Earthquake uplift and erosion of archaeological site L26/1 at the mouth of the Heaphy River

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ABSTRACT

This investigation assesses the current state of the key archaeological Archaic Maori site L26/1, and the impact of erosion on the site. The assessment is based on two days' field observations, and an analysis of documentary evidence. The site is situated on shoreline deposits uplifted about 3 m prior to occupation and is directly exposed to erosion by both marine and fluvial processes. Erosion of the deposits is inferred from positions of the river bank recorded on a cadastral map surveyed in 1898 and aerial photographs taken in 1955 and 1988. During the last 105 years, the river bank has eroded at an average rate of 0.31 m/yr, and the erosion is likely to continue. By 1961–63, when the site was excavated, it had probably already been substantially eroded. Of the site that was present in 1961–63, only about half now remains. Options for DOC to mitigate further losses of information are discussed in the light of present and inferred future stability of the site. It is recommended that DOC work with the archaeological community and iwi to formulate a research programme to be carried out in collaboration with appropriate external organisations.

Keywords: moa, Archaic Maori, wetland, artefact, erosion rates, tectonic uplift.

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1. Introduction

Site L26/1 is an Archaic Maori site situated on the south bank of the Heaphy River in the northern West Coast (Fig. 1). Excavation of the site in the early 1960s is reported by Wilkes & Scarlett (1967). The excavation demonstrated the presence of moa bones, stone pavements, flaking floors, fireplaces, and built structures that were probably either cooking shelters or the remains of small huts. Artefacts recovered from the site were typically Archaic, and included adzes, fishhooks, and darts.

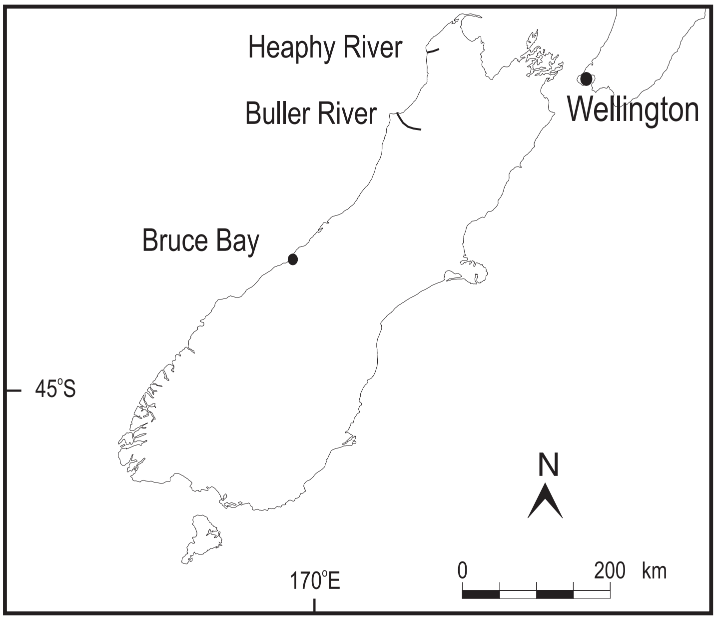

Figure 1. Locality map for the Heaphy River and places mentioned in text.

The site is unusual for two reasons. The first is because some of the artefacts were made of nephrite that had been worked by flaking rather than by sawing and polishing. The second is because of the presence of stone pavements, which are rarely found in New Zealand but are common in parts of Polynesia.

The site is currently eroding, and has been for a long time (Fig. 2). The erosion has exposed a section along the river bank that contains occupation remains (Fig. 3). Along the foot of the section at its eastern end are rounded beach cobbles, indicating that wave action from the estuary mouth has contributed to the erosion. The erosion is why the site was originally discovered, but is now threatening its continued existence. The West Coast Conservancy of the Department of Conservation is concerned to know how much site is likely to still remain, whether the erosion rate is increasing or decreasing, and what management procedures should be adopted for the site in the future.

