Chapter 8 Discussion and Conclusions

8.1 Introduction

The broad aim of this research has been to examine the relationship between coastal shell midden sites and theories of fluctuating sea-level in the Mid- to Late- Holocene on the east coast of Australia. Theories of Holocene sea-level instability have resurfaced in the past decade, giving archaeologists an alternative explanation for the patterns of midden location seen on the east coast of Australia, and offering new explanations for the assemblages excavated from these middens.

In this chapter I firstly summarise the overall findings of this research. I then discuss the possible reasons for the changes that were observed in the faunal assemblages from the case-study sites (see Chapter 7), and present my argument for why I believe that those changes support suggestions of a fluctuating sea-level in the Lower Macleay during the Mid- to Late- Holocene. I conclude this dissertation with a discussion of the implications of my research both for coastal archaeology and for coastal geomorphology. In closing, I highlight fertile areas for future research.

8.2 Findings of this Research

In Chapter 1, I listed five specific objectives for this research. They were -

1. To examine the use of shell middens as indicators of shoreline change.
2. To investigate the relationship between proposed sea-level models and shell middens on the eastern Australian coast.
3. To investigate two different models of shoreline change on the barrier coast region of the Macleay River, based upon geological, geomorphological and ecological information.

4. To test two alternative hypotheses about shoreline change through the re-analysis and re-dating of two archaeological sites now located on the Lower Macleay floodplain.
5. To determine whether changes observed in the marine faunal component of the archaeological assemblages in these two sites over the Late Holocene time period are consistent with the new sea-level models.

Objective One

In addressing the first of my objectives I showed that shell middens are good indicators of shoreline change which have been used on both tectonically stable and unstable coastlines to specify prehistoric shorelines. Their location in the landscape, relative ease of dating, and the archaeological assemblages retrieved from them, all add to the interpretation of shoreline change over time. In my review of the overseas literature, site location was identified as being the major variable in identifying sea-level change. The researchers I cited concluded that, if the position of middens changed in the landscape, this could be attributed to a change in the position of the shoreline. Likewise, a lack of shell midden sites in a region could be viewed as suggesting they had been destroyed when the sea-level rose.

The second variable linking changing sea-levels to shell middens was noted to be a change in the marine fauna represented in the midden over time – due to a changing environment, and therefore a changing habitat for the marine species in the waters adjacent to a midden site. The formation and ecology of estuaries as it is understood today provided important insights for my research. Estuaries can prove a difficult environment for many marine species, but they also provide a comparatively safe and secure habitat for juveniles of many species. While environmental conditions remain relatively stable, estuaries can provide a plentiful food supply for people occupying the land in their vicinity. However, if the environmental conditions are disrupted, changes in water temperature, salinity and turbidity will disturb the marine fauna inhabiting the estuary. Marine fauna have few options available to them if their habitat is disturbed: they can adapt, move, or die. The result of disrupted habitat will be a change in the species occupying the habitat, with some species being replaced by those which find the new conditions more amenable.

Not only would the marine species inhabiting an estuary be seriously affected by a changing estuarine environment, the consequences for the human population which relied on the resources of the estuary would also be significant. Some areas of the estuary may no longer be viable as a habitation site, either through a lack of food resources or because the environmental change creates an inhospitable terrain. Consequently, the location of living sites may need to be changed, resulting in the changing occupation patterns noted by archaeologists as possibly reflecting shoreline change. Similarly, changes in the availability of different types of food resources would alter the inhabitants' choice in diet, and so, the food debris that entered the archaeological record.

Shell middens were also shown to be useful in researching shoreline change because they are relatively easy to date. Precise chronologies were also identified as a necessity when determining environmental change from archaeological sites. When ample funds are available for dating (as was the case in some of the overseas studies) numerous dates can be obtained, giving fine-scale chronology for a site. Coastal midden sites contain an abundance of carbon based material suitable for radiocarbon dating. Charcoal is usually evident in midden sites, but the shellfish remains and faunal remains may also be used to provide dates of occupation of sites.

All of the points discussed above serve to make shell middens useful indicators for sea-level change. However, they have not previously been used for this purpose in Australia. The present research has therefore directly addressed the potential of using shell middens to further increase our understanding of coastal prehistory.

