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Environmental and Cultural Change in the Gippsland Lakes Region, Victoria, Australia.

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A thesis submitted for the degree of Doctor of Philosophy of the Australian National University.

December 1990
Declaration

Except where otherwise indicated this thesis is my own work.

K.L. Hotchin
December 1990
Acknowledgements

It is difficult to fairly acknowledge all the help I have received in undertaking this research, and I could easily fail to specifically mention everyone who has contributed in some way. Any failure in acknowledgment is better regarded as an oversight on my behalf rather than ingratitude.

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While I freely acknowledge help from many quarters it should be understood that I alone am responsible for any shortcomings in this work.
Abstract

The subject matter of this thesis spans the disciplines of Geography, Prehistory and Anthropology in attempting to examine the interaction of environmental and socio-cultural systems. The thesis is not meant to be primarily be an in-depth study of the evolution of the Gippsland Lakes system but is concerned with the question of the nature of the interaction of a small-scale society with its environment and how this is reflected in the cultural forms of the society.

That is, rather than being the focus of the study, reconstruction of changes in the environmental parameters of the field area over time is undertaken to support the primary inquiry into the nature of environmental-cultural interaction. The goal of the study is therefore to examine cultural process rather than sedimentary processes.

This empirical approach tests the correlation between the evolving landscape and the archaeological and ethnographic cultures of the Quaternary barrier systems of the Gippsland Lakes-Ninety Mile Beach region. This involves environmental reconstruction largely using published geomorphological and palynological information, and extensive archaeological site survey and analysis to develop an outline of the prehistory of the study area. Ethnographic and ethnohistoric reconstruction of aspects of the historical socio-cultural organisation of the area are undertaken in order to provide a comparative base for archaeologically reconstructed culture. The study identifies a number of problems with the use of the rich ethnography of the area.

Use of information hinges upon its validity and reliability. For these reasons sources of bias, particularly natural factors working upon the archaeological record, are investigated. These have considerable implications for the design and execution of survey, and for interpretation and analysis of results. It appeared that in the study area at least statistical description of site location data could not be carried out validly. It was also concluded that ethnographic accounts of the study area must be used with caution.

Shifts in the natural environment and cultural change in the area seemed to show a poor correlation. This gave rise to the conclusion that much of what is seen in the reconstructed
culture history is attributable to wider scale movements of cultural information in
prehistoric rather than to the details of the evolution of the local environment. Upon closer
examination it can be seen that this picture alters according to the scale at which it is
viewed.

There have been major spreads of information, including technological information,
which lead to economic and therefore ecological changes through the Holocene. This
expansion of ideas involved the proliferation of microlithic technologies in the mid-
Holocene, and in the later Holocene a wide-spread expansion of such technologies as fishing
hooks and tied-end canoes. As these phenomena also occurred beyond the study area it is
invalid to attribute them to local adaptive processes.

It is argued that the later Holocene developments, facilitated by technological innovation,
could have been induced by landscape evolution including estuary and wetland
sedimentation and evolution of other, rocky, coasts. At a closer scale, it can be seen that
within these trends local aspects of Holocene Aboriginal culture were closely adjusted to
local environmental conditions. Thus while gross configurations of local culture owe much
to broad scale historic processes, allowed or induced by large scale environmental
evolution, details of local culture may be explicable in terms of local conditions. At either
scale conscious perception and culturally informed response are indicated, and changes
must be seen as significantly induced rather than as the outcomes of random evolutionary
processes.

The concept of adaptation to environment is also examined from a theoretical perspective,
and the use of models of adaptation derived from neo-Darwinian theory in examination of
culture process is scrutinised. It is concluded that the application of an evolutionary model
based on natural selection to cultural process cannot be supported. A process of cultural
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Chapter 1

INTRODUCTION

This thesis is concerned with a test of the application of the theory of evolution through natural selection to the development of human cultural systems. The area of concern centres on the evolving Gippsland Lakes system in Eastern Victoria.

Two points must be understood. The thesis is not "anti-evolutionary", that is it is not concerned with scrutinising the theory of organic evolution through natural selection as it is applied in biological science. Secondly, while drawing on a range of empirical information both directly from field work, and from published sources, the thesis is not primarily an empirical "field" study, nor research into methodology.

The fundamental concern here is with an appraisal of a common proposition that Darwinian evolutionary theory can be directly applied to studies involving cultural process. That is, without alteration or qualification, Darwin’s theory can explain human cultural change in the same way as it can account for organic change.

Evolutionary adaptation has been frequently invoked as the link between the natural environment and local human culture. This link may be explicitly based on evolution through natural selection (eg Price 1982) or it may imply a vague or ill-defined process (eg see discussion of "adaptation" by Kirch 1980, Dunnell 1980, Durham 1976). "Adaptation" is a term is frequently used in Australian studies of prehistoric small-scale human populations. However, poor definition often makes it unclear whether the term is meant to imply evolution through natural selection of variance, or whether it simply refers to some vague process of adjustment.

The value of any theoretical proposition, such as the transferability of neo-Darwinian selection to cultural processes, depends on whether it can be refuted. The conditions posed in this thesis for such a test are that: within an area significant environmental changes apply selection pressures on a population; the population demonstrates cultural change over time; any cultural shifts can be related to the environmental changes; the generation of variation is random and not influenced by environmental changes; the process of selection is unconscious and undirected; no other selection processes apply; and that selection outcomes are explicable in terms of enhancing the fitness of the population.

A failure of the proposition to satisfy these conditions would suggest that natural selection of random variance has limited potential in the explanation of cultural phenomena.
The test demands inputs from a number of fields of knowledge usually defined as separate disciplines. Historical compartmentalisation of knowledge has led to the definition of bounded disciplines and drifting of method and outlook. This picture is complicated by the differentiation of national traditions, thus prehistoric archaeology is pursued as a sub-set of anthropology in the USA while in Britain and Australia prehistory as a discipline incorporates much of the same field. It might be argued that while in Australia and Britain geography is a developing discipline, it is somewhat understated in the USA. The present study is not constrained by divisions of disciplines and traditions, but draws upon the disciplines of geography, prehistory and anthropology whose inter-disciplinary differences may not always be as great as their intra-disciplinary differences.

1.1. Origins of the topic

The topic of this thesis arose from geographical-archaeological studies carried-out at Jack Smith Lake, Southeast Gippsland, in 1982 (Hotchin 1982). For location see Figure 1.1.

The most interesting archaeological finding was that there had been long periods since sea-level stabilisation during which there is no evidence of occupation in the area. From around 7000 BP until around 3000 BP the lagoon supported a sheltered marine ecosystem, but despite its resources Jack Smith Lake remained unexploited until around 4000 BP when a number of midden deposits were formed. Occupation lasted until 3000 BP.

After 3000 BP the lagoon appears to have had only intermittent marine connection leading to the extinction of the dense estuarine shell beds now preserved in sub-fossil form. Cessation of daily tidal connection meant the end of midden deposition and the initiation of another phase without evidence of human occupation. Finally, the second half of the last millennium saw a proliferation of evidence of Aboriginal coastal occupation, most conspicuously in the form of regionally extensive middens of the open beach bivalve Donax deltoides.

Dense fossil shell-beds in the lake floor, and the often high productivity of sheltered marine systems both suggested that the area would have been a valuable resource zone until the later mid-Holocene. This productivity of resources can be contrasted with oceanic waters whose potential may be limited (Russell-Hunter 1970:101-109). There was a tacit assumption on the part of the researcher that through an evolutionary process of adaptation the potential of the area would be realised and incorporated in the economy of the local population early in the Holocene. The decline of marine conditions would be expected to lead to subsequent adaptations to the now intermittently connected lagoon.
The short duration of occupation during the tidal phase, 3000-4000 BP was not immediately explicable with the environmental evidence and theory available. Similarly the subsequent apparent abandonment of occupation until the last millennium could not be explained easily in terms of the local environment, nor could the intense reoccupation of the area in the last millennium.

This was further complicated by the observation that the earliest occupation deposits at Jack Smith Lake contain microlithic elements based on exotic siliceous stone. The appearance of microlithic technologies in Southeastern Australian assemblages is widespread around 4000 BP (Mulvaney 1975:289-91), simultaneously with the beginning of occupation at Jack Smith Lake. The coincidence is problematic, as a causal relationship between the initiation of coastal occupation at Jack Smith Lake and the proliferation of microlithic technology could not be excluded from consideration, even though at the present time there is no known role for microlithic artefacts in coastal exploitation (eg. Mulvaney 1975:210-229). More recent assemblages, associated with middens of the sandy shore bivalve D. deltoides have a greater component of locally abundant quartz. Both widespread Donax exploitation and a greater use of quartz (or other common pebble stone sources) appeared to be part of a regional pattern. The complement is a decline in the redistribution of exotic silicified sediments which did not appear to be explicable in terms of local environmental history.

The question arose as to whether phenomena at Jack Smith Lake could be explained validly as adaptation to local environment, or if they were part of wide-spread changes occurring independently of local circumstances. This was in turn a challenge to the use of adaptation as an explanation of cultural forms, and therefore cultural change.

1.2. Research strategy

It was recognised that as the Jack Smith Lake field area is small it might not contain a representative sample of regional archaeology. It was anticipated that being part of the Gippsland Lakes-Ninety Mile Beach system similar prehistory and natural processes would apply to the whole area. Increasing the size of the area sampled was expected to increase the probability of both obtaining a fuller sample and covering a wider time span. This avoids the likelihood of the results being sampling artefacts. An expansion of the area covered and of the data base also allows finer resolution of any evolutionary processes of adaptation.

The first objectives were reconstruction of aspects of Aboriginal culture from the
Holocene Marine Transgression to the nineteenth century, and reconstruction of Holocene environments. Before a comparison of the two could be generated problems recognised in the initial work at Jack Smith Lake had to be resolved. These hinged on the reliability of the cultural record (ethnography and archaeology), the validity of the information base, and factors which can distort information, notably earth processes affecting preservation and visibility of cultural traces, and historical factors modifying behaviour. Another consideration is the question of broad-scale cultural changes (eg. introduction of microlithic technology) which cannot be explained simply in reference to local conditions.

It was recognised that concentration on the coastal and near coastal zone could lead to a criticism that the work represented only a single aspect of broader scale sociocultural and ecological systems. The purpose of this study is however not a regional reconstruction, which would be impossible within the limits of a single thesis, but an exploration of the operation of a restricted number of variables within a bounded area. Similarly the study is restricted to the period between the end of the Holocene transgression (ca. 6,800 BP) and the nineteenth century, the end of Aboriginal cultural autonomy.

Having established the environmental and cultural histories of the region the fundamental questions are: whether the reconstructed culture history of the area be related to the reconstructed environmental history, what other factors could be recognised as playing a part in the culture history of the region and what constitutes an appropriate model of cultural change?

1.3. Thesis Outline

*Chapters Two, Three and Four* are concerned with establishing the nature of the objective environment in which cultural processes occured.

*Chapter Two, Regional Background*, begins with short Aboriginal and European histories as background to later sections, notably reconstruction of prehistoric, proto-historic and historic Aboriginal culture, as well as a more representative picture of the historic hydrology of the Lakes. Without these perspectives both traditional Aboriginal society and environmental history can be misunderstood. This is followed by descriptions of elements of the general environment, climate, flora and fauna, in which Aboriginal cultures existed.

*Chapter Three* is an account of the regional geology and its geometry, as a background to landscape, climate and resources. It continues with an account of the coastal and lacustrine geomorphology which defines the Gippsland Lakes system. It is the geomorphic history of
the coastal barrier system which controls the hydrology of the system and thereby the environmental changes which have occurred during the Holocene.

Chapter Four complements Chapter Three and deals with regional pollen and sedimentary records toward establishing a history of Holocene climatic and sea-level variation as aspects of comprehensive environmental change.

Having examined the Holocene contexts of environmental change, Chapter Five deals with the aims and principles of the archaeological investigations. This is preceded by a consideration of non-archaeological influences on the archaeological record, and their role in shaping the aims and method of study. These factors include climatic and historic controls on vegetation cover, sediment movement over the land surface and factors leading to the disruption of the ground surface. This brings into focus the non-archaeological meaning of discovery of cultural deposits. Discovery is dependent on the nature of the initial cultural activity, processes leading to preservation, and finally exposure and visibility. The latter are dependent on both landscape dynamics and later patterned behaviour leading to ground surface disruption.

Chapter Six is an ethnographic reconstruction of aspects of the culture of the Aborigines of the region. It begins with a proposition that the patterns of culture and population encountered in 1840 are, as a result of the historic processes outlined in Chapter Two, unlikely to be fully typical of 1788. Among the postulated changes the most significant is massive depopulation due to the introduction of exotic diseases after 1789. It is anticipated that these changes lead to severe strains on the social fabric and existing institutions. From 1790 interaction of natural and cultural factors was increasingly eclipsed by external influences generated by colonial expansion through the sealing, whaling and pastoral industries. These directly affected adjacent populations and must inevitably have flowed over into the study area. Information on Aboriginal culture collected after contact in 1840 may be typical only of its own period, and can only be used to suggest characteristics of life prior to that time.

Reconstruction of population numbers using estimates of post-1788 mortality and ethnographic records of the distribution of named ethnic groups, indicate a remarkably large population and considerable population densities. The geography of ethnographic territories, and estimates of population density, suggest that a range of economic strategies, including different resource scheduling and seasonal movements were required by each group according to the area, diversity, and ecology of group territories.
Chapter Seven presents the results of field survey for archaeological deposits, and the results of analysis of site location and contents, notably lithic components. The first and most obvious results are the proliferation of occupation evidence dating to the last millennium, and the paucity of evidence of occupation during the period of free marine connection. Away from Jack Smith Lake there are few deposits which can be confidently dated to beyond the last millennium.

Analysis demonstrates systematic differences in site contents according to location and time. There are also differences in the use and curation of lithic material over time indicating changes in settlement and mobility. This evidence suggests a greater commitment to use of the Lakes and coastal zone in the later Holocene compared to the earlier period of coastal occupation.

Chapter Eight begins with a discussion of approaches to culture-environment interactions in Geography and Prehistory-Anthropology. This is followed by an exploration of the potential of evolutionary theory in explanation of cultural change, and the central concept of adaptation.

It is argued that the theory of organic evolution by natural selection is not transferable to the sphere of cultural process and change. Rather a process of culturally informed selection, possibly involving conscious inputs and choice, is likely to be a powerful force overriding natural evolutionary process. Recognition of perception, culturally informed generation and selection of variance, non subsistence-oriented behaviour, volition, complexity of social organisation and the significance of the range of satisfactions pursued, makes a single biologically oriented "Big Theory" of socio-cultural systems chimerical.

The chapter concludes with suggestions toward the development of a more satisfactory theoretical approach to human ecology.

Chapter Nine compares ethnographic portraits and the established prehistory of the area with the reconstructed landscape history and fails to discover significant correlations between local environmental and major cultural change. This indicates the weakness of a strict analogy with natural selection. A synopsis of difficulties with this line of explanation is presented, these include problems of scale; considerations rising from the fact of human conscious perception of environment; volition, values and conflicting goals; the Lamarckian rather than Darwinian nature of induced cultural response and misidentification of the human environment as the objective physical environment rather than one in which action is also controlled by considerations.
It is suggested that many of the cultural changes observed in the Holocene are most economically explained as arising from widespread flows of information, including information on technology, technique and ultimately such matters as social and sexual division of labour and consumption of product. This process of information flow is subsequently modified according to local circumstances in part at least by conscious cultural process.

This chapter concludes with suggestions for a more realistic theoretical approach to the evolution of cultural forms, applicable in the anthropological, archaeological and geographic study of small scale societies.

Two Appendices are included. The first gives details of site recording format, the second is a listing of sites investigated during the survey.
Chapter 2

Regional Background

The following chapter describes the historical and natural contexts of the area studied, as a background to subsequent chapters. It defines the study area and follows with an account of British contact with the area. An account of significant events affecting the Aboriginal population over the historic period is presented in order to set the scene in which later phenomena, particularly demographic change, occurred.

The historical sketches are followed by brief descriptions of significant aspects of the natural environment, including climate, fauna and flora.

2.1. The Study Area

The study area is defined according to physiography (see Chapter Three) and consists of a core and secondary area. See Figure 1.1. The core is primarily composed of Holocene and later Pleistocene depositional landforms located between the sea and scarped and terraced earlier Pleistocene and Tertiary, deposits forming the Gippsland plain and piedmont. It extends from Corner Inlet to the southwest, along the Ninety Mile Beach barrier complex to the historic outlet of the Lakes at Red Bluff near Lakes Entrance settlement.

The Secondary area is the Tertiary and earlier Pleistocene deposits of the piedmont, plains and lower valleys of the major rivers. This area is bounded by the elevated older rocks of the Dividing Ranges and South Gippsland Highlands.

2.2. Historical Background

The East Gippsland coast is the first land on the Australian east coast officially sighted by a European navigator, with Point Hicks, also known as Cape Everard, named by Cook in 1770. The first recorded European landing was of survivors of the wreck of the Sydney Cove who arrived by ship’s boat in 1797. In the same year George Bass found that Bass Strait separated Van Dieman’s Land and New South Wales. On the islands of the Strait he discovered rookeries of Australian fur seals and sea lions. It seems that sealers had beaten Bass to the islands, he reported:
The number of seals was by no means equal to what we had been led to expect. It is certain, however, that great numbers had been destroyed, and probably more frightened...

From the quantity I saw I have every reason to believe that a speculation on a small scale might be carried-on with advantage. There are seals more or less on all the islands on both sides of Furneaux’s land.¹ (Bass Monday 29 January 1798 in Bladen 1895)

By the end of 1798 sealers were in Bass Strait and a shady era in Australian history had begun. Although the resource had been largely depleted in the 1820’s limited activity continued up until the 1840’s. By this time the local elephant seal was extinct, and stocks of Australian fur seals and western stocks of New Zealand fur seals were seriously depleted.

Soon after the turn of the century, and in 1826-7, attempts were made to establish penal colonies at Sorrento on Port Phillip Bay, and at Corinella on Western Port Bay. Both settlements were short-lived. Under Collins, the Sorrento settlers moved south to the Tamar to establish the settlement of Launceston. No further attempts were made to settle Port Phillip until the Hentys landed at Portland, and Batman and Faulkner began squabbling over Melbourne in the 1830’s.