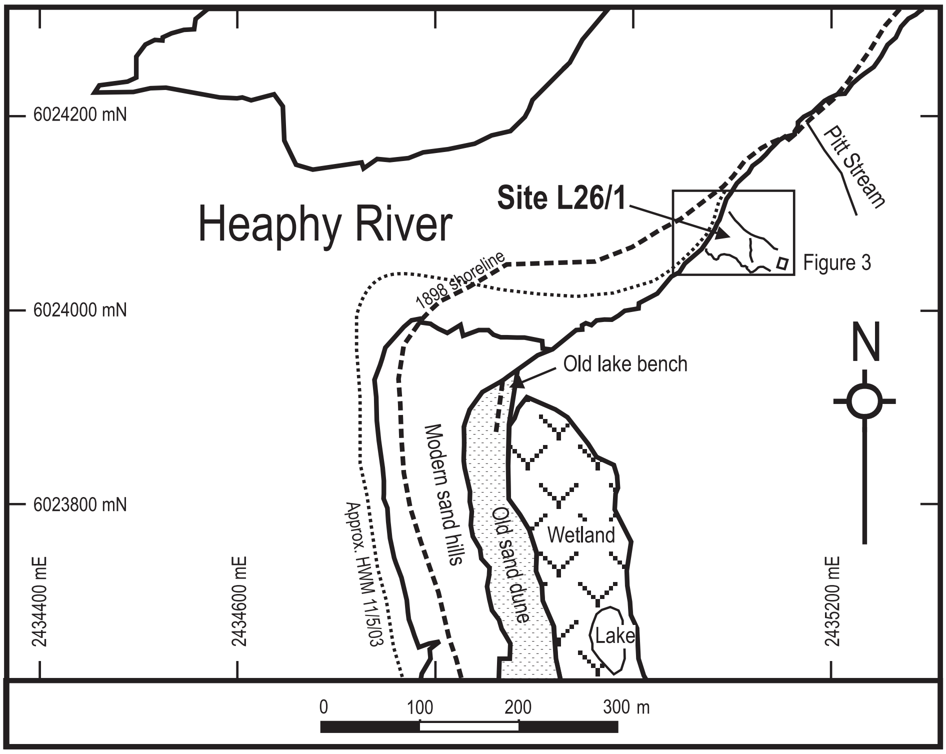

Figure 2. Heaphy River mouth drawn from aerial photograph SN C8922 L1/21 (1988), showing location of site L26/1and geomorphological features. Grid values in terms of NZ Map Grid.

Figure 3. Photograph of the Heaphy River estuary showing eroding river bank A–C, and the location of site L26/1.

2. Objectives

This report is in response to a West Coast Conservancy request to supply the following information about the site:

- A geomorphological context for the site and general locality, including: a description of how the landscape has formed; the probable dynamics of the locality over the past few centuries; and an outline of the key natural influences on landscape dynamics.
- An estimate of the present extent of the archaeological site and a record of what is currently exposed along the eroding bank of the Heaphy River.
- A comparison of the present remains with those from previous surveys, to gauge the impact erosion has had on the site over the intervening years.
- An assessment of the recent (last few decades) history of the site, with respect to types and extent of erosion, and nature of river and ocean dynamics.
- An assessment of the significance of what remains, both at an intra-site level and at a regional and national level.
- An assessment of the current stability of the site and general locality.
- An assessment of the probable future stability of the site over the next decade, and of the likely patterns of erosion and natural modification to the site. Include an outline of the probable type and magnitude of threats to the site in the foreseeable future.
- Recommendations for future archaeological management and investigation of the site.

3. Methods

Two days (10 and 11 May 2003) were spent at the site by eight people, including the authors, a representative from Ngati Waewae (the runanga with mana whenua over the land), and five DOC West Coast Conservancy staff. The present extent of the site was estimated from remains exposed in the eroding bank of the Heaphy River, and from test pits excavated to locate the site periphery. Account was taken of the geomorphology of upstream sections of the river, the estuary, river mouth, coast, and of sediments in and around the site, including Pitt Stream (Fig. 2), as an indication of the geological processes that may have influenced the location and extent of the site or the survival of archaeological remains. The exposed section along the river bank was cleaned with a spade and trowel, and drawn to scale.

All mapping was carried out using a Pro-XL GPS. Differential corrections from the GPS Control Wellington Base Station were carried out by Rob Curtis of Total Measurement Solutions, Lower Hutt. All GPS measurements were converted to New Zealand Map Grid, and are accurate to within 0.5 m. Where appropriate, measurements were also taken using a 30 m tape.

The impact of erosion was gauged:

1. From the relationship of Wilkes & Scarlett's (1967) excavations to the present position of the river bank, inferred from the remains of two infilled excavation trenches seen in section in the present river bank.
2. By comparing the position of the present river bank with: the surveyed position on an 1898 cadastral map of the Heaphy River mouth (SO5469), and aerial photographs taken in 1955 (E/8) and 1988 (SN C8922 L1/21).

The present position of the river bank was mapped using GPS. In order to compare the aerial photograph positions, three points on the ground that were identifiable on the 1988 aerial photograph were recorded and used to control the scale and position of the photo. The site is close to sea level and height distortion will be negligible. The photo was scanned at 300 dpi, and taking into account photo scale (1:15 000), positions estimated from the photograph are probably accurate to within about 3 m. Positions of identifiable points common to the 1988 and 1955 photograph were transferred to the 1955 photograph. The positions of the river bank on both photographs, assumed to be the edge of vegetation, were plotted and compared.

The 1898 map of the river mouth is in terms of an arbitrary datum, and traverse points could not therefore be mathematically converted to NZ Map Grid. Two points on the map were identified and co-ordinated from the 1988 photograph and used to control the scale and position. The points were about 1 km apart, one to the west of the site, the other to the east.

The south bank of the river recorded in 1898 was plotted from the map. What feature was actually mapped in 1898 is unknown, but because it marks the edge of a road reserve it is probably the top of the river bank. A direct comparison of the south bank of the river mapped in 1898 was then made with the aerial photographs, and the present day position.

The river bank at the site had been mapped in 1988, from a base line on a magnetic bearing from a corner fence post of a small paddock in front of the present DOC staff hut (Stopforth unpubl. 1988). An attempt was made to re-establish the baseline using tape and compass, and repeat the measurements. The bearing reported by Stopforth (unpubl. 1988), however, did not appear to match other data and no useful results were obtained.

The river bank had been mapped in 1985 by Jones & Hooker (unpubl. 1985) and their measurements were related to a group of stones, then 6.15 m from the river bank and 80 m from the nearby tramper's hut (Fig. 4). Subsequent measure-ments by Stopforth (unpubl. 1988) suggested that the stones were only 64.6 m from the hut. The stones have now been eroded away. The work described here indicates that Jones & Hooker's measurements were probably correct.

