollen analysis.

The Shag River Mouth pollen analysis shows a distinct transition from a dense scrubland in the immediate vicinity of the saltmarsh (Boyd *et al.* 1996) to more open “seral, fern-dominated communities” (Boyd *et al.* 1996). This is identified as two distinct phases, or ‘zones’, of vegetation at

the site. The first 'zone' identified "a landscape already heavily affected by burning" (Boyd *et al.* 1996, 262) though forest is still present as well as a mosaic of scrubland, fernland and grassland (Boyd *et al.* 1996). This develops in the second zone which "records the destruction of local scrub vegetation by fire" (Boyd *et al.* 1996, 263) and the "expansion of seral, fern-dominated communities" (Boyd *et al.* 1996, 263). The transition from dense scrubland to more open fern environment fits comfortably with the IBP model.

This movement of fire through the landscape around the site suggests that the cultural practice of land clearance is being applied by the occupants of Shag River Mouth. This strongly suggests that Shag River Mouth displays landscape management practices predicted by the IBP. The anthracological record can be compared with additional palaeobotanical data in order to understand the process.

When the anthracological record, limited though it is, is compared to the palynological record there is a clear association. The dense scrubland and varied environments are visible in layer 11 with a range of species including; *Olearia ?spp.*, *Coprosma ?spp.*, *Hebe ?spp.*, and *M. australis*. These species are all being collected as fuel. As many of them are too small to be reliably considered driftwood it appears they are being sourced directly from a living environment. This is contrasted with the single fire event represented in layer 7. In this context 75% of the total material identified was the relatively poor-quality firewood species *P. divaricatus* or saltmarsh ribbonwood. The remaining portion of the sample consisted of *S. microphylla*, *M. australis*, *P. taxifolia* and unidentified specimens.

The dominance of *P. divaricatus*, as a low value fuel, has been hypothesised earlier in this chapter to represent fuel collection methods. The proximity of the saltmarsh and thus quick access to fuel being of higher importance than the quality of the fuel in question. However, when considered in tandem with the dramatic vegetation transition reflected in the palynological record it may itself be a reflection of limited choice of fuel. Clearance of shrubs and scrubland around the site limits access to potential fire wood. In this manner both palaeoenvironmental data and archaeological charcoal data have been used to provide a richer picture of vegetation impacts at Shag River Mouth.

Palynological and faunal data generated from the primary investigations of Shag River Mouth, including the increase in relative quail numbers over time, established the fact of land clearance about the 14<sup>th</sup> century. Comparing the existing record to the anthracological data not only re-affirms the initial findings of vegetation change but illustrates how this change affected the daily lives of Shag River Mouths inhabitants. The charcoal identified from Shag River Mouth demonstrates how the removal of forest and dense scrubland resulted in reduced wood fuel choices.



The reasons behind each site's relationship to the IBP model may lie in the primary functions and targeted environments of Shag River Mouth and Purakaunui. As has been shown previously, the occupants of Shag River Mouth accessed all surrounding environments; estuarine, coastal, and open shrubland. Anderson and Smith (1996b) identify a shift in subsistence strategies over time at Shag River Mouth. They describe a shift from “an earlier [subsistence pattern] focussing largely on seals, moas and coastal birds; and a later [subsistence pattern] dominated by shellfish, fish and open country birds” (Anderson and Smith 1996b, 283). McWethy *et al.* (2010, 21347) suggest that the use of burning was an attempt to increase the productivity of the terrestrial environment through replacement of beech and podocarp forests with bracken and other carbohydrate sources. Removal of forests also created a more accessible environment. At Shag River Mouth it was in the interests of the inhabitants to maximise the terrestrial resources to replace those lost through exploitation in the ‘earlier subsistence pattern’. The significant food resources of moa, seals and coastal birds having been depleted during the earlier phase of occupation are replaced with finfish, shellfish and, most importantly ‘open country birds’ (Anderson and Smith 1996b, 283). The removal of dense shrubland would not only facilitate the growth of bracken but would increase access to terrestrial species, such as the New Zealand quail. This management of vegetation extended the period of viability at Shag River Mouth by maximising access to remaining resources.

Purakaunui contrasts with this resource use pattern as there is a clear coastal resource focus. Anderson identified the site as a temporary fishing camp, designed for seasonal use with the primary function of catching, and potentially drying, finfish species (Anderson 1981). Although new evidence from the excavations of Barber and Walter (2001, 2002) indicate that Anderson’s interpretation was overly simplistic there is still a clear coastal resource focus, with finfish dominating the faunal assemblage at Purakaunui (Latham 2005). Coastal birds also predominate with birds from the *Diomedea* genus accounting for nearly 50% of the total bird assemblage (Mitchell 2010).

