3. Management of archaeological sites under particular land uses: reserves, farming, forestry

Archaeological sites may be found under most land uses. This part of the report gives specific guidance to reserves and amenity managers, farmers and foresters. Its three main sections should be able to be read independently. The sections read together will provide a full grasp of the topic of practical site conservation.

3.1 SITES MANAGED AS AMENITY AREAS OR RESERVE LANDS WITH PUBLIC VISITING

On a small number of selected and accessible sites, land managers may wish to carry out a more intensive form of management which allows for higher numbers of visitors. As few as 20 people per day can create bare patches or informal tracks on a grass sward. As a general rule, any reserve with more than 5000 visitors per annum will need careful planning of visitor tracks and other facilities.

Picnic grounds have destroyed many archaeological sites, since modern-day picnickers like the same sheltered spots that were favoured by Māori and early European settlers. Where an archaeological site is to be presented to the public it should be assumed that there will be particular parts which come to have much use by families with small children. Anything which could be dangerous for small children, such as some types of herbicide sprays, or holes concealed by vegetation, will have to be avoided. Even banks of sand or loose pumice which children may tunnel into while adults are picnicking can present dangers.

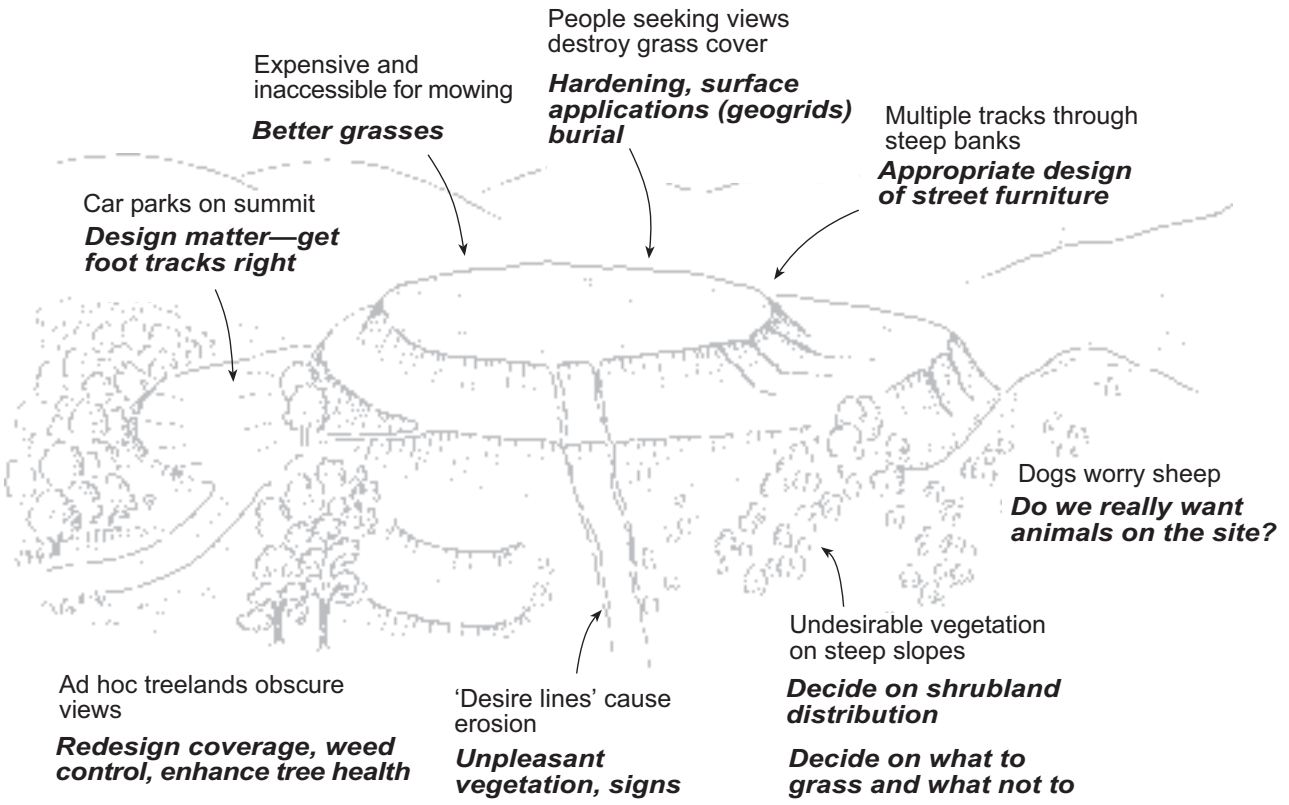
Figure 30 shows typical problems and possible solutions for a large reserve area containing archaeological sites and to which the public has access. Important issues are:

- How the public get access from the road end and while on foot; understanding the behaviour and needs of the public in general
- The maintenance of grasslands, shrublands and treelands and their role in ensuring site protection
- The design and utilisation of signs and other structures such as boardwalks, viewing areas, and barriers.

3.1.1 Public access and use

Monitoring and surveys should reveal the use people make of the reserve and how facilities could be improved. Desire lines are a common phenomenon: tracks made by people as they follow what is perceived to be the best or most interesting way around the site. These should be studied quite closely for two reasons: first, to gain an understanding of people's use and intentions and

Figure 30. Problems and solutions at landscape scale.



second, to divert the traffic in a realisitic way or to improve the track alignments and construction (Fig. 31).

Tracks and roads/carparks

Benched tracks need to be routed carefully so they do not destroy archaeological features such as banks, ruins or middens. All tracks on archaeological sites should be lightly cut into the surface (or not at all) and have a geosynthetic cloth between the topsoil surface and any track-surfacing material such as gravel. This minimises not only disturbance of the site, but also the amount of gravel needed. Care is also needed with drainage of tracks. A geosynthetic can be laid on the undisturbed soil surface and gravel laid on the surface of the geosynthetic. This creates a durable track surface with a minimum thickness of gravel and no risk of the gravel being absorbed into the soil surface. Under- or cross-track drainage can be provided by geotextile 'tubes' buried beneath the surface gravels, aligned across the track and filled with a coarse gravel. The base of the tube should be lower on the outer side of the track.

Near ruins or floors of ruins, gravel use should be restricted so that it cannot be kicked on to plastered, earth, soft stone or brick surfaces. Crushed hard metal with angular edges should be avoided. If gravel or metal gets on to soft surfaces it will be worked into them and cause damage. In general, softer irregular grades of beach or river gravel with rounded edges should be favoured, provided it is obtained lawfully. Where softer rocks such as crushed tuff, limestone, mudstone or weathered greywacke are available their use should be considered. Local farmers are usually a good source of advice on what locally available material makes good cheap surfaces for light traffic.

Figure 31. On Motuarohia, Bay of Islands, steps and railing to an accepted engineering standard on a severely eroded track to a viewpoint on the exposed platform of a pā.

Structures—towers, boardwalks, toilets, signs

In heavily used areas, the ideal in most places is probably a tough grass sward with built-up gravel paths and/or board walks which will withstand wind and water erosion and visitor activities. On steep slopes, advantage may be taken of existing eroded routes, rationalising their number, and stabilising those that are selected for continuing use. The function of boardwalks and/or steps is self-evident in protecting fragile or erosion-prone ground-surfaces (Fig. 31). Steps must be properly designed. There are ergonomic rules for the dimensions and proportions of flights of steps which should be followed in all built structures. They should be followed as much as possible where there is a gradual fall in a path and where the grade has to be improved or made up at specific widely spaced intervals. If the design guides are not followed, visitors will find the steps uncomfortable and continue to look for and make tracks away from them. In some situations, e.g. on a steep defensive bank, the ergonomic rules cannot be made to work. Rather than introduce a visually intrusive structure some lateral thinking (quite literally) is required. It may be possible to divert the track and steps to an easier grade elsewhere.

Walking on top of breastworks or banks should be discouraged. These features by and large give an earthwork site its character, and they can be all too easily ruined. On redoubts, the best ground-view is very often obtained from a vantage point on the breastworks or at the top of the bank. People tend to walk along the bank to obtain these views. Viewing towers constructed near the site allow a better oblique view than any obtainable on the site; signs asking visitors to stay off walls and explaining why, are obvious solutions to this problem. The viewing towers constructed at Te Porere (redoubts with free-standing walls) on the central North Island volcanic plateau, have considerably reduced the numbers of people walking on the walls there.