In 1823 Ovens and Currie set out from Lake George and discovered the Monaro, turning back a little short of Cooma (Wakefield 1969:12). Settlement of the South Coast of NSW was also underway, one of the earliest settlements being the Imlay brothers’ bay whaling station at Twofold Bay.

Drought in the Monaro in 1837-8 led local squatters to search for new lands. A servant of Lachlan Macalister, Angus McMillan, set-off in search of the country said by the Monaro Aborigines to lie to the south. McMillan left Currawong Station in 1839 and arrived at Omeo after two weeks, from there he began his exploration of the lowlands. He set-up stations for his master at Numblamunjie (Ensay) and on the Avon River. He was then instructed to discover a sea-port. In 1841 he decided on Old Settlement Beach, Port Albert. Within weeks of McMillan’s deciding on Port Albert the Clonmel was wrecked off Corner Inlet. While awaiting rescue people from the Clonmel passed their time exploring the inlet and were soon in Melbourne extolling its virtues. They too declared Port Albert a fitting port.

Within a few weeks of McMillan setting-off from Currawong Station his tracks were followed by the self-styled Polish count, Paul Strzelecki. He parted from McMillan’s tracks on the lowlands and proceeded west. His party crossed the Latrobe and commenced to climb into the South Gippsland Highlands (Strzelecki Ranges) where, short of rations and

¹Furneaux’s Land is Wilsons Promontory
barely able to make any progress, the group claimed to have nearly starved. After abandoning horses and scientific instruments the party finally escaped the hills.

They were soon in Melbourne and the publicity conscious "count" was announcing the new land to the world. Always conscious of the value of patronage he called the new land Gippsland, after Governor Gipps. Thus McMillan's Caledonia Australis, the realm of the would-be laird Macalister, was opened and declared available for all takers.

The Gippsland plains were subsequently settled through the spread of population in two lobes, one from the north via the Monaro, and one from the southwest via Corner Inlet. By 1844 the fronts of the two lobes had met, and the plains were occupied. Apart from a few minor settlements in the hills left after the gold rushes and soldier settlement in the Strzeleckis after World War 1 the pattern of settlement has not changed.

Until 1843 relations between Aborigines and the expanding British population may have been relatively peaceful, though Robinson (Mackaness 1941:10) was of the opinion that Aborigines had already suffered considerably at the hands of the settlers. This changed after 1843 and the revenge killing of Macalister's nephew Ronald Macalister. Retribution was swift in the Warrigal Creek Massacre near Jack Smith Lake (see Gardner 1975, 1980). Throughout Gippsland Aborigines fell-back or were driven from pastoral areas finding refuge in the ranges, wetlands and unsettled areas around the Lakes. Often shot on sight, they adopted guerilla tactics directed particularly against cattle. However, details of the conflicts which ensued have been lost in a conspiracy of silence. A veil of secrecy and solidarity is said to have settled on Australian frontiersmen when Europeans were tried following the Myall Creek Massacre. Indignation at the idea of Europeans being punished for killing Aborigines meant that "incidents" were concealed from those who did not need to know (Watson 1984:166).

The Gippsland gold rushes were relatively minor affairs. They did however consolidate existing strategic settlements such as Port Albert, and river crossings such as Bairnsdale and Sale. Other strategic settlements were existing staging posts such as Bruthen. Lines of communication and transport were inefficient because of the ranges to the north and the wet low-lying country around Western Port. Roads had existed from the early days of settlement (eg. see Robinson in Mackaness 1941) but had not been adequate.

This changed in 1858 when the Georgina Smith made the first commercial crossing of the outlet of the Gippsland Lakes. The outlet had been crossed before: Warman and de Villiers claimed the honours on 19 December 1846 (Port Phillip Herald 21 Jan. 1847).
There is plenty of water on the bar at the inlet when the tide is in, being from twelve to fourteen feet, and the channel a good width, but would not be safe to take at any other time; have named the inlet "Warman's Inlet", his boat being the only one that ever went through it. The tide is very rapid running at least five knots.

The crossing by the Georgina Smith was followed by increased traffic, with the Gippsland Lakes Navigation Company being established in 1864. The Company ran a weekly service to Melbourne using flat bottomed craft, as well as navigating the rivers as far as Bruthen (Tambo River), Sarsfield (Nicholson River), Bairnsdale (Mitchell River), and Sale (La Trobe River). The Avon which has since degenerated into a shallow braided stream, was navigable for 8km.

Commissioner of Crown Lands Tyers reported on the country in 1844 and suggested that not only was the outlet on the northeast end of Lake King open as a normal state "it is only one fathom deep at the entrance", but that an outlet on the northern end of Lake Victoria "...is too narrow and shoaly to be rendered available except for small boats" (Tyers in Bride 1983: 230). The latter is in the vicinity of the "Blow-Holes" on the northeast extremity of Bunga Arm, and is open only occasionally under modern conditions.

The history of Lakes navigation is important as it indicates the nature of the natural outlets. Geographers (eg. Bird 1978, Thom 1984) studying the area refer to the main outlet being intermittent or frequently "closed". Had this been the case it is probable that the coastal navigation would not have remained economically viable. Warman and Tyers' eye-witness accounts also indicate otherwise. It is apparent that although sometimes closed to shipping, outlets were not necessarily closed to tidal flow.

In 1869 an attempt to cut an artificial outlet through the Ninety Mile Beach barrier failed when funds ran out. The scheme was later revived and completed in 1889 when the last part of the artificial outlet was opened by storm waves (Fryer 1973).

2.3. Aboriginal History

The following section outlines historical influences which are likely to have interacted with human population size and distribution, social interaction and subsistence economy during the protohistoric and historic periods. It is argued that these influences are likely to have affected the pattern of Aboriginal life which early Europeans in the area witnessed, and which in turn have shaped accepted models of Aboriginal social and cultural forms.

The extent to which the Gippslanders were isolated from other Aborigines is not certain. Howitt (1904) suggests that they lived in something of a geographic and cultural
cul-de-sac. Evidence of cranial characteristics, from an admittedly small sample, suggests genetic links with the Upper Murray (Sinclair and White 1984). Bulmer (n.d.4) recognised a corroboree he saw in Gippsland as one which he first encountered some years earlier while a missionary on the lower Murray. This corroboree had presumably travelled along established routes of intercourse, possibly up the Murray. This is significant as it suggests routes of contagion into the region from the Murray-Darling basin. Robinson (Mackaness 1941:11) and De Villiers (*Argus* 26 Jan 1847) indicate lines of connection with Twofold Bay providing a link with East Coast populations.

A harbinger of British settlement, epidemics of small-pox spreading out from the convict settlement at Port Jackson, supposedly did not penetrate into the Gippsland region (eg. see Butlin 1983). John Bulmer, missionary at Lake Tyers with previous experience on the Murray, stated explicitly that he never saw a pock-marked Gippslander (cited by Curr 1887, Vol. 3:545). However, as will be argued in Chapter Six, arriving after 1860 Bulmer is unlikely to have seen any survivors.

The sealing industry was to have a profound effect on Tasmanian and Victorian coastal Aborigines (eg. see Ryan 1981). The sealers have a poor reputation in history, they included ex-convicts and escaped felons portrayed as a fugitive class content to live in isolation on the shores and islands of Bass Strait. Aboriginal women from Tasmania and the mainland were taken by the sealers to live with them on the sealing settlements as concubines or slaves. The sealers and their off-spring have come to be called the "Straitsmen". Keeping harems of presumably young and active Aboriginal women can be expected to have had considerable demographic and economic impacts on Aboriginal society. In the small population units regarded as normal among Hunter/Gatherers the loss of the labour and child-bearing capacity of the few young women per group is likely to have been important. If loss of the women involved fighting by the fit and active men of local groups labour and productive capacity is further eroded.

As the Straitsmen were not among the most genteel of their age it is reasonable to assume that they would be infected with the chronic communicable infections of their age, including tuberculosis and venereal diseases. Depending on previous ports of call acute infections too are likely to have been communicated. The first victims are likely to have been the Aboriginal slave-wives, or other women with whom casual encounters, rape etc. occurred. Whether contact was violent or benign Aboriginal women could introduce infection caught directly from contact with the Straitsmen, or from neighbouring populations who might have made contact, to their own communities without Straitsmen
ever re-entering a camp. In Gippsland contagion between populations would be aggravated
by local custom including concepts of hospitality involving the sexual favours of women of
host groups:

They have a custom of showing their good will to the parties by offering their lubras and
females, even of the most tender years; for chastity among them is a thing little cared
for... (Warman Port Phillip Herald 25 Feb 1847).

As is discussed in Chapter Six the loss of women, and/or transmission of acute and
chronic infections can be expected to have led to increased inter-group conflict, population
depletion, and disruption of alliances and political relations. According to the density of
inter-group contact these effects can be expected to have radiated out from the rocky shores
to the west such as on Wilson's Promontory, where the greatest contact is likely to have
been. Contact on the rocky shores of far East Gippsland is also likely to have occurred
although long term sealing stations are unlikely. As a consequence of the strong likelihood
of contact, infection, possibly taking of women and violence we cannot assume that
anything we think we know of historical groups is representative of the way things were in
1788. Further, we can expect the effects of contact at some distance from points of contact.

The sealing industry had declined by the 1820's, but pressure on neighbouring
populations continued. There was little chance of recovery before the arrival of sheep in the
Monaro, and whalers at Twofold Bay by the 1830's. Again it can be reasonably anticipated
that pressure from the margins could be expected to radiate into the Gippsland area.
Introduction of infection from the earlier failed settlements on Port Phillip and Westernport
is also a possibility.

It is therefore highly probable that the Aboriginal people encountered by McMillan on the
Gippsland plains in 1839 were to some degree living lives different from their ancestors'
prior to 1788. Important aspects of change include: population decline following chronic
and acute infections; changed patterns of relations between groups whose balance of
alliances and eminities may have been disrupted by the trauma of contact; changed
demographic structure resulting from the selective loss of the very young and aged from
infectious disease; the location and boundaries of population units. It is likely that
weakened populations may have become extinct through failure to reproduce, being
integrated into friendly groups or being unable to protect themselves from enemies.

An apparent example of the latter case is the Yowenjenne (Robinson in Mackaness 1941)
a Kulin-speaking population whose territory abuts the study area. This group was very
possibly debilitated by sealers along the nearby rocky coast before being annihilated by
Kurnai raiders from the east in the years immediately prior to the settlement of Melbourne.
2.3.1. The Wild White Woman

In response to calls from settlers throughout the Port Phillip District the government of the day set-up a force of native police to deal with Aboriginal resistance. Under the questionable leadership of Henry Edward Pultney Dana, the force was said, after being disbanded, to have "fully achieved the main purposes for which it was organised" (La Trobe in Bride 1983:440). An alternative indication of the effectiveness of the force is attested by the description "...those harpies of hell, misnamed police..." (Warman, Port Phillip Herald 21 Jan 1847).

The police were recruited among Kulin speakers from the Melbourne-Westernport area (Thomas in Bride 1983:404-411), who had warlike relations with the Gippslanders. Whether by accident or design a better group could not have been chosen to subdue the Gippslanders. Arriving in Gippsland in company with Kulin police Haydon (in Mackaness 1941:62-4) observed their reaction to hints that they would soon be in action against Kurnai:

...they took the greater interest, as it gave them an opportunity of retaliating on their old and formidable enemies, the Gipp's Land tribes, who had invaded Westernport some years since, and had nearly annihilated a whole tribe... Nearly all the remnant of this tribe whose members were then young, has now entered into the native force...

The massacre is likely to have been that of the Yowenjenne referred to above, it would appear to have occurred in the period prior to the settlement of Melbourne. A chance to balance old scores between Aboriginal groups came with the story of a white woman held captive by the Gippslanders. Relevant documents to the saga of the White Woman have been collected by Cuthill and lodged at the La Trobe Library, Melbourne as mss 10065.

The story appears to have been initiated by McMillan who claimed to have once, in the early days of exploration, caught a glimpse of a woman who may have been white. He claims she was driven away so his view was rather indistinct. He apparently did not see the matter as being worth following up as nothing was made of it until the later 1840's, a time when friction between the races was increasing. As Tyers reported to La Trobe:

The natives living in Gippsland may be divided into two classes: first, the natives of Omeo, Maneroo, the Mitta-Mitta, and other districts bordering on Gippsland; and secondly, the Warrigals or wild blacks- Aborigines of Gippsland. The former class, consisting of perhaps two or three hundred, lead the greater part of the year a vagabond, gypsy-like kind of life, moving in small parties from station to station....The second class, or wild blacks, numbering probably between 800 and 1000, are seldom seen by the settlers. They live in the mountains, and the morasses, and about the borders of the Lakes and the sea-coast. They are very destructive to the stock of the settlers....

(Tyers to La Trobe, December 9, 1846 in Cuthill n.d. My italics)

As if to order, sightings of a white woman were again made, including one from a Native Policeman of a yellow woman. Protector Thomas believed that light pigmented Aborigines
from territories near the rocky coast adjacent to Westernport were the mixed-race off-spring of the sealers (Barwick and Barwick 1984:9), and one may have been mistaken for a white woman.

At first the story of the captive woman was treated with suspicion by the authorities who suspected a waggish joke. Proponents of the story decided, according to their ethnic origins, that the woman was English, Scottish or Irish and had survived shipwreck only to see her chivalrous guardians slain by cannibals, and herself dragged-off and battled for by powerful chiefs. The public was aroused by such purple prose and rhymes that only the Victorian Age could produce. Appeals to chivalry, with racism and just a touch of misogynous pornography became the stock in trade of part of the press:

Exposed to insults worse than death
Compell’d to breathe the pois’ nous breath
Of a rank scented black;
To yield to his abhor’ d embrace,
To kiss his staring ugly face,
And listen to his clack

(Argus 7 September. 1847)

In response the burghers of Melbourne town mounted an expedition lead by the philanthropic Warman and de Villiers. Government too agreed to mount an expedition. This was manned by Border and Native Police forces, with hostility on the part of the police and troopers, and incompetence and indifference on the part of the leadership. Neither expedition found any white woman. A later, better led government expedition was required in order to achieve a resolution of sorts.

The Argus came to adopt an editorial line hostile to the Aborigines and bleeding heart civilian expeditioners. The rival Port Phillip Herald supported the civilian expeditioners and published their reports. The search for the captive woman was to be a media and commercial event.

The expeditioners faced a lack of interpreters. In the end this role was filled by a boy of about seven or eight years who had been living with Europeans for around six months. No one else could be found with any bilingual capacity because the constant state of hostility prevented contact. The boy was frightened by the reputation of Sgt. Walshe of the government party as a killer of Aborigines and had to be pushed to play a role.

It was decided in time that the woman was being held as the consort of a "powerful chief" named Bungelene who, after proving somewhat elusive, eventually made his appearance. Bungelene arranged for the searchers to receive a ship’s figurehead, which had apparently been adopted as a cult object. Finding that this "woman" did not satisfy the searchers his
native wife was eventually produced, she was apparently from Melbourne side. The initial
rumours of a white woman among the Aborigines are likely to owe a lot to the figurehead.
Bungelene’s wife was from the Melbourne area where the police had been recruited and it
is possible that she had been abducted during a raid, or had eloped. It is possible that the
figurehead and wife had been confused and formed a new composite person. Meanwhile
Bungelene was twice guilty before the Aboriginal and British servants of the Crown. The
use of an eight year old boy as interpreter and negotiator could hardly make things easier.
Neither the figurehead nor the native wife convinced the police of Bungelene’s innocence
and he died in captivity.

Eventually the tragic affair was brought to a close with a report that the bones of a white
woman and her infant had been discovered, examined by a country doctor, and the story put
to rest. The doctor was a local squatter, Dr. Arbuckle, and proceedings were witnessed by
his friend Angus MacMillan whose role in initiating the affair was crowned by putting it to
rest. For those who did not like this ending, she had drowned in the strait between Lakes
Wellington and Victoria, and her body never recovered.

The number of Aborigines directly killed is uncertain, but is believed that they were
numerous (see Thompson 1985:26-7).

Traditional life-styles were now passing and Aborigines became increasingly involved on
the fringes of colonial society, and in work on stations (Thompson op cit:31-2). This trend
was accelerated in the 1850’s when gold rushes lead to labour shortages. However a
number of Aborigines still lived partially traditional lives in more remote areas.

In the 1860’s the Government of the colony of Victoria set up a Central Board to look
after the interests of the remaining Aborigines. One action of the Board was to encourage
the establishment of missions. Two were set-up in Gippsland, at Ramahuyuck on Lake
Wellington under the Rev. Hagenauer, and at Lake Tyers under Mr. John Bulmer. In 1869
the Board gained the power to direct Aborigines where they could live, but few Aborigines
voluntarily entered the missions. Bulmer finally attracted, and gained the respect of the
Aborigines during 1870, particularly through his efforts and personal financial sacrifice in
stocking the station. While demanding that Aborigines adopt a suitable peasant economy
no-one but Bulmer thought to provide adequate wherewithall such as livestock.
Recruitment of Gippslanders to the mission continued until 1876 when the last few (n=39)
"wild" Aborigines in Victoria came down to the mission from the uplands (Thompson op
cit:36).
The next important stage in Aboriginal history came in 1886 when the *Aborigines Protection Act* redefined *Aborigine* to exclude any mixed bloods under 34 years of age. As a result numbers of people were expelled from the missions. The Act could also be used to punish insubordinance through expulsion. A result of the application of the Act was the foundation of two Aboriginal communities, those within the confines of the missions, and those often just beyond.

In 1903 Lake Tyers was transferred from the Anglican church to the state, and lay managers appointed. In the 1920's the remaining missions and reserves in Victoria were closed down and their occupants transferred to Lake Tyers. Government policies since then have come and gone, including assimilation through dispersal. In 1971 residents who had not been dispersed received title to the reserve from the state government, those who had left or had been expelled were not eligible.

Although the missions may have buffered the Aborigines from the worst of European society there was a price to be paid. Although Bulmer came to have some respect for aspects of Aboriginal culture, and indeed was a keen enough observer, he was a missionary and a man of his time. His purpose was to promulgate a cultural package at the expense of Aboriginal culture. He was in charge of Aborigines from a wide geographic area, as a result a *lingua franca* was needed. In the early days this was satisfied by the local dialect (Howitt 1904 refers to this as *Brabralong*), later with increasing ethnic diversity English superceded dialect. The homogenising of language and culture necessary for community survival occurred through destruction of cultural Aboriginality (Hercus 1965).