Although there is a clear coastal resource focus, the established forest would have provided resources including birds and timber for construction. Within the faunal assemblages a number of forest bird species were also present, including; kererū (*Hemiphaga novasealandiae*), tūī (*Prosthemadera novasealandiae*) and kōkako (*Callaeas cinereus*) (Anderson 1981; Mitchell 2010). The high abundance of podocarp species within the charcoal record, supports the likelihood of timber processing on site. This may have included the construction of structures and waka. The focus on coastal resources, and use of forest resources, may be the reason that Purakaunui does not follow the IBP model. As Purakaunui did not rely on terrestrial resources it may not have been in the interests of the inhabitants to remove the adjacent forest. The coastal resources that were targeted

at Purakaunui were not affected by an increase in open vegetation and therefore the burning of forest would have served little purpose.

This investigation has demonstrated the suitability of Shag River Mouth and Purakaunui for comparison. The two sites share a geographic location on the East coast of Otago, and more specifically are located on dune systems adjacent to estuarine environs. The chronologies of both sites place them within early Polynesian colonisation of the South Island of New Zealand, and their occupation duration is also comparable. The differences in site function, and resource use, could be the reason behind each sites uptake of intensive landscape burning.

Shag River Mouth represents a more intensive, and continuous settlement than Purakaunui, which ongoing investigations show had a complex settlement. Analysis of a range of archaeological data, including the charcoal record and faunal remains shows two distinct regimes of landscape modification and resource exploitation. The anthracological data generated through this investigation has suggested that Shag River Mouth fits within the IBP model. In contrast, the results of this research indicate that Purakaunui does not fit within the model of landscape modification suggested by the IBP.

## 7. Conclusion

This thesis posed several questions about curated charcoal assemblages. The core problem questions the viability of curated charcoal assemblages for retrospective analysis and asked:

‘Are existing curated charcoal assemblages appropriate sources for retrospective anthracological research?’

This core problem was tested in relation to the analysis of two archaeological charcoal assemblages. Three specific questions were tested from this analysis.

- 1) Can changes in fuel collection be viewed over time?
- 2) Do changes in fuel collection reflect on potential vegetation impacts at the site?
- 3) Are anthracological analyses of East Otago archaeological sites consistent with the IBP model for landscape modification?

Curated charcoal assemblages from Shag River Mouth and Purakaunui were analysed in order to answer the above three questions. The results, as discussed in previous chapters, reveal how curated charcoal assemblages that originate from cultural activity and secure stratigraphic contexts, can inform on fuel collection and use. The identification of vegetative impacts, especially those associated with the IBP, is limited and depends on a number of criteria; the nature of the assemblage in representing primary or secondary contexts, the number of units present within an assemblage, the sampling strategy that generated the assemblage and the presence of existing palaeobotanical research.

### 7.1 Primary and secondary contexts

The two curated archaeological assemblages represent both primary and secondary contexts. Shag River Mouth presents largely primary contexts in the form of excavated fire pits. In contrast Purakaunui is represented by secondary contexts. The differences presented by these two types of contexts were explored in the thesis as they are one of the fundamental influences as to how much information can be gathered from curated charcoal assemblages. It has long been established within international literature that primary contexts are inappropriate sources for vegetation reconstruction data (Asouti and Austin 2005; Théry-Parisot 2002; Théry-Parisot *et al.* 2010). Establishing how much this affects small scale retrospective anthracological analysis was one of the outputs of this research.

The assemblages from Shag River Mouth were limited as they predominantly represented primary contexts and as such could only inform conclusively on a small number of cultural fire events. The lowest cultural layer of Shag River Mouth High Dune excavation, layer 11, had three individual fire events (units C8, F4 and D7) as well as secondary midden scatter (units F8 and J5). This meant that layer 11 gave information on more general fuel collection trends. These general fuel collection trends were the targeting of the shrubland surrounding the site as well as the inclusion of opportunistically sourced wood, including driftwood.

The charcoal assemblage from layer 7, represents only a single fire event in the form of a large oven, feature 302. In this respect, this assemblage could provide extremely limited information of a single fire. The data generated from feature 302 show the dominance of *P. divaricatus*, a saltmarsh species, and smaller amounts of opportunistically sourced wood.