<u>Objective Two</u>

In addressing the second of my objectives I have showed how the belief in a stable coastline for the last 6,000 years in Australia has somewhat limited research into changing sea-levels relative to coastal shell middens. Australian archaeologists have remained in a stable coastline 'limbo', whilst researchers from other disciplines such as geology and geomorphology had begun investigating theories of fluctuating sea-levels in the Late Holocene as early as 1896. I explained that the information upon which the stable coastline view was based was presented by geographers such as Thom in the late 1960s. From this, archaeologists inferred that coastal shell middens should contain history of occupation of the coast for the last 6,000 years – unless the sites had been destroyed by wave action, storms or cyclones, or by destructive practices of European settlers such as using the shell from the middens in road making or sand mining. The idea of a smooth sea rise after the last glacial maximum at approximately 20,000 BP, until seas reached their present level at c. 6,000 BP, has been perpetuated in Australian archaeological studies for the last thirty to forty years.

Alternative suggestions have been made, especially in the last decade, about sea-level stability for the Australian coast. Flood and Frankel (1989) and Baker et al (2001) have proposed that the sea has risen at least once since the mid-Holocene, based on their research into fixed biological indicators from many parts of the Australian coastline. Their proposed sea-level curve for the Late Holocene shows a sea-level of approximately two metres higher than the present at c. 4,000 BP, and perhaps another rise of a smaller magnitude after 2,000 BP. These theories provided a starting point for my research into coastal archaeological sites, and their relationship to a changing sea-level, because of their potential to explain the relative youth of many coastal sites compared to those located just a few kilometres inland.

To test the applicability of this idea to the north coast of New South Wales before embarking on the main part of my research, I compiled published radiocarbon dates for shell midden sites in the area to assess roughly if there was an age difference between the foreshore and inland sites.

The results of this assessment showed that the foreshore sites were indeed significantly younger than those located a few kilometres inland, suggesting a relationship to where the sea was at the time of the middens' formation. Consequently, the proposal of this research to re-examine Clybucca 3 (an inland site) and Stuarts Point 1 (closer to the shoreline) was shown to have promise in answering questions relating to changing sea-level and the location of midden sites.

As shown in Chapter 3, the possibility of changing sea-levels in the Mid- to Late Holocene was not proposed by any of the researchers who had worked on the Macleay sites until the end of the 1990s. Everyone 'knew' that sea-levels had stabilised on the Australian coast at approximately 6,000 BP (Mulvaney 1975:137; Chappell and Thom 1977:281; Beaton 1985). Researchers concluded that the Macleay had been a large, shallow-water, estuarine embayment which had been infilled by sediments carried down the Macleay River. In his B.Sc(Hons) research, Flood's student, Mundell (2000), concluded that the theories of an unstable sea-level had some merit when applied to the Macleay floodplain. Mundell proposed that the sea-level had risen approximately two metres across the Macleay floodplain at c. 5,000 BP, forming an inland sea. The environment created by a sea-level rise in the Macleay region would be very different to the one proposed by researchers prior to 2000. The waters would have become deeper for a time period between approximately 5,000 and 4,000 BP, instead of becoming increasingly shallower as sediments filled the embayment. The Macleay floodplain would have gone through another similar period similar at c. 120,000 BP. It would have been a marine environment, largely governed by the tides and marine processes. The chain of hills to the west of the present coastline would have been the maximum point to which the sea could rise, not only during the last interglacial of the Pleistocene, but also in the mid-Holocene.

<u>Objective Three</u>

To address the third of my objectives, in Chapter 4 I began by presenting two alternative hypotheses for how the Macleay floodplain as we know it today might have formed:

1. That sea-levels rose sharply in the mid-Holocene to two metres higher than the present level, inundating the floodplain and forming a large, marine embayment; or,

2. That the area between the low-relief hills to the west, and the Inner Barrier sand ridges was gradually infilled with sediments carried down the Macleay River.