Toilets and fireplaces, like stock fences, should be placed well clear of the site. Siting such features requires advice from an archeologist familiar with the location. It will be advisable to ask an archaeologist to check the amenity planning on the actual ground and to test-pit to ensure there is no archaeological material present.

A pad of sand, soil or clay, 15–50 cm thick, may be a useful device for protecting parts of a site where general erosion is tending to occur. As discussed in the

physical techniques section, the pad may or may not be underlain by a moulded geotextile which will reduce the size of roots penetrating to the site. Depth of the pad should not be more than 60 cm.

Only in the rarest of circumstances should roads or carparks be built over archaeological sites. Where inevitable, they need careful conservation planning with the objective of deliberate site burial (see section 2.3.3, p. 45).

Barriers and signs

Dangerous or particularly vulnerable parts of a site may require barriers, including vegetation. However, vegetation such as low shrubs/flax should never be used as a barrier between visitors to a site, and dangers such as cliffs or rivers. They can be walked through without seeing the danger or may even overhang the danger—and they do not offer the support needed to arrest a fall.

Structures should be professionally designed and installed by tradesemen.

Signs warning of danger are common in many reserve areas. Signs could also be used more than at present to help control potentially damaging visitor behaviour. Visitors may be asked not to walk on or climb up banks. One can take a gloomy view of signs' efficacy when faced with evidence of the damage that they are meant to prevent. Yet, they have probably an ameliorating influence even though they may not prevent the worst behaviour. Signs can also be used to assist understanding of the conservation practices being used at a site—for example, the use of tall grass, shrubland clearance, tree felling, or restrictions on access to certain areas.

3.1.2 Vegetation management

Analysis of overall pattern of vegetation

Most reserves will have a balance of areas in grass, shrubland (which may be an important element of weed control) and treeland. Part of a particular site may have intensively managed grass to allow for access, good visibility of the site and views from the site. At the margins of the grass there may be ranker growth and a possible weed problem from past endeavours to manipulate the vegetation there. Other parts of the site may have specimen or single trees, such as a large pōhutukawa. How can the grass cover be maintained in these environments? The long-term processes which affect archaeological site conservation, the enjoyment of visitors, ongoing costs and other relevant factors need to be carefully studied.

The economical management of sites will require a minimum of mown grass in areas that are important for visitor access, the maintenance of views and certain kinds of weed control (for example, where broom is a problem).

Mowing and line trimming

More reserves should be mown or line-trimmed than is the case at present. If a site is to be maintained by mowing or line-trimming, planning needs to be undertaken to determine the appropriate frequency and to ensure that access for the mower does minimal damage to the archaeological site features. The following applies to sites under established mowing. In the mown grassland setting, grasses that are present, and establishment methods for desired species will depend on climate.

Figure 32. Good and bad in grass cover management. (A, left) Banks should be cut by a weed-eater; (B, right) ride-on mowers often create scalping where there is a rise in the ground surface.

Mowing itself will alter the composition of grass swards. Oversowing of grass seed or application of fertiliser may be warranted in some areas. This can be a waste of time and money unless carried out on the advice of a grassland specialist, who may wish to make soil tests. The peculiar features of archaeological sites need to be considered. Banks may have sterile subsoils (thrown up from the base of the ditch), with little topsoil (because of erosion). Grass seed or fertiliser may tumble to the base of the bank or the ditch where it is not needed. Further notes on this subject are found in section 2.2.3 (p. 25).

Much mowing is too close to the ground and is sometimes too frequent (Fig. 32B). This 'scalps' convex surfaces, reducing the profile of banks, and also kills the grass, leaving an opening for weeds. Mowing heights should be a minimum of 10 cm on level ground and 15 cm on convex surfaces. For steeper banks which cannot be reached safely with a mower, a line trimmer is best (Fig. 32A).

Where mowing is to be instituted, attention needs to be paid to designing access routes for 4WD ride-on mowers. A major drawback of mowers, and ride-on mowers in particular, is that they will generally require a smoothing of surfaces and access ways around the site. They may require wider access ways than are already present. Where possible, pre-existing tracks or other access ways should be used, even if they are not the most convenient routes. Modification of the original fabric (surface profile) of the site is not justified, except for safety reasons. If ride-on vehicle safety is at issue, then either hand-pushed mowers or line trimming should be used.

Mowing or line trimming should be timed so that desirable native grasses such as *Microlaena* or broad-leaved poa have an opportunity to flower and set seed. Generally this will mean no mowing from late spring through to mid- to late-summer.

If mowing frequency is reduced, the existing mowing equipment may not be powerful or robust enough to tackle the longer grass which has grown in the

increased interval. Utilising larger mowers will also have knock-on problems such as larger access ways and wheel damage to the site surface. The solution to this type of problem, balancing infrequent mowing with larger, more robust machines, needs to be the subject of planning and adjustment in the course of the year.

Tread-resistance will be a desirable characteristic of the sward in some areas of sites which receive high numbers of vistors. Existing patterns of use and wear should be analysed. In areas or on routes where people tend to create tracks, managers need to decide whether this foot traffic is to be allowed to continue or not. If it is to continue, these areas or tracks could receive an autumn or spring oversowing of dwarf ryegrass and dwarf tall fescue.

Mowing is generally a useful way of controlling weeds. In areas in which mowing is difficult and in which tall grasses are desired, weeds may need to be controlled using a selective herbicide. Herbicides such as Roundup will kill all plants and should not be used unless a replacement vegetative cover is planned.

Appendix 2, section A2.3 provides a specimen work plan for mowing on an archaeological site.

SWARD MAINTENANCE PLANS—WHAT IS NEEDED?

Mowing

- A plan of the site showing areas to be mowed/line trimmed
- Planned access ways and clear instructions on their use and/or creation
- Safety considerations for maintenance people/contractor and the public
- Specific mowing and line-trimming instructions—never less than 10 cm, 15 cm on banks
- Instructions to maintenance people to avoid scalping, a risk especially when using mowers with rotary blades
- A planned mowing schedule which takes special care to allow for seeding of native grasses and reduction of fire risk—these two will have to be balanced.

Ensuring healthy grass growth and shrublands

- Oversowing planned and carried out as necessary
- Survey irrigation, fertiliser and lime needs for microsites and apply as necessary
- Specify treatment of marginal areas and areas to be left to revert
- Treatment of specimen trees/groves of trees within the mowing regime—e.g. line trimmers or scrub saws should be used with care to avoid damaging trees/shrubs.
- Spraying for weeds, especially seedlings of leguminous trees or shrubs (gorse) and weedy grasses such as kikuyu
- Monitoring and inspection by someone knowledgeable about the archaeological site values.

Shrublands in amenity areas

In general, amenity plantings should harmonise with the natural vegetation of the area and of the site itself. There are numerous fast-growing natives that will quickly provide shelter. The Pittosporums, especially *P. eugenioides*, make rapid bushy growth at first and very attractive small trees after 20 years. *Olearia arborescens* rivals lilac for scent when in full flower and with some pruning forms dense shrubby growth. *Pomaderris kumeraho* forms more open and smaller shrubs but provides a mass of soft yellow bloom over a long period. All three species are tolerant of damage and, mixed with flax and the true native toetoe (*Cortaderia* spp.), would form good attractive shelter on many sites.

Plantings around picnic grounds beside pre-European sites will generally look much more appropriate if native species are used. There is no need to be purist about vegetation on gun-fighter pa, European redoubts or whaling stations. Historic trees or species in the vicinity such as poplars could be retained and supplemented with rust-resistant forms. Old forms of shrub and rambler roses were commonly established at an early date around European settlements and a durable and vigorous rambling rose such as 'Felicite et Perpetue' could be useful cover, especially on a a bank where the aim is to keep people off.

When planting shelter to protect areas used by visitors, e.g., grassed picnic areas, the possibility of the planted tree species seeding onto the site should be considered and such species avoided—karaka or karo (*Pittosporum crassifolium*) are examples. On sandy ground, shelter for people can also be designed to provide shelter from wind erosion.

3.1.3 Case study 1: historic landscape

Wider setting

This case study comprises a large site (over 100 ha) protected as a scenic and recreational reserve. It has many discrete sites and three major pā. It is located in the northern North Island, with the sea on one side and suburbs on the other. A Māori Reserve containing a pā bounds on to one corner. The Māori Reserve is in regenerating forest with some areas of gorse and ungrazed grassland.