### 2.4. The Natural Environment

#### 2.4.1. Climate

**Rainfall** A major cause of rainfall in southern Victoria is the passage of low pressure systems to the south of the continent, with cold fronts crossing over from west to east (Linthor 1969). In Gippsland a good deal of this is caught by ranges to the west so that the precipitation from these fronts can be diminished. While rain from the west can be regarded as basically a winter pattern, rain from the east is more uniform. It can arise from both cells generated over the Tasman, and from low pressure systems which have migrated from the west and intensified off Gabo Island.

Maximum rainfall occurs to the east of the region, and on elevated areas. Rain shadow effects occur below the ranges to the east and north of Sale, and in the deeper valleys of the Tambo, Mitchell, Macalister and Snowy rivers.
At elevations above 600m, snow falls occur fairly regularly, but rarely lie on the ground for long away from the main divide.

Rainfall for selected stations is included on Table 2.1, and rainfall distributions are shown in Figure 2.1, and included in Figure 2.2.

**Temperature** Temperature variations in the region result from the interplay of a number of factors such as proximity to the sea, altitude and topographic variation. Deeper valleys can undergo lower night temperatures, while the Fohn effect can lead to warmer winter temperatures. Local microclimatic effects occur at different places, eg. according to forest cover (Nunez and Sander 1982). See Table 2.1 and Figure 2.2.

**Evapotranspiration.** Estimates of Potential Evapotranspiration have been made using the method of Fitzpatrick (1963) for stations without long-term pan evaporation estimates. This involves three constants $k$, $a$ and $b$ which were calculated for East Sale and have been used throughout the region. See Table 2.1 and Figure 2.2.

**Wind** Wind direction and speed for East Sale Aero are summarised in Figure 2.3. Prevailing winds are from northwest to southwest. Close to the coast sea breezes tend to mask winds generated by larger scale circulation, particularly in summer when there are brisk daytime on-shore winds.

2.4.2. Regional Hydrology

Catchment discharges are the remnant of rainfall not lost through evaporation, transpiration, seepage into deep aquifers and impoundment. A major control on discharge is altitude, through a combination of variation in rainfall (through orographic effect) and temperature (as a function of height). Greater rainfall and reduced evapotranspiration at higher altitudes cause increased discharge from elevated catchments, the reverse applies at lower elevations. In snowy areas there is storage with discharge delayed until the thaw, coinciding with still relatively low Potential Evapotranspiration. This results in relatively high seasonal discharge.

Modern discharge figures do not accurately reflect past stream behaviour. Reasons for this include the diversion of large volumes of water to the Snowy Mountains Hydroelectric Scheme from the Snowy River, damming of the Thomson and Macalister rivers, diversion of irrigation and industrial water from the Snowy, Mitchell, Tambo and Latrobe Rivers. While most of the major streams still maintain entrenched, suspended load forms over their lower reaches, the Avon has altered in historic times to a broad shallow channel bed-load.
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</table>

**If area of lakes = 4 x 10^8, for 1m. rise 4 x 10^8 m^3 needed, for 1 cm. \( \frac{4 \times 10^8}{10^2} = 4 \times 10^6 \) m^3**

**PE estimate after method of Fitzpatrick, E.A. 1963**
Figure 2-1: Rainfall Distribution in Millimetres
Figure 2-3: Wind at Sale East Aero
form. This is attributed to increased run-off and/or sediment load following clearing, gold-mining and agriculture. Figures 2.4 and 2.5 illustrate the trench form of the bed of the Nicholson River at Nicholson, and the braided Avon at Stratford.

Figure 2-4: Nicholson River at Nicholson

Despite these difficulties Figure 2.6 shows discharge from streams entering the Gippsland Lakes. The data for the Macalister are from above the reservoir at Glenmaggie, while those from the Thomson predate the filling of the reservoir on that stream. See also Table 2.1.

Groundwater

The marked peak in winter discharge on all streams can be attributed to the capture of winter rain from the west by the ranges, relatively cool winter temperatures leading to reduced Potential Evapotranspiration and winter-spring thawing of snow. It should be noted that discharge peaks, measured at lowland stations, are out of phase with monthly Potential Evapotranspiration calculations (see Figure 2.2). This lag presumably reflects the importance of groundwater discharge into the streams. The continuation of stream flow in summer when rainfall on the ranges from westerly wind systems is reduced, and Potential Evapotranspiration is high, is further evidence of the importance of groundwater discharge.

Aquifers of Tertiary and Quaternary age are found on the coastal plain while fractured rock aquifers are believed to be important in upland areas. The water table in the lowlands
Figure 2-5: Avon River below Stratford
Figure 2-6: Median Stream Discharge

River discharges in cubic metres x 10^6

- La Trobe at Rosedale (minus inputs of Macalister and Thomson Rivers)
- Mitchell at Bairnsdale
- Tambo at Bruthen
- Avon at Valencia Ck
is controlled by direct hydraulic connection with surface water bodies such as lakes, swamps, streams and the sea.

Discharge of saline groundwater into the lakes may be a contributing factor to modern lake salinity. As the geology of the region contains abundant Cainozoic marine deposits salinity of the regional groundwater is to be expected. Elevation of the water table should follow as a consequence of irrigation and land clearing.

The magnitude of the contribution of saline groundwater to past salinity is uncertain. Lake Wellington is believed to be currently suffering salinity problems, but would not appear to have been badly affected early last century. Taking up land on Lake Wellington in June 1842 W. Odell Raymond reported to Commissioner Tyers that:

> the lake itself is a very large sheet of water, which I suppose to be in width twelve or fourteen miles... the water when I visited it was brackish, but not too much for stock, and we were soon able to enjoy a good pot of tea made with it after a long day's ride. I am, however, assured by Mr. McMillan (Mr. Macalister's superintendent), and the first discoverer of this country, who had visited it three times in the summer months, that he had never found it so before. (Raymond in Bride 1983:242)

In 1844 Tyers reported that Lake Wellington "is fresh throughout the year" (in Bride 1983: 230).

> ...the banks of the lakes are very reedy, making it difficult to land; the reeds run from 8 to 10 feet high. (Warman, Port Phillip Herald 23 Feb. 1847, in Cuthill n.d.)

The reed beds in this case are adjacent to Lakes Wellington and Victoria. This luxuriance is certainly not typical of the reed beds in the same area today. See Figure 2.7, summer reed growth on eastern Lake Wellington 1988. It is clear that salinity stress in the lakes at present is considerably greater than that witnessed last century.

### 2.5. Vegetation

Vegetation is controlled by a number of factors notably local climate, aspect, topography, soil, bed rock, salinity and disturbance history. As a result a wide range of vegetation units (however defined) can be identified and mapped in the study area.

The floristics of the study area are interesting as it lies on the boundary of two geographic regions. One of the most important differences is the transition from winter to summer rainfall across the region. This difference generates an ecological transition reflected in the distribution of taxa and structural units. A significant warm temperate wet forest taxon is relict "cabbage palms" (*Livistonia australis*), and lianes. These are located in deep gullies with a southerly aspect at the eastern end of the study area. Floristically these patches (locally called jungles) are rather depauperate representatives of warm temperate rainforest. See Figure 2.8.
In the west of the study area beyond the plains, the high rainfall intercepted by the South Gippsland Highlands maintains a quite distinct suite of cool temperate wet forest taxa.

**Impacts on Vegetation.** Vegetation changes in historic times have resulted from the impacts of logging, cultivation, grazing, gold mining, and the introduction of vermin and weeds. The lowlands have suffered the most intense effects from agricultural development. Much land reserved for nature conservation (e.g. in lowland National Parks) would be better regarded as regenerating rather than representative of natural states.

Arguably actions by Aborigines also may have had effects upon the structure and floristics of "natural" vegetation. Intense local impacts around habitation locations include traffic, collecting firewood, and seeding from camp refuse and faeces. In addition, human effects will include the impacts of fire. While it is not clear what effects Aboriginal burning may have had on Australian vegetation in the long term (e.g. see Horton 1982), fire was definitely a element in the ecology of Gippsland. Thus Bass sailing into Bass Strait (Bladen 1978: 1 Jan.1798, p 320) noted seeing the smoke of numerous fires behind the Ninety Mile Beach. John Bulmer (n.d.2, n.d. 3) reported the use of fire in driving game to spearmen during communal hunting drives. Howitt (cited by Hancock 1972:25-7) was of the opinion that since the demise of Aboriginal life-styles the lower stories of eastern Victorian forests had become denser through lack of burning.
Significant changes have occurred in the vegetation of the area since the Holocene marine transgression (Hooley et al 1980, Ladd 1978, 1979a, 1979b, 1979c, 1979d, Hope 1974). These studies will be discussed in Chapter Four.

**Humanly exploitable resources** Whether defined by floristics or the structure of dominant species, vegetation units may not be a good guide to hunter-gatherer resource potential. With the exception of some wet-gully taxa few of the defining trees or shrubs provide edible fruits, humanly exploitable resources lie in the lower storeys (or in animal life). These may be herbaceous, or relatively short-lived, and may have a more opportunistic biology than the defining upper storeys. Being liable to change and disruption (notably through burning, then subsequent successional processes) the value of vegetation units in hunter-gatherer resource studies may be better stated in terms of successional history rather than taxonomically. The distribution of the edible rhizome of the fern
*Pteridium esculentum* in open forests or woodlands is a good example of the greater importance of disturbance history over the floristics of dominants.

Structure will be significant for animal resources. The extensive Forest Red Gum (*Eucalyptus tereticornis*) open forests, and various open woodland forms in the lowlands would be productive of large macropods, coastal wetlands will favour significant birds, eg. ducks, swans. Other classes, eg. tall upland forests may be of limited animal resource potential.

A discussion of staple plant foods in Southeastern Australia (Gott 1982) indicates that some of the most significant taxa are aquatic (eg. *Typha spp.*, *Triglochin procera*, and *Scirpus spp.*), these are most likely to be encountered in the vicinity of the lower reaches of the rivers and the wetlands. Dryland plant staples include miscellaneous Liliaceae, Orchidaceae and rhizomes of *Pteridium esculentum*, the latter being a resource controlled by local fire histories. *Microseris scapigera* a significant dryland resource elsewhere in Southeastern Australia is virtually unknown in the region (Willis 1966).

2.6. Fauna

2.6.1. Mammals

The distribution of mammals can be related to the distribution of suitable habitats. Some species are quite narrow in their habitat requirements, others broad. A select list of distributions of mammal fauna is presented in Table 2.2. As can be seen from the table some of the most attractive game are very wide in their environmental tolerances, notably grey kangaroos, wombats and the possums.

2.6.2. Birds

See Table 2.3 for the regional distribution of selected birds. Taxa are included according to their economic potential, and are characteristically medium to larger bodied, and tending to large flocks or abundance. Two taxa, magpie geese and bustard, are today entirely descended from released stocks. Lowland forests or woodland, and wetlands are the most important habitat areas for economic birds.
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<th>KURNAI NAME</th>
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</table>

Table 2.4: Distribution of Selected Mammals

1 Closed forest
2 Tall open forest
3 Open forest
4 Riverine forest
5 Foothill woodland
6 Coastal woodland
7 Inland wetlands

Listing and habitat after Land Conservation Council, 1982

Kurnai terminology after Mansergh and Hercus, 1981
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<th>Latin name</th>
<th>Kurnai name</th>
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<td>pigeon</td>
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</table>

Table 2.3: Distribution of Selected Birds

Kurnai terminology after Mansergh and Hercus, 1981.
2.6.3. Fish

The rivers draining the study region all rise in the south and east of the watershed of the Dividing Range, and with the exception of the Snowy River all major streams drain into the Gippsland Lakes. They follow a similar pattern and pass through a number of distinctive phases: as upland fast flowing freshwater streams, through slow flowing lowland freshwater streams, into estuarine river tracts down to the lakes. Because of the overall similarities of the evolution of these streams, with their zoned habitats, general statements can be made regarding their fish faunas.

A representation of the zoning of key fish taxa is presented in Table 2.4.

The streams of the study region have suffered considerable modification during the period of European occupation. These effects complement the introduction of exotic species eg. trout, European carp and perch, and goldfish, which have all established feral populations (Land Conservation Council 1982).

Bulmer (in Smyth 1878:204, nd.1, nd.2, nd.3, nd.4) lists the fish commonly taken by Gippsland Aborigines, and the methods used. These are set out below with notes on behaviour and biology. Bulmer uses dated or imprecise vernacular names. Taxonomy is further complicated by the biogeographical location of the study area in the transition between eastern and western, and southern and northern species, sub-species and breeding stocks (Winstanley 1981:91). This applies to bream, snapper and Australian salmon in particular. These differences mean variation in the biology of sometimes very similar or identical taxa, and thus difficulties in determining relevant details of their biologies.

**Snapper** (nerabogang), *Chrysophrys auratus*, hooked. Snapper inhabit estuarine waters in younger growth phases but tend to keep to deeper water, particularly over reefs, in older phases (Roughley 1957:76-8). Larger fish will enter estuaries to breed in summer where water temperature is greater than eighteen degrees centigrade, and at this time will enter shallow water (Jenkins 1986:517). Fishermen claim that larger fish only enter shallow water at night. Snapper were probably most accessible as younger fish. They take the hook fairly freely, but living over rough bottoms may have been risky to net. As the Gippsland Lakes lack hard rock outcrops reef habitat is missing, it is likely that Bulmer’s reference is to other estuaries along the coast.

Snapper may not have been a significant resource.

**Gurnet** (koortgut), Triglidae, netted. A number of species are called *gurnet* or *gurnard* in
<table>
<thead>
<tr>
<th>Common name</th>
<th>Latin name</th>
<th>Kurnai name</th>
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<tbody>
<tr>
<td>Anchovy</td>
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<tr>
<td>Bass</td>
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<td>Flathead</td>
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<td>Greenback flounder</td>
<td>Rhombosolea sciripina</td>
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<td>Arripis trutta</td>
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Listing and habitat after Land Conservation Council, 1982
Kurnai terminology after Bulmer in Smyth 1978, p204, and an anonymous list in Cuthill n.d.
southern Australian waters, including deep water species. These are not important commercially on the Lakes, and presumably were similarly not so in the past. As demersal fish they could be taken with a drawn net, perhaps incidentally rather than as target prey.

This may not have been a significant resource

**Flounder** (pertrip), Pleuronectidae, spearred. A number of species of flounder occur in southern Australian waters, but most are small fish. The nearby sea-grass beds at Corner Inlet produce commercial quantities of the Greenback Flounder *Rhombosolea tapirina* (Nichols and Klumpp 1983), one of the few commercially sized species in Australian waters. *R. tapirina* is not reported to undergo any significant annual migratory movements and may therefore have been available throughout the year.

Repeated mentions in the literature, a capacity to be caught using spear and torch, and nets, and perennial availability make these potentially important.

**Garfish** (thacki), *Hyporampus melanochir*, spearred. *H. melanochir* feeds over sea-grass in nearby Corner Inlet (Nichols and Klumpp op. cit.). It is possible that another garfish *H. regularis* (Roughley 1957:21-22) might also be found in the estuarine waters of the Lakes. As both types of garfish feed over shallow sea-grass beds they may have been easily netted.

A potentially valuable perennial resource.

**Large flathead** (bimbang) and **Flathead** (brindal), Platycephalidae spearred, hooked, netted. There are a number of species of flatheads in southern waters. A likely candidate for Bulmer's **large flathead** is *Platycephalus fuscus*, the largest of the Platycephalidae and an estuarine species. It migrates to the lower reaches of estuaries to spawn over sandy or weedy bottoms in the summer months. His **flathead** is difficult to identify, but is possibly the common *Platycephalus laevigatus* commercially fished from the seagrass beds of nearby Corner Inlet (Nichols and Klumpp op. cit.). This species does not appear to be migratory. Platycephalidae characteristically have large mouths and take the hook easily.

Both taxa are potentially available throughout the year, common, and therefore potentially valuable.

**Bream** (kine), *Acanthopargus butcheri* or *Acanthopargus australis* hooked, netted. The ranges of the two species overlap in Gippsland waters. *Acanthopargus australis* the more northerly species gathers near outlets in May-August prior to an off-shore breeding run when a full moon coincides with a flood tide. Good catches are made in lower estuaries and
on beaches after high fresh water discharges force fish downstream (Roughley 1957:83-4). *A. butcheri* spawns in estuaries in Oct.-Nov. where salinities range from 11-18 p.p.m. Modern fishermen regard both types of bream as shy of the hook.

Fishermen after *A. butcheri* fish downstream after high stream discharges and upstream after low discharges. This is effectively a strategy of following isohalines.

Maximum catches of *A. australis* are likely to be predictable as fish will be concentrated in the lower reaches of estuaries through the winter months. Runs through the outlets can be predicted according to lunar and tide conditions. Winter higher river discharges can be expected to further concentrate fish. Spawning aggregations and displacement by floods mean that seasonally at least bream will be relatively restricted, making netting on the outlets, and along isohalines productive. This advantage occurs in winter with *A. australis*, a period in which fishing might otherwise be poor. Peak availability of *A. butcheri* is more likely in spring.

The bream are the historic mainstay of the commercial fishery and are likely to have been equally abundant in the Aboriginal fishery. Away from the seasonal peaks both taxa were evidently available to non-net fishers.

**Perch** (tambun), *Macquaria novomaculeata* or *Macquaria colonorum*, netted, hooked.

The two species of *Macquaria* are frequently confused and their status as separate species has been debated (Lake 1976, 1978, Harris 1985a). The most recent research favours two species. *M. novomaculeata* is regarded as essentially a freshwater species which moves down to brackish waters in winter to breed at salinities of 8-14 p.p.m. where *Phragmites* or other plants provide nursery habitat (Harris 1986). *M. colonorum* is essentially estuarine and breeds near outlets in winter.

As with the bream, concentrations of fish in breeding habitats, eg. as defined by salinity, would be advantageous for the fisherman. As they are not particularly numerous today, but might have been more so in the past, concentrations in breeding habitat may have rendered them more significant.

It is likely that the Tambo River and Tamboon Inlet received their names from this taxon.