A cross-section drawn from the 50 metre contour in the Tamban Forest to Back Beach just south of the present Macleay River entrance (Figure 3.20), and Mundell's (2000) models of the environment of the Macleay floodplain at 4,300 – 3,700 BP and 3,700 – 2,900 BP (Figures 3.17 and 3.18) show how the floodplain would have appeared if the sea had risen two metres. One of the models that I subsequently proposed in Chapter 4 illustrated how a two metre higher sea-level would have affected the marine biota. If the sea was two metres higher than at present, the embayment would have become a large marine environment, rather than an estuarine environment, supporting numerous species of marine taxa. This would have been an extremely productive environment for the procurement of marine resources by the Aboriginal people living in the Macleay. However, as the sea-level dropped again between 3,700 – 2,900 BP, the marine environment would have been greatly disrupted, especially if the sea-level fall was relatively rapid as proposed by Baker et al. (2001). If this had occurred, it should be evidenced by changes in the marine fauna represented in the shell midden case study sites.

The models that I presented in Chapter 4 made detailed predictions about the effects on the marine fauna of changing habitats based upon the ecological research into fish and shellfish. I also predicted what would have occurred in different time periods if the sea-level had risen and fallen again. For example, for the period 5,000 BP to 3,500 BP, my model predicted that, if Hypothesis One were correct, the seagrass beds of the embayment would have provided a habitat for mobile shellfish such as the cockle, but oysters would only be abundant in areas with a rocky substrate, prior to the formation of mangroves. A range of fish species would have been expected to inhabit the estuarine embayment, with plentiful small species finding the shelter of the seagrass beds a suitable habitat.

However, my model predicted that if Hypothesis Two was correct for this time period, the infilling of the embayment by sediment would have provided a much more suitable habitat for oysters, not only on the rocky substrate, but also as mangroves would have been able to form much earlier in the sequence. Oysters would have also flourished because the shallower waters would have been warmer, allowing the oyster beds to overwhelm other species of shellfish. Smaller species of fish may have found this environment more challenging than the environment proposed in Hypothesis One. Seagrass beds would have been sparse due to the influx of sediments, and the turbidity of the water, destroying nursery habitats for small fish. The discussion of my findings in relation to these models is presented below.

Objective Four

My fourth objective involved the re-analysis and re-dating of Clybucca 3 and Stuarts Point 1. As explained in Chapter 5, Section 3, there was insufficient funding to date both sites. Stuarts Point was chosen as the most important one to re-date because of the controversy surrounding its c. 9,000 BP date (see Chapter 6). In Chapter 6 I presented the new radiocarbon dates obtained for the Stuarts Point 1 shell midden. These dates show that the site does not date to the Pleistocene-Holocene transition, but is mid- to late-Holocene in age. This places the occupation of the site in the time frame which has been proposed for a sea-level rise and fall of approximately two metres on the eastern Australian coast. As the midden is situated on the Inner Barrier which formed during the last interstadial of the Pleistocene, prior to human occupation of the continent, it appears that the peninsula was not inundated by oceanic waters during the proposed mid-Holocene rise in sea-level. Rather, it would have become an extremely favourable environment for the collection of marine resources such as shellfish and fish, and may have been somewhat protected from the conditions of the foreshore by its situation on the considerable dune of the Inner Barrier.

The re-analysis of the archaeological marine faunal assemblages from the Stuarts Point 1 site has shown a pronounced change in the shellfish fauna represented over time, and an increasing dependence on terrestrial fauna after 3,700 BP. The Clybucca 3 site showed a use of terrestrial fauna throughout the time of occupation, with an increased use of fish in the time period circa 4,300 – 2,900 BP. The shellfish assemblage was dominated by oyster throughout the time of occupation.

In the following section I address the fifth objective for this research by discussing and determining the most probable reason for the changes seen in the marine faunal assemblages from both of the case-study sites.

8.3 What Caused the Changes in the Clybucca 3 and Stuarts Point 1 Assemblages?

The Lower Macleay shell middens of Clybucca 3 and Stuarts Point 1 have provided case-study sites to test theories of sea-level fluctuation in the Late Holocene. The location of these two sites, and all of the shell midden sites situated in the Lower Macleay, emphasise the importance of site location as being a major variable in the study of changing sea-level in relation to coastal midden sites. The two sites are located 12 kilometres apart, with Clybucca being situated on the western margin of the floodplain where the topography begins to rise into the foothills of the Great Dividing Range, and Stuarts Point being situated close to the present shoreline, separated from the ocean only by a narrow strip of land and the Macleay Arm. Nonetheless, both of these sites contain marine fauna, which is perhaps understandable in the case of Stuarts Point. However, the Clybucca sites in the present day are high and dry, and some distance from a marine environment (Figure 5.1).