The results from the Shag River Mouth analysis cannot be considered suitable standalone evidence for vegetation reconstructions or the identification of vegetative impacts. The number of sampled fire events is simply too small to be considered appropriate for these anthracological applications. However they still provide an extra facet to the larger palaeobotanical investigation provided by the palynological report, soil and vegetation assessment of the local environment. The palynological report detailed the largescale landscape change that occurred at Shag River Mouth; as shrubland was replaced with fernland. The fire events analysed within this thesis from Shag River Mouth provide a more human aspect to the landscape change as they directly reflect how people interact with their changing vegetative environment.

The anthracological analysis of the two Shag River Mouth assemblages show a significant change. The earlier ovens utilise a wide range of taxa and suggest that fuel was taken both directly from living environments and as relict wood. The later oven (feature 302) is almost entirely represented by a low value saltmarsh species (*P. divaricatus*). This transition in fuel collection, from a varied selection to a concentrated focus, was considered in tandem with the existing palynological report to reflect the differences in fuel availability.

As the surrounding shrubland is removed, potentially to encourage the growth of bracken, the available fuel wood is reduced to those environments not suitable for bracken growth, such as saltmarsh. The reduction in available species necessitates fuel collection from the remaining vegetative environments, despite the lower fuel value of those species, and opportunistic relict wood collection. In this respect the high concentrations of *P. divaricatus* within the layer 7 charcoal assemblage can be considered a reflection of reduced fuel choices and a direct human reaction to largescale landscape changes in the vegetative environments of Shag River Mouth.

At Purakaunui, both sampled assemblages consisted exclusively of material sourced from secondary contexts. As these secondary contexts contained information on multiple fires the data generated from the samples is considered representative of the general fuel collection patterns. The data from the lower cultural layer, layer 4, showed exploitation of an established matai and totara forest, with species from the forest margin being targeted as well as the larger podocarps. A transition away from such a high relative abundance of podocarps is noted in the younger cultural layer, layer 2. Instead, a greater number of species and specimens from the forest margins and understory were identified.

The nature of the Purakaunui assemblages, as secondary contexts, allows for the generated data to be interpreted as evidence of both general fuel collection patterns and vegetation impacts. The changes visible in the results of the analysis of the two assemblages shows no drastic change in the fuel collection patterns. Although the relative abundances of the species identified fluctuate the exploited environments remain constant with an established matai and totara forest providing the majority of the fuel.

Analysis of the Purakaunui assemblage also addressed the topic of vegetation impacts. Identifying vegetation impacts at Purakaunui provides not only a regional comparison with Shag River Mouth but also the large scale vegetation impact represented by the IBP, determined to have occurred between 1270AD and 1600AD (McWethy *et al.* 2010, 21344).

As discussed above, the anthracological analysis from Shag River Mouth was compared with an existing palynological report identifying the removal of open shrubland and replacement with bracken and fern growth. This landscape modification, ostensibly in order to encourage the growth of bracken, an important carbohydrate source, is compatible with the largescale landscape modification identified as the IBP (McGlone 1983, 1989; McWethy *et al.* 2009, 2010).

The IBP model was constructed using palaeoenvironmental data (McWethy *et al.* 2009, 2010). At Shag River Mouth this is consistent with the model, with the palaeoenvironmental data from pollen cores providing the most significant evidence for vegetation burning. The analysis of charcoal from cultural activities at Shag River Mouth provided additional insight into how this affected vegetative interactions; namely fuel collection.

Purakaunui was also occupied within the IBP, however the vegetation impacts identified through the anthracological record do not correlate with expected impacts. The IBP is characterised by a dramatic transition from established forest to open, bracken-dominated fernlands through the liberal application of fire (McWethy *et al.* 2009). Despite Purakaunui presenting a suitable

opportunity for such a transition, having both an established forest and the dry east Otago climate, large scale vegetation impacts are not visible within the anthracological record.

The impact that is visible is a reduction over time in the relative abundance of podocarps. This reduction is effectively a decrease from 52% of the total assemblage in layer 4 to 28.8% of the total assemblage in layer 2, and is accompanied by a complementary increase in medium and small tree species. These differences between layers were interpreted as an encroachment into established forest. This vegetative impact contrasts with the dramatic vegetation modification identified at Shag River Mouth, and is interpreted as a manifestation of the difference between the two occupations.

