Return to previous file: Part 1

Figure 5. Typical branching tracks in summer (left) and winter (above) on One Tree Hill. The multiple tracks are formed because people prefer to walk on a grassed surface rather than a muddy or dusty one. The solution is to limit visiting, or to re-route and re-design the track so that people are comfortable walking on it. *Photographs: Dianne Harlow.*

- Damage caused by any kind of machinery use including bulldozing, ploughing, stump pulling and posthole diggers

1.5.2 Past disturbance and soil formation

The modification of a land surface did not end when its first occupiers departed. In hill country, pre-European sites commonly had a grass, bracken (*Pteridium esculentum*), shrubland and forest succession from the 1820s to the 1840s—a period of rapid population decline and radical changes in settlement pattern for Maori. This forest probably lasted for up to a century until the 'breaking-in' of hill country for farming from the late nineteenth century through to the 1940s. Most sites will have experienced some soil development under these vegetative covers, even without major disturbance such as tree throw.

There are many soil-forming forces at work on archaeological sites. The chemical and physical constituents of the soil break down through weathering and some are leached out of the soil. Trees are felled by the wind. Soil animals live within confined surface horizons, and in some areas of the country wild pigs root for their preferred foods. All the above processes are accompanied by soil development. However, it must be remembered that most of the biological activity is in the topsoil and is inevitable. Topsoils will have formed beneath the bush that covered many archaeological sites before farm development or plantation establishment. Such soils will vary in depth and may contain archaeological evidence. Generally, the topsoil provides a protective blanket for all but the most fertile and deeply buried of the old soils or fill preserved in the archaeological site. The surface of the topsoil may show depressions or humps that indicate the presence of a pit or a mound or other sub-surface features beneath it.

An understanding of modern disturbances of the soils on archaeological sites is important when deciding on appropriate management. If a site has been deeply cultivated, pig-rooted, or if large trees have grown on it in the past, it may reasonably be argued that further root growth can do no further harm and trees may be allowed to grow. The interiors of pa have warm, fertile and often sheltered soils. Since abandonment, the surface layers may have been cultivated—initially through Maori horticulture in the early to middle nineteenth century, and then by European arable farming.

Erosion products have buried all or part of some sites, protecting them beneath a robust mantle. Elsewhere, erosion may be removing or destroying some sites, leaving little of archaeological value. Any sort of disturbance of the soil degrades the surface profile of a site.

The following is a generalised history of rural sites from about A.D. 1820:

- Repeated fires sweep through site, destroying wooden structures
- Short-lived fire weeds and grasses establish
- Pits, trenches, depressions, holes fill in and form a stable profile
- Bracken/manuka cover develops
- Banks, first rapidly, then gradually, attain a more stable profile and angle of repose
- Forest becomes established
- Long-term slow forest processes are established
- By 1890–1910, land containing sites is either reserved or subject to forest/shrubland clearance and farm development
- The latter causes rapid changes to soil surfaces and greatly increases erosion

Later, remnant patches of forest, unsustainable farmland that has reverted to shrubland, and farmland itself, can be subjected to more intensive uses. Plantation forestry introduces roads, farmland may be more closely fenced, and fertiliser and stocking density increases. For a number of reasons, the decades since 1945 have seen great increases in the intensity of land management which have been destructive and continue to have potential to cause more destruction. These influences include farm re-settlement of soldiers after WWII, land development grants, lifestyle blocks, bulldozing and ploughing technology improvement, and changes in product demand (e.g. from sheep to cattle, from grazing to arable). Greater efficiency and profitability is unavoidable, but it does not need to be accompanied by destruction of archaeological values.

1.6 CONSERVATION PLANNING

The ICOMOS New Zealand Charter stresses the need for close consideration and documentation of the values and management intent behind stabilisation or restoration, and the need to document any changes made. When the values and physical features of a place have been documented, it is possible to develop a conservation plan (Kerr 1996). Examples are the Pukerangiora Pa and Te Koru Pa conservation plans (Department of

Conservation 1998, 2000). At this stage also, the management agency or landowner should have given an indication of the resources that are available for the proper conservation of the place. Some interventions may have technical merit and be feasible, but they may not be possible because of cost.

Under the Reserves Act 1977 (s. 41), all reserves should have a management plan which specifies conservation practices at the reserve. The Department of Conservation, Queen Elizabeth II National Trust, the New Zealand Historic Places Trust and most local government agencies will also have some form of over-arching management strategy and specific plans for land and sites under their management or covenanted with them. International models such as those of English Heritage (1999) also have potential application.