As I showed in Chapter 3, shell middens are not scattered randomly over the Macleay floodplain, but are instead located on specific landforms, on the former beach ridges below the western hills, on the Inner Barrier, or on the residual bedrock of former off-shore islands. The Stuarts Point 1 shell midden would have remained above the water if a two metre sea-level rise had occurred, because it sits on the Inner Barrier sand dune which is believed to date to the last interstadial of the Pleistocene approximately 120,000 BP. The peninsula of Stuarts Point would have been foreshore prior to the formation of the Outer Barrier sand dune system. During periods of higher sea-level, the site of Clybucca 3 would have been closer to the waters edge than it is today, as it is located just below a spur of land which extends into the estuary at the point where the land begins to rise into the foothills of the Great Dividing Range. Areas of the floodplain which are now swampy marshes would have contained considerably more water.

Whilst site location was identified as an important variable in the inference of sea-level change over time, it was not the only variable identified. A change in the use of resources over time, as evidenced by archaeological deposits, was also identified as a means of supporting hypotheses of environmental change from archaeological sites.

The radiocarbon dating of Clybucca 3 had placed the occupation of the site firmly within the time frame of the Mid- to Late- Holocene. In re-analysing the faunal material from this site I have shown that terrestrial fauna was evident in the archaeological deposits prior to 5,000 BP, reaching a peak between 3,887 – 3,350 cal BP, and dropping sharply after 3,300 cal BP. Fish and shellfish only make a substantial contribution to the archaeological assemblages in the period after 4,300 BP. These findings support Hypothesis One, that a sea-level rise occurred in the Macleay between 5,000 BP and 4,500 BP, and then fell again c. 3,500 BP, because the archaeological remains are indicating a period of time when the site was more accessible to a marine environment than it is in the present. If Hypothesis Two were correct, it would be expected that an extensive marine environment would have existed adjacent to Clybucca, prior to its infilling by sediments, and that this would be reflected in the archaeological record.

The shellfish remains at Clybucca, consisted overwhelmingly of oyster, however, it was noted during the excavation that a lot of the oyster remains were still attached to rock, and did not bear the marks of mangrove roots. This is consistent with the sea-level having been higher than it is at present in the time period 4,300 – 2,900 BP to provide a marine environment conducive to oysters growing on the rocky substrate. The infilling of what had been a large open marine embayment by sediments (Hypothesis Two) would have predicted the growth of mangroves at Clybucca earlier than areas closer to the coast – as this is where the sediments carried down from the tablelands would have been first discharged onto the floodplain. If the scenario proposed in Hypothesis One had occurred, there would be substantially more marine water adjacent to the Clybucca site. However, it may not have been as deep as locations nearer the coast, thus may not have allowed the growth of substantial seagrass beds and the fish and shellfish communities which inhabit them.

At Stuarts Point, from c. 4,000 BP, fish and shellfish are abundant in the faunal assemblage. Hypothesis One proposed that this time frame would coincide with a time when the sea had risen to a level two metres higher than the present 500 to 1,000 years before the occupation of the site. The gap between the rising of the sea and the occupation of the site allowed enough time to elapse for the development of a marine habitat for shellfish and fish. The optimal time for the inclusion of large quantities of fish and shellfish in the diet of the people occupying Stuarts Point, evidenced by the archaeological remains, is between 4,300 BP and 3,700 BP. During this time frame large quantities of fish and shellfish remains do appear in the midden, with only small amounts of 'other' fauna. Hypothesis One predicts that the time prior to 3,500 BP would have been the period when the marine embayment would have been at its most productive.

