

Figure 31. Steps and railing (built to an accepted engineering standard) on a severely eroded track leading to a viewpoint on the exposed platform of a pa on Motuarohia, Bay of Islands.



Zealand 2004) incorporates the Building Code and should be followed. It will be held by all local government agencies and by the Department of Conservation.

Tracks and roads/car parks

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 raised formations and only if necessary lightly cut into the surface. They should 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.

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 maximum recommended grade on a walking track is 15 degrees (see Standards New Zealand 2004: section 2.5). In some situations (e.g. on a steep defensive bank), the ergonomic rules for tracks 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.

The function of boardwalks and/or steps in protecting fragile or erosion-prone ground-surfaces (Fig. 31) is self-evident. Steps and staircases 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 (see Standards New Zealand 2004: section 3.18). They should be followed where there is a gradual fall in a path greater than 15 degrees and where the grade has to be improved or made up at specific intervals. If the design guides are not followed, visitors will find the steps uncomfortable, and will continue to look for and make tracks away from them.

Walking on top of breastworks or banks should be discouraged. By and large, these features 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 archaeologist familiar with the location. It will be advisable to ask an archaeologist to check the amenity planning on the actual ground and to dig test-pits 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 section 2.3—Non-vegetative methods for site protection—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 car parks be built over archaeological sites. Where inevitable, they need careful conservation planning with the objective of deliberate site burial (see section 2.3.3).

Barriers

Many historic places have inherent risks (to a modern visitor) that are part of their heritage character—pa are often on cliff edges, derelict structures have unprotected falls or failed structural elements. The degree of risk to visitors needs to be carefully balanced against the competency

and care that might be exercised by visitors, the desirability of providing access, and the intrusiveness and expense of barriers and other structures on the heritage fabric of the place.

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. Barrier structures should be professionally designed and installed by tradesmen (see Standards New Zealand 2004: section 3.3.19–3.22).

Signs

Signs warning of danger are common in many reserve areas, but 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 the efficacy of signs, when repeatedly faced with evidence of the damage that they are meant to prevent. Yet, they probably have 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 pohutukawa. 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 (e.g. where broom is a problem).

Roundup topping as a growth retardant

This treatment is applied to kikuyu in autumn, and other grasses in spring. The advantages of such treatment are:

- Reduces growth of weeds
- Improves grasses

- Reduces spring growth flush and need for frequent mowing/heavy grazing
- Reduces stock numbers
- Improves grass palatability
- Kills kikuyu (like a frost)
- Reduces fire risk

The disadvantages of Roundup treatment are:

- Public objection to chemical use
- Possibly particular cultural objections to use on sites
- Aerial spray drift and legal liability

Mowing and line-trimming

More reserves should be mown or line-trimmed than is the case at present. The following applies to sites which are under established mowing regimes. In the mown grassland setting, grasses that are present and establishment methods for desired species will depend on climate. Mowing itself will alter the composition of grass swards. Over-sowing 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.)

Much mowing is too close to the ground and is sometimes too frequent (Fig. 32A). 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 7-10 cm on level ground and 10-15 cm on convex surfaces. No more than $\frac{2}{3}$ of the existing grass height should be cut. For steeper banks which cannot be reached safely with a mower, a line-trimmer is best (Fig. 32B).

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. Tractor-drawn reel mowers capable of giving low grass cutting heights may have uses on broad level areas, provided there is good access.

Where mowing is to be instituted, attention needs to be paid to designing access routes. 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 an issue, then either hand-pushed mowers or line-trimming should be used.



Figure 32. The bad and the good in grass-cover management. A. Ride-on mowers often create scalping where there is a rise in the ground surface. B. Banks should be cut with a weed-eater.

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 visitors. 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 over-sowing 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 at full strength will kill all plants and should not be used unless a replacement vegetative cover is planned.

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

What is needed for sward maintenance plans?

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/contractors and the public
- Specific mowing and line-trimming instructions—never less than 7–10 cm, or 10–15 cm on banks and not less than $\frac{2}{3}$ of the existing grass height
- Instructions to maintenance people to avoid scalping and mowing too close, 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

- Over-sowing 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—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 should be a landscape plan in place as part of the overall conservation or management plan to ensure that the vegetation which is planted or maintained is in keeping with the historic landscape setting, to maintain viewing corridors and screening unwanted sights (such as modern housing or a car park) adjacent to a reserve.

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 kumerabo* 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 native 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 bank where the aim is to keep people off. Otherwise, as for all archaeological sites, planting of trees and shrubs should be kept at a minimum. Sustainable exotic grass cover should be the aim.

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 pa. It is located in the northern North Island, with the sea on one side and suburbs on the other. A Maori Reserve containing a pa bounds on to one corner. The Maori Reserve is in regenerating forest with some areas of gorse and ungrazed grassland.