Site significance is based on the excavation report of Wilkes & Scarlett (1967) and an assessment made in 1985 by Jones & Hooker. Comparison is made with other sites in the area, and judgements of significance are made in terms of current understanding of New Zealand prehistory.

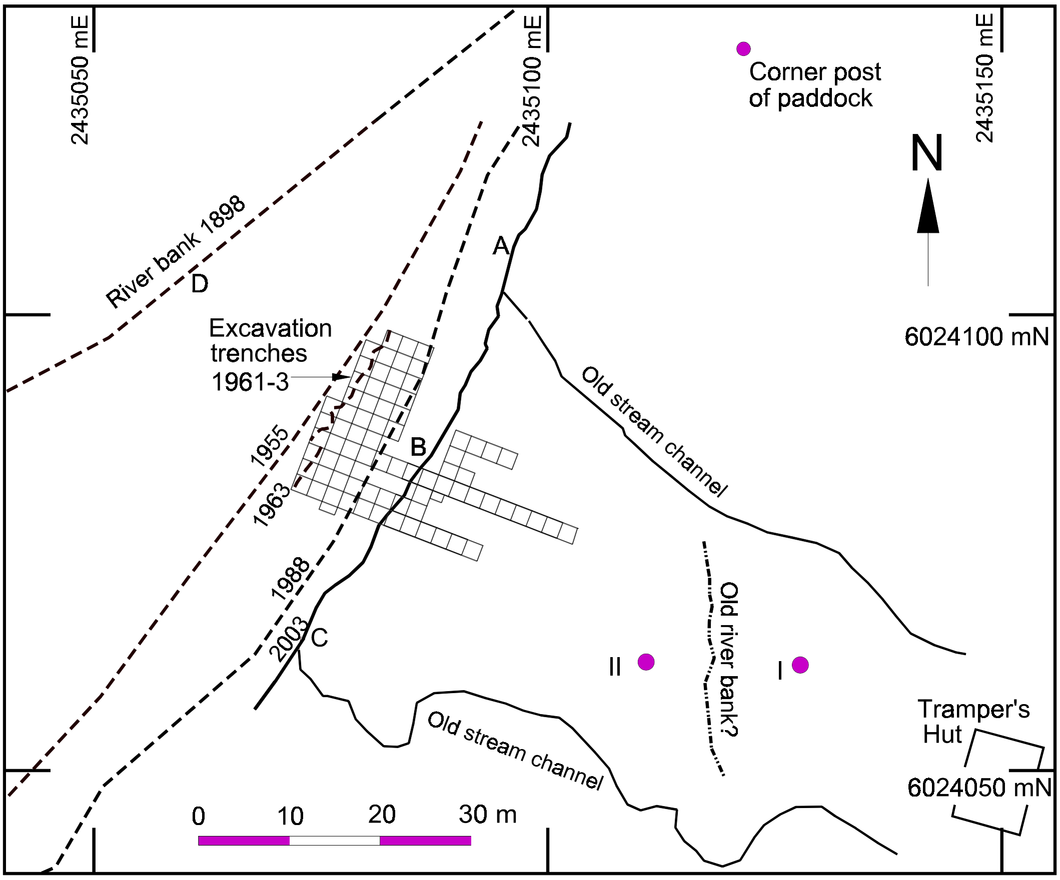

Figure 4. Position of Heaphy River south bank for the years 2003 AD, 1988 AD, 1963 AD, 1955 AD, 1898 AD. Excavation trenches are those of Wilkes & Scarlett (1967).
A–B–C = section shown in Fig. 5. B–D is line along which erosion is measured (Table 2).
Grid values in terms of New Zealand Map Grid.
II & I = test pits, with and without estuarine/marine gravels, respectively.

4. Results and discussion

4.1 GEOMORPHOLOGY

The Heaphy River has a catchment of approximately 400 km^2. The geology of the area is complex, but generally consists of Cretaceous diorites and granodiorites (Separation Point Suite) in the upper headwaters, late to mid Devonian granites and granodiorites (Karamea Suite) throughout the catchment, and the Eocene Brunner Coal Measures, bioclastic limestones, calcareous mudstones, and Quaternary floodplain material in the lower reaches (Rattenbury et al. 1998). The gross morphology of the river is governed by a combination of fluvial erosion along bedding planes, valley incision during glaciations, and fault control (see below).

Over the past few thousand years, changes in the general geomorphology of the region, and by association the Heaphy River, have most likely been governed by seismic activity (Goff & McFadgen 2002), with earthquakes feeding sediment into river systems via landslides, and rivers delivering this material to the coastal zone. Single landslides or floods (cyclonic or otherwise) represent lower magnitude, higher frequency events superimposed on this pattern. Sediment transport, representing both erosion and deposition, in the Heaphy River is therefore governed by pulses of material moving downstream through the point bar system (Fig. 5). During periods of high sediment supply, point bars are larger than normal, exacerbating the lateral, meandering flow of the river.