There is no statutory requirement for plans—formal or informal—for freehold land where there are archaeological sites. However, the Historic Places Act 1993 gives protection to all sites. District plans will also often have provisions requiring protective measures for sites. A minimum plan for good freehold land management which accommodates archaeological site protection is given next.

1.6.1 Minimum management requirements for archaeological sites

- Are there any sites on the land?
- What are they?
- Where are they and what is their extent?
- How important are they?
- What risks are there to site condition?
- Can they be effectively managed within the general farm or forest operation?
- What operational measures or expenditure (e.g. on fences) is needed to protect the site?
- Where can advice be sought on the above matters?
- Is there financial or other assistance available?

1.7 INTERVENTION

Intervention is any action taken to improve the condition or reduce deterioration of an archaeological site. Intervention may include ceasing any activity which is causing damage to a site. Intervention is one of the key deliberations framed in conservation plans. Planning philosophy stresses the importance of the decision as to whether or not to intervene (e.g. ICOMOS New Zealand 1992). For archaeological sites, relevant matters to be taken into account are:

- Review of the values and a cultural or scientific assessment of the site
- Management intent—what is being sought by intervention and site management?

- Consultation with tangata whenua
- Are there any requirements for authorities/consents under the Historic Places or Resource Management Acts?
- The likelihood and rate of change to site condition with no intervention
- The impact of intervention on the values of the site
- The proven long-term reliability, cost, and cost-effectiveness of the technique used
- The need to monitor and record the effectiveness of the intervention
- The impact of intervention on non-archaeological values of the site and its environs (e.g. the flora or broader ecological processes)
- Public attitudes toward intervention—public education or information may be needed to explain the intervention

When is intervention warranted?

Intervention is warranted to achieve these outcomes:

- Prevent degradation of archaeological layers
- Manage vegetation cover that is, or will become, unstable
- Maintain clear definition and surface visibility of earthworks for public appreciation
- Close off features from public access or viewing
- Encourage greater public visitation
- Maintain views of the site, and views from one site to another
- Stabilise backfilled archaeological excavations
- When monitoring shows that damage to a site is occurring, particularly when the condition is accelerating or worsening rapidly
- When minor damage can be easily and effectively arrested

Intervention may be warranted to protect one or a combination of the following: surface features, stratigraphy, ruins and excavated sites which have been left open to the elements, or backfilled archaeological sites. Restoration and repair are also justified for earthwork sites damaged by machine work, animal or human tracking, or natural processes such as tree throw.

Some modification and even deterioration of sites visited by the public is inevitable. The benefits for conservation to be gained by greater public awareness will outweigh the disadvantages. The deterioration, however, should be made good at regular intervals so that the public gains an impression of care and concern for the archaeological values. An obviously damaged site will suggest to the public that the site and others like it are unimportant. Also, destruction left by vandals leaves an impression of lack of care and the site is more likely to suffer further deliberate damage—vandalism breeds vandalism.

The archaeological ideal is to establish relatively permanent vegetation which will preserve the site indefinitely by preventing erosion, but which will not cause damage by invasive large roots. As a general rule, stable cover means a stable site underneath (Jones 1998). An existing native forest has probably taken 100–200 years to establish on a site and is generally stable. There are few grounds for removal of such forest—equally there are limited grounds for attempting to establish new native forest on sites. On some sites which are not to be interpreted for public visiting, it may not matter if the views of the site are obscured by dense bracken or manuka. However, in many cases it is desirable to maintain earthwork sites in a condition where they remain visible from a distance, even if not accessible to visitors. Particular forms of vegetation can be established on sites where the public are to be kept out. Thick shrubland or gorse (*Ulex europaeus*) are examples: these are usually successional species in most parts of the country and will inevitably be invaded by larger shrubs and trees with potentially damaging roots. In the course of a vegetation succession, management should generally be aimed at retarding the development of larger trees within areas of intact archaeological sites. The growth of trees may be more acceptable in damaged areas or on immediate site boundaries if root spread problems have been considered (Crow & Moffat 2005).

For sites which are to be presented to the public, a different kind of vegetation and management will be needed. Grass cover, with or without patches of treeland, or an open, managed treeland are vegetation types most suited to the needs of visitors.

Small incremental changes, reversibility of method (or reversibility by relaxing of vegetation management), and improved monitoring effort are the key steps forward.

When is intervention not warranted?