During this time period there is a change in the species of shellfish dominating the archaeological assemblage. This change in the dominant species occurs after 3,700 BP, when the cockle began to be replaced by oyster, and mud whelks began to appear. The appearance of increased amounts of oyster at Stuarts Point is indicating the growth of mangroves, and perhaps the loss of seagrass beds which provide a habitat for cockle. The substrate at Stuarts Point is not a suitable habitat for oysters, and mangroves would have needed to grow to provide an attachment point for the oysters. Once oysters began to colonise the area they may have proliferated rapidly. It is the apparent speed of the replacement of cockle with oyster which is interesting at Stuarts Point. Whilst fish are still plentiful, the comparative amount of cockle dropped, and oyster formed a major part of the shellfish assemblage. This is indicative of a major change in the environment of the Macleay in the time period after 3,700 BP. If Hypothesis Two was correct, the replacement of cockle with oyster may have occurred over a longer time period, evidenced in the archaeological record by similar amounts of oyster and cockle at some point in the deposition of shellfish remains. Instead, we see the shellfish component of the economy – which had been heavily reliant on cockle – change to less reliance on shellfish with the dominant species identified being oyster. After 3,700 BP oyster and mud whelk make up over 80% of the shellfish found by weight. The time period when this state becomes most apparent is after 3,700 BP, and before 2,900 BP, suggesting that the hypothesis that the sea-level dropped at c. 3,500 BP is supported by the evidence of the Stuarts Point shellfish assemblage.

Fish play a major role in the diet of the people inhabiting the Stuarts Point site prior to c. 3,700 BP. Numerous species were identified from the site, with Platycephalidae being prominent until the period when the shellfish change occurred. Along with the change from cockle to oyster, the most numerous fish species recovered changed from Platycephalidae to Sparidae. It is difficult to attribute this to a change in water depth. Whilst Platycephalidae inhabit waters to 30 metres in depth, they may also occupy quite shallow waters. Bream, on the other hand – the most numerous of the two species of Sparidae identified at Stuarts Point – like to inhabit shallow waters of the estuary, only leaving this environment for their annual spawning runs. Bream feed upon oysters, which may explain the prominence of this species at Stuarts Point in the time period when oysters are most prolific.

After the change from cockle to oyster in the lower layers of the Stuarts Point site, the most dramatic change in resource use evidenced by the archaeological assemblages is the change in the amount of terrestrial fauna being used in the upper layers of the site. In the time period dated to after 3,5000 at Stuarts Point all categories of marine fauna have decreased in importance in the assemblages, but terrestrial fauna has increased. This suggests that by this time the occupants of the site could no longer rely on marine resources to be as plentiful as they had been previously, and had started making more use of the surrounding resources from the sclerophyll forests. This would be consistent with Hypothesis One, with the lowering of the sea-level causing a dramatic change in the availability of resources in the region. In contrast, the slow infilling of the embayment by sediments (Hypothesis Two) should have resulted in a more gradual change in the use of terrestrial resources. This is despite the fact that, after 3,500 BP, the Macleay would have been taking on the characteristics of its present environment whichever of the hypotheses was true. The fact that the inhabitants of the site abandoned it, even after they had changed their resource procurement strategy, suggests that the loss of the marine resources may have had more impact on the Aboriginal population of this site than can be evidenced by archaeological faunal assemblages.

In summary, the results of the re-analysis of the marine fauna from the Clybucca 3 and Stuarts Point 1 sites indicate a greater likelihood that there was a sea-level rise in the Macleay region at approximately 4,500 BP than that a gradual sedimentation occurred. A number of lines of evidence point to this being the case. Firstly, the sites do not appear to have been inhabited prior to the Mid-Holocene. Secondly, both sites appear to have had an episode when marine fauna became abundant. This occurred after 4,300 BP at Clybucca, and between 4,000 – 3,700 BP at Stuarts Point. Finally, the changes evidenced in the fauna recovered from the sites do not indicate a slow, gradual change in the environment, but instead suggest episodes when change happened relatively rapidly. Figure 8.1 shows the significant changes which occurred at both of the case study sites plotted on Baker et als'(2001) sea-level curve, and depicts the changing resource pattern as the sea-level rose and then lowered. Consequently, whilst it is not possible to state categorically that the environmental change evidenced by the archaeological assemblages is the result of a two metre rise in sea-level between 5,000 BP and 4,000 BP, it is possible to say that the results of this research favour Hypothesis One, and therefore provide strong support for that conclusion.