Site description and condition

The three pā sites are of ring ditch form with difficult access to the platform. There are old bulldozed tracks onto the platforms of two of them. These two are covered in gorse. The third has not been damaged and has a cover of mānuka and shrubland with tree ferns in the ditch. Vegetation on the rest of the reserve is patchy with areas of ungrazed grass and gorse, and some pōhutukawa on the coastal cliffs. In the gullies there is regenerating tawa forest. Cattle are occasionally let in to graze in winter. The aim of the grazing is to keep the grass down and to keep ground vegetation clear in the shrub and treeland areas. The substrate of the site is friable volcanic clays and tuff.

Identification of management issues

The reserve is for recreational activities. Some parts of some sites are impacted by the yards of houses. In the treelands, there are numerous shrubby weeds which have escaped from the suburban gardens. Problems are as follows:

- Kikuyu is spreading rapidly through the grassland areas.

- Cattle are eroding the banks and camping in the shrubland and the treelands.
- Mountain bike riding is exacerbating foot erosion in some places.
- The track network in the reserve is largely informal and unplanned.

Particular management issues include the following:

- Vehicles are not able to get access but a large carpark is adjacent to the reserve boundary.
- The track network needs thorough review and rationalisation.
- Fencing needs thorough review and improvement.
- The local community wishes to maintain pedestrian access and open areas for recreational purposes, and use of the reserve for access to fishing spots and for scenic lookouts.

Management options

The land managers must deal with some imperatives such as the maintenance of recreation opportunities and maintain cooperation with neighbours. To a greater or lesser extent the following options are open:

- Conserve the archaeological and historic features.
- Increase the rate of planting to re-vegetate the area while keeping tracks and viewpoints open.
- Continue grazing at the present level or increase it.
- Do more labour-intensive management including mowing of selected parts.

Management objective

- Maintain recreation opportunities and conserve the historic features. The specific objectives should be to achieve an overall cover of stable grassland and treeland that would allow public visitation and restrict the opportunity for invasion by woody weeds.

Recommendations/guidelines

Landscape/site evaluation

- Re-survey archaeological features to determine which should be retained in grassland for site conservation, landscape visibility and visibility to the public.
- Conduct a detailed evaluation of archaeological features and their desirable degree of visibility to visitors.
- Devise a re-vegetation plan aimed at reducing negative features such as informal tracks or other erosion 'hot spots' (localised fretting) and stock pressure if any.
- Evaluate practicable mowing and grazing regimes and determine the appropriate amount and nature of mowing.
- Map all disturbance including bare soil and significant areas of weed invasion.

Devise an infrastructure plan

- Review the infrastructural elements (paths, drains, etc.) including informal tracks and 'desire lines' on the site.
- Design a fencing pattern that allows control of stock in treeland areas, so that native grasses can establish, and install the fences.
- Design for improved paths, lookouts, seating, mowing access and drainage.

Devise a vegetation management plan

- Grazing should be restricted: to the ridge crests, by fencing; to certain seasons, i.e. only late spring and autumn; and in intensity.
- Where present, kikuyu grass could be removed by spraying with glyphosate (Roundup) and native grasses such as meadow rice grass (*Microlaena stipoides*) encouraged instead.
- Level or near-level areas, which have been defined in the landscape evaluation as needing to be kept clear, should be mowed.
- The adequacy of existing fencing needs to be evaluated. Closer subdivision may be needed to minimise numbers of stock and prevent access to their preferred camping areas.
- On areas to be kept in grassland, mowing should be instituted, with blade settings at a minimum of 10 cm, or higher depending on whether surfaces are convex or not. An attempt should be made to establish native grasses which will adapt well both to the arid ridges, and to the semi-shade of the areas of open forest.
- Determine the overall pattern of these factors to allow for public and mowing-machine access, and provide an acceptable accidental-fire control procedure.
- Carry out soil fertility surveys of microsites to determine whether selective fertiliser applications are needed in the spring and autumn seasons.
- Advice should be sought on means to enhance the establishment of the native grasses—mowing or grazing at the wrong time may make establishment difficult (see Section 3.3).

Shrubland and treeland

- In those areas not to be kept in grass, a mix of shrubland and treeland would be consistent with original vegetation, Māori values, soil protection and amenity usefulness.
- Define areas into which appropriate native trees may be planted to create a fairly open treeland but one not subject to weed invasion.
- Define those areas which can be allowed to revert to a low shrubland/flax/fern cover, to be managed by a line trimmer or scrub saw perhaps on a two-year cycle. Such areas should include the steep, otherwise unmowable scarps of archaeological features.
- Select shrub or tree species to enrich habitat and to improve erosion control. Plant them in designated areas with the objective of enhancing any existing treelands.
- Following evaluation of archaeological, landscape and visitor values, any steep slopes, currently suffering stock damage and which are to be fenced-out, should be planted in an appropriate cover of low shrubs or trees.
- Initiate repair and replanting of bare areas, or areas with weeds, that in the long term can be shaded out.
- Unstable trees, or trees that could become unstable, should be removed before they disturb the soil.

3.1.4 Case study 2: Pā in mown grassland

Wider setting

The following case study applies to sites north of Nelson-Marlborough, the region in which most pā sites are found. Recommendations could also be

extrapolated to archaeological sites located in environments where the recommended grass species occur naturally.

Site description and condition

The archaeological features comprise a central area with many pits and a perimeter ditch and bank. The site presents several microsites reflecting different environments which should be considered for separate treatments. Species recommended for each microsite vary according to their adaptation to the environment of each microsite, and their impact on feature visibility. Soil fertility and pH are likely to be lower on steep faces and in areas such as banks where subsoil has been exposed.

Microsites present will include:

- Open areas of the site interior
  - — Some areas of heavy wear from visitors and tracks.
  - — Level or near-level areas with reasonable sward of grasses and herbs well adapted to dry hot conditions.
- Banks and ditches
  - — North, west and east-facing aspects, sunny with minimal shading, well drained, e.g. banks, mounds, trench and pit walls and scarps.
  - — South-facing shady aspect, well drained slopes. Scarps facing south.
  - — Wet, poorly drained, heavily shaded areas, and areas prone to short-term saturation, base of trenches and pits.

Identification of management issues

- The site has always been regarded as an important one but the statutory management plan is 20 years old and out of date.
- Weediness including large growths of gorse in areas not accessible to the mower.
- High visitor numbers are expected to continue and to increase.
- Visitors take inappropriate desire lines over banks and attempt to get into pits or depressions.
- Mowing has been too close and is scalping the tops of banks.

Management options

- Cease mowing and allow site to revert to gorse weedland in the expectation that regeneration of forest will occur in next 100 years. Restrict public access.
- Reduce costs by grazing the site with low numbers of sheep or yearling cattle. Large cattle are not an option if only because of lack of water source. Sheep are likely to be stolen off the site.
- Devise clear mowing and line trimming plan that will allow good conservation of existing site and also allow for weed control. Some improvement to grass cover and the ground covers of the banks.
- Improve signs to inform visitors and to encourage them to keep off banks and out of pits.

Management objectives

- A mowing and line trimming plan that will allow good conservation of existing site and also allow for weed control.
- Improvements to grass cover and the ground covers of the banks.

Recommendations/guidelines

Prepare a conservation plan, incorporating the following points:

- Ride-on mowers should not be used on the site. On hand mowers, the blade should be set at a height of 10 cm above the ground.
- Legume and broadleaf weeds should be controlled.
- Steep banks that cannot be safely mowed should be line-trimmed. Any shrub growth in these areas should be cut with a scrub saw and swabbed with a systemic herbicide to prevent re-growth.
- Interpretation signs should be erected asking visitors to stay off banks.
- In areas where there are worn patches, appropriate re-seeding of grasses should be undertaken. Clinging rata and ferns should be planted on the steep shaded slopes of banks.
- Regular monitoring should be instituted.

3.2 SITES MANAGED WITHIN FARMLAND, LIMITED OR NO PUBLIC VISITING

Land with warm microclimates and with sources of fresh water were primary determinants of Māori settlement patterns in the period from c. A.D. 1400 to 1830. Only small areas of such land lie within New Zealand's formal protected area network. These tend to be small areas of coastal forest reserve. A majority of pre-European archaeological sites exist on farmland. They occupy only a small proportion of the area of a farm but are often features which are prominent in landscape views and appreciation. Outside of the warmer regions, there are still some sites of Māori origin. In most areas, there are other important sites relating to past industrial or farming activity. Such sites or places are often grazed or ploughed. Some features remain as the only visible elements of an ancient past in the landscape. They are important to Māori and other New Zealanders and are also repositories of unexcavated archaeological data. Their protection is an important obligation of trust on private land owners.