Intervention is not warranted when:

- Following a period of monitoring, the site is judged to be in stable condition
- There is a high risk of intervention causing damage or catastrophe owing to lack of knowledge of the site or ecological setting
- There are no patches of active erosion
- There is no risk of earthmoving equipment gaining access (e.g. during fighting fires or to remove gorse)
- There is stable native vegetative cover—climax forest or advanced succession
- There are no damaging weeds present and the site is not a source of weeds of concern to adjacent landowners
- There is an expression of wishes by tangata whenua, or from other culturally appropriate practices, against intervention
- Ease and simplicity of management are required (i.e. no-care management)

1.8 MONITORING

Monitoring is essential in most site management. Monitoring is of particular importance because almost all of the technologies in use for archaeological conservation do not have proven long-term effectiveness. It is needed to judge the stability of the site. It allows reflection on the values of the site and the complexity of the forces which may be at work and causing damage. Detailed regular monitoring should be carried out on sites of high significance. Sites of lesser significance should be monitored at longer intervals, or when there is reason to believe that deterioration is accelerating.

For sites under active management, the functions of monitoring are to:

- Assess how effective management techniques have been, and whether further inputs are required
- Detect whether further action is needed and take steps to see that it is carried out
- Assist in determining whether a particular management technique has wider applicability

Every site that is under a regime of managed care needs to have a formal review (preferably annual) of earthworks or site condition, evaluating the existing conditions. Special attention should be paid to conflicts between access and condition, the appropriateness of infrastructure, current maintenance operations (e.g. mowing or line-trimming), and the causes of any damage. The goal is to clarify and amend future work programmes, conservation plan annotations, mowing plans, etc.

Figure 6. Monitoring wattle blown over on Matekerepu Historic Reserve, Bay of Plenty. The wattle has grown from seeds fallen into cattle-pugged areas of a former grazed grassland. Although part of a process of natural soil formation and plant succession (in this instance, to coastal hardwood forest), this type of damage is unnecessary and can be controlled on archaeological sites.

Any acceleration in the rate of movement, or cracking of the soil or soil surface, should be examined for possible causes. The rate of acceleration may give a clue as to whether catastrophic failure is possible. However, most of the damage done to sites is creeping and accumulative. Fretting (patches of surface erosion) are cause for concern because they are the clearest indicator of a process that in the long term will accumulate severe damage. On many earthwork sites it is possible to observe small areas under active erosion (e.g. where a foot track goes over a bank or where the bank is undermined by sheep camping). In some instances, the erosion will heal by natural processes. In others, some intervention is needed. In yet other instances, the eroded profile may be more stable and intervention in the erosion process will interfere with the original fabric, introducing the need for costly long-term maintenance. Another frequent cause of disturbance is the growth of tree weeds (Fig. 6). In time these will become unstable and will be toppled by high winds.

The choice of monitoring technique is not as important as the specification of points on a site at which observations are taken. All monitoring requires accurate site plans on which photo points, written notes, sketches, other measurements, or installations can be located. For monitoring to have long-term meaning it is important the points used each time are the same, so that comparison over time is possible. In relatively featureless ground, accurate central points and perimeter boundaries need to be determined by GPS so that the site can be re-located. The Pukerangiora Pā Historic Reserve Conservation Plan (Department of Conservation 2000) contains a detailed plan of the site with extensive notes on condition, based on low-level aerial photographs and ground inspections, with archived photographs.

Monitoring reports should be kept so that they can be referenced to see changes. For institutions, this can be in files that will be archived. Reports on the condition of sites are welcome in the New Zealand Archaeological Association site recording scheme, filed under the site number (see www.nzarchaeology.org/recording.htm).

Monitoring methods are the subject of ongoing research and development of operating procedures by DOC and by the Auckland Regional Council (Walton 2003).

2. Management issues and conservation techniques

This part of the guide concentrates on techniques to manage archaeological sites that will be applicable to a wide range of different ecological settings. It deals first with erosion control, followed by vegetation and ecologically appropriate methods. Then a range of broader environmental influences that raise management issues (such as burrowing animals) are covered. Physical methods of site protection and issues which arise in restoration and reconstruction are also covered briefly.

The primary focus of most of the techniques is on erosion control. There will generally be no single solution for any particular problem. Land managers must assess the factors affecting the site and determine their own course of action. It must be remembered that these are guidelines, not certain solutions. One advantage with archaeological sites is that usually the area to be dealt with will be small, and labour-intensive methods which could not be used on large areas may be quite practical for conserving the archaeological values of a site.

