Figure 14. The tall native sedge *Gahnia* sp. with its drooping habit provides a good protective cover on the banks of this pa in the northern Urewera.

light raking will dislodge any seed held in the surface vegetation. Covering the seed with up to 5 cm thickness of straw (or hay, if potential weeds are not a problem), a germination cloth or hessian will provide protection for the seeds and seedlings and help the absorption and retention of moisture by the soil (it will eventually rot down).

Where there is a well-formed topsoil, or if the site is known to have been ploughed or cultivated, scarifying the surface of the soil is acceptable. In firm soil or clay—on or towards the top of banks, for example—scarification by swinging a hoe may be acceptable, but care should be taken not to dislodge too much of the soil down-slope.

Where there is easy vehicular access to a site, it may be worth considering hydroseeding—the procedure used to grass road cuttings. This is a very fast and effective method of re-grassing bare ground. Private companies dealing in erosion control and management may offer useful advice, as well as the hydroseeding service.

As with any form of vegetation establishment, considerable forethought needs to be given to organisational budgeting, planning, and approval cycles. The biological cycle involved with seed collection and sowing does not fit well with normal financial year cycles, and planning may need to allow for a suitable lead-in period.

The specimen work plan in Appendix 2 (section A2.1) gives further details on seeding.

Sedges

Several native sedges such as *Gahnia* spp. or 'hookgrass' (*Uncinia* spp.) can form good protection against erosion and some, such as the tall species of native sedges, may also prevent or discourage access away from approved tracks (e.g. Fig. 14). Some sedges may do well in drier areas. Sedges can be propagated by stripping seed in the appropriate season and planting the seed, or by planting stem and root divisions of existing plants. Local advice should be sought on the appropriateness of, and methods for, planting sedges.

2.2.5 Establishment of grasses on ground cleared of scrub or fern

Scrub- or fern-covered ground can present a major problem in establishing a suitable seedbed, especially where there is a heavy growth of native shrubland. Burning provides an ashy seedbed and the remaining semi-burnt woody material will provide shelter for the young seedlings. Burning will stimulate the germination of legume seeds such as gorse or wattle. Where burning is not feasible, herbicide spraying followed by removal of most of the woody material may be the only solution. Immediately after the death of most of the vegetation, the site may be vulnerable to

erosion, and as much broken-down, dead vegetation as possible should be left on the site. A temporary mulch or geosynethetic cover (see below) may be needed on some areas.

The timing of ground preparation and seed sowing is critical. In the South Island, late winter or early spring is the best time to oversow with grass seed, but in the North Island, over-sowing in autumn can be successful. It is usually advisable to sow a mixture of two to four species of grass and clover. White clover and a rank ryegrass such as Grasslands Nui will be useful where gorse seedlings must be suppressed, but browntop and the finer ryegrasses may be more durable on paths which will have to cope with treading. In drier areas where there is not much control on the grazing, cocksfoot and subterranean clover may be considered. On steep slopes with low fertility, browntop, crested dogstail, and danthonia can be used to get a quickly established sward, in conjunction with a legume (e.g. white clover). Most sites will profit from a dressing of fertiliser, particularly of lime and superphosphate. On small areas of steeper slopes (greater than 30 degrees), it will be desirable to broadcast fertiliser by hand ensuring that it is thrown into the slope and on to the soil surface—or use hydroseeding. Although costly, irrigation should be considered for the first summer, or in dry periods within the first year of growth.

2.2.6 Grazing

Grazing is a potentially useful tool for archaeological site management. It ensures, among other possible objectives, that a site remains visible and accessible at little net cost. However, cattle and high densities of smaller animals can cause rapid changes to ground surfaces (Trimble & Mendel 1995). It is noticeable that grazing heavy animals on archaeological sites, especially in winter, is destructive of surface features. Stock camping can also be a problem. Much erosion occurs on microsites (patches of banks less than 10 m long) and, cumulatively, these small individual areas of erosion will do much damage. Stock damage over decades can completely wear away a site (Fig. 15A). This long-term trend to almost complete destruction can be observed when comparing old and current aerial photographs. It is not uncommon to find the lateral roots of trees perched up to 60 cm above the ground surface and other evidence of heavy wear, on grazed banks.