The general management objective for archaeological sites in farm land should be least-cost identification, protection and management of the archaeological sites, with the least possible restriction on farm activity. It will be possible to integrate some seasonal farm activities on most sites but not all. For example, many archaeological sites on hill country should not be used for close winter grazing, or for the establishment of bull paddocks or for farm forestry patches. A secondary objective which might be expressed in district plans could be to maintain landscape views, some of which reveal aspects of the past.

Figures 33 and 34 show some typical farmland problems and possible solutions. Sites consisting mostly of surface earthworks are particularly vulnerable to a wide range of every-day farm activities—roading, preparation for fencing, fencing, stock tracking, stock erosion generally, weed clearance and ploughing. Overgrazing on friable soils may be a problem (Fig. 33). Sub-surface sites buried more than 20 cm below a topsoil on level or near-level ground may also be at risk from ploughing or road or gateway construction. The principal farming activities that need some care when carried out on or near archaeological sites are grazing, farm infrastructure (fences, paddock design, irrigation channels, roads

Figure 33. Erosion on a pā in North Taranaki. The main causes are friable soils and overstocking with sheep. Sheep do not have access to the small shrub and tussock-covered knoll in the distance which is in good condition. A site such as this should be fenced-off and monitored.

Figure 34. Fencing patterns on a typical pā: good and bad.

and tracks) and ploughing and disking (including border dyking). Figure 34 shows a suggested good fence pattern, based on an actual example in the Waikato.

3.2.1 Grazing and pasture care

Control of the behaviour and density of grazing animals is the key to maintenance of surface-earthwork archaeological sites such as pā (there are 6000 in New Zealand), earthwork fortifications in general (there are about 600 nineteenth-century fortifications) and the ruins of European structures and industry. Relevant factors in grazing are included in the following box:

Stock type and numbers—what is appropriate?

- We recommend limiting stock numbers: no more than 10 stock units/ha.
- We recommend controlling stock-type: sheep or goats, yearling cattle only, not bulls or dairy cows.
- We do not recommend mob stocking, but if needed it should only be carried out infrequently and for a short spell (less than seven days).

Grazing season and format—what is best practice?

- We recommend limiting the grazing season: not in winter or very wet weather.
- We recommend *either* rotational grazing but keeping grazing period short with plenty of feed available *or*
- Set stocking at no more than 10 s.u./ha.

What is the best form of sward to maintain?

- We recommend fertiliser application to maintain sward cover and not for production.
- We recommend the maintenance of a desirable grass height of 6–10 cm. Note that this height is also consistent with satisfactory levels of production and pasture weed control.

Paddock design and stock water

- We recommend that sites be fenced into their own small paddock. In addition:
- This paddock should receive limited stocking but otherwise be integrated with a useful grazing strategy for the farm.
- We recommend that stock water is supplied away from the area of a site—do not supply on site because animals will create soil damage at the trough.

The objective of grazing and pasture care on archaeological sites should be to maintain the surface sward so that soil erosion is prevented. Within individual paddocks, vulnerable 'microsites' such as the tops of banks or places of shelter need to be monitored. Set grazing to maintain a grass height of 6–10 cm is the most preferable balance between pasture production and weed control, on the one hand, and archaeological site protection on the other. The box shows preferred stocking rates of no more than 10 s.u./ha. On friable soils and in cool temperate or dry areas, stocking rates will probably need to be lower than this, but for those conditions rates are difficult to specify. The key principle is: *if damage is being done then further review is needed*. Omata Stockade Historic Reserve in Taranaki is set-grazed at very low stock numbers and the grass in summer is tall and rank. In winter on South Island hill country, stocking at 10 s.u./ha will be too high. The sheep in such places need to be hardy. Occasional rotations may be desirable. This will allow any small areas of erosion, e.g. in camping places, to heal over.

Suggested optimum maximum stocking rate (s.u./ha) for archaeological sites on lowland (e.g. Waikato basin), warm coastal hill country and cool temperate conditions are shown in Table 1.

GRAZING

Sheep and goats

- *Set-stocking with sheep is the best type of grazing for archaeological sites*; it should be managed so as to avoid the need for cattle or periodic mob stocking to graze down coarse grasses.
- Wethers are the preferred animals for grazing. They should be used at low stocking rates (6–10 s.u./ha) to maintain a pasture height of 6–10 cm.
- Stock units per hectare will need to be varied during the course of the year to avoid weediness in summer pastures and poor grass survival in the autumn.
- Gates and water (if provided) should be well away from site features.
- Dogs from urban areas will be problematic for with sheep, so young cattle may be preferred for urban or near-urban areas.
- Goats at low stocking densities may be used for removing weeds such as thistles or gorse, but they can cause severe erosion by tracking up and down slopes.

Cattle, horses, deer

- Cattle grazing should be minimised.
- *Never graze cattle on archaeological sites in winter*.
- Yearling cattle may be used occasionally to graze archaeological sites but only for short periods in summer/autumn, or when the feed is too coarse for sheep.
- Horses have especially damaging grazing behaviour (pawing and ripping out lumps of grass) and should not be allowed on sites.
- Deer should not be used for grazing because they mob and their sharp hooves displace soil downslope.
- Deer fences distract from the landscape visibility of the site unless carefully planned.

Shelter and water

- Sheep need to be provided with ample shelter (from sun, rain and cold winds) away from the site features so that they do not camp on parts of the site and create erosion patches.
- Water should not be reticulated to stock on the archaeological site itself.

TABLE 1. OPTIMUM STOCKING RATES IN WINTER AND SPRING, STOCK UNITS PER HA.

	WINTER	SPRING
Warm temperate	4	10
Warm temperate with friable soils	None	8
Seasonally dry coastal country	8	4
Cool temperate	None	8

A possible disadvantage of set grazing is that animals will find preferred places for more or less permanent shelter and over time can do a great deal of damage by creating and enlarging sheltered spots. Rotational grazing could be attempted but with the objective of maintaining the sward cover—not to maximise production. Mob stocking has been carried out on Turuturumokai near Hawera where sheep were forced to eat dry long grass stalks. This stocking initiated erosion in some places. We recommend that mob stocking only be carried out infrequently and for a short spell (less than seven days).

Particularly slip-prone or friable soils, for example those based on papa, sand or volcanic ash, are very vulnerable to erosion. Decisions on grazing of archaeological sites on such soils need to be made carefully. Generally, it will be best to avoid grazing.

Pasture maintenance

Pasture grasses on archaeological sites should be in good condition, tillering (sending out ground-level stems from which new leaves will grow) and maintaining good coverage of the soil surface. If the grass is to be utilised for stock grazing, clover could be oversown in the appropriate season. Fertiliser and lime need to be applied. Fertiliser use should be limited to what is required to maintain strong plant cover and preferably to allow a cover of perennial grasses (native or not) to establish. Two cardinal rules are: keep stocking density low (no more than 10 s.u./ha) and never let the pasture be overgrazed. Limited feed will lead to animals roaming the fencelines looking for 'greener pastures'. Where fencelines run through the site, this behaviour will produce destructive erosion.

Low intensity of stocking by light animals is on balance the most desirable practice to maintain archaeological features. It minimises the risk of erosion but keeps the site visible and clear of potentially intrusive tree and shrubland roots. No stocking or very limited stock density risks having weeds or shrublands developing on the site. The site will develop areas of poor sward coverage and its landscape visibility will be reduced.

Where pasture is not stocked and allowed to regenerate into shrubland, the only methods for reducing weeds or shrubs is selective spraying or handcutting, or a full mowing regime. Bulldozers should not be used to remove shrub weeds. For guidance on stocking rates, stock erosion prevention and grassland establishment see sections 2.2.3–2.2.6 (p. 26), 2.2.10 (p. 42) and 3.2.1 (p. 18).

WEED CONTROL

- Do not use bulldozers to clear weeds such as gorse on archaeological sites, if there is a possibility of archaeological sites under the weeds.
- Weeds may be sprayed.
- Some weedy areas (e.g. steep slopes) may be more efficiently fenced out and left to regenerate.
- Disturbance of grass cover, e.g. by cattle pugging, or removal of shrubland will commonly lead to weed infestation in most farmland areas.