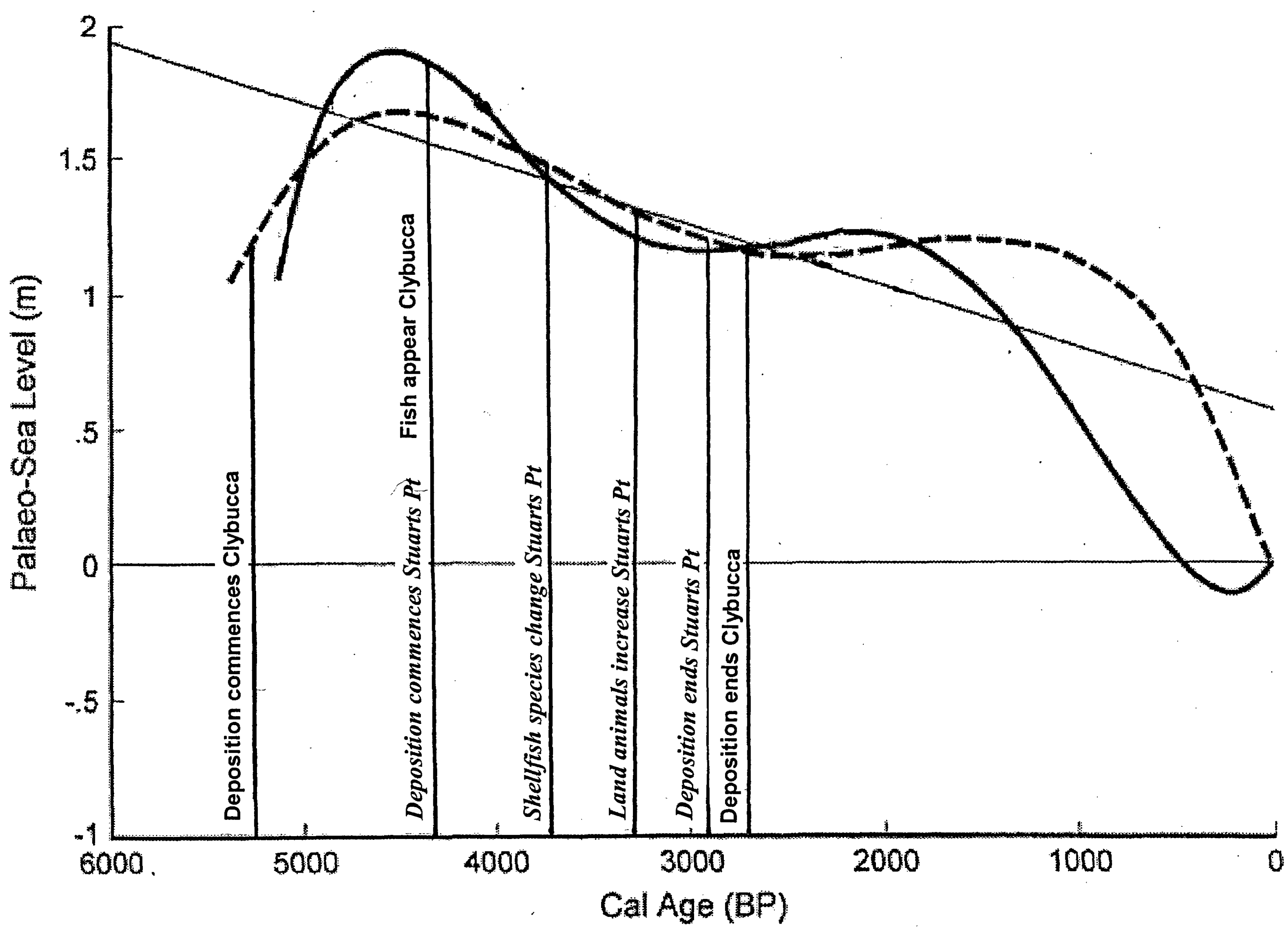

Figure 8.1 **Timeline of significant events at Clybucca 3 and Stuarts Pt 1 – Sea Level Curve (after Baker et al. 2001)**

8.4 Implications for Australian Prehistory

The implications of this research for our understanding of the prehistory of Australian coastal occupation are quite significant. Instead of believing that coastal shell middens carry a record for the last 6,000 years of prehistory of the continent, researchers may have to consider the location of the sites which they are studying in relation to where the sea-level could have been at the time the sites were occupied.