**Travalla** (kari), *Seriolella brama* (?) hooked. Fish now called travalla are essentially marine, although younger *S. brama* may enter estuaries (Scott et al. 1980:162). This taxon appears as a casual visitor to estuarine waters and unlikely to be pursued as a key species. It is possible that Bulmer confused Travalla with Trevally, a more common taxon in the Gippsland Lakes.
Sand mullet (krinyang), *Aldrichetta forsteri* (?), hooked, speared and netted. Sand mullet today is *Mugil cephalus* but these are regarded as almost impossible to hook, as Bulmer suggested his sand mullet were. Yellow-eye mullet *A. forsteri* are a mainstay of the Lakes fishery, will take the hook, and are likely to be what Bulmer meant by sand mullet. In a survey of ichthyoplankton in Port Phillip Bay, Jenkins (1986:518) failed to identify any larval examples of *A. forsteri* although juveniles are abundant. He concluded that this species may move off-shore to breed although no such migration has been recorded, certainly not of the scale witnessed with *M. cephalus*.

Fat mullet (pertpiang), *Mugil cephalus* (?), netted. Fat mullet is not a common term today. Bulmer elsewhere refers to pertpiang making migratory runs through lake inlets, this is very typical of *M. cephalus*. In southern Australia this species forms large shoals in the lower reaches of estuaries to begin a sea-ward migration as early as February. The exit from estuaries may be triggered by weather conditions, heavy rains and high river discharges may force fish into the lower reaches of the estuary, strong off-shore winds may trigger the run (Roughley 1957:31-4). Modern fishermen take advantage of the run to net large hauls. Largely feeding on algae, detritus, diatoms etc. it is only rarely able to be hooked. *M. cephalus* returns to estuaries after breeding runs, and continues to shoal throughout the rest of the year. Only a proportion of the population leaves every year, the rest remain in estuaries and range in schools throughout their length (Thomson 1955).

Both of the mullets offer advantages to the Aboriginal fisher. They feed at a low trophic level and therefore form a large available biomass. This mass is complemented by a schooling habit throughout the year which allows bulk harvesting. There are seasonal aggregations whose behaviour, controlled by weather conditions, are predictable and able to be exploited. Flesh is oily, and is presumably relatively high in calories compared to white fish.

The mullets are given repeated mentions by Bulmer suggesting that these advantages were realised in the Aboriginal fishery.

Sea trout (billing), *Arripsis trutta*, hooked and netted. *Arripsis trutta* enter protected waters in early growth stages. After a few years and reaching a length of 20-25 cm. they leave protected waters (Roughley op. cit.:64-66). Despite being an important fish in the cannery industry (as "Australian Salmon"), details of the biology of eastern stocks of *A. trutta* are not well known, western stocks have been better studied. Adults are pelagic but keep to coastal waters and are frequently taken by beach fishermen on the Gippsland coast. Both Robinson (Mackaness 1941), and Howitt refer to the sight of Aborigines in bark canoes
spear the "salmon" off the south coast of NSW. In December-January pelagic *A. trutta* spawn, and develop a strong inshore schooling habit (Stanley and Malcolm 1977).

While frail bark canoes may have been seen off the often sheltered NSW coast, the unprotected higher energy coast of the study area may not have allowed many safe launches. Larger adult fish may not have been easily available. Younger individuals are gregarious and could be netted throughout the year in sheltered waters.

Eels are frequently referred to in the ethnohistoric and ethnographic literature. There are two species of freshwater eels in the study area, *Anguilla australis* the southern Australian species, and *A. reinhardtii* whose natural distribution runs east and north. They were speared. Both are believed to have similar biologies and life histories (Beumer n.d., 1983) spending the greater part of their lives in freshwater, although the males may not penetrate as deeply into the hinterland as the females. Upon reaching maturity adults leave freshwater in late winter and move downstream to congregate in estuaries during spring-summer. During summer-autumn they move to sea. Peak runs occur in the evening between dusk and moonrise in the last quarter of the moon.

During the colder months they can become torpid and easily collected in hinderland locations, but may be uncommon in the Lakes. In the warmer months they enter near marine waters in prime condition and carrying a good deal of fat, calorific returns are likely to be good. There is no record of Gippslanders building barriers to intercept migrating eels as was done in Western Victoria (eg. see Presland 1977, 1980). However, as Robinson (in Mackaness 1941:23) talking of Aboriginal fishing near Bega (Biggah) to the Northeast recorded, "... the latter are taken in Weirs, Eels and other fish in ponds are stupefied with an infusion of Bark." It can be assumed that these wide-spread methods were similarly available in Gippsland.

The commercial fishery is based on bream, but numbers of yellow-eye mullet, salmon, flathead, garfish and tailor are also taken (L.C.C. 1985). The list is quite similar to that of Bulmer with the exception of tailor. This may be because of the damage tailor can do to nets with their teeth, or because their feeding habits make trolling rather than bait fishing more productive (Roughley 1957). *Mugil cephalus* are not important in the modern fishery.

In addition to table fish the Lakes also support a fish-meal industry based on small schooling fish: anchovies, sprats and so on (Engraulids, Clupeids etc). What we know of

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2fish generally
mesh-sizes of large Aboriginal nets (see Chapter Six) indicates that they were not exploited in bulk. However Smyth (1878:389) describes a Gippsland hand net used to catch small fish for bait, and suggests nets used to scoop out small fish from streams were common in Victoria. This type of fishing is likely to be most useful if migration runs occurred in streams entering the Lakes. Useful taxa may also include Galaxiids and Grayling.

Being low in the food chain Engraulids and Clupeids are abundant and likely to form a considerably greater combined mass than larger higher level carnivores. They form large schools and can be bulk harvested, and being oily may provide, weight for weight, good calorific returns. In many respects they are a similar resource to the mullets except for their smaller body size.

2.7. Discussion

The study region is a well watered fertile area on the transition between east coast and southern Australian climatic systems. This is reflected biogeographically in the distribution of key plant taxa, communities and structural units across it.

It has undergone considerable modification in historical times. Effects include degradation of streams, introduction of vermin and weeds, increased lakes salinity resulting from both enhanced exchange and increased saline groundwater discharge, land clearing and changed burning regimes.

A number of points of relevance arise from the discussion. The first is the relatively late official settlement compared to adjacent areas of Southeast Australia, leading to decades of indirect effects of British expansion being felt in the region. It is probable that a number of aspects of contact Aboriginal socio-cultural organisation were atypical of the prehistoric period. A significant area of change is demographic.

It should also be noted that historic patterns of hostility may owe much to this period of indirect proto-historic contact. The fact of intense conflict between all groups, including British ethnics, prevented useful early contact including ethnography. Labour demands during the gold rushes, destruction of morale since the hunt for the Wild White Woman, environmental degradation, concentration of Aborigines in missions, on-going problems of disease, alcohol and marginalisation after the late 1840’s all threatened the continuity of traditional culture. By the time Bulmer and Howitt began to seek details of traditional culture in the 1860’s-70’s much of it was already historic.

It is clear that rather than being only intermittently connected to the sea, the lakes were
sufficiently well drained for outlets to allow scheduled passage to small schooners. Indeed, on the evidence of the eye-witnesses of the day it would appear that there were two historically active outlets rather than the single example at Red Bluff usually cited. Even when impassable to coastal shipping it would appear exchange of waters could still occur, absolute closure may not have been as common as portrayed by some geographers.

The distribution of selected fauna demonstrates that the most productive areas for human resources are likely to have been the lowland forests and woodlands, the lower tracts of the rivers and lakes, and the fringing wetlands. These are likely to have been areas of similarly high production of plant food staples. The areas best able to have supported large Aboriginal populations were therefore on the lowlands rather than ranges and most particularly near water bodies and water courses. These were of course areas with considerable appeal to early pastoralists, as were the broader upland valleys. As populations were rapidly dispersed from much of these areas to more marginal country by the early 1840’s, and before the arrival of interested or enlightened observers, it might be argued that knowledge of much regionally normal behaviour is ethnographically lost, or recoverable only through archaeological inference.

Another aspect of the biology of the area is the annual or seasonal salinity requirements/tolerance of important fishes. As many are quite specific in their preferred salinity ranges their location at any time will be controlled by isohalines. This is important in a system the size of the Gippsland Lakes where cycles of restricted and open discharge and variation in rainfall and river discharges mean potentially major shifts in isohalines in relatively short periods. In a system the size of the Gippsland lakes such shifts in isohalines might be translated as shifts along the system of possibly many kilometres. This will demand, in turn, a greater degree of mobility on the part of fishers than would be expected on the smaller lagoons of the Australian East Coast.
Chapter 3

Landscape History

The evolution of the physical landscape provides the background against which all biological activity occurs. As such it also sets the conditions and limits within which general environmental parameters change, and thereby selection pressures are imposed on all biota.

The following discussion is a synopsis of the geological history of the region with particular reference to the structural evolution of the area leading to modern landscape configurations. This is fundamental to later biological and cultural activity in controlling climate, division of the landscape into structural areas, variety and distribution of biota, and later affecting communication between populations. The general geology of the area is also significant as rock itself is a resource to people using stone tools.

This is followed by a discussion of the late Quaternary of the study area as the background against which the evolution of the Lakes occurred. The sequence of Holocene evolution according to different authors is discussed, and a synthesis and criticism is presented. The results of this chapter will be compared with archaeological results (see Chapter Seven) and aspects of the ethnographic culture of the region (see Chapter Six), to determine the value of an adaptation approach in the study area.

3.1. Geological history

The following outline of regional geological history is based on contributions in J.G. Douglas and J.A. Ferguson 1976 Geology of Victoria. See Figure 3.1.

3.1.1. Paleozoic

Ordovician (See Beavis F.C. et al 1976:25-44). The study area is part of a wider area encompassed by the Tasman geosyncline. In Victoria it is composed of a number of sub-basins defined by the axes of older Cambrian rocks. These are today represented by lines of metamorphic "greenstone" outcrops running through western, central and north-eastern
Figure 3-1: Regional Geology (See foldout overleaf)
Victoria. The Ordovician sediments within the basins suggest marine deposition. (Douglas and Ferguson 1976:25)

The Upper Ordovician saw the beginning of orogeny, intrusion of plutonic rocks, and deformation in Eastern Victoria.

*Silurian-Middle Devonian* (see VandenBerg, et al 1976). Orogeny, deformation and intrusion of igneous rocks continued, with acid volcanism represented by rhyolite, rhyodacite and ignimbrite. Locally sub-aerial erosion and underwater deposition are indicated by stratigraphic unconformities. Subsidence is indicated by the deposition of the Buchan limestones, which are followed by terrestrial deposits.

*Upper Devonian-Carboniferous* (see Marsden et al 1976) Some evidence of marine deposition persists in far East Gippsland-South Coast NSW with a a terrestrial-marine-terrestrial cycle indicated. Otherwise, very little evidence of marine deposition during the Upper Devonian-Carboniferous is preserved in Victoria. The major rocks are non-marine sediments, acid volcanics and granitic intrusions. On the Genoa River a set of amphibian tracks are said to represent a very early record of terrestrial quadrupeds.

*Permian* (see Bowen and Thomas 1976). While Permian rocks are common in the west of the state, and northeast in the Sydney basin, no outcrops are known from eastern Victoria. The period is represented by borehole records of deltaic or near-marine sediments at a depth of 1073 m., suggesting local subsidence.

### 3.1.2. The Mesozoic

The Mesozoic is largely represented by the Cretaceous, beginning with a period of rapid subsidence of the Gippsland Basin leading to deposition of the thick Strzelecki group, including debatable marine sediments. This is reversed in the mid-Cretaceous by uplift. No upper-Cretaceous rocks are known.

The major outcropping of Cretaceous sediments in the Gippsland Basin is the two horsts of the Strzelecki Ranges, or South Gippsland Highlands. The major rocks are sandstones, mudstones and putative greywacke, there are also carbonaceous rocks including coal beds (Douglas 1976).
3.1.3. Cainozoic

Mid Cretaceous uplift was followed by late Cretaceous-early Paleocene sundering of Australia from New Zealand and the Lord Howe rise around 60-80 my BP. This resulted in inundation of the Gippsland basin. Only 20% of the basin is today located onshore. Tertiary sediments consist of alternating terrestrial and marine sediments reflect cycles of subsidence and emergence. Important rocks include extensive brown coal, basic volcanics and shallow marine limestones.

The appearance of the highlands has been attributed to Oligocene uplift, continued in the putative Miocene-Pliocene "Kosciusko Uplift", a period of deposition of extensive gravel fans (the Haunted Hills Gravels).

The long evolutionary history of the region, and particularly in the Tertiary, has led to the formation of five readily recognisable tectonic/structural divisions within the Cainozoic rocks of the Gippsland Basin (See Hocking 1976). These are shown in Chapter Six to have have considerable relevance to human population distribution in the region.

1- *Lakes Entrance Platform* Defined to the north by the Paleozoic rocks of the Highlands, this feature marks the approximate northern boundary of the Gippsland Lakes region.

2. *Lake Wellington Depression* Containing the Gippsland Lakes.

3- *Latrobe Valley Depression* Located landward of the Lake Wellington Depression this division comprises terrestrial sediments as well as basic volcanics.

4- *Baragwanath Anticline* This northeasterly continuation of the South Gippsland Highlands is capped by Cainozoic sediments. It meets the coastal zone around the vicinity of Letts Beach, and separates the Lake Wellington Depression from the Seaspray Depression.

5- *Seaspray Depression* The sub-aerial part of this division is bounded to the north by the South Gippsland Highlands and the Baragwanath Anticline, and to the south by Bass Strait.

The relevant earlier *Pleistocene* history of the Gippsland Basin is largely concerned with eustatic sea-level adjustments during glacial cycles, leading to the deposition of barrier features, a process which continued into the Holocene. This is more fully discussed in the section which follows.
3.2. Late Pleistocene and Holocene Geomorphology of the coastal zone


Bird (1961, 1965, 1978), who is a founder of coastal geomorphology in Australia, undertook a study of the Gippsland barrier and lagoon system in the 1950's. His study area runs from Red Bluff to the vicinity of Letts Beach (Letts Beach may not be shown on more modern maps, it is the Paradise Beach and Golden Beach area). Although he initially suggested that the whole of the barrier system may have evolved in the Holocene (Bird 1961), this was later revised, and much of the area has since been assigned a Pleistocene age. Bird has not undertaken extensive radiocarbon dating of the system, and has presented a relative sequence rather than an absolute chronology. Attempts by Bird to use the vegetation succession (1978:71) as a relative dating tool have been criticised by paleobotanists (Hooley et al 1980).

Jenkin's larger study extended into Southwest Gippsland, and goes well back into the Cainozoic. As a result he gives only limited attention to the Late Quaternary of the area. Like Bird he does not use absolute dating, suggesting instead a relative sequence of landform evolution against sea-level changes (see Jenkin 1968, tables 1 and 11, pp 18 and 71). Unlike Bird, Jenkin makes more reference to interpretation of sections, but does so without citing an extensive program of boring. Like Bird, Jenkin relies heavily on interpretation of surface morphology.

Thom's interest lies in surface morphology, depositional facies, stratigraphy and absolute dating of a relatively limited area of the Ninety Mile Beach and Boole Poole Peninsula, between Ocean Grange and the village of Seaspray. Unlike both Bird and Jenkin he carried out an extensive program of drilling, and dating to determine the stratigraphy and sedimentary history of the area (Thom 1984, Thom et al 1983).

Ward's work has been concerned with soils and sea-levels, and significantly has attempted to relate local geomorphic features (river terraces and lake shore features) to overseas sea-level records (Ward 1971, 1977).

Bird defines a barrier as:

...a sedimentary deposit built-up above high tide level, and standing off-shore, or standing across the mouths of coastal inlets and embayments, the term bar being restricted to similar features that are submerged by the sea for at least part of the normal tidal cycle. (Bird 1978:1)
He recognises three barrier formations in the Gippsland Lakes region, see Figure 3.2. His first, prior, barrier persists as remnants on the eastern side of Lake Wellington and the northern shores of Lake Victoria. His second inner barrier is intermittent with a major break east of Sperm Whale Head (SWH), and encloses Lakes Wellington, Victoria and King. The third, outer barrier lies to seaward and is separated from the inner barrier by lagoons (notably Lake Reeve), sand-flats and saltmarsh and extends the length of the Ninety Mile Beach (Bird 1978:49). Elsewhere in this thesis the outer barrier will be referred to as the Ninety Mile Beach barrier.

The prior barrier has been obscured near Lake Wellington where its surface morphology has been largely reworked. To the northeast remnants such as Banksia Peninsula are supposed to maintain their original surface morphologies. Gravel deposits are incorporated in exposures along the shore of Lake Victoria. These are taken to be of fluvial or deltaic origin. They are claimed to be incorporated in barrier deposits, or to form a nucleus of deposition. Gravels are not typical of the inner or outer barriers.

The evolution of the inner barrier is attributed to a spit growing across the embayed mouth of the greater Latrobe River. This outlet deflection can be attributed to both sediment supply from the hinterland and long-shore drifting from the SW. It incorporated Sperm Whale Head (SWH), part of Boole Poole Peninsula (BPP), Flanagan, Fraser and Rigby Islands, and land under Lakes Entrance township. Bird (1978:64) suggests that once the spit was in place vertical accumulation and progradation followed leaving a series of ridges whose characteristics match those on Banksia Peninsula. From this he concludes that the prior and inner barriers were deposited close in time, despite their significantly different contexts. He cites the degree of podsolisation and maturity of the vegetation succession as further evidence.

The ridge topography of Sperm Whale Head has been disrupted by numerous parabolic dunes, aligned E-W with bases below present lake water levels, indicating formation during a period of lower sea-level (Bird 1978:68–9), but with prevailing winds similar to those of today. Initiation of instability is attributed by Bird to erosion on the edge of the then sandy ridge caused by meanders of the prior greater Latrobe River.

Bird recognises two suites of ridges on Boole Poole Peninsula (1978:70), a more northerly set which he includes in the inner barrier, and a southerly set which he likens to outer ridges at Letts Beach and on Rotomah Island. The swales of the northerly set are partially inundated, due he suggests to either compression of (hypothetical) organic deposits or tectonics. He suggests (1978:74) that the multiple ridges of the outer barrier at
Figure 3-2: Location of Barrier Deposits after Bird, 1978
Letts Beach may be a result of a local abundance of sediment or of tectonic uplift, relating barrier emergence to local geological structures. The tectonic argument complements his suggestion of submergence of the more northerly ridges of BPP. From the above it would appear that Bird favours a model of barrier growth in which a core of sediment (eg. fluvial deposits), or uplift of an existing structure are at least desirable preconditions. This is matched by recourse to eustatic change to aid emergence, as well as supposedly widespread evidence of Holocene emergence on the Australian coast (op cit:75). This position has been acrimoniously debated by Gill (1982), Gill and Hopley (1972), Thom et al (1972), and Bird’s passing assertion of epeirogenic uplift adds nothing to the debate.