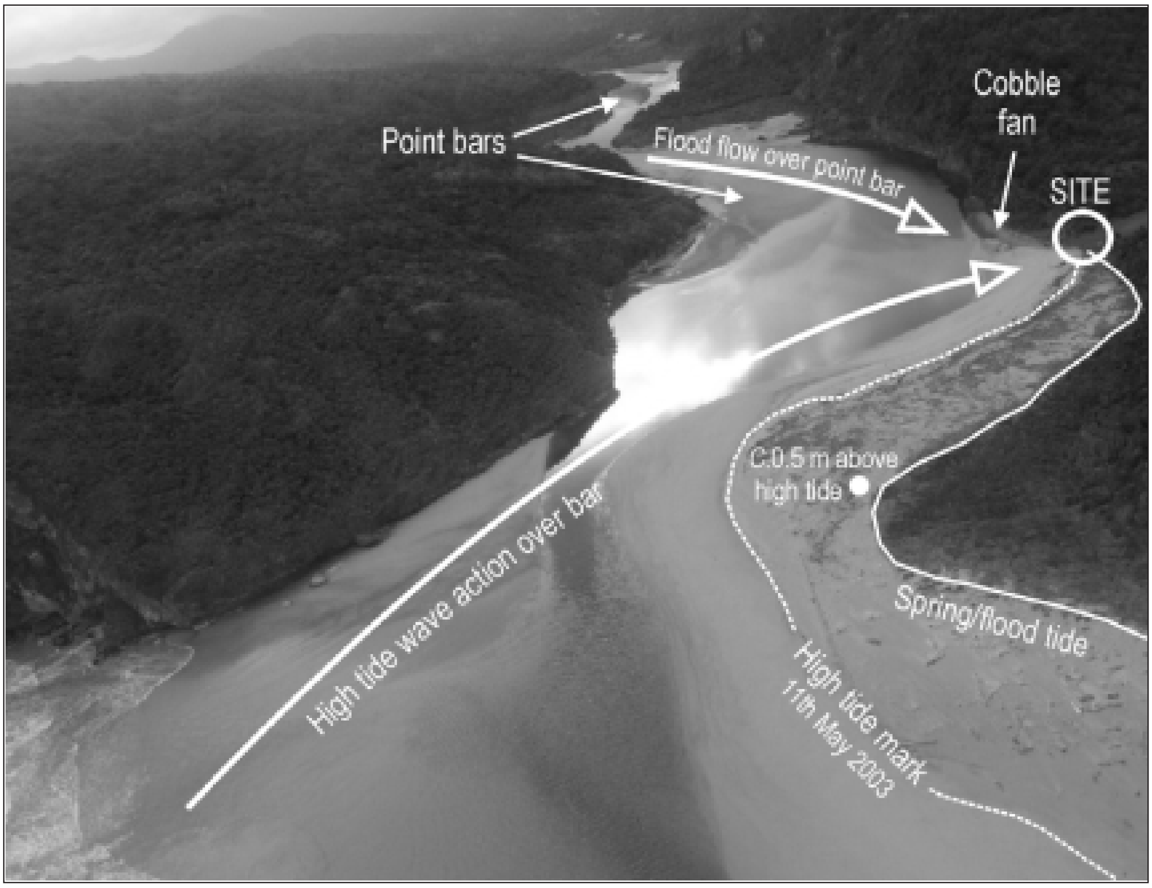

Figure 5. Aerial photo looking east showing the site with respect to major geomorphological conditions.

The lower reaches of the river adjacent to the site show evidence of these processes. Sometime prior to prehistoric Maori occupation there was an uplift event of approximately 3.2–3.3 m (see below) that appears to have confined the Heaphy River to its northern bank. Prior to this uplift, Pitt Creek was building an alluvial fan on the old southern river bank (Fig. 4) and it continued to do so in the new, uplifted, geomorphological setting. A cobble fan marks the current position of this feature (Fig. 5). Immediately upstream, point bars are extensive and are dominated by coarse sands and gravels, whereas downstream at the river mouth the spit consists primarily of medium to fine sands (Fig. 5).

In general terms, the geomorphology of the spit is governed by the interplay between fluvial and marine processes and their ability to transport sediment. In flood the river bursts through the spit, eroding vegetation, downwasting the elevation of the spit and at high tide the sea creates a marked erosional surface

(Fig. 5). During lower flows the spit starts to reform as longshore drift delivers more sediment to the river mouth. In storm events, northwesterlies in particular, the sea downwastes the spit, either breaching it or widening the tidal channel. The present morphology indicates the results of a recent storm with eroded foredunes to the south, a downwasted spit (about 0.5 m above high tide – 11 May 03), and a low bar with both flood and ebb-tide deltas indicating the recent washing of sediment into the estuary. At any one time therefore, the banks of the estuary are exposed to a combination of fluvial and marine processes.

The recent history of the site indicates that there were attempts to settle the area but that these were largely abandoned in the early 1900s, although grazing continued until 1985 (Table 1). A limited flood history indicates that there have been at least four major events, including Cyclone Bola, in the last 21 years. The overall physical processes acting on the site are a balance between the high and low flows of the river and the degree of wave action penetrating into the estuary. Low (river) flow conditions allow waves to build up the spit, encouraging ponding in the estuary on the landward side and lateral erosion of the river bank at the site. During flood flows the river erodes the spit and the southern river bank. Erosion of the spit allows the sea to penetrate more effectively into the estuary at high tide. In moderate conditions of both river flow and wave action the current stability of the site largely depends upon the morphology of the spit (moderate to near drought conditions applied during the site visit, although the spit appeared to have been recently downwasted by a storm).

TABLE 1. RECENT HISTORY OF THE HEAPHY RIVER AND AREAS ADJACENT TO SITE L26/1 (BASED ON CHALMERS, UNDATED; ANON. 1988).