2.1 EROSION CONTROL—GENERAL CONSIDERATIONS

Erosion of archaeological sites by wind, water, and slope movement is a frequent cause of their degradation or loss (Fig. 7). This section is an introduction to the protection of sites from erosion, with some advice on where assistance might be obtained.

Figure 7. Ill-advised planting of trees is failing to protect this deep, rapidly eroding midden at the mouth of the Waiotahi River, Bay of Plenty.

2.1.1 Wind

Wind erosion in New Zealand often affects sites in dune areas which were occupied when the dunes were stable, but are threatened when the dunes re-mobilise. Sites can be damaged by sand removal from the surface, or by being undermined from the margins. Active dunes bury existing vegetation and then move on, leaving the site exposed and putting even apparently stable sites at risk. Midden sites which become pedestals with a cap of shell or stone protecting a small area of sand beneath them (but generally being undermined all around) are usually beyond protection.

The causes of sand erosion can be remote from the site and connected with sea erosion of foredunes, vegetation loss some distance from the site, and overall changes in sediment supply to beaches. Large-scale movements covering tens of hectares or more require major efforts to manage, and are the province of local or national governments rather than individual landowners. Localised efforts to control erosion within large sand dune areas may succeed for a period, but in the long term are usually to no effect. Sometimes, however, the problem may be of a smaller scale and interventions, such as local planting and fabric-covered fences transverse to the prevailing wind direction, can be effective in aiding restoration, provided the fundamental initiating cause is also addressed. Soil conservation officers in regional councils may be a source of advice for good practice appropriate to a local area. Vegetative methods, such as a succession of marram grass (*Ammophila arenaria*) followed by lupins (*Lupinus luteus*), have been successful over much of New Zealand. Such interventions usually require monitoring and maintenance beyond their initial construction, and can be undone by one extreme storm. The New Zealand Forest Service stabilised dunes by planting a sequence of marram, lupin, and then *Pinus radiata* in a number of large-area programmes. Marram grass can create high unstable dunes and, being an exotic, is no longer encouraged as a method of stabilisation. Recommendations on native sand-binding plants (Bergin & Herbert 1998; Bergin & Kimberley 1999; Bergin 2000) should be read in the light of the severe long-term processes that are at work on the coast.

2.1.2 Rivers and streams

Erosion of banks by rivers and streams is a natural phenomenon and any control measure needs to be based on a knowledge of the whole of the catchment and the floodplain, not just parts of the bank. Most waterways move course by meandering across a plain. Any intervention to limit that has to be of a scale commensurate with the size of the plain over which the stream or river is moving. Sometimes bank erosion is human-induced because of a failure of understanding of the wider system. Measures taken upstream to confine a stream or river within banks can have downstream consequences of more erosion. Discharges of stormwater drains can cause local erosion. Changes in land use, such as urbanisation, can increase flood peak flow rates and increase the energy the stream has available to apply to bank erosion.

Effective local interventions can be made through river training and bank protection. Interventions within waterways are subject to the Resource Management Act 1991 controlled through regional councils. Councils will also give advice on what waterway erosion control methods are effective and permitted. Willow plantings, which can be effective in stabilising banks, are not permitted in some areas because of the consequences of their spread.

2.1.3 Coastal erosion

Erosion of archaeological sites—which may be part of beach deposits or on top of slopes and cliffs—is a common experience in New Zealand. It is one which is likely to increase, if and when global warming causes sea level to rise. As with wind erosion, the underlying systems of coastal currents, sediment supply and removal are complex and cover a large area. Small local interventions may not work. Severe erosion events usually result from a set of conditions: high tide, currents, particular wind direction and strength, and large waves and storm surge, especially when low atmospheric pressure causes a rise in sea level. Waves are never all the same size. Protection is needed against the largest and most infrequent, not the average wave.

On 'high-energy' coasts—where breaking waves are continuous or common—the design criteria for sea defences must give permanent protection against substantial waves combined with storm surges. Such structures are very expensive and are usually only affordable when very valuable real estate lies behind them. It is common to see under-engineered structures (built in an attempt to protect property) which fail in the next large storm. The cost of failure is multiplied by the loss of what has been assumed to be protected; often new structures that have been built behind the under-engineered structure.

Interventions can include groynes to trap sediment moving along a beach, off-shore artificial reefs to break waves before they reach the shore, addition of sediment to beaches, and sea walls (Fig. 8). The last

Figure 8. Rip-rap sea wall protecting areas of the site of Tokitoki, Ohiwa Harbour.

of these poses particular problems. Sea walls reflect waves and cause greater turbulence and erosion immediately in front of them; they often fail through being undermined by such erosion; and they often fail to retain the beach material behind them and the erosion continues despite their presence. Specialist engineering advice is needed for any of these structures.