Drought

Drought is a particular problem for headlands and ridges. These often have the most outstanding archaeological features, are the first to be denuded of grass cover during drought, and are then exposed to wind erosion. In moist periods following a drought, dusty eroded ridge surfaces are likely to develop unsatisfactory weed and weedy grass covers.

Particular problems associated with dry periods are:

- Stock in dry periods become restive and roam around the fences creating tracks.
- Most grasses will bolt to seed and only cattle will eat the coarse forage so created.
- Stock trampling and resting in dry dusty ground can be as damaging as on wet ground.

Stock should be removed from sites early in any prospective dry season so that dead or dormant grass cover will remain.

Reversion to shrubland or forest

Tall grassland or a shrubland is the best long-term stabilising cover. The preferred cover for most sites will therefore be infrequently grazed grass which will eventually revert to tall grass, native grass and/or shrubland.

When a grassed site is fenced off from stock to give added protection, in most farmland it will present a short-term weed problem. This could be treated by short spells of grazing or application of a selective herbicide which works on the weeds, not the grass. This will remove any potential problem from having a source of noxious weeds on a property. An adequate weed-free tall grassland can be assured by patching any erosion scarps with fescue or cocksfoot or other varieties of grass species adapted to relatively low fertility and seasonally dry conditions. The site area could be stocked on a few occasions before final exclusion of all stock, or the area could be stocked on a set basis in early summer or early autumn. Eventually, provided there is a local shrubland seed source (within, say, two kilometres), most areas that are fenced out and permanently retired from grazing wil be come shrublands. Five decades of being fenced out from grazing will do no harm to most archaeological sites, unless there is a problem with aggressive weed trees.

On the principle that long-term stable vegetation cover is the best cover, existing native forest on archaeological sites should be left alone and it should not be used for shelter, grazing or relief grazing.

Farm roads, fencing, paddock design

Farm roads and the bulldozing of fence lines have damaged many archaeological sites over the years. The construction of roads and fences are possibly the single greatest cause of harm to archaeological sites.

Pā were often built on narrow ridge lines which controlled access from rivers or the coastal strip to the hill country. To take advantage of good drainage, pits were also built on ridges and are common both on high points and saddles. Therefore, they too are vulnerable to roads installed to give access to remoter parts of a farm. For a typical site on a farm, suitable arrangements for fencing are shown in Figs 34 and 35. In the past, a common pattern in bulldozing has been

for part of the perimeter ditch of a pā to be filled in and used as a road. The defensive ditches also form a barrier to stock (nineteenth-century ditch and bank fences sometimes used sections of pā defence), so that rough tracks were sometimes pushed through to provide access for stock along the ridge or onto the platform of the pā.

Farm roads, gateways and bulldozed fencing lines should not be put through or on archaeological sites. If they are essential for some reason, such construction will require an authority or consent from the local body or an authority from the Historic Places Trust under the Historic Places Act 1993. Existing roads through sites should not be widened unless with authority or a consent. As far as possible, current or future uses should utilise existing roads and the roads should not be extended. Alternative routes should be sought for new or wider roads, even if it means a less satisfactory, sidling route.

In designing new developments, it is well worth considering the long-term design so that key sites are protected. Paddocks should be designed, as far as possible, so that the fences run across, rather than along the ridge line. Stock will wander along fence lines and do extensive damage along ridges. Fences should not intersect on archaeological sites for the same reason (Figs 34, 35). For example, if a site is on a high point it could be ring-fenced, perhaps with one gate for periodic access for stock as noted elsewhere. The sides of paddocks could radiate out from the central ring fence around the high point.

Permanent, well-sited fences which allow sheep through but not cattle are the best. This can be achieved by removing or not installing the bottom wires of a fence. Because they are temporary and of generally light construction, electric

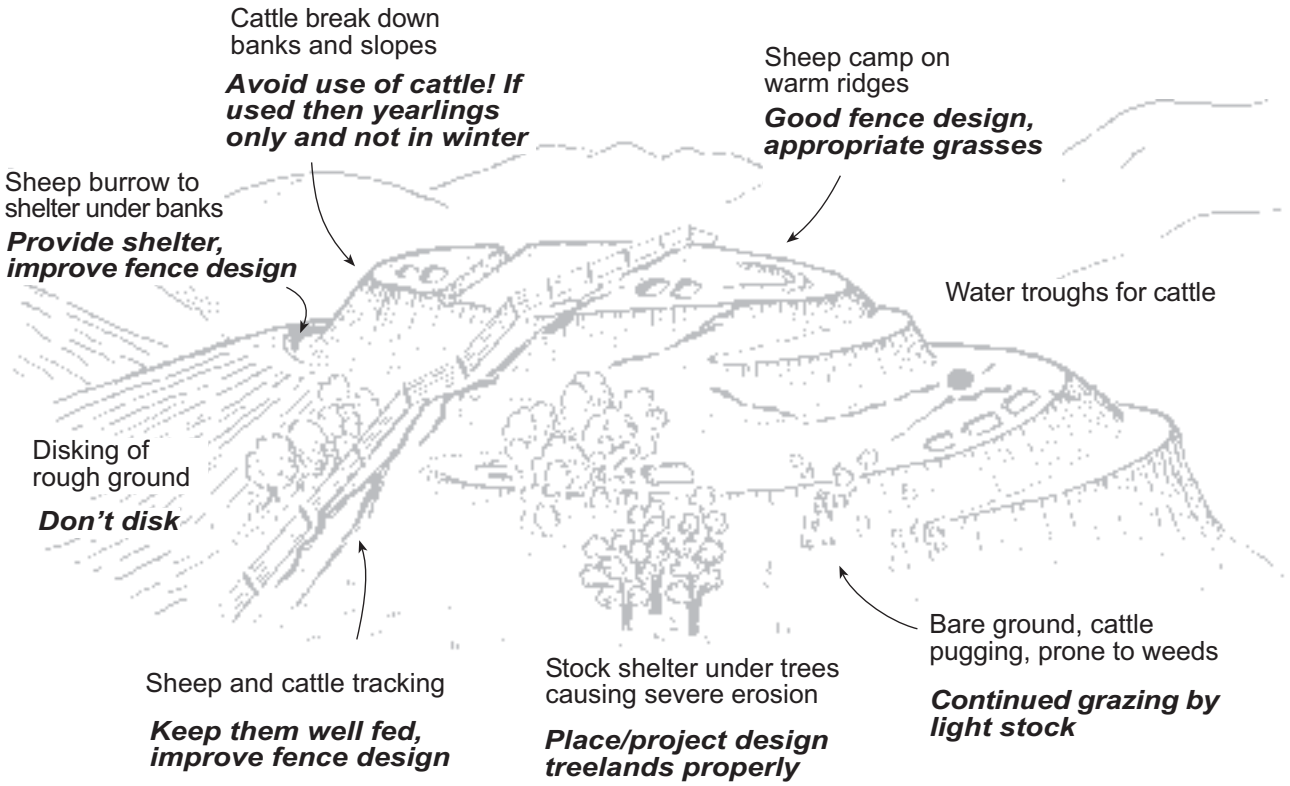


Figure 35. Typical problems on a grazed site.

fences should also be considered for use where a site needs to be grazed for short periods only.

Coastal lands can be a particular problem for grazing, where privately owned land abuts against beach and dunelands. Cattle may have access to the dunelands from the adjacent farms, even though the dunes may be Crown property. Middens are common in dunelands and these areas are seldom fenced.

ROADS AND FENCES

Roads

- Sites are especially at risk when creating access roads or fencelines.
- Before bulldozing roads or fencelines, landowners or managers should check first for the existence of pits, pā or other archaeological sites, and call in an archaeologist where there is doubt.
- It should be possible in most instances to design roads and fencelines that do not impact on sites.
- Any modification or damage that is necessary to a site to establish a satisfactory line should be the subject of an authority from the Historic Places Trust.
- New roads or improvements including gateways, water tanks and water troughs should not be placed on archaeological sites.
- Where damage to a site exists already, this may be used as a fenceline or for stock access.

Fences

- Fencing can damage archaeological sites.
- Fencing should not run through sites; likewise, gates should not be placed on sites.
- Check for sites, especially pits, before bulldozing to create smooth fence lines.
- Use special techniques (such as extra-long battens or sections of wooden planks) to securely fence depressions such as pits.
- Plan paddocks to set aside archaeological sites, or to effectively manage set stocking.