DATE	EVENT
1864	Potato fields at river mouth
1893	Start of animal grazing
1909	Attempt to resettle the area
1909–14	Renewed land clearance
1929	Murchison earthquake
1982	‘100 year’ flood
1985	Major flood
1985	End of animal grazing
1988	Cyclone Bola
1990	Major flood

It is suggested that a relatively downwasted and mobile spit should be viewed as the norm. This reasoning lies in the fundamental drivers of sediment supply. Major sediment pulses are governed by seismic events and, on the scale of hundreds to thousands of years, changes in nationwide coastal geomorphology are in a relatively quiescent phase (Goff & McFadgen 2002). There is likely to be a lower than normal supply of sediment reaching the coastal zone and therefore features such as sand spits are becoming less stable (Goff et al. 2001). Conversely, coarser material has largely been deposited in river point bars, exacerbating river meandering. On a scale of decades the situation is similar. Fine sediment input related to the 1929 Murchison earthquake and probably most of that for the 1988 Cyclone Bola storm have worked their way through the fluvial system. Broadly, the sediment supply to the nearshore zone is therefore reduced and short-term fluctuations (monthly/yearly) need to be viewed with this in mind.

The current stability of Site L26/1 is governed by the geomorphology and physical processes discussed above. The cobble fan constructed by Pitt Stream (Figs 3, 5, 6 and 7) has served to protect the site during periods of low river levels and at low tide, although minor refraction of downstream flows have exacerbated erosion at the eastern end. During high river levels and at high tide, however, the fan does not protect the site. The material in the fan indicates that many of the terrestrial-derived pebbles and cobbles have been abraded *in-situ* to form material of apparent 'marine' origin. This abrasion occurs at high tide when wave energy is sufficiently strong to induce abrasion and hence most material of 'marine' origin is in the upper fan area, whereas that of 'terrestrial' origin (non-abraded) is beneath wave base in the lower fan. This indicates that wave energy is sufficient to not only cause *in situ* abrasion of large clasts on the upstream side of the site, but also to erode the less cohesive sediments of the river bank downstream. At high tide, waves entering the estuary refract around the sediment accumulated behind the spit and focus in on the site (Fig. 6).

Figure 6. Aerial photo looking south showing track of refracted waves that enter the estuary at high tide. The uplifted lake bench is shown (solid line), the possible southern extension (dashed line) and areas requiring more detailed geomorphological and archaeological investigation (question marks).

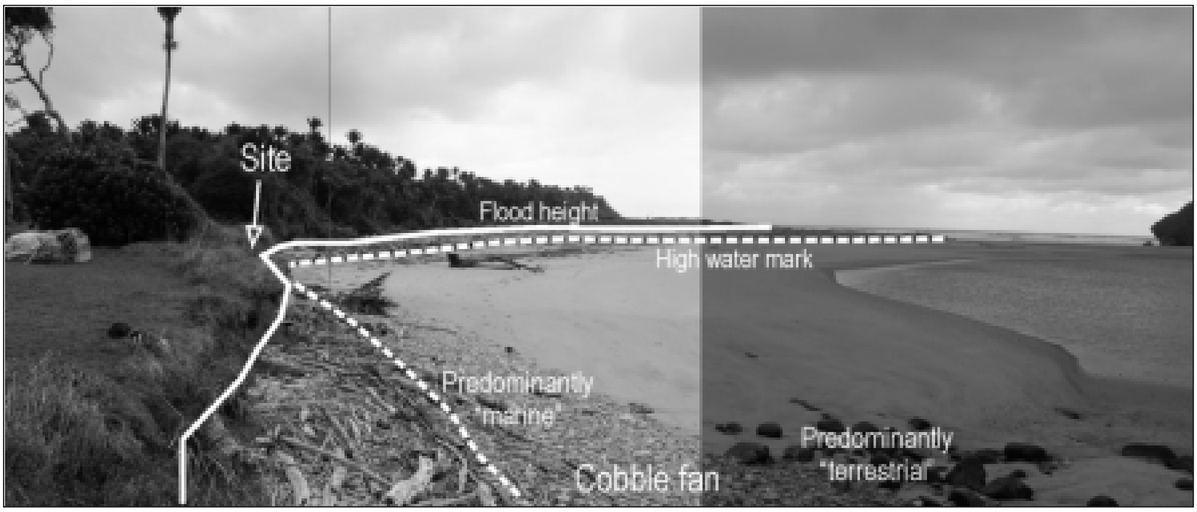

Figure 7. Photo looking west along the southern river bank. The cobble fan is in the foreground and the low-lying spit is in the background.

During both flood events and high tides, meandering river flows are directed by the upstream point bar into the same area of river bank, Site L26/1, the outside of the meander bend (Fig. 5). Contemporary high tide and flood levels are indicated by a line of organic debris and denuded vegetation respectively (Figs 3, 4, 6 and 7). These show that Site L26/1, and the general locality, are exposed to erosion from one or both of river and wave action during high tides on a daily basis. During periods of storm, river flood, and/or downwasted spit conditions the site will be more susceptible to erosion.

4.2 ARCHAEOLOGY

Site L26/1 is located to the south west of Pitt Stream that flows into the Heaphy River (Fig. 2). The stream has built a small fan comprised of stones, gravel and sand, that interfingers with estuarine/marine cobbles, gravel, and sand. The site is bounded to the east and west by dry stream channels. Seawards of the site, the river runs close to a wetland with a small lake, and previously cut across the northern end of a large sand dune, estimated to be several thousand years old, between the wetland and the sea.