Shag River Mouth is hypothesised to represent continuous settlement, and thus significant resource depletion (Anderson, Allingham and Smith 1996). This resource depletion is identified not only in relation to vegetation but also fauna. McGovern-Wilson *et al.* (1996) identified a decrease in the number of coastal bird species over time and a corresponding increase in open country birds, notably New Zealand quail. The presence of moa species is also noted as decreasing over time, illustrating an intensive, local exploitation (Anderson and Smith 1996b).

It is not clear whether Purakaunui represents continuous settlement. On the limited evidence available it may represent several periods of use over a period of <100 years. Faunal analysis at Purakaunui has identified a focus on coastal resources, including finfish species, red cod, barracoota, and coastal birds (*Diomedea*) (Latham 2005; Mitchell 2010). Terrestrial species are present in small quantities, with the exception of kuri, and some forest birds (Latham 2002, 2005; Mitchell 2010). The interpretation of the site as a temporary fishing camp is overly simplistic and the identification of lined pit features indicates a more complex site function.

The IBP model is used to identify largescale landscape modification but does not address how it was implemented at an occupation level. Analysis of two suitable occupations within this theses has demonstrated how the inclusion of archaeological charcoal assemblages enrich the palaeoenvironmental data through insight into human action. Whilst the Shag River Mouth data strongly correlates with the practices predicted by the IBP model, this investigation highlighted how the loss of the cleared environments affected the availability of wood fuel. Low value fuels were sourced from environments not suitable for clearance, such as the saltmarshes. At Purakaunui, where no palynological data was available, the charcoal assemblage gave a clear indication that fire clearance was not occurring. The identification results show the maintenance of podocarp forest, providing evidence against the assumption that vegetation clearance was widespread and rapid along the East coast. The anthracological investigation of these archaeological charcoals has resulted in a more nuanced understanding of anthropogenic vegetation impacts during Polynesian colonisation of East Otago.

## 7.2 Constructing the most appropriate sample

This study acknowledges limitations presented in the forms of sample sizes and the availability of parent bags from which the curated charcoal was gathered. Attempts to mitigate the first limitation were made through the use of cumulative sampling, whereby a sample was deemed 'representative' when the plotted data of number of identifications over incremental identifications established a plateau. The second limitation, the availability of parent bags, was identified as an unavoidable problem of some curated assemblages and one that needs to be considered for future research.

The practical considerations of field sampling have been identified within this thesis as one of the key opportunities for bias to affect the anthracological record.

At Shag River Mouth, both bulk samples and concentrated deposits were sampled. Bulk sampling prevents bias from entering curated assemblage by preserving all sizes of charcoal, increasing the visibility of smaller taxa. Small taxa are often difficult to identify within charcoal assemblages due to their poor preservation but are important for both understanding fuel collection strategies and for reconstructing vegetative environments.

In contrast, hand selection, especially of larger charcoal specimens, provides significant bias towards the larger taxa and ultimately prevents the sample from representing either fuel collection trends or the vegetative environment. Although no assemblage analysed within this research was represented solely through hand selected material two parent bags from Shag River Mouth layer 7 (stake 3 and stake 4), contained the remains of large charcoal specimens. In both examples 86% of the material identified was to a single taxa (*P. divaricatus*). It is clear that these 'stakes' were individual *P. divaricatus* specimens which have subsequently degraded into small specimens. As such, they potentially introduce significant bias into the data for this layer.

The bulk sampling of charcoal samples in the field is also beneficial for future anthracological analysis as it encourages sampling of secondary contexts. The differences in primary and secondary contexts has been a key theme throughout this thesis as they don't provide the same opportunities for anthracological research. As discussed previously within this chapter, the characteristics of both primary contexts disqualifies them from providing standalone evidence for vegetation reconstruction or investigating vegetative impacts. The primary contexts analysed within this thesis were accompanied by a complementary palynological study which permitted interpretation related to vegetative impacts, however this will not always be possible. In order to maximise the range of anthracological applications, field samples would ideally sample secondary contexts as they can provide inferential evidence for vegetation reconstruction and vegetative impacts, as demonstrated through the analysis of the Purakaunui assemblage.

Future research within the field of anthracology in New Zealand can endeavour to establish appropriate sample sizes for the different climates and environments of this temperate country. The cooler climates of the South Island, and the wetter climates of the west coast of the South Island, would require pilot studies to suggest appropriate sample sizes. This investigation has established appropriate sample sizes for the temperate east coast of Otago with three assemblages indicating suitable representation at 250 specimens. Future studies can also address the assumptions of the IBP, testing the palaeoenvironmental data on an occupational level.