Site description and condition

The three pa 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 manuka 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 pohutukawa 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

- There is no operative management plan
- Tangata whenua are concerned about erosion of two wahi tapu at specific places on the site
- 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

- Vehicles are not able to get access, but a large car park is adjacent to the reserve boundary
- Rubbish is being dumped
- 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 co-operation with neighbours. To a greater or lesser extent the following options are open:

- Improve conservation of the archaeological and historic features
- Review reserve classification
- Define current recreation activities and set out the limitations, opportunities and places for those activities
- Increase the rate of planting to revegetate 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

The management objective is to maintain recreation opportunities and conserve the historic features so that they can be appreciated. 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

- Consultation should be undertaken with tangata whenua, and with local community interests and other stakeholders.

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.
- Analyse views to maintain desirable ones and minimise intrusion of undesirable ones.
- Conduct a detailed evaluation of archaeological features and their desirable degree of visibility to visitors.
- Devise a revegetation 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

- Lay out desired/acceptable uses for different parts of the site/landscape.
- Review the existing 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

- 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.
- Grazing should be restricted to the ridge crests (by fencing), allowed only in certain seasons (i.e. only late spring and autumn), and controlled in intensity.
- Where present, kikuyu grass could be removed by spraying with glyphosate (Roundup), and native grasses such as meadow rice grass (*Microlaena stipoides*), or a low-growing shrub such as *Muehlenbeckia complexa* could be encouraged instead.
- Level or near-level areas, which have been defined in the landscape evaluation as needing to be kept clear, should be mowed.
- 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.
- The overall pattern of these factors should be determined to allow for public and mowing-machine access, and provide an acceptable accidental-fire control procedure.
- Soil fertility surveys of microsites should be carried out 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, Maori 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 2-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, plant any steep slopes currently suffering stock damage and which are to be fenced-out in an appropriate cover of low shrubs or trees.
- Initiate repair and re-planting of bare areas, or areas with weeds, that in the long term can be shaded out.
- Remove unstable trees, or trees that could become unstable, before they disturb the soil.

3.1.4 Case study 2—Pa in mown grassland

Wider setting

The following case study applies to sites north of Nelson–Marlborough, the region in which most pa 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, and level or near-level areas with a 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, and scarps facing south, wet, poorly drained, heavily shaded areas, and areas prone to short-term saturation, bases 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.
- Institute monitoring to fine-tune mowing and other management.
- 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 by determining the best times to mow to allow for seeding, reducing fire risk, etc.

Recommendations/guidelines

Prepare a conservation plan, incorporating the following points:

- Ride-on mowers should not be used on this particular site. On hand mowers, the blade should be set at a height of 7–10 cm above the ground for level areas, and 10–15 cm on slopes or convex areas such as tops of banks.
- Provide on-site assistance when setting up a new mowing contract, walk the site with the contractor.
- Legume and broadleaf weeds should be controlled.
- Institute Roundup ‘topping’ (see 3.1.2 above) as a means of reducing weeds and slowing grass growth.
- 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 regrowth.
- Use mowing pattern to assist in the control of visitor behaviour, e.g. keep rough long grass on banks to deter walking there.
- Well-sited 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

Land with warm microclimates and with sources of fresh water were prime spots for Maori settlement 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 privately owned farmland with limited or no public visiting. They may occupy only a small proportion of the area of a farm, but are often features which are prominent in landscape views and public appreciation. Outside the warmer regions, there are still some sites of Maori 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 Maori 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 and stock erosion generally, weed clearance, and ploughing. Overgrazing on friable soils may be a problem

Figure 33. Erosion on a pa 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.



(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 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.