Ploughing, disking in hill country

The first ploughing or border dyking of an archaeological site will do immense damage and completely destroy shallow features. In the past it may have been preceded by deliberate levelling of earthworks or uprooting of foundations. Such damage is relatively unusual today and would normally be controlled by the need for an authority under the Historic Places Act 1993 and, perhaps, under the district plan. Areas with sites that might still be vulnerable to ploughing or other destructive activities include isolated coastal terraces and flat ground around river mouths; also high country terrace land where there are nineteenth- and twentieth-century sites such as goldmining races, dams, etc.

Subsequent ploughing probably does less damage, provided it is no deeper than the first. However, the issue of subsequent ploughing involves more than the

depth of penetration of the plough. Repeated ploughing increasingly disperses archaeological materials and, on sloping ground, tends to displace soil downslope so that new soil layers are penetrated with each ploughing.

In some hill country where 'hard grasses' establish, bulldozers pulling large sets of disks are sometimes used to rehabilitate pasture. This is particularly destructive of sites such as pits which lie on midslopes or ridges. The same applies as for ploughing new ground.

PLOUGHING

- Sites should not be newly ploughed, or old ploughed areas given a deep ploughing, without an authority from the Historic Places Trust under the Historic Places Act 1993.
- On flat or near-flat land, a site that has been ploughed may be ploughed again to the same depth.
- On previously ploughed sites, renewed ploughing may still turn up archaeological evidence and artefacts.
- A margin of five metres or more of unploughed land should be left around archaeological sites when the surrounding land is being ploughed.
- Fencing sites off makes accidental ploughing impossible.

Plantation trees on farmland

Trees should not be planted on archaeological sites. The removal of plantation trees already on a site may be left to the planned cropping period but precautions to protect the site need to be carried out as detailed elsewhere in these guidelines. Sites should not be planted in native trees.

3.2.2 Case study 3: Pā in warm temperate pasture

Wider setting

The pā site is in production pasture. The district receives good rainfall, and has warm winters and naturally fertile but friable volcanic soils. The wider ecological setting includes gorse and pampas grass with no native regeneration underneath in nearby gullies, with the nearest native forest some 5 km away. There is some poorly managed farm forestry (*Pinus radiata*) nearby with pine seed blown from this onto the site. The district plan has a general clause supporting the protection of significant sites and some assistance is available for fencing.

Site description and condition

The site consists of a ring-ditched platform which has been levelled on one side and a road cut up onto the platform. The site occupies a hill crest. The sides of the site are steep and there are open ruas (cave-like pits) on the platform. The site is grazed by dairy cows and there is extensive erosion of banks, with the banks also undercut for shelter. Two fencelines run through the site and intersect at a gate on the platform of the pā. On the pā platform there are some large pine trees—stock shelter under them, creating erosion patches. Some gorse is growing in patches on the steep banks.

The total area of the site is about one hectare. A boundary fence runs close by the edge of the site but otherwise it is simply one part of a large paddock about five hectares in area.

Identification of management issues

- Sheep would be the best animal for grazing but are not available on this property nor in the district.
- There is a need to reduce erosion of banks, also banks are being undercut for shelter.
- If left ungrazed, the grassland will revert to gorse and pampas grass and become a source of weeds elsewhere on the farm and in the district.
- There is a need to re-arrange inappropriately placed fences which are concentrating stock on the platform.
- There is no water in the paddock so cows are only let in over winter and spring; hence there is severe site damage.

Management options

- The landowner could make some long-term income by fencing off the site and planting it in pine trees. This is not a suitable option because of

  — the damage the tree roots will do

  — the damage caused to the site by the eventual harvesting of the trees, and

  — the risk of damage from wind throw in an isolated small plantation on top of an exposed ridge or hill.
- Special precautions could be taken to ensure the site is conserved while allowing the area to serve a low-intensity use in the overall management of the farm. Fencing off an appropriate area with minimal stocking would maintain a moderate-height grass cover and good conservation of the site. Some repair or accelerated grassing of erosion spots would be desirable.
- The precise area of the site could be fenced off to allow it to revert to tall pasture grasses, native grasses and weeds with no further action. The small area of land concerned would minimise loss of productive land and would require no further inputs other than the fencing. There would almost certainly be a weed problem and many pine seedlings would establish on the site.
- The area could be fenced off with re-vegetation with an appropriate shrub-land cover, and with the intent of allowing native forest to develop in the long term. Any native plant cover would have to be deliberately planted as seedlings.

Management objective

- Site is to be conserved while ensuring some return from the land and minimising maintenance costs.

Recommendations/guidelines

Allow the area to serve a low-intensity use in the overall management of the farm. Fence area of site and allow a minimum of stocking to keep grass at a moderate height and to control weeds.

Stock management and fencing

- Seek assistance and advice from the district council or other sources. Cost any changes and apply to the district council for a grant.

- An attempt should be made to find hardy wethers, stocking at a density of no more than 6/ha.
- Maintain minimal stocking with yearlings or with sheep within the fenced area.
- Maintain a moderate height grass cover (6–10 cm) at all times and good conservation of the surface of the site.
- Remove fencelines through the site and the gateway. Fence to create a single paddock for the site; the new fence should be a minimum of 20 m from the recognisable surface features of the pa. This will allow simpler management of stock on the site itself and prevent the stock wandering up and down fencelines causing erosion.
- If a one-hectare paddock is created, six wethers or two or three yearling cows would be sufficient stock.
- Since the site occupies a hill crest, it should be fenced either within the smallest possible area which encloses the site, or within a fence pattern that allows a division into dry or north-facing aspects and wetter south-facing aspects.
- Where there is erosion, fence it out or find some other means of preventing erosion or excluding stock.
- Away from the site but within its fenced area, fence in some trees or tree-plantings or provide shelter in some other form.

Stock water

Water outlets should be positioned by the new fence. Water may not strictly be necessary. In periods of abnormally low rainfall, yearlings should be kept out of the paddock but wethers may be kept there. Cattle and dairy cows should not be allowed into the paddock in any season.

Shelter

At some point, preferably when the fences are being installed, the trees should be felled. Care should be taken to ensure that the stock have other adequate shelter from sun and cold winds within the new paddock. Trees that are away from the site could be retained if they are providing shelter, or the paddock fencing arrangement could be designed to incorporate trees or other sources of shelter such as a gully head. An artificial shelter could be installed for the sheep, or a small protected planting could be fenced out from stock and eventually made available to provide shelter. If properly designed, the yearlings or sheep will shelter there, rather than on the pā.

Pasture and grass cover

Generally only sheep should be obtained and retained for this particular site. If their numbers are kept low, there will be spring surpluses of grass which will go to seed and produce a cover of coarse grass. Young cattle, yearlings and heifers, but not fully grown cattle, could be let in only on occasions when the grasses have become too coarse for the sheep. In periods of long drought (which is not expected in this district), the sheep could be taken from the paddock and grazed on better pasture within the farm. Some repair or accelerated grassing of erosion spots will be desirable at that time in anticipation of better rainfall.

The option of tall grass cover should be explored. If stock are removed, grasses will grow rank for a number of years but will eventually stabilise in a cover of perennial ryegrass, cocksfoot, and some weedy exotic grasses such as brome

and native grasses such as meadow rice grass (pātītī, *Microlaena stipoides*). The possibility of accidental fire needs to be considered since this sort of rank cover can become a fire risk. If the ground surface is broken, e.g. by pugging, the neighbourhood weeds, especially woody legumes, will take hold. Gorse and wattle, in particular, will rapidly establish. They can be controlled by occasional grazing but are likely eventually to take hold unless full stocking is re-instituted. With little or no grazing, the woody legumes will need to be spot-sprayed or pulled by hand.

Some encroachment of benign weeds such as hard or ring fern, bracken fern, inkweed and thistles might be tolerated in areas to be given light grazing.

Condition of archaeological features

It will be worth making a record of the archaeological features and the land manager should inspect the place for active erosion at least twice a year in winter and late summer. There may be assistance available from the Department of Conservation, Historic Places Trust or the district council to carry out these tasks. Any particular problems with erosion should be addressed. Some minimal restoration may be necessary.