The prehistoric occupation remains in the river bank (Fig. 8) are consistent with those reported by Wilkes & Scarlett (1967) and Jones & Hooker (1985), but they are less varied. They include remains of fireplaces, but no shallow pits, or parts of stone pavements. They are situated on a sandy soil that overlies the estuarine/marine and fan deposits. These deposits agree with descriptions of Wilkes & Scarlett (1967), and are broadly correlated with their estuarine and mudflow deposits respectively. To the west of the section, the deposits become very silty, they have a higher proportion of stream fan deposits, and there are no occupation remains.

Remains of the two infilled trenches from the Wilkes & Scarlett (1967) excavations, one about 2 m wide, the other about 4 m wide, were 2 m apart (Fig. 8). The number, size, and distance apart of the remnant trenches, place the

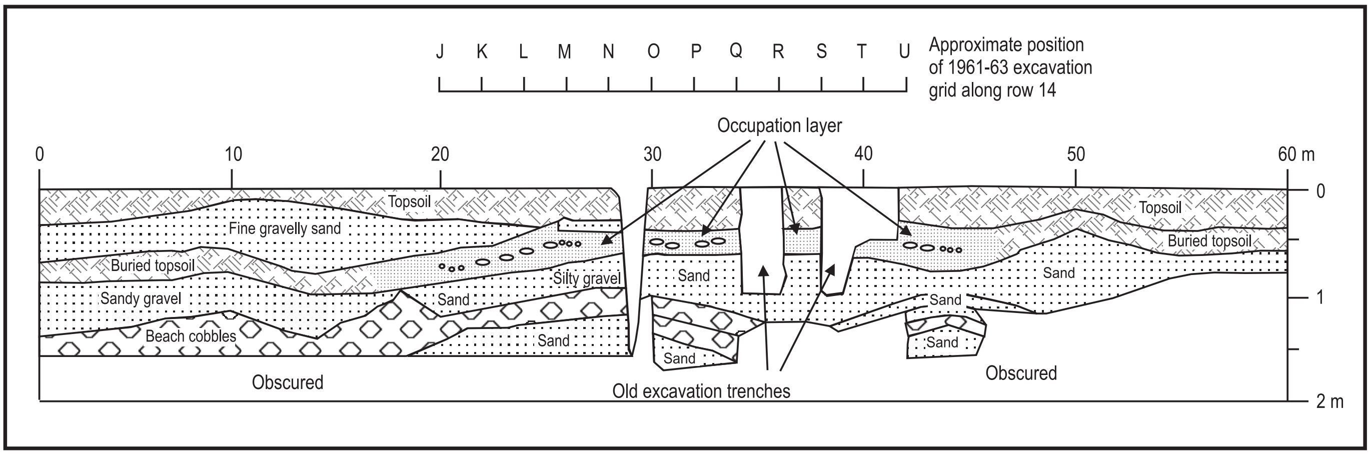

Figure 8. Sketch of the section at Site L26/1 showing occupation layer and other deposits, exposed in the south bank of Heaphy River.

present river bank somewhere along rows 13–15 of Wilkes & Scarlett's (1967) excavation grid. The eastern edge of the oven debris recorded by Wilkes & Scarlett (1967, fig. 5) cuts the rows at an acute angle. The distance of the eastern end measured from the nearest pit edge in the present section (Fig. 8) indicates that the present river bank is probably along row 14.

The present extent of the archaeological site (Fig. 4) shows that the site is located on an area of high ground between the two dry stream channels. Occupation remains in the section (Fig. 8) are restricted to the higher parts of the marine/estuarine deposits, and do not extend onto the lower slopes bordering the eastern stream. No clear evidence of prehistoric cultural activity was found in the banks of either channel. A small patch of blackened soil in the eastern channel might have resulted from cultural activity, but could also be due to natural darkening of the soil from plant growth. Inland, the occupation is bounded by a low rise in the ground surface that marks a deposit of alluvium, probably from Pitt Stream. Compared with the area of the site excavated by Wilkes & Scarlett (1967), less than half now remains.

There has been an ongoing erosion of the river bank at least since 1898 (Fig. 4). Along the line B–D (Fig. 4), the river bank has retreated a distance of 33 m, of which 13 m has taken place since 1955, and 5 m since 1988. The average annual erosion rate along B–D has been reasonably steady between about 0.24 and 0.35 m/year (Table 2), and can be expected to continue in the foreseeable future as long as the river bank is exposed to wave action from the estuary

TABLE 2. DISTANCES TO FORMER POSITIONS OF THE RIVER BANK FROM THE PRESENT RIVER BANK, AND INFERRED LINEAR EROSION RATES ALONG LINE B–D (FIG. 4).

YEAR AD	DISTANCE TO FORMER RIVER BANK (m)	INTERVAL (YEARS AD)	DISTANCE ERODED (m)	YEARS	LINEAR EROSION RATE (m/yr)
1898	33	1898–1955	20	57	0.35
1955	13	1955–1988	8	33	0.24
1988	5	1988–2003	5	15	0.30

mouth. The impact of the erosion has been to remove those parts of the site with extensive cooking remains and stone pavements. What is left of the site still contains stone pavements, ovens, shell midden, postholes, and stone flakes, but these are nowhere as numerous or extensive as they were 40 years ago. On the other hand, those remains that are left appear to be in an area that includes post holes that may represent structures such as houses or shelters.