Bird suggests that sediments have been delivered from off-shore, and discounts transport around Wilson’s Promontory (1978:77). On the evidence of a supposed spit pointing southwest into Corner Inlet he argues against longshore nourishment of spits growing northeast along the Ninety Mile Beach. Elsewhere however he suggests (1978:73) that lateral growth had occurred at Lett’s Beach. Referring to his figures 13 and 14 (Bird 1978:37-8) (see Figure 3.5) it can be seen that orthogonals of waves generated to the southeast present normal to the supposed spit into Corner Inlet, and obliquely south of Lakes Entrance. Swell generated to the southwest will set up drift SW->NE. That is regional wave energy is capable of sediment delivery in two modes, from off-shore and along shore. The barriers of this coast are likely to be hybrid features.

Jenkin (1968:23) defines barrier as:

...an elongate deposit formed essentially by marine action and exposed during at least part of the tidal cycle. A “bar” is a generally elongate deposit which remains submerged...

He differentiates emergent unattached barrier islands from attached barrier spits. Complex barriers are newer barriers welded onto older ones, and he suggests (1968:23) that barrier-type deposits may be “welded directly onto the mainland”. How these can be differentiated from beach systems is not clear. Jenkin’s barriers are necessarily emergent only part of the time, and equivalent to Bird’s bars.

Jenkin presents the evolution of the region in terms of phases, see Figure 3.3. His first phase of barrier evolution is regional Phase IVa. Deposits of this phase, predating the last Glacial, consist of Bird’s Inner and Prior barriers (Jenkin 1968:72,86). This incorporates not only the deposits at the foot of the escarpment but the inner part of Sperm Whale Head (SWH). The simultaneous deposition of supposedly equivalent near-shore and off-shore features through supposedly similar processes is a problem.

The next depositional period is the early Holocene Phase VI (Jenkin 1968:43, 87) which
Figure 3-3: Location of Barrier Deposits after Jenkin 1968
saw the deposition of his second barrier complex. Deposits of this phase include a second set of ridges on the outer part of SWH, and beach ridge series on Rotomah Island, Letts Beach and the southern end of the NMB. Bird (1978:67) strongly disputes Jenkin’s identification of a younger series of ridges on SWH and asserts that the whole of the feature represents a single period of deposition.

Jenkin’s Phase VII or outer barrier deposits link the Phase VI elements, such as at Letts Beach and McLaughlins Beach, and form the continuous NMB. He suggests an age of less than 4000 BP (1968: Table VII, p.105).

Jenkin recognises two steps in barrier growth; the first is initiation, the second of sub-aerial growth. The later phase is based on common beach and dune processes, the problem lies in building an emergent body upon which sub-aerial processes can occur. On the basis of wave tank experiments he proposes four sets of circumstances in which break-point bars can be initiated (1968:87-88):

1. Shallow water, strong waves, sediment derived from seaward floor
2. Shallow water, moderate waves, sediment fed to the seaward floor
3. Shallow water, moderate waves, sediment derived from seaward floor
4. Moderate depth water, moderate waves, sand derived from shore

In the first three cases a stationary bar is formed, in the last the bar advances and overrides the beach.

He suggests that a qualitative comparison with the Gippsland coast can be made. (Jenkin:1968:89). There the coast has a shallow profile, and the major swell waves are relatively moderate in power. Allowing for abundant sand supply, transported in from off-shore and moved along-shore, Jenkin suggests that the initial barrier can form without calling upon uplift or eustatic changes to initiate emergence, indeed he asserts that there is no evidence of either having occurred. This explanation is adequate given that Jenkin’s definition does not demand full emergence of his off-shore bar. He also suggests barrier initiation through spit elongation nourished with beach drifted sediments (1968:89). Emergence, presumably through continued inputs of sediment, permits vertical, lateral or horizontal growth, including progradation.

Thom’s (1984) work is restricted to the Ninety Mile Beach barrier, and the Boole Poole Peninsula. Although he describes his work as concerned with the whole system, it should
be noted that his report is overwhelmingly concerned with the southwestern to central area of the system. Thom does not discuss the historic outlet at the northern end of Lake King.

He (Thom 1984:233-4) defines barriers as:

...bodies of detrital sediment, which rise above present sea-level and block off or impound drainage from the hinterland. Typically, they are elongate sand bodies, parallel to the shore, and separated from the 'mainland' in whole or in part by an estuary or lagoon, swamp or marsh, or sand or mud flat. Various types of topographic association with the "mainland" can be recognised. These include: complete detachment as "barrier islands", perhaps forming a barrier-island chain separated by inlets; connection at one end to the mainland with an opening at the other end which is being progressively infilled by alongshore sand transport- a barrier spit; and attachment to both headlands (perhaps with a minor inlet opening) with little evidence of alongshore sand transport- a bay barrier.

He identifies three major geomorphic elements of barrier systems: the sand body, enclosed low energy back-barrier area and tidal channels which may be associated with deltaic deposits. Barriers are divided into six types (Thom 1984:235-9): prograded barriers; abundant sediment leads to the growth of multiple ridges, stationary barriers; limited sediment supply means vertical accumulation only, receded barriers; negative sediment supply or rising seas cause landward migration over prior back-barrier zone, episodic dune barriers; receding beachfaces and high winds initiate transgressive dune fields, barrier-inlet type; resulting from alongshore migration of inlets, or spit growth, composite/hybrid barriers; elements of more than one type represented.

Relying heavily on facies differentiation according to the sedimentary environments outlined, stratigraphy and absolute dating Thom approaches the barriers from a more process oriented position. This approach is however complemented by a morphological analysis as is indicated by his barrier taxonomy above.

 Beds of lower littoral sheltered marine mollusca were identified above sea level in Lake Reeve sediments by Gill (1982), by Jenkin at Lake Denison (1968), and at Jack Smith Lake (Hothin 1982), see Figure 3.5. The Lake Reeve deposits date to between 6800 BP and 4500 BP. At Jack Smith Lake a single date on the now dry lake floor suggests contraction of the area under tidal influence around 4500, while archaeological data suggest the maintenance of tidal connection until 3000 BP. No dates are available for Lake Denison.

Further evidence for emergence is the formation of evaporites above the dated shell beds on Lake Reeve. Thom dates their formation to prior to 3000 BP (Thom 1984: 248), but does not himself propose they are evidence of emergence. The beds have moved from at or below the lower littoral, a metre or more below the then mean sea level, to close to one metre above the current water table at Jack Smith Lake, that is emergence in the order of 2m.
This evidence of emergence led in the past to some fairly heated polemic (eg. see Gill and Hopley 1972, Thom et al. 1972). An alternative explanation to eustatic adjustment or tectonics is hydro-isostatic adjustment (Chappel et al 1982). However conversations with Gill prior to his death indicate that he did not favour hydro-isostasy, but preferred eustasy. His death prevented further discussion so his reasons cannot be put here.

Thom (1984:252) suggests that with rising sea-levels a proto-barrier moved forward until stability around 6800 BP. Washover, nearshore wave processes and upper shore aeolian sedimentation modified the proto-barrier and lagoon through erosion and deposition. The lagoon was connected with the sea through numerous tidal inlets with a major opening at Ocean Grange opposite the gap between Sperm Whale Head and Boole Poole Peninsula. Continuing sediment supply led to continuing outlet constriction, and locally at Letts Beach, Rotomah Island and Boole Poole Peninsula to barrier progradation.

A final phase of barrier accumulation is demonstrated in the sand bodies opposite Boole Poole Peninsula (along the Bunga Arm) and Lakes Entrance township (along Cunningham Arm) dated to less than 2-3,000 BP (Thom 1984:254-6), this latter period of deposition is attributed by Thom to a hypothetical period of increased storminess.

A number of sediment sources are suggested by Thom: from inner shelf sand bodies, from
a SW->NE transport of sand along the beach face (resulting in the erosion of the barrier in the southern sector), and a hypothetical sand storage within the now Lake King basin feeding the prograded ridges of the Boole Poole Peninsula and Rotomah Island (Thom 1984:257). He emphasises on-shore movement and vertical growth perhaps, at the expense of the alternative of long-shore delivery of sediment whose role during earlier barrier growth is demonstrated by a series of recurved spits along Lake Reeve south of Ocean Grange.

The Bunga Arm and Cunninghame Arm barrier elements are superficially similar to the spit deflecting the outlet of the Snowy River at Marlo suggesting that long-shore supply to a deflected outlet must be considered. The coast of the region diffracts and intercepts swells generated by two wind systems, from the southeast and southwest respectively, see Figure 3.5. Both systems are capable of delivering sediment to the Ninety Mile Beach barrier. As Figure 3.6 demonstrates, diffracted southwesterly storm seas are capable of activating and redistributing sediment along the coast to the northeast.

**Figure 3-5: Orientation of Diffracted Swell Waves, after Bird 1978**

The possibility must be entertained that outlet constriction on Lakes Victoria and King began with barrier accumulation, enhanced by on-going regional hydro-isostatic rebound. This can be expected to have led to disruption of the beach and off-shore profile which must then evolve toward equilibrium form. An aspect of re-establishment of equilibrium
profile is reworking of off-shore sediment and delivery to the near-shore zone, possibly in the form of the last set of barrier elements. This process can be expected to be complemented by along shore sediment transport under the influence of southeasterly winds and swells.

Two hypotheses arise from the above: the current morphology of the barriers of the NMB is not inconsistent with a history of hydro-isostasy; tidal exchange with Lakes Victoria and King was not terminated by 4000 BP, but may have continued relatively unconstricted until or after the last phase of barrier accumulation 2-3000 BP.

Ward has been concerned with Pleistocene and Holocene sea levels, with associated landforms such as marine and river terraces, and with the characterisation of regional soils (Ward 1971, 1977). Much of the area with which he is concerned lies inland of the present study area and is not directly relevant here.

He has recorded a number of "stranded shores" in the Gippsland Lakes which he takes to represent Holocene high sea levels at +7.5ft (4,700 BP), 4.5ft (3,000 BP), 3.0ft (1,500 BP) and 1ft (750 BP). Dating involves Lake Reeve results and extrapolations from New Zealand and South Carolina. Such an approach is fraught with pit-falls, and relies on assumptions of coastal stability, and the validity of global scale extrapolations. The status of the stranded
shores can be questioned and alternative explanations of these features could be more closely investigated. It is further feared that determination of sea-level variations of 1 ft (30 cm) or possibly 3 ft (90 cm) are too fine to be credible. If verifiable, Ward's results could be pursued as evidence of Holocene sea-level history, particularly of the mid-Holocene relative high sea-level which has been so acrimoniously debated.

Such variation is also of considerable archaeological significance affecting such factors as the location of lakeside occupation locations, and the processes and therefore history of tidal connection, and the sedimentation of the system.

3.2.1. DISCUSSION

The work quoted above shows a broad range of definitions, understandings and approaches to the process of explanation.

There is no consistent definition of what a coastal barrier is. Agreement ceases with the observation that they are off-shore bodies which may be free, or attached at one end. Jenkin breaks with the others whose features are fully emergent, but apparently agrees with Bird that although defined as off-shore features barriers might be welded onto prior bodies, in which case they appear to be beach-like.

For a barrier to emerge the balance of deposition-erosion must be positive. Bird's call on uplift or sedimentation around a core is unsatisfying. Simply, if wave delivery of sediment is not at least equivalent to the rate at which wave power can erode it an emergent feature cannot evolve. Jenkin is of some help at this point as the wave tank experiments he reports do lead to the formation of sub-surface bars, but not of fully emergent features. Although Bird notes the importance of on-shore sediment delivery he, like Jenkin, seems to require barrier initiation in situ. Thom departs at this point with the barrier precursor rolling landward ahead of rising sea-levels. It is not certain if this "proto-barrier" is fully emerged or a bar.

So far the term barrier has largely referred to barrier islands, or free unattached off-shore features. In addition to free off-shore emergent features all three make minor reference to what are in effect spits, i.e. elongate sand masses attached at one end to a fixed point, the "mainland", or a barrier island. Such features might perhaps be further sub-divided into those nourished essentially through long-shore drifting of sediments, as would appear to be the case with the recurved spit sequence southwest of Ocean Grange, and those nourished by delivery of sediment from rivers as would appear to be the case on the Snowy River and possibly the features adjacent to Bunga and Cunningham Arms.
Both Bird and Jenkin differentiate three phases of barrier initiation, although what each recognises is quite different. Bird recognises a single Holocene growth phase in his outer barrier. Jenkin differentiates two phases of Holocene evolution. The first is represented by a substantial part of the Ninety Mile Beach including prograded sections such as at Letts Beach. The later parts have significantly less soil development, and include relatively recent sands, as in the elongate sand bodies opposite Bunga Arm/BPP and Cunningham Arm/Lakes Entrance. These latter sections are dated by Thom as somewhat later than the main body of the barrier, ie <3000 yrs.

While there has been no direct dating of the older deposits sheltered marine shell from Lake Melanyara, a wetland immediately to the west of Sale township, was dated by both radiocarbon and U/Th methods (Schornick 1973). The samples were all of bivalve molluscs, five of "oyster" (Ostrea?), two Anadara and one Neotrigonia. All are familiar sheltered marine species and the presence of some buffer (eg. barrier) to marine energy is implied. The average U/Th date is 101,000 BP, while the oldest U/Th assay of the set gives a date of 125,000 BP. This coincidence with the last interglacial is perhaps suspect. Schornick suggests that the Uranium content of the "clams" (ie Anadara and Neotrigonia) is higher than the Ostrea, suggesting the likelihood of post-depositional contamination. However, the use of oyster shell is of concern. The structure of Ostrea, with alternating dense and porous laminae lends itself to contamination and it is remarkable that Ostrea did not prove to be highly contaminated. A single radiocarbon date was determined at 28,000 BP, presumably on shell.

It must be concluded that the results are contradictory and not reliable.

3.2.2. Late Holocene hydrology.

The natural outlet was recorded as migrating many kilometres back and forth along the coast in historic times, according to the short-term balance of drifts generated by southeast and northeast swells (Fryer 1973:130). As noted in Chapter Two, the cutting of the artificial entrance cannot be regarded as ending "semi-permanent enclosure of the lakes" (Thom 1984:253). On the contrary coastal navigation appears to have regularly crossed the entrance with enough reliability to allow weekly scheduling of shallow draught schooners, although crossing would appear to have been exciting on occasion.

In Table 2.1 it can be seen that under conditions of mean rainfall and median river discharge there is a surplus of water to be discharged from the outlet throughout an average year. That is, if discharge through the outlet were prevented, the level of lake water would
rise above msl, an unstable energy differential across the outlet would be established. Saturation of sediments above sea level could be expected to increase instability. This reasoning suggests that the outlet can be expected to be open for much of the time, but as systems do not consistently work as averages both massive discharges and outlet closures can be expected.

The Red Bluff midden site is located adjacent to the historic outlet, and contains rocky shore mollusca as well as Mytilus and Ostrea. Although Mytilus are to be found on ocean platforms on the eastern Australian coastline, in Victorian waters it is regarded as essentially estuarine. Mytilus like Ostrea must have been collected from sheltered marine waters, that is the tidal Lakes.

Radiocarbon dates show the oysters and mussels were collected around 450 BP (see Chapter Seven on Radiocarbon Dating). Experiments on Ostrea angasi and Mytilus edulis planulatus demonstrate that at 22°C Ostrea can survive up to 8 days at salinities as low as 20 ppm, and as high as 45 p.p.m. At the same temperature Mytilus can survive 10 days at extreme salinities of 15 and 45 p.p.m. (Nell and Gibbs 1986). This indicates that although outlet closure may have occurred on occasions the persistence of these taxa demands tidal exchange near the outlet could not be totally eliminated for more than a few days or weeks in the immediate prehistoric period.

The absence of Anadara trapezia from the modern fauna (see Poore 1982) and the archaeological sample is significant. It is common in middens elsewhere and would presumably be collected if it was present. Nell and Gibbs (op cit) record similar environmental tolerances for Anadara and Mytilus, its absence therefore cannot be attributed solely to local salinity variability.

There has been some debate over the modern state of Anadara and its distribution in Victorian waters (eg. see Gill 1972, Black 1971, Macpherson 1966). Although once thought extinct in southern waters, it was rediscovered in association with both Mytilus and Ostrea (Black 1971) in surveys of Port Phillip. The find locations are deeper waters away from Anadara's normal lower littoral habitat. This may confirm the hypothesis that low air temperature may limit their modern distribution. This is significant as the period in which they were abundant, >4500, is thought by some to have been a period of improved climatic conditions.
3.2.3. Sea-level History

A number of workers have argued for a mid-Holocene relative high sea-level (Gill 1971, 1982, Gill and Hopley 1972, Jenkin 1968:316, Lawrence et al 1976:275, Donner and Jungner 1981, Ward 1971, 1977). As noted above there was some heated disagreement on the validity of this sea-level variation (see Thom et al 1972). Perhaps a critical factor with some of the combatants is the location of their respective study areas and a wish to extrapolate from their particular cases, to the general. Reconciliation of the contradictions is suggested via the process of hydro-isostacy applied in Northern Australia by Chappell et al (1982). That is, off-shore down warping and on-shore upward movement is caused by the loading of the broad continental shelf of the Bassian Plain by rising sea-levels.

Evidence of relative emergence has come from Lake Reeve, a shallow cul de sac off the main lakes. Hotchin (1982) estimates emergence at Jack Smith Lake in the order of 2m, comparable to that estimated by Gill for Lake Reeve. Extinction of inter-tidal fauna 4-4500 BP and formation of evaporites by 3,000 BP (Thom 1984:248) indicate a continuing process. While Thom attributes the elongate sand-bodies off Bunga and Cunninghame Arm to a putative period of storminess it should be recognised that re-establishment of equilibrium profiles after emergence would be expected to lead to progradation or deposition of off-shore sand bodies. As these bodies only appear 2-3000 BP it appears that the outlets were possibly unimpeded until 1-2 millennia after the extinction of intertidal fauna in shallow Lake Reeve.

The process of continuing emergence and lake contraction is indicated to the south at Jack Smith Lake where articulated Anadara shell from the emerged bed of the lake gave a corrected date of 4490 ± 97 BP (ANU 3176 [uncorrected]= 4940 ± 90 BP), comparable with terminal dates along Lake Reeve. Nearby midden deposits indicate however that tidal fauna, Anadara and Ostrea, dated at 3830 ± 97 (ANU 3255 uncorrected = 4280 ± 90) and 2680 ± 87 (ANU 3242 uncorrected = 3130 ± 80) were collected some time later, presumably from unemerged areas of the lagoon. It must be noted that the persistence of tidal exchange at Jack Smith Lake for another millennium is likely to owe much to transport northeast of sand along the shoreline thus minimising outlet constriction.