In hard hill country, hares can be important in maintaining grass cover. Rabbits will burrow and should not be tolerated on archaeological sites.

Grazing licences or concessions on reserves have not always protected archaeological conservation values and have destroyed other historically associated elements of a site or landscape such as trees. Grazing should be carried out for particular site management objectives, and strictly controlled. The objectives are:

- General vegetation control
- Keeping height of grass down for site visibility and lessening fire risk
- Preventing shrubland succession

Grazing may often be the least-cost means of maintaining and perpetuating grasslands, but cost-saving should never be the overriding consideration. Earthwork sites should not be grazed as high-producing grasslands. Managers of archaeological sites should monitor grazing licences or informal arrangements with neighbours, to ensure that:

- The archaeological site is not used for winter run-off pasture
- Inappropriate or unapproved fencing, gateways, or water lines or troughs are not installed
- The land is grazed only lightly
- Treeland or artificial shelter for the animals, consistent with the reserve setting, is in place

The archaeological conservation values of the land should be assessed, and stock numbers, animal type, and grazing levels set so as to ensure protection of those values. For a grazing licence, these calculations will also give an indication of the price to be charged for the licence.

A suggested guideline is to maintain a grass height of 6–10 cm. On firm soils in the north, this will mean an average stocking of no more than 10 stock units (s.u.) per ha. (Stock units are further defined in the Glossary, see Appendix 5.) A fertiliser maintenance rate of 15–25 kg per s.u. is an accepted rule of thumb to achieve these grass heights and grazing levels. The Auckland Regional Council recommends a base rate of 375 kg per ha which for 6–10 s.u. per ha is a somewhat higher rate of application. These rates may be contrasted with rates for a high-producing dairy farm of about 1000 kg per ha.

Any reserve that is being grazed and which shows satisfactory conservation condition can be checked to re-affirm this guidance. Stock and pasture consultant Ross Duder notes that Mount Eden (Auckland) is stocked at 4.5–7 s.u. per ha in spring and summer. Problem microsites and the overall archaeological values of the area will still need to be monitored closely. Ross Duder also recommends that young cattle used on large