Erosion of soft-rock cliffs can often be stopped by quite modest interventions of sea walls, particularly in more sheltered waters. Toe protection for the wall is important. It must be remembered that the slope behind such a wall will not usually be stable in the long term. While erosion may have been slowed, it will not stop as the slope evolves to a flatter, more stable profile.

Interventions in the coastal zone are subject to Resource Management Act 1991 controls through regional councils. Councils are a source of advice on coastal erosion problems and are also responsible for permits.

2.1.4 Erosion along the shores of lakes and reservoirs

Wave erosion on the shores of artificial reservoirs built for water supply or hydropower can expose and damage archaeological sites. Because sites tend to be near rivers, they may be submerged near the dam, but exposed to erosion in the strand line further upstream at the other end of the lake. The interventions needed in these circumstances can be quite modest compared with sea defences, but the same methods apply. Some ruins (such as foundations) may be strong enough to be left in the strand line—for example, the structures of old Cromwell on the shoreline of Lake Dunstan, Central Otago.

2.1.5 Slope failure

Slope movement is common in New Zealand's broken topography, and can take many forms: some may be shallow, some deep-seated. The mechanical properties of the slope will vary depending on the type of soil or rock involved.

A common cause of damage to New Zealand archaeological sites is slope movement where tracks or roads have been cut into the sides of sites, leaving over-steepened slopes which are slumping or fretting back to a flatter profile. Maintenance of the road or track by removing any accumulating sediment will keep the process active. One possible intervention is to decide whether the road is necessary and to either backfill the cut, or stop the removal of debris to allow natural re-stabilisation.

Anther intervention is to stabilise the slope. Where slumping is happening, possible interventions include re-shaping, re-filling using appropriate methods (where small areas are concerned), drainage (if water is a factor), toe-weighting, and gravity retaining walls. Engineering advice is needed to assess the problems and for the design and construction of these interventions.

Where surface fretting is taking place, vegetative control methods can be effective. Retaining vegetation at the top of the slope, and providing a more sheltered environment on the slope are important measures. Hydro-seeded grass can be helpful in starting the process of revegetation on areas of bare ground, but in the generally infertile soil exposed in cuttings, grass may only survive as long as the fertiliser applied with it lasts. A succession to vegetation tolerant of the soil conditions is needed. Studying the methods applied on local public roads—particularly where these have been in place for several years—will give ideas on what is effective with the local soils and geology. Roadsides are especially useful because they receive little or no grazing and are cut infrequently (Jones 1988). In this respect, they match the general recommendations of these guidelines for archaeological site management.

2.1.6 Freeze-thaw

In Central Otago and on the North Island's volcanic plateau, frost may cause damage to stone and earthwork structures, earthen mortars, and bricks. The moist, lower parts of a structure may freeze. The water in the structure expands as it freezes, expanding the soil volume and displacing it. On thawing, small amounts of surface soil fall away. In the course of many cycles of freeze-thaw, large volumes of soil may be removed, giving rise to a characteristic hollowing and undercutting of the base of walls. It may be mistaken for pig-rooting. If similar damage can be seen in road batters in the district, then it is likely to be freeze-thaw. The solutions are literally 'stop-gap' ones:

- Maintain a convex surface on the top surface of the bank or wall by adding limited amounts of topsoil and plant some water-shedding vegetation such as grass or flax (*Phormium cookianum*).
- Avoid placing too much topsoil mass on the top of the bank, except the limited amounts needed to maintain the convex surface.
- Keep the grass long on the tops of banks and line-trim annually after the main visitor season.
- Place a mulch (e.g. from line-trimmer debris) in and at the base of the hollowed-out area and do not line-trim in these cavities.
- Discourage people from walking on the bank by keeping grass long, by not providing easy access to problem parts of the site, and by signs asking people to stay off.
- Reconstruct or restore only if the bank does slump completely.
- Pack the overhang at the base of the bank with vegetative matter to reduce the effect of frost.

2.2 VEGETATION MANAGEMENT FOR SITE PROTECTION

For any particular site, a land manager has to predict what the future development of the vegetation is likely to be if it is either left to its own devices, or subjected to some form of management. Such assessments may require input from a botanist or an ecologist with an understanding of the development of the local vegetation. Whatever form of vegetation

Continue to next file: Part 3