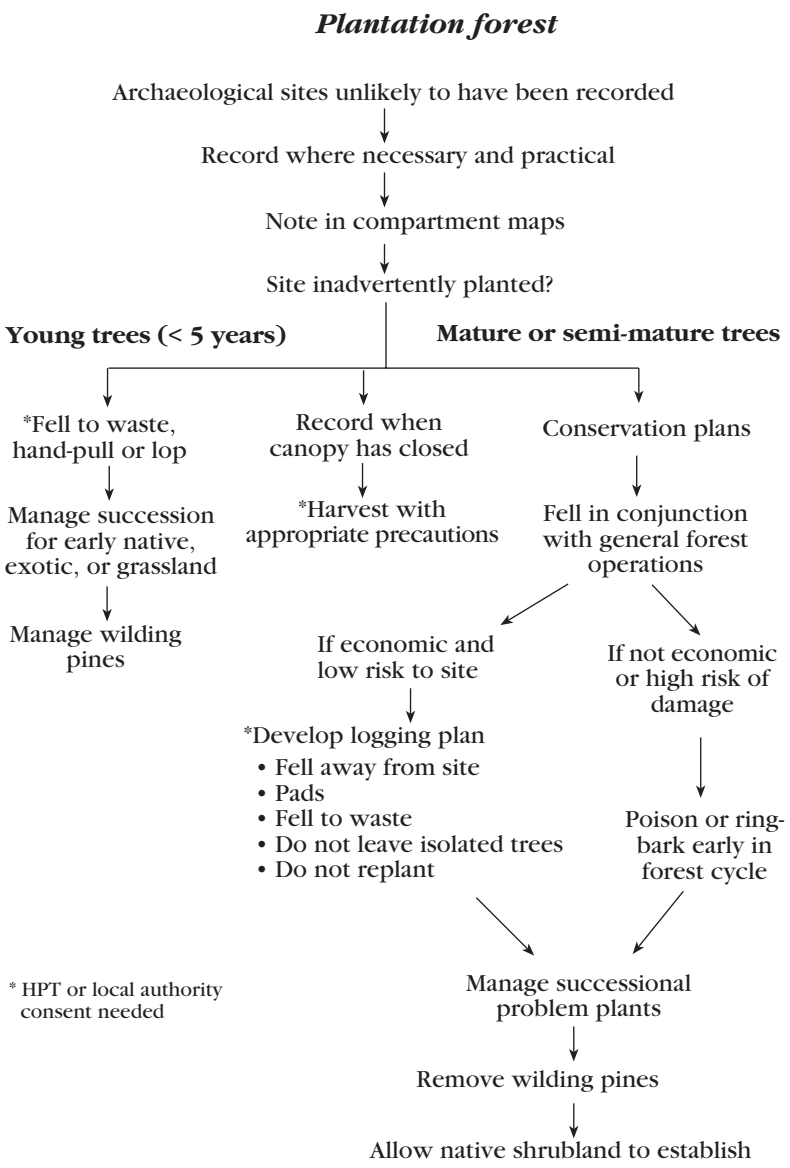
3.3 SITES MANAGED IN PLANTATION FOREST, LIMITED OR NO PUBLIC VISITING

Plantation forests are often established in areas where there has been past human settlement and where nature conservation values have been heavily modified by that settlement. It is important to evaluate any proposed planting land. This may require surveys of areas proposed for afforestation not only before any land management is undertaken but also by the end of the planting season. Land clearance and planting will reveal many sites that could not have been detected beforehand. Figure 36 shows a decision-making process for archaeological site management in a plantation forest or where plantation forestry is planned.

LAND EVALUATION

- Is there a good survey of the area mapped at a scale of about 1:10000 suitable for forestry and detailed records of archaeological site location and extent?
- Forest managers should insist on careful detailed evaluation, by an archaeologist, of sites before land purchase or re-planting. Statutory provisions should be followed and their implications for the management of the sites reviewed.
- The archaeologist should describe sites and record site location and extent on forest management records/maps.
- There should be re-evaluation and reassessment of the condition and significance of sites before each planting and harvest phase.
- The forestry company should have detailed management objectives for the land area of the sites. Although pā are often ideal hauler sites or landing stages, they cannot be so used.
- The effect of leaving archaeological sites open or in shrubland cover in the overall management of the forest must be assessed. The shrubland is most at risk from fire and most at risk of being used as a trail in a fire emergency.

Figure 36. Archaeological site management process in a plantation forest.



3.3.1 Planting around protected sites

Sites to be protected should not be planted. Where trees have had to be felled off a site which should have been protected, it should not be re-planted. The area of the sites should be defined on the ground by the archaeologist. The planting perimeter can vary but should be a minimum of 10 m horizontally or 20 m slope distance outside the site itself. This distance will depend on slope, whether vehicle access is required past or around the site, and on the way in which trees will be felled at harvest. Room for forest operations should be left around the site if it is in a position which will create difficulties for forest management, and specifically allow for eventual felling and hauling. It is not always easy to construct roads or firebreaks around a site on a steep-sided ridge.

Trees planted on the perimeter of an open areas will come to lean over the area, so that often they will only be able to be felled into it. Some methods are available to deal with the problem of felling trees in this situation—see section 2.5.1, p. 49.

3.3.2 Harvesting precautions

Before harvest, the archaeologist should visit and re-mark the sites with posts, tape or spray as necessary. The logging contractor should discuss felling and other harvest procedures on site with the archaeologist. The archaeologist should present the protection of sites as an objective and discuss felling down to the detail of individual trees with the contractor, seeking the advice and co-operation of the contractor as to what is practicable and safe. The contractor should brief the archaeologist on any danger anticipated or to be avoided.

Figure 37 illustrates precautions that can be taken where a site has inadvertently been planted and is coming to harvest. In some cases trees may need to be felled to waste. It may not be possible to haul them or it may be that, in the interests of site protection, they are best felled into ground from which they cannot be recovered, e.g. over a cliff. In other instances where both archaeological and wood values are high, helicopter removal of fallen trees may be needed. Any slash from forestry operations should be moved as little as possible, but cut finely so that it is on the ground and rots quickly.

At time of felling, the person at the stump must be in control and should be aware of the whereabouts of any archaeologist present in a monitoring role. Extra cost may be incurred and felling subsidies may be necessary. District plans may allow for such assistance. New authorities may be needed from the Historic Places Trust.

If sites have been planted in an earlier rotation, it is essential that they be felled at the same time or soon after the rest of the forest. This is not only more cost-efficient but also removes the risk of windthrow of newly exposed trees left in isolated patches (Fig. 38). Following harvest, blocks that have large numbers of sites or perceived risk of large numbers of sites should stay unplanted. Re-evaluate sites and likely management precautions that will be needed.

Appendix 2, section A2.3 provides a specimen work plan for tree felling and removal.

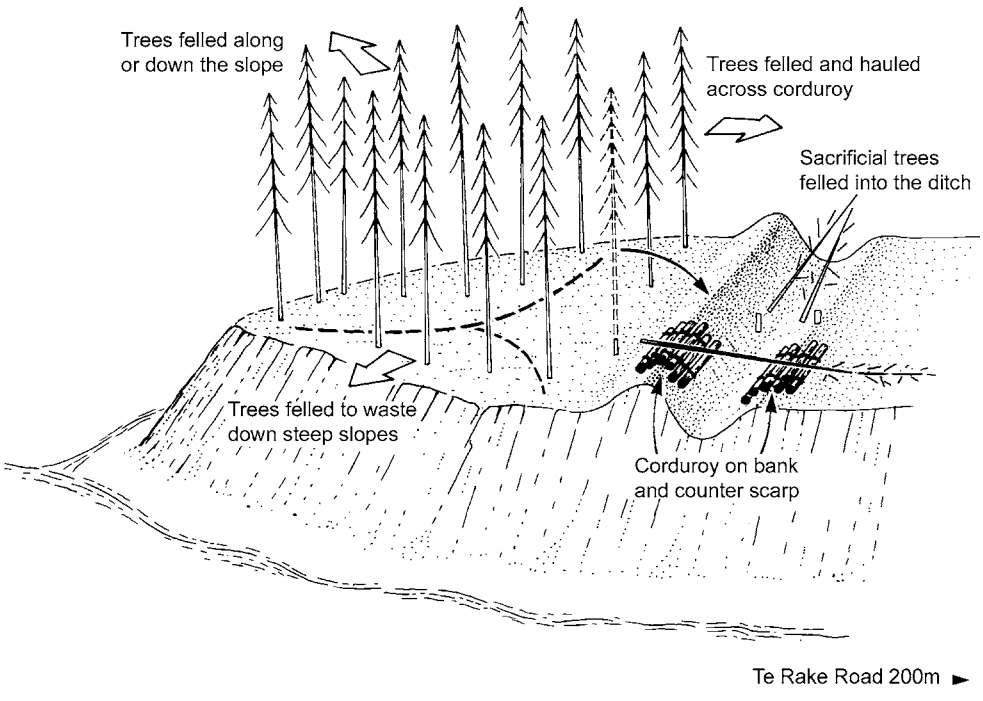


Figure 37. Suggested harvesting sequence for a typical pā site that has been inadvertently planted.