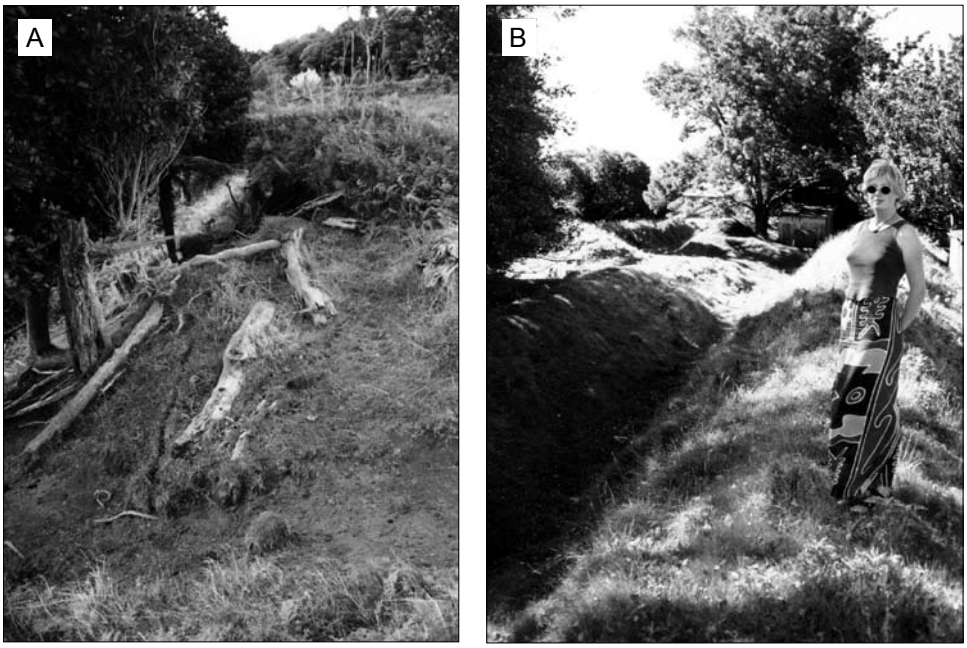

Figure 15. Grazing. A. Sheep are tracking through and camping below these karaka on Pukerangiora Historic Reserve. An early attempt to move the sheep off using prickly branches has worked at one spot, but has displaced the site of erosion down to below the trees. B. Light set grazing by sheep (probably less than 10 s.u. per ha) with ample shelter, has protected the banks of Tapui, a pa near Manutuke, Gisborne district.

sites such as the Auckland cones need to be conditioned (trained) to the presence of people, so that they do not rush about.

Figure 15B illustrates the maintenance of very steep banks by using set stocking of a few sheep for a long time with few fertiliser inputs. Although set stocking is recommended, it should be possible to manage several larger sites or reserve areas by rotating the same stock from one area to another. One area can have no stock for a period, while the animals are put to use elsewhere. Seasonal fire risks and roading and fencing practices to allow for grazing are further factors to be taken into account. These technical points are covered in more detail later in these guidelines.

Relevant factors in stock management on archaeological sites

- Stock numbers—up to 10 stock units (s.u.) per ha
- Stock-type—sheep (preferably not rams) or goats, yearling cattle (equivalent of 5 s.u.) only
- Permissible grazing seasons—not in winter or very wet weather
- Set stocking is preferable to intensive rotational grazing
- Keep plenty of feed available; grass should be 6–10 cm in height (in the north this means average stocking of 10 s.u. per ha)
- Fencing should not slice across a site
- Top-dressing—soils should not be fertilised to maximise production but to maintain even grass cover and prevent erosion
- No gates or yards on a site
- Stock water and shelter should not be supplied on the features of the archaeological site

Specific comments on stock type and grazing intensity are given below in section 3.2 on farming practice. Another form of intensive grassland management is in areas used for haymaking or for amenity areas, such as city parks. Their management shares some similarities with grazing. The advantages and disadvantages of intensive management are summed up in Table 3. They may be compared with a similar range of advantages and disadvantages for native or low-intensive grassland management in Table 2.

Sheep tracking and camping, cattle wallows—some solutions

All grazing should be monitored to identify erosion hotspots. For an example, see Fig. 15A, where sheep are burrowing for shelter in the banks of a pa: trees on the bank appear to exacerbate the problem, as animals are attracted to the shelter that banks and trees provide, and create destructive 'camping' grounds (Prickett 1985: 63–70). The question to ask is: Why are the sheep camping at this spot? The answer is probably because it is level or can be made level by trampling and provides shelter from wind and sun (e.g. under a tree, on the north side of a bank, or beside a ruined wall, or where sheep can rub against a post).

Before a solution is attempted, the area of the paddock enclosing the archaeological site and adjacent paddocks should be surveyed to see if