This thesis has shown that ultimately the ‘appropriateness’ of an assemblage can only be categorised when the purpose of the anthracological research is considered. Assemblages from both primary and secondary contexts have provided valuable information on fuel collection and vegetative impacts. It has been demonstrated that in order to generate the greatest amount of data through retrospective anthracological analysis the most appropriate samples are bulk samples belonging to secondary contexts. The value of anthracological analysis can be considered at its highest when it provides insight into the everyday lives of past people. This has been achieved at both archaeological sites investigated with the resource depletion at Shag River Mouth providing a regional contrast to the more sustainable forest interactions visible at Purakaunui and placing them both within the context of early Polynesian environmental impacts.



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# Appendices

## A. Species Identification key

Species keys; A simplified guide for identification of species from with both Shag River Mouth and Purakaunui assemblages. Where anatomy is described for genus only anatomy (eg. *Hebe* ?spp.) that is found among the majority of species is included. Adapted from Meylan and Butterfield (1978) and Patel (1967a, 1967b, 1968, 1973, 1978, 1986, 1995, 1995a).

| Species                                 | Vessel arrangement  | Rays   | Other identifying features  |
|---|---|--|---|
| <i>Coprosma</i> ?spp.                   | Vessels are mostly distributed evenly although some samples display a slight ring porosity. Vessel arrangement varies between species though can be solitary, in radial multiples or irregular clusters of 2-6. | Rays are multiseriate, heterogeneous type II, 2-9 cells wide.  |   |
| <i>Coraria arborea</i><br>Tutu          | Vessels are distributed evenly throughout the growth ring. Vessels are either solitary or in irregular multiples of 2-8 cells. Growth rings are slightly distinct to distinct.                                  | Rays are multiseriate, approximately 10-20 cells wide.   | The axial parenchyma is vasicentric paratracheal, sometimes banded.                                   |
| <i>Discaria toumatou</i><br>Matagouri   | Vessels can be either solitary, in radial multiples of 2-3 cells or clusters of 2-8 cells.  | Uniseriate and multiseriate rays present. Multiseriate rays are mostly heterogeneous type III 3-20 cell wide, although occasionally up to 40 cells wide. | Vessel member walls are occasionally smooth but are generally overlaid with faint helical thickenings |
| <i>Hebe</i> ?spp                        | Vessels are distributed evenly throughout the growth ring. They can be solitary or in radial multiples of 2-5 cells. Growth rings are slightly distinct to distinct   | No rays.   | Often small diameter wood with pith still visible.  |
| <i>Kunzea robusta</i><br>Kanuka         | Vessels distributed more or less evenly although some samples present ring-porosity. Vessels can be either solitary, in tangential pairs or oblique pairs of 2-5 cells.   | Rays are both uniseriate and multiseriate. Multiseriate rays are heterogeneous type II, 2-4 cells wide.  |   |
| <i>Leptospermum scoparium</i><br>Manuka | Vessels distributed more or less evenly although some samples present ring-porosity. Vessels in multiples, often displaying a strong oblique pattern. Growth rings mainly distinct.                             | Rays are both uniseriate and multiseriate. Multiseriate rays are heterogeneous type II, 1-3 cells wide.  |   |