The amount of erosion since 1898 supports the inference made by Wilkes & Scarlett (1967) that the site had once been considerably more extensive. They suggest that about seven acres of land (2.8 ha) were eroded following the 1929 (Murchison) earthquake, and that it was probable the site had covered much of this area. This would make the Heaphy River an important focus of prehistoric occupation, and enhance the significance of the remaining portion of the site.

The estuarine/marine deposits extend inland beneath the site as far as an old river bank (Fig. 4), a distance of about 35 m, and rise to a height of about 3.2 m above a similar deposit currently accumulating along the beach in front of the section. Their height is close to the height above high water mark of a wave-cut notch in the rocky shoreline just north of the Heaphy River estuary, and of an old lake bench cut into the old sand dune between the wetland and the sea (about 3.3 m).

The estuarine/marine deposits, wave cut notch, and old lake bench indicate that some time before the site was occupied the Heaphy River mouth was uplifted tectonically by about 3 m. As a result of the uplift, the estuarine/marine gravels would have provided a comparatively well-drained soil, and probably explain why the site was located at its present position. Rainfall at the Heaphy River mouth is high (between 3.2 and 6.4 m/year (Tomlinson 1976)) and the silty soils tend to get very puggy and inhibit drainage (Wilkes & Scarlett 1967), a condition that the estuarine/marine deposits would help to ameliorate.

How soon before the site was occupied it was uplifted is hard to say. The soil that has formed on the estuarine/marine deposits appears to be very young. There is some structure to the subsoil, mainly a weakly developed blocky structure with single grain, but this may be a result of the silt content as much as a factor of time. Charcoal was seen in the sandy gravel beneath the occupation layer, and is reported in a similar stratigraphic context by Wilkes & Scarlett (1967) who suggest that it may be cultural charcoal. If the charcoal is cultural charcoal, the uplift occurred after about 1250 AD, which is the currently accepted date for the Polynesian settlement of New Zealand (Anderson 1991, McFadgen et al. 1994). A single radiocarbon date for the site on shells (NZ509, 965 ± 68) calibrates to between about 1280 and 1465 AD. Uplift of the site shortly before it was occupied would have been an advantage to its inhabitants, because the young vegetation on it would have been more easily cleared than the more mature forest on older surfaces.

Pursuing this line of reasoning for a little longer, if good drainage and ease of clearance were important, then other uplifted parts of the river estuary would have provided similar advantages—in particular, the uplifted lake shore bench along the eastern side of the old sand dune (Figs 2 and 6). The bench would have had the added advantage of being close to the wetland with its attendant food resources, and it is possible that located on the bench there may be other sites similar to site L26/1. There may also be small pockets remaining of uplifted estuarine/marine deposits with archaeological remains on them. It would be worthwhile for the DOC to carry out a detailed site survey along the bench and around the estuary to see if such sites exist, because if they do, the pressure to respond to the destruction of site L26/1 might be reduced.

5. Future management options

Estimated erosion rates from 1898 onwards are reasonably consistent (Table 2) and there is no reason to believe that these will slow in the near future. In all likelihood rates may well increase. The river appears to be working its way southwards towards the old (pre-uplift) river bank (Fig. 4), although it could easily extend further south to form a lagoon similar to inferred pre-uplift conditions. Pre-uplift conditions most likely saw the river flowing southwest into a large lagoonal system ponded behind the old sand dune (Fig. 2) and then out to sea at about the present river mouth. Present river morphology and erosion patterns indicate that it is reverting to a similar form. This morphology appears to be determined by two overarching factors, upstream bedrock anchoring of the nearest point bar and an inadequate supply of sand to the spit. The former serves to focus river flows towards the site, and will continue to do so for the foreseeable future, and the latter allows the sea to penetrate into the existing lagoon, directing wave energy towards the site. This also seems likely to continue for the foreseeable future. Over the next decade or so there will most likely be similar or higher rates of erosion, with most of the remaining archaeological material being removed. Natural modification of the area will continue until either the next uplift event or the river mouth attains equilibrium morphology with its bedrock controlled flow patterns.

The geomorphological results indicate that Site L26/1 is under continued threat from erosion. This threat is likely to increase with time as natural processes continue to adjust to the prevailing physical conditions. If erosion were to continue at the present rate, all of the previously excavated area will be lost within 60 years. The most significant areas of the excavated archaeological site will be lost within the next decade or so.

The Heaphy River site is generally acknowledged by the archaeological community as a key West Coast site (cf. Davidson 1984). It is the only comprehensively known site on the West Coast (Anderson 1982). A similar-aged site at Buller River mouth has extensive Archaic remains (Orchiston 1974), but is unpublished and its remains are largely unanalysed; furthermore, the site is in private ownership and its current state is not known. Bruce Bay has early occupation remains (Jones et al. 1995, Allingham & Symon unpubl. 1999), but these have not been investigated in the same detail as the Heaphy River site. Unlike the Heaphy River, which is potentially within a climate zone that might support kumara gardening, Bruce Bay is too far south.