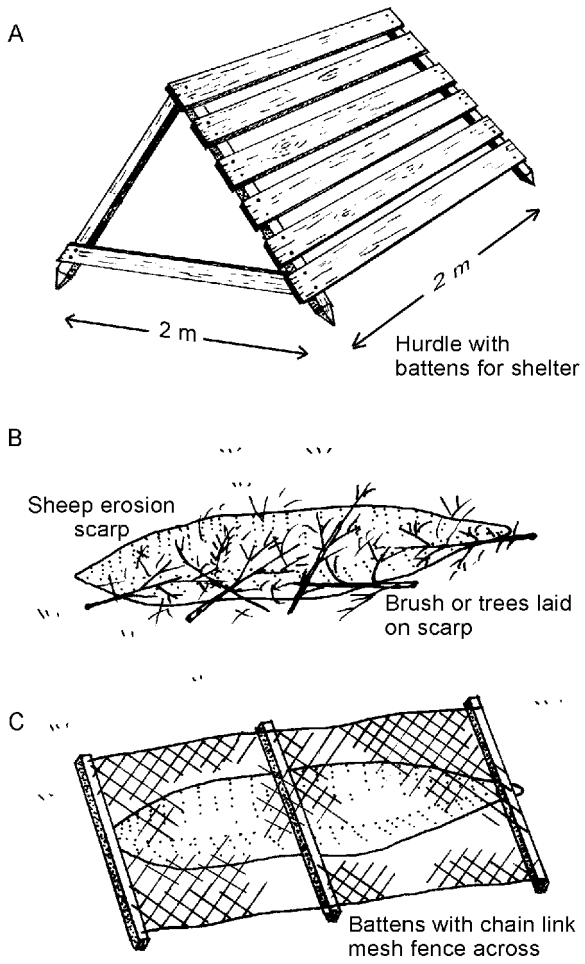

Figure 16. Shelters and barriers. A. Wooden hurdles with slats to provide shelter for sheep. B. and C. 'Uncomfortable' temporary barriers to stop sheep camping.

alternative shelter is available in a less damaging position. There is no point in diverting sheep away from their camping spots unless there has been adequate provision for shelter elsewhere within the paddock. The paddock configuration could be designed or re-arranged to allow stock access to this shelter (e.g. by including an existing patch of trees or part of a windbreak). If there simply is none, a means of providing it should be sought. Small patches of trees and undershrubs could be planted inside a temporary fenced-out corner of a paddock. Within 5 years, the temporary protective fence could be removed to allow the sheep back in. Otherwise, movable forms of shelter (e.g. wooden hurdles, constructed up to 2 m long, with slats) could be provided (Fig. 16A).

Where patches of erosion have formed, it is best to deter sheep by piling branches with plenty of twigs on to the erosion scars (Fig. 16B). It is difficult to get complete coverage, and ingenuity of sheep in displacing brush or slightly relocating their camping should not be underestimated. An advantage of the branches is that grass will readily grow underneath and the branches will eventually rot away. Another method is to use short lengths of recycled chain-link mesh fence (say about 2 m long, stapled on to two or three battens) placed in a slightly elevated position over the erosion area and its margins (Fig. 16C). Grass will grow underneath. The fence portions can be made in a workshop and easily transported to the field. This also works well where sheep are burrowing or working their way into banks. The wire can be pulled up every 18 months, so that it does not become fixed beneath tall grass, and can be re-located to problem areas elsewhere.

TABLE 3. ARCHAEOLOGICAL SITES AND INTENSIVELY MANAGED GRASSLANDS.

ADVANTAGES	DISADVANTAGES
Legumes supply nitrogen	Cost of fertilisers and lime
Amenity grass varieties have good cover, low growth and drought resistance	Winter is period of peak need for grass which may lead to undesirably high stocking in that season
Fencing and gateways may be designed to assist conservation	Stock camping, tracking around ill-designed fence lines
Varieties tiller, therefore good ground cover	Pugging and erosion around water troughs
Stock numbers may be kept low; grazing rotated	Risk of erosion, severe erosion if overstocked
Varieties palatable	Severe erosion if stocked with cattle
Reduced scope for weed and shrub erosion	Water must be supplied for cattle
On flat land or easy slopes, can be combined with mowing, and hay-making	
Little net cost when farming returns considered	
Tread-resistant, may be used in pathways	

2.2.7 Native shrublands

Where an archaeological site is not meant for public visitation, and where it is not in stable native treeland cover, the objective should be to create and maintain a thin-stemmed, densely canopied cover, such as a manuka shrubland. Figure 17 shows a decision-making process for maintaining sites in a thin-stemmed native shrubland.