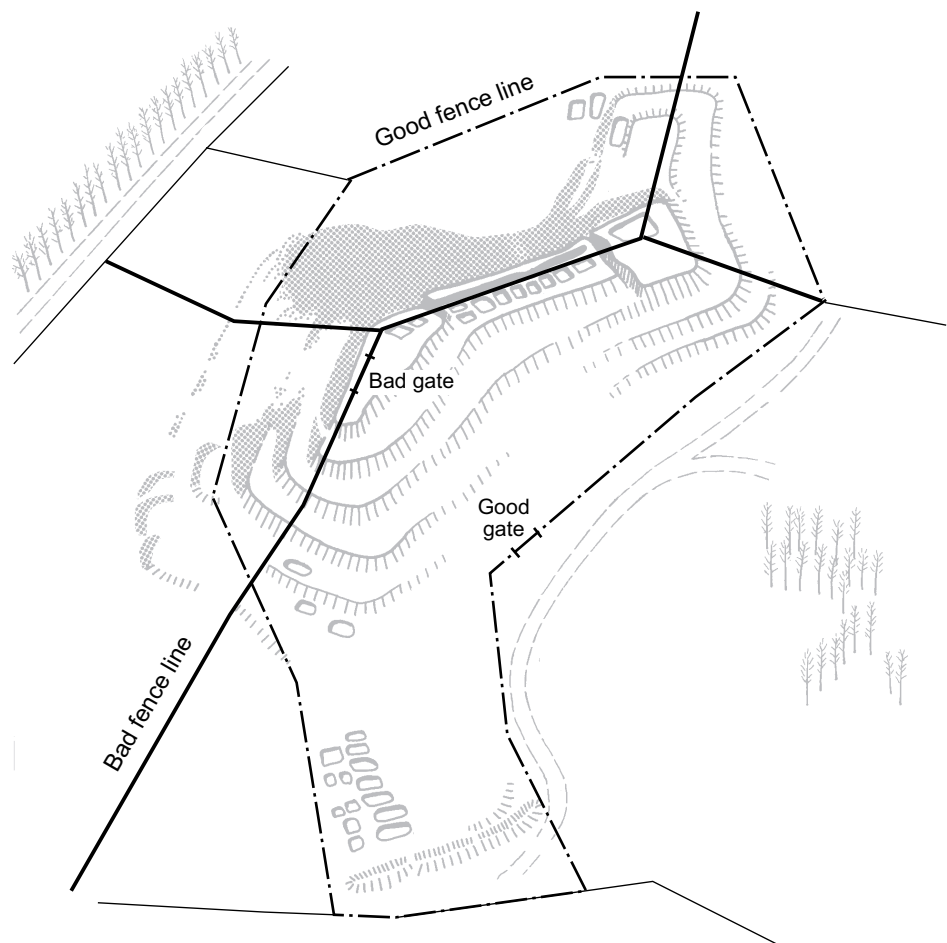
3.2.1 Grazing and pasture care

Control of the behaviour and density of grazing animals is the key to maintenance of surface-earthwork archaeological sites such as pa (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 next.

Stock type and numbers

- Limit stock numbers to no more than 10 stock units/ha
- Control stock-type: sheep or goats, yearling cattle only, not bulls or dairy cows
- Mob stocking is not recommended, but if needed it should only be carried out infrequently and for a short spell (less than 7 days)

Figure 34. Good and bad fenceline and gate positions on a typical pa site.



Grazing season and format

- Limit the grazing season: not in winter or very wet weather
- Either use rotational grazing (but keeping grazing period short with plenty of feed available), or use set stocking (at no more than 10 s.u. per ha)

Best form of sward to maintain

- Fertiliser to be applied to maintain sward cover and not for production
- Maintain a desirable grass height of 6–10 cm (note: this height is also consistent with satisfactory levels of production and pasture weed control)

Paddock design and stock water

- Sites should be fenced into their own small paddock
- This paddock should receive limited stocking, but otherwise be integrated with a useful grazing strategy for the farm
- Stock water should be supplied at a point away from the actual site, because animals will create soil damage at the water 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, any 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 preferred balance between pasture production and weed control on the one hand, and archaeological site protection on the other. The section on Grazing (below) shows preferred stocking rates of no more than 10 s.u. per ha. On friable soils and in cool temperate or dry areas, stocking rates will probably need to be lower than this, but it is difficult to specify rates for those conditions. 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. per 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. per ha) for archaeological sites on lowland (e.g. Waikato basin) and warm coastal hill country are shown below.

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. per ha) to maintain a pasture height of 6–10 cm.
- Stock units per hectare will need to be varied during the year to avoid weediness in summer 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 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 and camping on high points.

Grazing—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 down-slope.
- Deer fences distract from the landscape visibility of the site unless carefully planned.

Grazing—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.

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. Mob stocking should only be carried out infrequently, and for a short spell (less than 7 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 and maintaining good coverage of the soil surface. If the grass is to be utilised for stock grazing, clover could be over-sown 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. per ha) and never let the pasture be overgrazed. Limited feed will lead to animals roaming the fence lines looking for 'greener pastures'. Where fence lines 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.

Weed control

- Do not use bulldozers to clear weeds such as gorse 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

- 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, it will present a short-term weed problem in most farmland. 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, 2 kilometres), most areas that are fenced out and permanently retired from grazing will become 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, 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.

Pas 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 pa 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 pa defence), so that rough tracks were sometimes pushed through to provide access for stock along the ridge or onto the platform of the pa.

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. When there is no alternative but to run a permanent fence through a site, damage to subsurface features can be minimised by using driven waratahs or proprietary 'Stapelok' fence types which use small footprint galvanised steel posts.

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