The site is an unusual example of an east coast style Archaic site in a west coast environment (Anderson 1989). It contains a variety of imported stone—Nelson argillite, North Island obsidian, chert, serpentine—as well as stone from West

Coast sources, suggesting that it is possibly an outpost of an Archaic exchange system (Anderson 1982). It is close to the northern limit of seal breeding about 1600 AD (Anderson 1997), and its content may have a bearing on the impact of human predation on seal colonies.

The significance of the site assumes that there are no other, similar sites nearby. Significance and future management options may need to be reassessed if other, similar sites are found in its vicinity, for example situated on the old lake shore bench.

Assuming that there are no other remains of similar age and character to the Heaphy site around the river mouth, then there are three options for the Department.

Option 1. Do nothing

This response might be appropriate if the site was now stable, but the erosion is ongoing. Therefore, considering the archaeological significance of the site, this option is not appropriate and is unlikely to be supported by the New Zealand archaeological community.

Option 2. Monitor the site

If monitoring is carried out in order to indicate when something important is exposed, then by the time a response has been organised to recover data the information has gone.

If regular monitoring is carried out to record information, perhaps in response to a research plan, the approach would be piecemeal for a situation that requires a comprehensive answer and for this reason is undesirable.

Option 3. Science-driven research

This approach acknowledges the importance of the site. It is pro-active, and intended to extract all possible information from the site in terms of current research issues, to benefit archaeological research and Ngati Waewae interests. Research design would require appropriate expertise from the wider archaeological community and Ngati Waewae. It might be considered desirable to plan the recovery of information in a staged programme that keeps ahead of erosion. Such a programme would ensure the survival of the more inland parts of the site for as long as possible, to take advantage of future research goals and new techniques of recovery and analysis.

DOC could organise, fund and carry out the work, or alternatively DOC could collaborate with universities and other external agencies such as museums, with shared organisation and funding. This would seem to be the preferable option as it involves DOC, the archaeological community, and Ngati Waewae in formulating a research programme, and shares the costs and research task between DOC and outside organisations.

We recommend that DOC carry out a detailed site survey of the estuary margins and uplifted lake bench. Then DOC and Ngati Waewae, in conjunction with the archaeological community, formulate a research programme to recover the remaining archaeological information from the Heaphy River site, and carry it out in collaboration with appropriate external organisations.

6. Acknowledgements

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7. References

Allingham, B. J.; Symon, A.J. 1999: Salvage excavation of a Fourteenth Century Midden at Bruce Bay, South Westland. Unpublished Report to Ngai Tahu Development Corp. Ltd.

Anderson, A.J. 1982: West Coast, South Island. Pp. 103–111 *in*: Prickett, N. (ed): The First Thousand Years. Dunmore Press, Palmerston North.

Anderson, A.J. 1989: Prodigious Birds. Moas and moa-hunting in prehistoric New Zealand. Cambridge University Press.

Anderson, A.J. 1991: The chronology of colonization in New Zealand. *Antiquity 65*: 767–795.

Anderson, A.J. 1997: Prehistoric Polynesian Impact on the New Zealand Environment: Te Whenua Hou. Pp. 271–283 *in*: Kirch, P.V.; Hunt, T.L. (eds): Historical Ecology in the Pacific Islands. Prehistoric Environmental and Landscape Change. Yale University Press, New Haven.

Anon, 1988: Heaphy River and its effect on the Moa Hunter site, as at 1 April 1988, L26/1, 1 p.

Chalmers, B. (compiler) undated: The Heaphy and its people. New Zealand Employment Service and the Lotteries Commission.

Davidson, J.M. 1984: The Prehistory of New Zealand. Longman Paul, Auckland.

Goff, J.R.; McFadgen, B.G. 2002: Seismic driving of nationwide changes in geomorphology and prehistoric settlement – a 15th Century New Zealand example. *Quaternary Science Reviews 21*: 2313–2320.

Goff, J., Nichol, S.; Chagué-Goff, C. 2001: Environmental changes in Okarito Lagoon, Westland. *DOC Science Internal Series 3*: 30p.

Jones, K.L.; Hooker, R. 1985: Report on Heaphy River archaeological site inspection L26/1. Unpublished report, Department of Conservation, Hokitika.

Jones, K.L.; Hooker, R.; Anderson, A.J. 1995: Bruce Bay Revisited: Archaic Maori Occupation and Haast's 'Palaeolithic'. *New Zealand Journal of Archaeology 17*: 111–124.

McFadgen, B.G.; Knox, F.B.; Cole, T.R.L. 1994: Radiocarbon calibration curve variations and their implications for the interpretation of New Zealand prehistory. *Radiocarbon 36*: 221–236.

Orchiston, D.W. 1974: Studies in South Island, New Zealand, Prehistory and Protohistory. PhD Thesis, University of Sydney.

Rattenbury, M.S.; Cooper, R.A.; Johnston, M.R. (comp.) 1998: Geology of the Nelson area. Institute of Geological & Nuclear Sciences, Lower Hutt, New Zealand. 1:250 000 Geological Map 9.

Stopforth, N. 1988: Heaphy River, and its affect on the moa hunter site, as at 1 April 1988. L26/1. Unpublished notes, Department of Conservation, Hokitika.

Tomlinson, A.I. 1976: Climate. Pp. 82–89 *in*: Wards, I. (ed.) New Zealand Atlas. Government Printer, Wellington.

Wilkes, O.R.; Scarlett, R.J. 1967: Excavation of a moa-hunter site at the mouth of the Heaphy River. *Records of the Canterbury Museum VIII (3)*: 177–208.