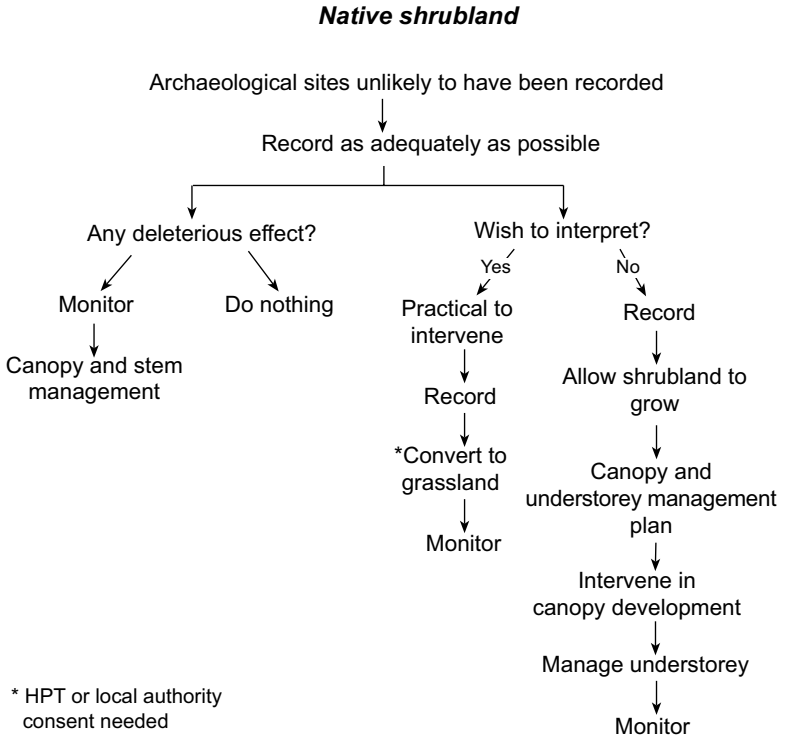

Figure 17. Management issues and likely ecological processes in native shrubland.

Many native shrublands are nurseries for large tree species. However, large trees are not a desirable cover on a site where the stratigraphy is to be preserved. (They may be acceptable on sites which are open to the public and where the main point of interest is in the surface earthworks.) On archaeological sites, all potentially large trees will require regular inspection. Specimens with the potential to grow to more than 10 cm diameter at breast height (d.b.h.) will need to be removed. This includes older-growth manuka, although an even-aged old stand should not be felled. The interval between inspections will depend on growth rates of the trees, and can be determined by the local land manager.

Kanuka and manuka brush

On bare soils, especially subsoils exposed in old roadways or on heavily eroded banks or ridges, manuka mats may be of use. The objective is to get the seeds of the manuka to settle on the soil surface. Branches of manuka or kanuka are scattered and pegged down, or laid in loosely woven mats. This can be done at any time of year for manuka, but only in March or April for kanuka. Before the branches are gathered, they should be checked to ensure that seed capsules are present and that they have not released seed. The brush layer should be thin to allow plenty of light to reach the seedlings.

Applying brush will be most useful on any areas of bare subsoil—for example, in mitigating the effect of a road or track scar or in holding slips on the steep ground below archaeological sites in hill country. Brushwood held by short stakes driven in rows across a slip has the advantage of applying an instant poultice to a bare surface to reduce rain wash. Brush is also useful in preventing or healing 'desire lines' created by people walking outside of designated tracks.

2.2.8 Native forests and treelands—issues and guidance

Many sites which were maintained in bracken and shrubland by nineteenth-century burning, and subsequently farmed, will have had little tree growth. These sites will include most ridges in populated areas in the North Island. Regeneration of native forest on these sites will be destructive in the long term and should be controlled.

On sites where forest is regenerating (provided significant stratigraphy has not already been destroyed), it is recommended that any young tree with the potential to grow larger than 10 cm d.b.h. be felled. Destruction of stratigraphy may be supposed to have occurred in any areas where trees have grown to a large size (over 30 cm d.b.h.). Inspection of parts of the stratigraphy of the site by excavation may be desirable. In any event, the felling of stable, mature native treelands is not recommended.