Emergence may be likely to enhance outlet constriction along the shallow cul de sac of Lake Reeve, but this may have relatively limited effects on the main lakes considering their size and depth. It is unreasonable then to assume that local effects on an outlier area were matched by events on the main system.
3.2.4. Ecological change

The best demonstrated Holocene ecological changes are the extinction of the estuarine mollusc beds previously found in Lake Reeve, after 4,4500 BP. Characteristic taxa in the Lake Reeve faunal assemblage are *Anadara*, *Ostrea*, *Mactra*, *Nassarius* and *Notospisula* (Thom 1984:247).

Of these taxa only *Notospisula* has been identified in the modern Lakes (Poore 1982). It occupies a range of habitats, notably muds or muddy sands near the outlets of rivers (Robinson and Gibbs 1982, Marine Research Group of Victoria 1984, Macpherson and Gabriel 1962), and may therefore be regarded as having a high tolerance of fresh water, this is consistent with its present occurrence in the Gippsland Lakes which are subject to considerable annual salinity variation.

As the Lakes proper are likely to have been similarly affected by fresh water inputs through the Holocene it can be expected that the fauna will always have contained a significant component of tolerant species. It is unreasonable to imagine the main lakes as sheltered marine rather than estuarine solely on the evidence of Lake Reeve faunas.

Historical records indicate that prior to the opening of the artificial outlet Lakes salinities were lower than at present and that vegetation in the past was less salt tolerant. The former denser vegetation is indicated by the peaty soils now stepped and cut-back by wave action. Below the step the lake shores are sandy indicating the reworking of the prior shores, see Figure 3.7. The decline of the reed beds is generally attributed to increased salinity since the opening of the outlet (Bird 1978:111-34). Clucas (nd) suggests that *Phragmites* is progressively stunted by salinities above 4 ppm, and at 16 ppm loses the ability to develop rhizomes and flower properly.

On 5 November 1846 James Warman (*Port Phillip Herald* 23 Feb 1847) described the lower Latrobe River as it entered Lake Wellington,

> it has a most noble appearance, all fresh water, and quite soft; the uniform depth is from ten to fourteen feet...

On Lake Victoria, 8 November he recorded,

> The water of this lake is brackish abounding with swans, ducks &c... the banks of the lakes are very reedy, making it difficult to land; the reeds run from 8 to 10 feet high.

The location here is the northern shore of the Sperm Whale Head peninsula. On 10 November he was off the delta of the Tambo River in Lake King,

> The appearance of Lake King is, I think, superior to Lake Wellington; the land greatly improved, the depth of water much greater, and nearly free from weed; the water is only slightly brackish, but as you near the Tambo it is perfectly fresh and soft;...

The water at these locations is today seasonally brackish to salty, Bird (1978 figures 7 and
8 pp. 15-16) presents modern surface salinity readings. Off the mouth of the Latrobe current salinities can range from 0.5-5ppm, off the Tambo and along Lake Victoria, 1-20 ppm. It can be assumed that these surface readings will be lower than bottom readings (due to the density of cold saline marine waters).

Although the enlarged outlet has lead to increased salinity through greater inflow of marine water this is not the only probable historic explanation of Lakes salinity. Increased irrigation, damming of rivers and clearing of trees has been undertaken over a region with extensive Tertiary and Quaternary marine deposits. Under these circumstances increased discharge of saline groundwater into regional streams and Lakes is to be expected. Whatever the magnitude of this problem in the present, historical records make it clear that it was insufficient in the past to lead to high levels of salinity.

It is also clear from historic records and archaeological data (see Chapter Seven) that exchange of water across the historic outlet[s] persisted after 4000BP, allowing marine
organisms to persist in the vicinity of the outlets. However, it is clear that the habitat was not comparable to the extensive intertidal flats of the old Lake Reeve.

3.2.5. Implications for Human Occupation

Structure and relief modify climate, and thereby the distribution of habitats and biota. By breaking the land into topographic units geology provides a natural background against which cognitive differentiation of human populations also can occur. Within the uplands it is likely that population distributions were significantly controlled by the location of broad inter-montane valleys. The obstacles imposed by geology can also be expected to affect movement of information, and people, between areas.

By controlling the distribution of biota, structure and relief control human "carrying capacity", a major control is the distribution of rainfall according to aspect and topography. The valleys of the major rivers and the central area of the plains and lakes are dry due to rainshadow effects while the ranges surrounding the Gippsland Basin are well watered. Above all the location of streams, drainage lines and ultimately the Gippsland Lakes are controlled by the underlying structure of the regional geology. This in turn is of considerable significance for the location of biological resources.

The major rocks of the highlands are of little use to stone tool users, excepting volcanics such as rhyolite, and quartz. The soft Tertiary and Quaternary deposits have little promise unless indurated and cemented by silica. The regional distribution of silicified sediments is not known, but association with basalts in the Strzelecki Ranges is likely. High grade silcretes occur extensively in the Buchan area (I. Houshold pers. comm.). Gravels containing quartz and other rock from the highlands (see Goede 1976) are ubiquitous in alluvial and deltaic deposits, and provide a wide-spread resource, see Figure 3.8. The highly metamorphosed "greenstones" of the Paleozoic Tasman Geosyncline form a series of linear outcrops across Victoria historically prized for stone hatchets. No "greenstone" quarries are known in the study area although quarries occur on the Howqua River to the northwest.

As it is reasonable to assume water bodies were foci of Pleistocene occupation we can suppose that evidence of Pleistocene occupation of Bassiana will be under the alluvial sediments of the river systems or the lake basins. Now uninundated country is likely to have been some distance from water and any occupation was of a secondary, specialised or marginal nature.
With a supposed date no younger than the last Inter-glacial, the older barriers predate the accepted chronology of *Homo sapiens* in Australia. Human traces are not likely to be incorporated in their fabric. The exception is the parabolic dunes of the SWH barrier with a possible age equivalent to the peak of Last Glacial aridity. This lies within the period of dated human occupation of Australia and incorporation of evidence into the fabric is possible. Elsewhere in the older deposits any incorporation of occupation evidence must be regarded as a consequence of surficial reworking.

The events of the last 7000 years begin with sea-levels stabilising at approximately modern levels and occupying the valley of the Latrobe/Mitchell River. Rising sea-levels were matched by a proto-barrier moving forward and being nourished by sediments from the prior Bassian Plain, drifted along the shore and reworked from Pleistocene riverine deposits.

The proto-barrier contained a sheltered tidal lagoon, colonised well before 6,800 BP by a
suite of typically estuarine taxa. Growth of the barrier continued, with both off-shore and along-shore delivery of sediments, the latter leading to spit elongation and deflection of the Latrobe river. This is indicated by the forms of recurved spits southwest of Ocean Grange. Sediment delivery to the barrier led also to vertical and lateral growth of proto-barrier nuclei. In the southwest eventual negative sediment supply led to barrier transgression.

Sea-level stabilisation is followed by a period in which the developing barrier system contained an extensive shallow area of tidal lagoons extending from Corner Inlet to near Ocean Grange. This is represented by Lake Reeve, Lake Denison and Jack Smith Lake, and intermediate wetlands below the escarpment. Fresh water inputs from minor streams were small resulting in a stable sheltered marine conditions.

Any evidence of early coastal occupation will have been destroyed through reworking before advancing shorelines. Depending on the rate of advance at the time the immediate shore zone can be expected to be a relatively unstable area due to the variable balance between the rate of sediment delivery and erosion. Occupation of the proto-barrier is likely to have been hindered by processes such as wash-over, which would also eradicate evidence.

Between Ocean Grange and Red Bluff the developing barrier continued to enclose the tidal embayment of the greater Latrobe and Mitchell rivers, but the outlets are likely to have been broad, lacking the elongate sand bodies now blocking them. Due to the volumes of fresh water to be exchanged, migrating isohalines and their greater depth, the major lakes are likely to have been more complex environments than the shallow Lake Reeve system. The latter can be regarded as essentially sheltered marine, the former estuarine.

Valley and basin in-fill, and shore-line progradation transformed the drowned valley. This meant a decrease in lake area and depth, but an increase in productive marginal terrestrial environments.

After 4500 BP the protected fauna of Lake Reeve was extinguished leaving fossil shell-beds now located above msl. At Jack Smith Lake the area of tidal inundation appears to have contracted simultaneously, but marine fauna persisted until around 3000 BP. Thom attributes this to barrier growth constricting tidal outlets, but it is argued here that emergence, up to 2m at Jack Smith Lake, is strongly indicated. Apparent emergence is plausibly attributable to hydro-isostatic adjustment. Outlet constriction continued up to the last 2-3000 years with the growth of elongating off-shore sand bodies. Even with continuing constriction it is clear that over the last last 450 years the northeast outlet has frequently been open, although not always to shipping.
Outlet constriction and diminished exchange of water is likely to have led to more variable salinity and increasingly freshwater conditions, the modern pattern of only seasonal inundation of Lake Reeve, and often extensive flooding. The increasingly freshwater conditions can be expected to permit the growth of less salt tolerant macrophytic fringing vegetation, and the appearance of historically extensive *Phragmites* grasslands. The complement of in-filling and shore-line progradation is expansion of lake fringing and riparian vegetation communities leading to increased environmental diversity. It can be expected that with the passage of time such increasing environmental diversity will lead to greater diversity of species present from marine to freshwater, and a similar complexity of fringing terrestrial habitats. Not only the increased diversity but the spread of particular habitats, eg. freshwater wetlands increased the potential of the area for human exploitation.

It appears therefore that, despite the significant changes that have occurred in the environments of the area, nearly all have been of a gradual and incremental nature. Even the termination of the tidal shell-beds, a fairly discrete event, would appear to have extended over a period of half a millennium. That is the environmental changes with which the populations of the area must have coped did not have a dramatic onset.
Chapter 4

Holocene Environmental History

This chapter explores ecological changes over the Holocene using palynological records from the study area and adjacent areas. The purpose of this account is to establish environmental changes complementary to landscape evolution, relating to the contexts in which people lived during the Holocene and early Pleistocene. It concludes with a discussion of the implications of environmental change for socio-cultural organisation.

4.1. Magnitude of Environmental Change

This study is concerned with the proposition that a correlation exists between the scale of environmental change and the scale of cultural change. As the study examines the application of biological evolutionary theory to cultural process it must be understood that the link between the two is not to be understood as a causal mechanical one. Darwinian evolution, which is scrutinised in Chapter Eight as a possible model for cultural-environmental interaction, does not allow for the induction or "forcing" of variance within a biological population.

Darwinian evolution is concerned with the selection of randomly generated variance. Because the theory proposes no causal link between environmental change and the generation of variance within a biological population it would be quite wrong to propose that environmental change can force the appearance of variation in a population.

The amplitude of environmental change may be considered an important factor in relation to the amplitude of any supposed consequent biological variation. This is not because larger scale changes force larger scale adaptations, but that they can be expected to impose greater selective pressures. At one extreme selection pressures may be so great and of such sudden onset as to severely limit the ability of organisms to adapt through incremental changes to existing forms. In contrast it is likely that smaller scale environmental shifts may not exceed the tolerance of a biological system and not apply great selective pressure favouring change, or at least not leave visible evidence in the fossil (or archaeological) record.
As discussed in this chapter, palynological records for the Holocene provide ambiguous evidence of any mid-Holocene climatic optimum. That is, the intensity of any such change is such that it is not readily detectable in all pollen cores. It would be unwise to attempt to relate changes in other systems, cultural or natural, to a set of changes which are not themselves readily demonstrated.

An example of an extreme effect is the well known drying of the Pleistocene lakes of the Willandra system. In this case the intensity and rapidity of the changes are so great as to make the process of adaptation virtually impossible, and extinction rather than adjustment more likely. In the Willandra case there is no evidence of any organism reliant on the waters of the lakes managing to adapt to the changed circumstances. The only exception is humans who appear to have adjusted their cultural systems rather than their genetic make-up. As will be made clear in Chapter Eight this process is not one of adaptation in the Darwinian sense.

Between these extremes of imperceptible and overwhelming environmental changes is the middle-range where substantial environmental shifts can be confidently documented, and where significant but not catastrophic pressures on survival strategies can be expected. The Gippsland Lakes with their radical hydrological changes and remodelling of the landscape (as discussed in Chapter Three) fall within this middle ground.

4.2. Pollen Sites

Holocene pollen records have been established from two swamps on Sperm Whale Head in the Gippsland Lakes area (Hooley et al 1980), on Wilson’s Promontory to the west (Hope 1974; Ladd 1978), to the east at Lake Curlip on the lower Snowy River (Ladd 1979a), and in the Eastern Highlands on the divide between the Errinundra River (Ladd 1979b), and the Delegate River (Ladd 1979c, 1979d).

Further from the study area two additional pollen records are examined from the Mt Kosciusko area to the north, (Martin 1986), and from Hunter Island, in Bass Strait (Hope 1978). See Figure 4.1.
4.3. Gippsland Lakes Area: Sperm Whale Head

Hooley et al (1980) sampled two swamps located near the village of Loch Sport; Loch Sport Swamp and Hidden Swamp. Both sites are located in depressions at the foot of parabolic dunes, believed by Bird (1978:72) to be related to the meandering Pleistocene Latrobe River initiating erosion on the Sperm Whale Head barrier deposits. As the mechanism implied by Bird is hard to understand, an alternative cause for dune remobilisation might be sought in Pleistocene aridity.
A Pleistocene date for the formation of the parabolics is indicated by the depth of the bases of the blow-outs below current water tables. As deflation will not proceed below the water table the depth of the floor of a blow-out provides a measure of the depth of the contemporary water table. Lake water levels are now the key control on the water table, in a period of lower sea-levels the control would be climatic or related to river levels. In the swamps investigated by Hooley et al the lake water level (i.e. sea level) is around 85 cm below ground level. The depths of the swamps sampled were 310 and 260 cm (mean 285 cm). It is apparent that deflation of the bases occurred at a period when sea-level was at least 225 cm (i.e. 310-85 cm) lower than at present. Bird (1978:72) suggests that in the nearby Killarney Swamp organic clays and silts continue to -6m below current lake levels.

4.3.1. Stratigraphy

The general stratigraphy of the Loch Sport Swamp comprises an upper 40-60 cm of calcium and magnesium rich deposits grading into lake muds at around 60-100 cm (Note: dolomite has been commercially mined elsewhere on Sperm Whale Head). This transition was radiocarbon dated at 4430±150 BP (Gx 4952) in the Loch Sport Swamp core. At around 160 cm lake muds grade into coarse detritus muds. A similar transition was dated to 5080±180 BP at Hidden Swamp. At around 220 cm a transition occurs to coarse white sands with grey-brown decomposed organic matter. In Loch Sport Swamp this change-over is dated to 7200±320, at Hidden Swamp 6840±150, at 260 cm. These dates are comparable within the first standard deviation.

The cores indicate that the marine controlled water table stood around 175-135 cm (i.e. 260-85=175, 220-85=135, mean = 156 cm) below present around 7000 BP. This is compatible with Gill's date of 6810 BP on estuarine, lower littoral shell at a depth of around 2m near Seaspray a little south of SWH (Gill 1982, Figure 10 p.32). This is in turn similar to the sea level curve published by Donner and Jungner (1981, Fig.9, p.30).

At 5000 BP a transition from coarse muds with banded sands, to lake muds indicates a changed sedimentary environment or sediment catchment. The presence of carbonate precipitates in the top part of the cores after 4430 BP indicates that after that date the sea was at still-stand, and might even have fallen. This can be deduced as the carbonates would appear to indicate the beginning of intermittent inundation and therefore the end of relative sea-level rise.
4.3.2. Fossil Evidence

Hooley et al (1980) made a more detailed study of the Hidden Swamp record than Loch Sport Swamp. In zoning the pollen record dryland and aquatic taxa have been treated separately. The fossil evidence is of both pollen and molluscs.

Molluscs A number of molluscan taxa are present after 7000 BP in both swamps, including Cerithiidae, Eryciniidae, Mytilidae, Salinator, Tatea, Hydrobia, Coxiella and Potamopyrgus. Some are thought by the authors to indicate marine salinities, but because of the association with fine sands they propose that the shells may have been blown in from coastal dunes.

The Cerithiidae are small sheltered marine gastropods (Macpherson and Gabriel 1962:107-111). The Eryciniidae like the Cerithiidae comprise a number of genera of sheltered marine taxa, and no specific habitat requirements can be stated. They are very small, fragile, bivalves which often shelter in crevices, the "roots" of sea weeds, shell cavities etc. (Macpherson and Gabriel 1962:331-335).

The Mytilidae are the mussels, of which there are at least five genera in Victoria inhabiting marine and estuarine environments, they require a solid sub-strate on which to attach eg. wood, large shells etc. (Marine Research Group of Victoria 1984:83-5).

Salinator are gastropods of the sub-class Pulmonata, air breathers and related to the terrestrial snails and slugs, comprising two species in Victoria, Salinator fragilis, and S. solida. S. salinator inhabits mid to upper littoral muddy flats, the latter muddy supra-littoral saline, and salt marsh areas (Marine Research Group of Victoria 1984:77, Macpherson and Gabriel 1962:260-1, Smith and Kershaw 1979:67-8).

The genus Tatea has one species in Victoria, Tatea rufilabris, a small gastropod of the estuarine lower section of streams (Smith and Kershaw 1979:42-3). The one common species of Hydrobia in Victoria, Hydrobia buccinoides, a gastropod, also inhabits tidal streams and lagoons (Smith and Kershaw 1979:50-51). Potamopyrgus has one species in Victoria Potamopyrgus niger, a freshwater gastropod from a little above tidal influence in coastal streams (Smith and Kershaw 1979:49-50).

Coxiella are gastropods represented in Victoria by two species, one, Coxiella molesta is known only from Port Phillip. The other C. striata comes from saline areas beyond tidal effects (Smith and Kershaw 1979:43-45).
The mollusca indicate a broad range of coastal environments from non-tidal reaches of coastal streams, through sheltered marine conditions to saline flats above the normal influence of tidal flux. It is apparent that the swamps have served as a trap for material derived from a number of sources.