Figure 38. On this forest in Nelson, archaeological sites have been left in tall trees. These patches will be subject to windthrow, creating more damage than harvesting the trees.

ARCHAEOLOGICAL SITE MANAGEMENT FOR FORESTRY COMPANIES

- Companies should adopt and internalise archaeological site management procedures.
- Trees should not be planted on archaeological sites.
- Ensure roading and firebreaking and fire control operations do not impact on the site.
- Harvest and fire control plans should cover identification and protection of sites.
- Vegetation cover on open land with sites—who will control wilding pines, likely forest succession?
- Site management can be done in conjunction with other operations.

Bulldozers or any heavy-wheeled or tracked machinery should not be allowed on archaeological sites. This includes skidders, hydraulic diggers and bulldozers. Bulldozers or hydraulic diggers may be walked through a site, unless soils are especially friable, but this should be done with caution and with a minimum of turning. Winching to control the line of fall of trees onto a mat of previously felled branches or placed corduroy may be needed (see section 2.5.1 on problem trees, p. 49). Hauler tracks or the routes of cable logging should not pass through sites. Motorised carriages on the hauler lines may be a useful asset for clearing low ridges with sites on them.

Archaeological sites that have been inadvertently planted, and identified some years later, may be harvested (with special precautions to protect the site) at the same time as the wider harvesting programme. If identified in time, it should be possible, well before (more than 10 years before) harvest, to poison young trees that have been inadvertently planted. Figure 39 shows an example of poisoned trees on a pā in the Whirinaki valley.

Figure 39. On the pā Hinamoki II, some Douglas fir were poisoned about 20 years ago. The poisoning was intended to be progressive and in the event not all of the trees were poisoned. The trees at left and in the distance will have to be felled away from the site. Poison at this stage is not practicable because the live trees are scheduled for harvesting and poisoned trees in their midst would create a hazard for the logging gangs.

Figure 40. An ideal thin-stemmed shrubland cover on the bank of Hinamoki I, Whirinaki Valley. Douglas fir such as the specimen at left have been poisoned or felled off the pā in the previous 15 years. Future management should ensure that surviving Douglas fir is felled away from the bank and that shrubs with capacity to grow larger than 10 cm d.b.h. are removed so that the thin-stemmed shrubland cover is maintained.

3.3.3 Ongoing forest management for protected sites

Archaeological sites left unplanted within a plantation forest will always be vulnerable to vehicle traffic, either routinely or in emergencies such as fire. In the course of the final winter inspection or survey of a planted area, obvious ridge access ways should have a minimum of one or two white posts 1.2 m above ground at the 20 m perimeter mark. The post may have identifying details for the site on it, such as a tag saying that it is an archaeological site and giving the site number or compartment plan details. Although ground marking is not particularly effective (it can be obscured by low vegetation and may not be noticed by a bulldozer driver), it is a useful adjunct to marking on forest planning/compartment maps.

Firebreaks and roads should have been planned and constructed to avoid archaeological sites in the winter planting season or before. If this work is not done by then,

sites will be at risk not only from ad hoc firebreaking if a clearance fire gets out of control, but also from roading constructed just prior to harvest.

Compartment plans or stand records should have the archaeological sites and their extent and identification marked on them in draft by the archaeologist and in 'published' form by the company draftsman. Planting boundaries around the site may be defined by differential G.P.S. and plotted directly into forest planning/ compartment maps. The site should have the same prominence as other management details and it should be a permanent record held and available for all day-to-day and longer-term management purposes. At 1:10,000 scale it should be possible to show the extent of the archaeological site as an outline area.

Routine maintenance of archaeological sites should be carried out in conjunction with regular forestry management operations. For example, when trees are thinned or pruned, wilding pines or other trees could be cut out from and around protected sites. In the early stages of forest establishment, seedling pines (which may have been inadvertently planted on a site) should have been pulled. Weed control (e.g. pampas grass) may be necessary. Alternatively, a few sheep may be let loose in the blocks once the trees are established. Sheep tend to concentrate on the clear grassed areas where the protected sites will be. A thin-stemmed dense shrubland cover, one of the preferred covers for archaeological site conservation (pp. 34–37) is likely to establish in some areas (Fig. 40). Clearance of firebreaks should only be done following reference to the compartment plans and should not be left to the discretion of bulldozer drivers. Bulldozer and other operators should be fully briefed on known sites and should report any damage inadvertently done, or if other sites previously unknown are disturbed.

RISKS TO ARCHAEOLOGICAL SITES IN FORESTRY BLOCKS

- Bulldozing of roads, firebreaks, fire control operations
- The full extent of sites has not been properly recorded in the company's compartment maps; out of date documentation
- Harvesting, especially hauling, skidding and landing construction
- Wilding pines and weeds establishing on non-planted areas

… AND SOLUTIONS

- No planting or replanting of sites
- Long term, on-ground identification of sites by marker posts
- Plantation establishment and logging plans that protect sites
- During felling operations, sites are clearly marked with posts/red plastic ribbon
- No felling onto sites, no hauling across sites.

3.3.4 Case study 4: Sub-surface site (midden) in coastal plantation forest

Wider setting

The site is in a plantation forest (*Pinus radiata*) on North Island west coast dunelands, about three kilometres inland from the coast. The foredunes have long been stabilised by marram grass and a zone of sacrificial salt- and wind-stunted pine trees.

Site conditions

The archaeological site is a midden located on an old dune surface with light sand soils. The midden is exposed and spilling on to an iron pan on older Pleistocene dune surfaces. The midden has not been planted and is surrounded by 15-year-old pines about 10 m tall. The layers of midden cover about 50 m^2. The iron pan has various depressions cut into it which appear to be the outline of storage pits. The surrounding pine trees are 10 m from the perimeter of the site and will overshadow it as they come to maturity. Pampas grass and some three-metre tall seedling pines have established in pockets of more recent sand soils on the site and on the pit depressions. The site has been surveyed out of an area of the former state forest and vested as a wāhi tapu with local Māori trustees.

Management options/issues

- *Leave alone*. Wilding pine trees will grow large and a pampas and mānuka shrubland will slowly develop over the site with some bare patches. This is unacceptable to the forestry company because they want to see sources of pampas seed eradicated before harvesting and re-planting. Also, minimal interventions as below will enhance the conservation status of the site.
- *Remove wilding pines and spray pampas grass* and trust that slow soil formation and drifted sandy topsoil plus pine needles, plus some moist shadow areas, will lead to a cover of stabilising grasses and native shrubs. Bracken and mānuka will eventually be shaded out by the surrounding, maturing pines but will come away again on felling of the surrounding forest.
- *Excavate part of the site to evaluate significance* and then decide on total excavation or further stabilisation measures. If the site is valuable, cover exposed areas with filter cloth and bury site with a cover of raw sand/sandy topsoil up to 50 cm deep. A total of up to 50 m^3 of sand/soil may have to be moved to cover the site area. The surface of the buried area could be deliberately re-planted by placing mānuka slash, etc., but otherwise left to naturally re-vegetate.

Management objective

- Incur the least possible cost by leaving site alone and occasional monitoring to check on natural establishment of native shrubland and to remove pines.

Recommendations

- Ensure the forest records contain an up-to-date reference to the site and a guide to finding it again.
- Wilding pines established on the site need to be removed and the site should be left to revegetate naturally and be monitored by the iwi's archaeologist every two years.
- On harvest, trees should be felled and hauled so as to minimise damage to the archaeological features.
- Any action on conservation needs to be taken by the forest manager as part of its general forest operations, advised by iwi trustees and their archaeologist. Management options/issues would probably be considered by the iwi trustees following a recommendation by their archaeologist and in discussion with the forestry company with cutting rights.

- Whatever management is chosen, adequate records of the location details should be kept. The extent and condition of the site should also be noted in the forestry company's records. The site should be marked on the ground.
- When the forestry block comes to be felled, the area of the site should not be used to fell trees into or used as a landing or log staging area.
- A midden such as this should only be investigated further on the basis of a clear research plan, and only when that plan is in place.