The time is coming when teaching resources will need to acknowledge the new theories of a fluctuating sea-level for the coast of Australia. The most recent text cited in this study for Australian archaeology (Mulavaney and Kamminga 1999), still proposes a stable shoreline for the past 6,000 years. Mulvaney and Kamminga briefly allude to an unstable coastline, however this is unreferenced and disregarded by the authors. Students of archaeology cannot be expected to explore new theories if the same argument is being presented to them in 30 or so years of teaching material.

Furthermore, the review of the progression of the term 'Pleistocene coastline' has shown that many archaeologists have taken on research from other disciplines without contemplating the implications of what they are presenting. The use of terms such as 'old' or 'Pleistocene' coastline may have been appropriate prior to the widespread use of dating techniques such as radiocarbon dating, but it has no place in the present study of archaeology. As I have shown, it is a nonsensical term which was used as a means of relatively dating a site prior to direct methods of dating. It continued to be used because someone had used it in the past, but this is no longer appropriate.

8.5 Implications for Australian Coastal Geomorphology

The research has shown that archaeological data can be used to test geomorphological theory. Despite the precautionary remarks cited earlier in this dissertation on the pitfalls of using theories from other disciplines in archaeological research, I have found the process extremely inspiring. By combining knowledge from more than one discipline, outcomes for research, in this case on coastal middens, have been enhanced. I also believe that archaeology has a lot to offer studies in coastal geomorphology, and a continuation in this research could enhance geomorphological studies as much as it has contributed to my archaeological research.

8.6 Concluding Remarks

This research has used a number of avenues for exploring changing sea-level in the Late Holocene on the eastern coast of Australia. Research from other disciplines such as geology and geomorphology have made large contributions to this study, along with archaeological analysis. However, I believe the scope of carrying out this kind of research could be broadened by the addition of yet more research from other disciplines. There was no research into changes in vegetation over time for the Macleay Region for me to consider during this research. Cotter (1996, 2001) has presented models for Holocene environmental change in the Moreton Bay region, approximately 500 kilometres north of the Macleay, using palaeobotanical and geomorphological studies. A study of this kind for the Macleay region could only enhance the outcome of environmental research, and further our knowledge of this environment at the time the middens were being formed.

More research is needed in Australia into the analysis of archaeological fishbone assemblages. Comparative reference collections need to be expanded so that a full range of species which inhabit different environmental zones can be made available. This would also aid in the estimation of the live size of fish recovered from archaeological sites. Research of this kind is very time consuming, but as Australia is a country with a very large coastline, fish resources should be important in many coastal sites, and therefore an important aspect of coastal archaeological research.

Radiocarbon dating is an essential tool in examining environmental change over time from archaeological sites. The need for precise chronologies was pointed out in Chapter 2. Many of the northern New South Wales coastal sites have been dated on the basis of only one or two radiocarbon dates. This makes establishing the precise chronologies needed for environmental reconstruction research very difficult. Another problem is that the dating was often carried out many years ago, and it is difficult to compare dates across sites without knowing full details of how the dating was done. Many of the dates may not have been calibrated or corrected for marine reservoir variation. The correction of dates from sites already dated, and obtaining more dates for sites already excavated, would greatly enhance our ability to study site location in relation to changing sea-level.

If more excavations could be carried out at Stuarts Point, and more radiocarbon dates obtained, it would provide further testing of the Mid- to Late Holocene sea-level rise hypothesis. Obtaining dates along the length of the peninsula should indicate where the sea-level was over time. Sites at the northern end of the peninsula should have a basal date between 5,000 – 4,000 BP, when the embayment would have attained its most marine-like character, and should have a shorter duration of occupation than those located further to the south, which could be expected to have a longer period of occupation.

In closing, this research project has been both an exciting and a difficult one. It has been difficult because of the constraints involved in using material that was excavated so long ago, but it has also been exciting because of the privilege of being able to re-examine this material in light of today's archaeological methods and understanding. Similarly, it has been difficult because of the challenge of melding archaeological data and geomorphological theory, yet this has perhaps been the most rewarding aspect of the project. I hope that this research will encourage others to appreciate the potential of marine faunal analysis not only to address the usual archaeological questions, but also to contribute to cross-disciplinary endeavours.

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