|  |   |  |   |
|--|---|--|---|
| <i>Melicytus lanceolatus</i><br>Mahoe-wao      | Vessels are distributed evenly throughout the growth ring. Occasionally solitary but mostly in radial multiples or irregular clusters of 2-5 cells. Growth rings are indistinct to slightly distinct. | Multiseriate and uniseriate rays present. Multiseriate rays are normally heterogeneous irregular 2-10 cells wide.  | Vessel member walls are normally smooth but are occasionally overlaid with faint helical thickenings. |
| <i>Melicytus ramiflorus</i><br>Mahoe           | Distributed evenly throughout the growth ring, vessels in radial multiples or irregular clusters of 2-8. Vessels may also be solitary. Growth rings are indistinct to slightly distinct.              | Both multiseriate and uniseriate rays are present with multiseriate rays heterogeneous irregular, 2-10 cells wide. | Vessel member walls are smooth.   |
| <i>Metrosideros umbellata</i><br>Southern Rata | Vessels are normally evenly distributed throughout the growth ring. They are normally solitary although rarely can be in radial multiples. Growth rings are indistinct to slightly distinct.          | Rays are heterogeneous, mostly type II, 2-4 cells wide.  |   |
| <i>Myoporum laetum</i><br>Ngaio                | Vessels are distributed throughout the growth ring in radial multiples of 2-5 cells or occasionally in irregular clusters of 2-6 cells. Growth rings are indistinct to slightly distinct.             | Uniseriate and multiseriate rays present. Multiseriate rays are heterogeneous types I and II, 1-4 cells wide.      |   |
| <i>Myrsine australis</i><br>Matipo, Mapou      | Vessels are distributed evenly throughout the growth rings in radial multiples of 2-5 or solitary   | Rays are multiseriate, heterogeneous, 4-10 cells wide.   | The vessel member walls are overlaid with prominent close helical thickenings.                        |
| <i>Nothofagus ?spp.</i>                        | Vessels are distributed evenly. Vessels are in radial multiples of 2-6, occasionally irregular clusters. Growth rings are moderately distinct to distinct.  | Rays are a uniseriate or biseriate, although <i>N. menziesii</i> has multiseriate rays 1-3 cells wide.             |   |
| <i>Olearia ?spp.</i>                           | Vessels are distributed evenly throughout the growth ring. Vessels can be solitary or in multiples displaying an oblique pattern.   | The rays are mostly multiseriate heterogeneous type II 2-6 cells wide.   | Vessel member walls often have helical thickenings.   |
| <i>Pittosporum ?spp.</i>                       | Vessels are distributed more or less evenly throughout the growth ring. Vessels are   | Although both uniseriate rays are present they are uncommon. Multiseriate rays are either                          | Vessel member walls are overlaid with prominent helical thickenings.                                  |

|  |  |   |  |
|--|--|---|--|
|  | present in radial multiples 2-5. Growth rings indistinct to distinct   | homogenous or heterogeneous types II and III, 2-5 cells wide.   |  |
| <i>Pennatia corymbosa</i><br>Kaikomako                 | Vessels are mostly solitary and evenly distributed though they may also be in 'false tangential pairs' or radial multiples. Growth rings indistinct to moderately distinct.  | Rays are heterogeneous type II. Multiseriate and uniseriate both present. Multiseriate rays 2-7 cells wide.                                   | Vessel member walls have faint to prominent helical thickenings.   |
| <i>Plagianthus divaricatus</i><br>Saltmarsh Ribbonwood | Vessels are arranged, along with the axial parenchyma and fibres, in concentric bands. Growth rings are slightly distinct to distinct.   | Rays can be either uniseriate or multiseriate however most are multiseriate. These are homogenous, or heterogeneous type II 11-25 cells wide. |  |
| <i>Podocarpus totara</i><br>Totara                     | No vessels. Growth rings are moderately distinct to distinct. Axial parenchyma abundant.   | Rays can be uniseriate or biseriate.  | Cross field pits are mostly small and crupressoid or taxoid.   |
| <i>Prumnopitys taxifolia</i><br>Matai                  | No vessels. Growth rings are indistinct to slightly distinct. Axial parenchyma absent  | Uniseriate to biseriate rays present.   | Cross field pits are large and cupressoid.   |
| <i>Pseudopanax crassifolius</i><br>Horeka              | Ring porosity visible in some samples, though may also be evenly distributed. Vessels can be solitary but are mostly in irregular clusters of 2-10 or radial multiples of 2-7. Growth rings are slightly distinct to distinct. | Rays are both uniseriate and multiseriate. Multiseriate rays are heterogeneous types II and III, 1-6 cells wide.                              |  |
| <i>Sophora microphylla</i><br>Kowhai                   | Vessels are distributed evenly throughout the growth rings and are found in irregular clusters of 2-15, occasionally more. Growth rings are indistinct to slightly distinct.   | Rays are multiseriate, heterogeneous type II and III, mostly 5-10 cells wide.   | When viewed in the tangential section axial parenchyma are storied.  |
| <i>Streblus heterophyllus</i><br>Turepo                | Vessels are mostly solitary but radial multiples and clusters are also present. Growth rings are slightly distinct to distinct.  | Heterogeneous type II and III. Multiseriate and uniseriate present. Multiseriate rays 1-5 with occasional increase up to 8 cells wide.        | Axial parenchyma are abundant and present in paratracheal bands 2-34 cells wide with abundant intercellular spaces. Vessel member walls smooth |