There is a greater density of shell in the Loch Sport core. Six samples were collected: at 215 cm dominated by Cerithiidae, Salinater and Potamopyrgus (this is soon after 7000BP), at 205 cm Eryciniidae, Salinater and Potamopyrgus, 195 cm Cerithiidae and Erycinidae, Salinater and Potamopyrgus, 165 cm Potamopyrgus and Tatea. At 57 cm and 10 cm, and the transition to carbonate deposition (after 4400 BP) the fauna is dominated by Coxiella with no tidal fauna.

Mollusca are less common in the Hidden Swamp record, and do not appear until the deposition of carbonates begins 110-32 cm below ground surface. The main species is the salt-tolerant Coxiella with a lesser proportion of Salinater and Hydrobia. In the upper 32 cm of the core the number of molluscs, particularly Coxiella increases, with a Mytilid at 15 cm. The presence of Hydrobida and the Mytilid in the upper part of the core are worth noting as they could be construed as evidence of continuing tidal connection.

Hooley et al (op cit:357) suggest that pre- 7200-6800 BP swamp conditions were ephemeral with either a low water table or low precipitation. Perennial swamp dates to after 7000 BP. From 5200 to 4000 the proportion of arguably biogenic carbonates and algal cysts increases. Shallowing of the swamps and increased salinity, suggested by both carbonates and Coxiella, is thought to have occurred as a result of reduced rainfall (Hooley et al. op cit), swamp shallowing is matched by an increase in Chenopod pollen.

**Pollen History.** In the lowest level there are high values for heathland *Casuarina*, and evidence of Eucalypt woodland. High *Banksia integrifolia*, an insect pollinated taxon, may indicate proximity rather than abundance.

An increase in *Pomaderris* and tree *Casuarina* after 7000 BP represents increased moisture availability. A reduction in *Pomaderris* from 5000 BP demonstrates an expansion of open woodland and contraction of taller moister forest in the swales. There is an increase in Eucalypts, Compositae, Poaceae and *Pteridium*, and a decline in *Casuarina* after 4000 BP indicating an expansion of open forest and woodland over *Casuarina* scrub and heath. While a decrease in moisture is suggested it is noted that there is an increase in charcoal. There is an increase in Chenopods matching the deposition of carbonates.
In the uppermost layers charcoal increase is matched by an increase in *Leptospermum*, *Pinus* and *Plantago* indicating historic burning, clearing and weed proliferation.

Hooley *et al* (op cit:359) suggest a lag between changes in climatic parameters and vegetation adjustment. They suggest that when vegetation is out of equilibrium with its moisture environment it may be structurally more susceptible to burning. This makes sense of the apparent coincidence of increased charcoal with major vegetation changes. They observe that vegetation history is a result of a complex of factors. It is therefore unwise to attempt to explain the status of vegetation in terms of autogenic succession alone, here they refer specifically to Bird’s (1978) attempts to use the successional status of vegetation as an index of the age of underlying landforms.

They suggest that prior to 7000 BP conditions were relatively dry and the preservation of organics in the swamps was poor due to the lack of permanent water. After 7000 BP better representation of organics and moist taxa indicate moister conditions until around 5200 BP when open water coincides with *Pomaderris* decline, due to increased salinity demonstrated by a proliferation of Chenopods.

Further decreased moisture around 4000 BP is indicated by increased Chenopod counts and deposition of carbonates. Greater aridity contributed to increased fire susceptibility, leading in turn to a decline in *Casuarina*.

**4.3.3. Sea-level and climatic variation**

A goal of Hooley *et al*. (1980) is clarification of Holocene sea-level history. They conclude a progressive rise in sea-level occurred until around 5200 BP, after which the evidence suggests stability. This is matched by early to mid Holocene greater moisture availability, confirming the results of Hope (1974) and Ladd (1978).

A complicating factor partially perceived by Hooley *et al* (op cit:359) is the evolution of the Ninety Mile Beach and Lakes outlets. Bird (1978:9) records that in 1952 unusually severe flooding led to a rise in water level in the order of 2 m, and that this took two weeks to discharge through the artificial outlet, and that prior to the modern outlet the level of the lakes consistently stood above sea-level. This suggests that as the barrier evolved and tidal exchange was impaired, increased water levels are likely, there would also be an increased trend to seasonal flooding.

High lagoon water level can be expected to raise the local water table. Annual fluctuations can be expected to result in mixing and salination of ground water. In contrast
a steady sea-level, or rising sea-level, can be expected to float a relatively undisturbed lens of freshwater above denser marine or saline lagoonal waters. During the initial rise in sea-level a rising freshwater lens could mimic increased effective precipitation. After the sea had reached approximately modern levels outlet constriction can be expected to initiate a regime of seasonal fluctuation in lake level, and therefore oscillation of the water table. The increased salinity can be expected to produce results mimicking decreased moisture (eg. proliferation of Chenopods).

It is possible therefore to see the initiation of moister vegetation around 7000 BP as a consequence of either increased effective rainfall or elevation of the freshwater table following the Holocene marine transgression. Decreased available moisture after 45000 BP can be explained by a lowered water table caused either by decreased rainfall, or emergence. Historic regimes of variable and often perched lake levels resulting from emergence proposed in Chapter Three, established conditions compatible with intermittent inundation and continued precipitation of carbonates. A date of around 4400 BP for the beginning of carbonate precipitation is compatible with termination of tidal exchange in Lake Reeve, and apparent emergence at Jack Smith Lake.

Thus although Hooley et al do not support the hypothesis of Holocene higher sea-levels, their evidence can be construed to indicate the contrary case. This is not to confirm or deny Holocene climatic change along this coast.

4.4. Wilson’s Promontory

Pollen records from Wilson’s Promontory have been examined by Hope (1974) and Ladd (1979a).

Hope (1974) sampled three locations on the western side of the Promontory, two are on the calcareous dune country of the Yanakie Isthmus connecting the granite body of the Promontory to the mainland, one is on the granitic body. The first is in a coastal wetland (Cotters Lake) backed by calcarenite and separated from the sea by Holocene coastal dunes, and a peat outcrop on a nearby beach. The third site is located within the now largely sedimented estuary of Tidal River.

The second site, the Darby Beach peat outcrop, has produced little useful pollen evidence, rather its interest is stratigraphic. The peats grade into sands and overlie sands containing marine shells, interpreted as a beach deposit. The lower peat dates at 5880±90 (GaK 1969), the whole feature is exposed on the shore and is covered by normal high tides and is taken
to lie at approximately modern sea-level. To have formed this peat would have had to have been separated from the sea by at least a foredune. This site also indicates that sea level 6000 BP was at modern levels.

Shells of *Austrosuccinea* in the upper 30 cm indicate deposition in freshwater. There is no upper date on this peat so we cannot determine how long the metre or so took to be deposited, or for how long the sea stood at that level. For this reason any environmental record will be open ended and of limited value.

The Cotters Lake site has a basal date of 4070±140 BP (GaK 1680) but is assumed to be still depositing sediment. At Cotters Lake the water depth appears to have increased since its inception around 4000 BP. The record indicates a decline in *Casuarina* after 4000 BP which is matched by an expansion of Eucalypts. Later, *Casuarina* are eclipsed by *Banksia*. Tall forest elements such as *Nothofagus* are scarcer than in the Darby Beach samples.

Like Cotters Lake the Tidal River site is still active, it has a basal date of 4990±100 BP (GaK 1717). Around 1m of sandy algal deposits and peat separate this from a second date, 4910±90 (GaK 1716) above it. The two dates are inverted but statistically the same. If this is accepted the intervening material must have been deposited very rapidly.

Given the difficulties attached to the records a few statements can be made. The Darby Beach material indicates that after the commencement of deposition there was a high level of Eucalypt and tall forest material being delivered to the site. Without further time depth little more can be said.

At Tidal River much of the pollen is likely to have been transported in by water. The evidence suggests that in the earlier stages the input of wet forest elements (*Nothofagus*, *Pomaderris* and *Dicksonia* among others) was greater than that of today, suggesting that this type of forest was more extensive. It is estimated that around 3600 BP wet forest and tall Eucalypt forests retreated, although this may have begun around 4000 BP.

Hope suggests a broad outline of climatic history:

- 5700-4000 BP conditions probably moister that at present

- 3500-1400 BP conditions become drier, comparable to the present, there is a slight expansion of aquatic taxa around 1400 BP

- 1400-PRESENT conditions drier after short term improvement
Hope suggests that there is little evidence of sea-level variation, and located in permeable sands, the sites discussed would be sensitive to such change. His evidence suggests that the sea reached its present level prior to 6000 BP and shows no sign of significant change since.

Hope suggests that his climatic evidence is comparable to palynological results from Western Australia at a comparable latitude, and work from the Western District volcanic plains. The overall picture into which the Wilson’s Promontory work is thought to fit is of an early to mid Holocene period of wetter conditions from 6000 to 4500 BP with subsequent drying until another wetter period from 2500-900 BP. The model has a period of greater aridity than the present during 4000-2500 BP, and another period of aridity during the period 900-500 BP. Hope notes however that his record does not fully reflect this pattern, notably lacking the period of greater aridity 900-500 BP. Differences in methodologies prevent Hope from claiming direct parallels.

Ladd (1979) provides a pollen record from the eastern side of Wilson’s Promontory. The site is a coastal wetland separated from the sea by prograded ridges, and is under the influence of a stream feeding in from the granitic hinterland. The sediments sit on a deposit of coarse sands derived from either short distance stream transport or slope erosion. Throughout the section the proportion of sand declines over time with the exception of a band of fine grey sand at 31-40 cm below ground surface. As it is described by Ladd it would appear to be derived from a somewhat different source to the underlying coarse angular sands, and similar sands incorporated in the lower peat levels. Its age and descriptive characteristics suggest aeolian derivation associated with the terminal stage of the marine transgression. The other sands would appear to indicate water transport. The pollen site is located close to modern sea-level.

There are two radiocarbon dates available, at 175 cm (not the base of the organic deposit) a piece of wood gave a radiocarbon assay of 11450±230 BP (GaK 3434). Charcoal from the upper sandy unit 30-40 cm below ground level gave a radiocarbon date of 6980±190 BP (GaK 4703). By extrapolating sedimentation rates Ladd derives a figure of 13000 BP for the beginning of deposition of organic sediments. Peat from the beach is believed by Ladd to have derived from more than 3 m below modern sea-level.

The pollen record suggests that prior to 11500 BP a Eucalypt forest was in place with an understorey of Banksia. After 11000 BP the Eucalypt forest is replaced on the site by a Melaleuca-Leptospermum scrub or heath. This association is thought to represent an elevated fresh water table. Water-logging is thought to have increased with an invasion of
sedges around 9300 BP. The vegetation of the area appears to have remained effectively unchanged until around 7000 BP. From this period salination of at least part of the swamp is indicated with an increase in halophytic vegetation such as Chenopods, and a possible replacement of *Melaleuca squarrosa* heath by *Melaleuca ericifolia* scrub.

A succession from salt-marsh to *Melaleuca ericifolia* is possible.

This record fails to identify post-transgression climatic variation, largely because this period is poorly represented on the core. It does however indicate post-glacial climatic amelioration was well underway by 13000-11000 BP, prior to the sea rising to its present level. The wetness of the heath replacing the earlier Eucalypt forest cannot be attributed to marine controlled water tables at such an early date and climatic causes must be invoked. The later success of halophytic vegetation can be attributed to the effect of the marine controlled water table following the marine transgression on this low elevation site.

There is no evidence published to suggest any Holocene land-sea level differentials.

It can be assumed that a period of aeolian activity is represented by the dated sands at 30-40 cm This is likely to be associated with the arrival of the shoreline adjacent to the sample location. On this evidence the shore-line can be assumed to have reached its modern position around 7000 BP.

4.5. Lower Snowy River

Lake Curlip (Ladd 1978) is a freshwater lake located in the lower Snowy River valley in what was previously an estuarine reach. It is located about 11 km from the modern outlet near the settlement of Marlo, and is in fact fed by the Brodribb River rather than the Snowy. The location was chosen on the assumption that it would sensitively reflect climatic changes. This assumption is based on the area being one of the last "outposts" of warm temperate or sub-tropical plant species and vegetation types, notably closed forest. Two palynological targets were the "Cabbage Tree Palm" (*Livistonia australis*), and "Lilly-Pilly" (*Acmena smithii*). The former is represented in the region by a limited number of individuals which comprise a disjunct population 130 km from the nearest population. *Acmena* too are on the edge of their natural distribution, although small numbers can be found in unusually protected locations to the west as far as Wilson’s Promontory.

Because of their presumably finely balanced status it was expected that the history of the pollen of target taxa in the catchment of Lake Curlip would reflect small scale climatic fluctuations. In order to aid characterisation of environments associated with pollen
assemblages a program of trapping modern pollen was set-up in a number of locations representing modern communities, including wet forests now restricted to riparian environments.

The core consisted of approximately 10 m of sediment. The lower 7 m consisted of amorphous black mud in which were found the shells of the estuarine molluscs, *Notospisula parva* and *Paracanassa burchardi*. Above this were similar black muds lacking estuarine mollusc fauna, above the muds was a layer of brown fibrous peat derived from *Phragmites* or closed scrub vegetation. Two radiocarbon dates were obtained, near the base of the sediments at 10 m an assay of 5220±140 BP (SUA 160) was obtained. The second date, 1710±110 (SUA 159) was obtained at approximately 2 m and dates the top of the upper, shell free, black muds. By extrapolation, the date of termination of deposition of black muds is at around 1500 BP.

The lower 7 m of sediment, deposited between 5200 and 1500 BP is dominated by Eucalypt pollen. Along with the Eucalypts there are low numbers of a number of other dry-land taxa including Asteraceae, *Casuarina*, *Dodonaea*, *Leptospermum*, *Melaleuca*, *Pomaderris*, *Drimys*, *Telopea* and *Podocarpus*. This list includes wet and dry forest taxa. The wet taxa suggest a vegetation similar to modern riparian closed forests in the region. Spores are more abundant than the pollen of many flowering taxa while herbs, sedges and grasses are poorly represented. Forams present indicate saline waters.

After 1500 BP counts of Eucalypts fall off while there is an increase in *Leptospermum* and *Melaleuca*. Wet forest elements continue in diminished proportions, as do dry forest elements such as *Casuarina* and *Dodonaea*. Spores are less common than in the lower sediments. Cyperaceae and *Triglochin* values rise dramatically, while Poaceae and *Typha* also increase. It is suggested that as the proportions of dry and wet forest taxa do not change through this period the relative land areas covered by them are probably not significantly altered. Much of the pollen from this period seems to be locally derived, with the amount delivered by water diminished.

It is apparent that swamp vegetation proliferated during this period, indicating that the site had been isolated from marine influences and that the water was fresh. Subsequently the area of open water contracted and the core site was overtaken by the swamp succession. The ideal succession should have been from submerged vegetation during open water through a *Triglochin*-sedge step, to *Phragmites* grassland and ultimately to a closed scrub dominated by *Melaleuca*. 
The ideal succession seems however to have been reversed, so that the *Melaleuca* stage is partially replaced by a second *Phragmites* stage. The components of the intruding community at present are identified as *Carex*, *Phragmites* and *Typha*. A factor which may have brought about this part reversal is burning (Ladd 1978:408). The rhizomes of *Typha* were of course eaten by Aborigines, and Head (1983) suggests firing of *Typha* swamps was deliberately undertaken by Aborigines as part of their management of this resource in Western Victoria.

Despite the expected sensitivity of the catchment to environmental variation the record does not show the Holocene climatic variation indicted by Hope on Wilson’s Promontory, or Hooley *et al* on Sperm Whale Head, nor can it be made to indicate sea-level variability.

### 4.6. Uplands, Errinundra-Delegate Divide

The records discussed so far have been from the coastal or near coastal zone. There the environmental record is influenced not only by local effective precipitation and temperature, but possibly by factors such as sea-level effects on the local water table. It is useful therefore to examine inland pollen records. Two inland pollen records from close to the study area are from the vicinity of the head waters of the Delegate and Errinundra (Bemm) Rivers.

The first of the sites is from the Rooty Breaks Swamp on the headwaters of the Errinundra River at around 1100 m ASL (Ladd 1979a). The vegetation is a mix of Eucalypt forests on the higher ground with a distinctive rainforest beneath. One outstanding characteristic is the presence of tree *Podocarpus* as wet forest dominants, at lower levels these are replaced by *Atherosperma-Elaeocarpus*. Other important taxa are *Lomatia*, *Telopea*, *Pittosporum* and *Pomaderris*.

Although there are changes in taxa over time, Ladd considers that rather than reflecting environmental change the differences are due to altered water-borne pollen inputs after a stream crossing the site changed its course. Taking this into account Ladd concludes that there is no real evidence for Holocene climatic change. He further suggests that evidence which might be construed as indicating climatic amelioration in the mid-Holocene, and thereby agreeing with Western Australian and lowland evidence, is likely to be misleading. The latter sites are watered by mid-latitude westerly air flows, whilst Rooty Breaks is predominantly watered by east coast cyclonic systems. Achieving the increased rainfall recorded in other locations watered by a westerly air-flow requires shifting this system north, thus diminishing local rainfall.
Ladd suggests that the distinctive rain forests were in place by the beginning of sedimentation, dated to at least 5530±135 BP (Gak 4946), and that little climatic change appears to have occurred since then.

Ladd (1979b, 1979c) also undertook vegetation and pollen studies on the headwaters of the Delegate River at approximately 900 m ASL. Three radiocarbon dates were obtained 8265±250 BP (Gx 4155) at 155 cm, 12160±310 BP (Gak 5846) at 295-300 cm, and 11890±250 BP (Gak 5098) at 322-327 cm Ladd notes that the last two dates are inverted, but similar within the first standard deviation.

At the base of the record the main taxa represented are grasses, Eucalypts (in fairly low numbers), and other taxa notably Araliaceae, Podocarpus, Ranunculaceae, Asteraceae and Epacridaceae. Overall the quantities of tree and shrub pollens represented are very low suggesting alpine herbfield or grassland. Ladd suggests that the climate was then cold but there is no evidence for it being wetter than it is now. A temperature 5 °C cooler than today is estimated. This is followed by an expansion of trees and shrubs, and finally Dicksonia tree ferns by 8000 BP. Conditions became moister than they had been earlier, but there is no evidence that they were ever moister than they are today. Likewise conditions had also warmed by this time. There is little evidence that dryland vegetation has changed much in the area since this time.

4.7. The Alpine Area

Martin (1986) has carried out pollen analysis of sediments from the Kosciusko region. Both sites are from cirques located greater than 1950 m ASL.

The record begins at an uncertain date but Martin suggests that during the period <16000-ca 11800 BP the pollen record is dominated by distant non-alpine taxa, with little evidence of local contributions. It is characterised as an alpine desert. This period marks the interval between the initial melting or starvation of the Australian mainland glaciers and the inception of conditions suitable for the growth of vascular plants.

Climatic amelioration is indicated during the period 11800-ca 10600 BP with a rapid expansion of low herbfield taxa. This was followed during the period up to 6700 BP by an expansion of alpine grassland, and a contraction of herbfield. The evidence suggests that the tree-line was still rising at this time, although it had yet to reach its present elevation.

The period ca 6700-ca 4500 is marked by an increased incidence of wet sclerophyll forest taxa including Pomaderris, Dicksonia and Cyathea. Pomaderris continues to be
represented up to 3300 BP. Before this time *Eucalyptus* appears to have reached approximately its modern elevation, with possibly a minor advance during the period 3300-3000 BP.

The period from 3000 BP to the present is a period of what is taken to be instability due to postulated drought, frost (*increased*?), soil erosion or other causes. A role for fire is possible but not demonstrated.

A greater dryness, and continentality is suggested to have occurred over the last 4000 BP, generally agreeing with Hope and Hooley *et al.*

### 4.8. Bassiana

Hunter Island lies a few kilometres off the northeast Tasmanian coast, and was previously a low hill on the Pleistocene isthmus connecting Tasmania with the mainland. Hope’s study was of pollen contained within cave sediments collected during archaeological investigations of the site (Hope 1978). Archaeological work indicates that occupation began around 23000 BP and continued intermittently up to the last millenium. Basal dates are not available on non-cultural deposits.

During the period 28-23000 BP the site was not occupied by humans. The area near the mouth of the cave appears to have supported a population of *Eucalyptus*, with some shrub taxa and grasses. During the earlier part of this period the presence of *Nothofagus* pollen indicates a level of moisture similar to today, this however decreases over time. Time also saw a decline in heath taxa, eg, *Monotoca, Epacris, and Leucopogon*, suggesting a thinning of what might have been a heathy understorey to woodland. There is little to suggest forest cover in the region.

The period 23000-ca 14750 sees a decline in *Eucalyptus*, an absence of most shrubs except for proliferating Asteraceae, and an increase in grasses up to 21000 BP. This grass-Composite association is important up to 15600 BP. It is claimed to be an unusual association lacking analogues in modern Australian environments other than in central desert regions, and in the Central Plateau of Tasmania. In the latter case, Hope (1978:506) notes frequent burning and grazing by domestic animals and rabbits are considered to be essential to the maintenance of this association.

The continued presence of *Eucalyptus* is thought to be in part due to the protection of the sheltering hill, and perhaps to relatively long-distance pollen transport. Toward the end of this period there appears to have been an increase in heath, some ferns and *Eucalyptus*.
Intermittent human occupation occurred through this period. After a gap occupation evidence changes with deposition of shell midden from around 7200 BP. This indicates sea-level was then close to the present shore. The transition from Pleistocene to Holocene conditions is not well demonstrated due to an apparent depositional hiatus some time between 14850 and 7180 BP. The vegetation after this time is similar to that around the mouth of the cave today.

Changes have occurred through the Holocene, including a decline in the dominance of *Monotoca* and *Acacia* around 4000 BP, and replacement by *Leptospermum* and grasses. *Banksia* rises around 2100 BP and then falls off again.

No specific climatic indicators were identified, indeed the vegetation of the most rigorous period appears to be without parallel in modern Australian climatically defined communities. Similarity with hot desert communities suggests that aridity may have been an important factor controlling Pleistocene environments. Wind too may have had a controlling effect on Pleistocene vegetation away from the protection of the hills. The Holocene record suggests little climatic variation.

The major correlation with the human presence is seen in spores of epiphytic ferns, which presumably could not survive burning, wear and tear. Fine charcoal through the deposit indicates on-going burning, presumably as a result of both natural and humanly lit fires. There are not any major effects which can be attributed solely to human actions.

### 4.9. Discussion and Summary

The palynological work above shows many of the problems intrinsic to this method of environmental reconstruction. High on the list of problems is taphonomy. Two cores, from Lake Curlip and Rooty Break, demonstrate a similar taphonomic problem resulting from changes in pollen transport. In these cases significantly different assemblages occur prior to and following hydrological changes to streams delivering water-borne pollen to the core sites.

Some general statements can be made about Holocene regional environments. These begin in the terminal Pleistocene before 12000 BP when on the evidence of Ladd’s (1978) Wilson’s Promontory record, on the Delegate River (1979c, 1979d), and Kosciusko (Martin 1986) the climate was improving after the glacial maximum. It is likely that improvement actually began earlier than this on lowland sites. It is not clear however whether temperature or effective precipitation is the more important factor in any particular case.
How long this trend to amelioration lasted is not clear from the record. The Delegate River evidence suggests that by 8000 BP conditions were much as they are now. The Hunter Island record too suggests that by around the 8000 BP date modern vegetation was pretty well in place. In contrast, Hooley et al argue for climatic improvement until some time before 5200 BP. Hope also finds evidence for a mid-Holocene period of improved conditions on Wilson’s Promontory. The same trend is indicated by Martin for Kosciusko. This amelioration does not appear on the Lake Curlip record which is overwhelmed by both the evolution of the estuary of the Snowy River, and the swamp succession.

The Delegate River site is watered by cyclonic rains from the Tasman, while Wilson’s Promontory is oriented to receive rainfall from the mid-latitude westerly circulatory system. As both areas began to experience Holocene climatic regimes simultaneously around 12000 BP, it can be concluded that modern circulatory patterns were in place by that date. Modern sea-levels were attained around 7000 BP, some millennia out of phase with climatic adjustment.

Sea-level history in the study area is not clear. On Sperm Whale Head evidence of climatic amelioration, then deterioration has been shown amenable to interpretation as, in part at least, sea-level variation. This variation can further be shown to generally accord with that established for the Ninety Mile Beach by Gill (1982), and Donner and Jungner (1981). This agreement does not appear to hold good for the Wilson’s Promontory sites where the most economical appraisal of the evidence points to essential stability.

If the matter were referred to the previous vituperative debate on southern and eastern Australian sea-levels (Gill and Hopley 1972; Thom et al 1972) the evidence from this short stretch of coast could be used by either camp. As sea-level variation here is best considered in terms of isostatic movements it might be suggested that the paleozoic granitic batholith of Wilson’s Promontory might move independently of the younger rock of the Gippsland basin.

Another factor differentiating Wilson’s Promontory from the stability type sites of the New South Wales coast is the timing of sea-level stasis. Regional evidence suggests that around 7000 BP approximately modern sea-levels were attained. This pre-dates the 6000 BP for modern sea-levels claimed along the NSW coast (see Donner and Jungner 1981). The Wilson’s Promontory information is therefore at variance with the adjacent Ninety Mile Beach in terms of the sea-level stability record, but in agreement over the timing of the transgression.
4.10. Implications for human occupation

Recent environmental changes have had consequences for human habitats and occupation as a result of climatic change and subsequently marine transgression.

The simplest is the advance of the coastline leading to inundation of Bassiana following the Holocene marine transgression. Dating of the early human occupation of Tasmania indicate that this plain was traversed and occupied by 23000 BP on Hunter Island, discussed above, with penetration as far as the glaciated southwest clearly demonstrated before 20,000 BP (Blain et al 1983; Kiernan et al 1983; White and O'Connell 1982). Aboriginal capacity to occupy the steppe of the southwest, and the evidence of Hunter Island, indicate the probability that, despite its apparently grim climate, Bassiana too maintained a human population.

After a sea-level drop in the order of 125-150 m, rising after around 16000 BP to modern levels around 7000 BP, we can derive a mean rate of rise in the order of 125-150 m/(1600 minus 7000 = 9000 yr) = 13.9-16.7 m per millennium, or 0.14-0.16 cm per annum over the Bassian Plain. As the 150 m isobath lies approximately 100 km off the Gippsland coast a mean rate of advance of 11.1 km per millenium, or 11.1 m per annum can be derived. This would be a humanly perceptible rate of advance. During a sentient life span in the order of perhaps fifty years an individual would witness the erosion of something in the order of 550 m of estate.

At such a rate of advance shorelines must have been dynamic environments with volumes of terrestrial sediment reworked in the mid and lower beach zones. It can be assumed that at times the systems would be incompetent to redistribute the volume of reworked sediment. In such circumstances formation of equilibrium profiles would be incomplete and with immature coastal vegetation successions modern coastal landscapes may not have been common. Resource availability is likely to have been limited in the immediate coastal zone. Lampert and Hughes (1974:228) further argue that until shore platforms evolve along rocky coasts they too remain relatively resource poor areas.

It is therefore proposed that during the period 16-7000 BP the Gippsland coast would not have been attractive as a human resource area, even though climate and aspects of vegetation away from the shore were largely stabilised some time earlier.

While the cold, arid and windy Bassian Plain prior to 15-16,000 may appear unattractive the structure of its resources may have allowed a significant human harvest. As discussed by Kelly (1983) the limited productivity of such a steppe is likely to have been accessible
as grasses and herbs to a small number of larger herbivores (eg. grazing macropods, some types of megafauna). In contrast, higher productivity "better" areas of woodland or forest can be expected to have a fauna of smaller dispersed animals. The evidence of the dense archaeological bone deposits of Pleistocene Tasmania (eg. Fraser Cave, Kiernan et al 1983) demonstrate selective hunting of the herbivores of the steppe. The archaeological evidence of game specialisation, and inference about the ecology of the steppe, suggest that an appropriate model of exploitation of Bassiana should emphasise specialised hunting of larger animals rather than generalised gathering.

Expansion of woodland or forest after the 15-16,000 BP amelioration lead to a contraction of steppe, although the two are not likely to have been closely synchronised. Insufficient evidence has been published of how Bassian vegetation was structured between then and after 12,000 BP. It can be expected however that the hypothetical larger game hunters of the steppe would need to develop a more generalised economy until the plain was finally inundated by 7,000 BP.

Small magnitude variations in Holocene climatic parameters are hard to relate to cultural systems. Fundamental problems are the actual magnitude of variations, the tolerance of biota and communities to variation in environmental parameters, lapse times between biotic response and environmental stimulus, the nature of cultural inputs into the forms of natural systems, and how environmental perception processes within socio-cultural systems deal with variation. Problems therefore have two aspects, changes within natural systems and the process of human response.

In the Holocene one of the most significant suites of ecological changes is that associated with river valley and lake basin sedimentation. These occurring independently of climatic change, result in restriction of the area directly affected by salinity, and expansion of shore-line vegetation, notably Phragmites communities. The expansion of key aquatic vegetation results in both greater availability of human foods, eg. rhizomes of Typha, Triglochin and Scirpus, and in breeding and feeding habitat for a number of other taxa, notably fishes and water-birds. This process was also almost certainly enhanced by constriction of tidal flow and possibly by emergence.

It is apparent that the attractiveness of the area for human consumers has been increasing over the Holocene, although the termination of tidal exchange in the mid-Holocene saw the most impressive ecological change in the extinction of marine communities and presumed expansion of estuarine ones.
Chapter 5

Archaeological studies, theory and method

In Chapter Six it is argued that details of culture, and subsequently human ecology, witnessed during historic times need not reflect conditions prior to 1788, nor can conditions immediately prior to 1788 be assumed to reflect the earlier Holocene. To reconstruct Aboriginal culture throughout the greater part of the Holocene, for which there is no documentation, we are required to turn to archaeological information.

A mere compilation of data cannot speak for itself, and like ethnographic information must be interpreted. Interpretation of archaeological information requires that a number of problems be recognised: whether past actions leave recognisable traces, whether they can be preserved, whether natural processes permit their discovery, the degree to which the range of traces discovered is representative of the range of past activities and the validity of sampling and analytic procedures applied to the traces. In addition to these fundamentally mechanical considerations outcomes are ultimately governed by the legitimacy of the interpretative theory applied.

An approach to information which does not explicitly approach these problems may not make a significant contribution to our understanding of the past. This chapter is concerned with how these considerations were applied to formulating the approach to archaeological investigations in the present study.

5.1. Survey Aims

The aim of site survey was to locate and record Holocene archaeological deposits within the coastal and near coastal zone. It is therefore both spatially and temporally bound. Because of its restricted scope, survey objectives are not enhanced by a large scale random sample of regional deposits. It was not anticipated that a regional survey would add to the picture of developments within and relevant to, the coastal zone and the immediate topic.

There were also logistical constraints on the achievability of a larger scale representative sample. One of the major problems is limited ground surface visibility so that the location
of disturbed ground is a major archaeological constraint. Human activities are the single most important cause of ground surface disturbance in the region. The area is well vegetated with heathlands, woodland, salt marsh and farmland. As a consequence ground surface visibility is restricted. Most visibility comes from tracks, cuttings and other bare patches. Overall the area lacks extensive erosion so that sub-surface deposits are obscured. As these effects (eg. track building) result from patterned human behaviour it can be assumed that there are locational biases. A minor cause of exposure is animal burrowing (rabbits and wombats). Again systematic habitat preferences are likely to bias the location of exposures.

The lack of exposures therefore has two effects, it limits opportunities to examine deposits, and means that exposures are biased toward a restricted range of locations.

A later problem was redundancy of information. This was anticipated as it was known that along the Ninety mile Beach Barrier there are numerous similar degraded Donax deltoides midden exposures low in artefactual material and identically located. It was apparent that with the number of such exposures, and their uniformity of context and contents, survey of the fore-dune would produce a good deal of redundant information. It was decided to limit survey in this zone.

Delineation of landscape units for the purpose of sampling is undertaken on the assumption that different resources are located in different environments so that different tasks or patterns of habitation will be represented on each (see Plog 1976). This requires that proportionally equivalent amounts of exposure are available on each. Two options in defining landscape units are topography and vegetation. Both are problematic. If, as it is assumed, people are guided in how they arrange their activities by the supply of food, vegetation should be the more reasonable unit. But modern vegetation patterns are the outcome of a range of successional, interference, hydrological and geomorphic processes and cannot be assumed to be strictly representative of the past. How vegetation units are defined also depends on the researcher, for example vegetation might be defined according to structure, in which case the whole study area could fall into few categories (eg. woodland, closed scrub or saltmarsh), or according to floristics. In the latter case units of survey might be defined according to dominants, as a combination of dominants and understorey, or any other floristic characteristic, eg. the presence of a key resource species.

As has been argued in Chapter Two, production of key taxa is likely to be linked to historical factors, notably fire-histories. Thus productivity of Pteridium esculentum in a modern woodland may not be equivalent to that of the past although the structure and
floristics of the woodland dominants may be equivalent. Over 140 years of grazing, clearing and changed burning regimes has occurred since Aborigines had unrestricted use of the area there is every reason to assume that changes have occurred.

In addition, similar looking topographic units may have different geomorphic origins and ages, and are not to be regarded as equivalent throughout the period of interest. Landform units need not represent single formational episodes or processes. Depositional landforms may contain elements derived from different environments at different times, e.g. a prior wash-over plain may be transformed into a dune field by subsequent reworking of sediments, and as a late Holocene environment may be equivalent to a range of other low relief sandy environments.

It was decided in light of the complex Holocene history of the area that it was unrealistic to attempt to formulate definitive small scale analytical landscape units at a distance. In some circumstances, e.g. with apparently recent cultural deposits, it is reasonable to infer that modern configurations are equivalent to those at the time of deposition. With older deposits such assumptions cannot be made.

5.2. Human behaviour and archaeological evidence.

5.2.1. The organisational importance of the satisfaction of physical needs; background to survey aims

It is customary to approach the archaeology of hunting-gathering peoples via their physical environments and the dependent variable, economy. This approach is based on the not always explicitly stated assumption that the single most important factor in the organisation of hunter-gather lifeways is the satisfaction of physical needs, the most important being the need for food.

The extent to which the socio-cultural forms of a society allow the fulfillment of basic needs, and enable the individual to reproduce himself might be suggested as a measure of the success of a socio-cultural system. If the success of sociocultural systems is measured in terms of the well-being of all members, many must be regarded as failures. Success defined in terms of the reproduction of systems regardless of satisfaction of all members is a different matter. From an historical perspective it would appear that satisfaction of select segments of societies is dependent upon the under-satisfaction of others. It might be argued that systematic undersatisfaction of needs is the driving force of some systems, e.g. capitalist.
This problem of differential satisfaction may not be as acute in the type of small scale society under examination here, but even so it is naive to expect that all do equally well, eat identically, and have equal access to socially desirable resources or equal right to determine what resources will be exploited, and when. As will be argued in Chapter Eight, we cannot assume some sort of natural evolutionary process will ensure the evolution of a level of optimality in resource targeting and scheduling, nor can we assume that all members of small-scale societies are equivalent units of production and consumption in either the present or the past. For example in Australian societies the diets of males and females are believed to have differed significantly (Bowdler 1976, Cowlishaw 1981) as a consequence of social organisation of labour. Systematically unequal access to knowledge, status goods and the productive and reproductive capacity of women, is commonly seen as underpinning a generalised Aboriginal Australian gerontocracy and the control of men by other men.

However, without economic competence the social superstructure cannot persist, nor is it possible for a society as a whole to maintain a hierarchy of other needs without maintaining a minimum satisfaction of food and energy requirements. Thus while we cannot presume to make the food quest the single most important factor in the organisation of hunter-gatherer behaviour it must be recognised as significant.

5.2.2. Assumptions regarding variation in behaviour and site location

From an evolutionary perspective there is an expectation that behaviours reflect selection outcomes, and are therefore adaptive. It follows that we can expect a tendency toward optimality in materials or energy use according to environmental parameters. This position demands efficiency in expenditure of time and effort. The applicability of evolutionary approaches to Holocene cultural behaviour is discussed in Chapter Eight and found inadequate. This does not however negate the development of some level of efficiency or rationality of resource use.

It is axiomatic that hunter-gatherers need to regularly procure food requirements. It follows that they can be expected to organise themselves or their labour in order to keep the level of expenditure of effort and time in the procurement of daily essentials at an acceptable level. Among the manifestations of organisation we can expect that habitation sites are located in order to permit satisfactory access to resources. If the rationale of effort minimisation is valid, the time and effort expended in transporting materials will be managed by siting consumption locations with access to resources according to such principles as the return rate, density transportability and so on of different resources.