On some soils, tree roots may not penetrate very deeply, particularly if there is an iron pan, stones, or indurated ash shower close below the surface. However, most archaeological sites contain layers and pockets of very fertile soil and are above any hardened layers, making them vulnerable to root growth.

Manuka and kanuka are often preferred as a nursery crop for larger native species whether naturally recruited or planted. On archaeological sites, the recruitment of potentially large tree species into manuka should be monitored over a 20–50-year time period. Trees should be removed (or selectively removed) where that is prescribed for in a conservation plan. (Plans should allow for such removal.) Kanuka larger than 10 cm d.b.h. should be removed, not only because of the root growth, but also because this species is prone to wind-throw.

In many situations, archaeological sites exist in areas of former pasture destined for overall native revegetation. Examples are the reserves on Motutapu Island, Tiritiri Matangi, and Mana Island. A conservation plan in these circumstances will often allow for, or prescribe, a mosaic of grass over the archaeological sites and planted shrubland and developing forest in the balance of the area. Sometimes this pattern will be present in mixed shrubland/grass areas where grazing has simply been removed. Excluding an area from grazing without additional planting will also often result in an increase in weed species, some of which can grow into substantial trees. It will be necessary to allow additional resources for weed control when leaving open areas ungrazed. If not, the shrubland will come to shade the grassland, reducing the latter's ability to compete, and the shrubland and trees will naturally encroach. In these circumstances the encroaching shrubland should be taken back to its planned or original

boundaries around the grassland. Native tree protection provisions in district plans will take precedence over any special-purpose plan such as a conservation plan. These provisions are becoming more common and restrictive, particularly in urban areas. Special council permission will be required in some circumstances to remove trees. Also, removal may be allowed in a current land management plan, but it may not be allowed in 20–50 years' time. Conflicting objectives may therefore arise in such circumstances, with the risk that native vegetation protection will uniformly prevail over archaeological protection. Shrubland or gorse areas are sometimes underplanted by people interested in promoting future native forest regeneration areas. Managers responsible for archaeological sites in such areas must work to ensure that such planting is done in accordance with the objectives of archaeological site protection.

Some trees are prone to wind-throw in the medium term (50–150 years). Examples are rewarewa or wattle, which are both trees that can grow to a large size and become unstable early in a forest succession. They should be removed if there is reason to believe that they will become unstable within 5–20 years, or if monitoring shows that they are causing site damage.

Figure 18 shows the general procedures carried out at Te Koru Historic Reserve, Taranaki, to remove potentially damaging trees and to improve ground visibility and ground covers (for the conservation plan, see Department of Conservation 1998). In this context, where ground-level visibility is required, it should be remembered that some smaller species, such as whauwhaupaku (five-finger) or mahoe, coppice vigorously with probably little slowing down in root growth when the stem is cut. The stumps should be treated with a systemic herbicide immediately after cutting; if treatment is delayed, the application of herbicide becomes ineffective.

Trees that were probably introduced to the vicinity of a site by Maori, such as ti (cabbage trees) or karaka, should be left as elements of the cultural landscape. Karaka can form dense thickets of seedlings which thin out naturally. In particular places, such as the edges of banks or in ruins, they may need to be removed. Any increase in coverage by such species should only be according to a conservation plan. Generally, they should not be allowed to cover archaeological features.

In grazed grassland areas, the ground beneath individual trees or groves of trees will be used by stock for shelter. An evaluation of the effect on the site should be made. Such trees or groves should be removed if damage is or will be severe in the long term. Alternative shelter should of course be provided. This may be arranged by new planting in a temporarily fenced area or by re-arranging fence alignments and paddock areas to incorporate shelter.

Principles for native shrublands and tree cover

- If an earthwork site has a stable tree cover (i.e. coverage of long-lived species), leave it alone—stable cover equals stable surface earthworks.

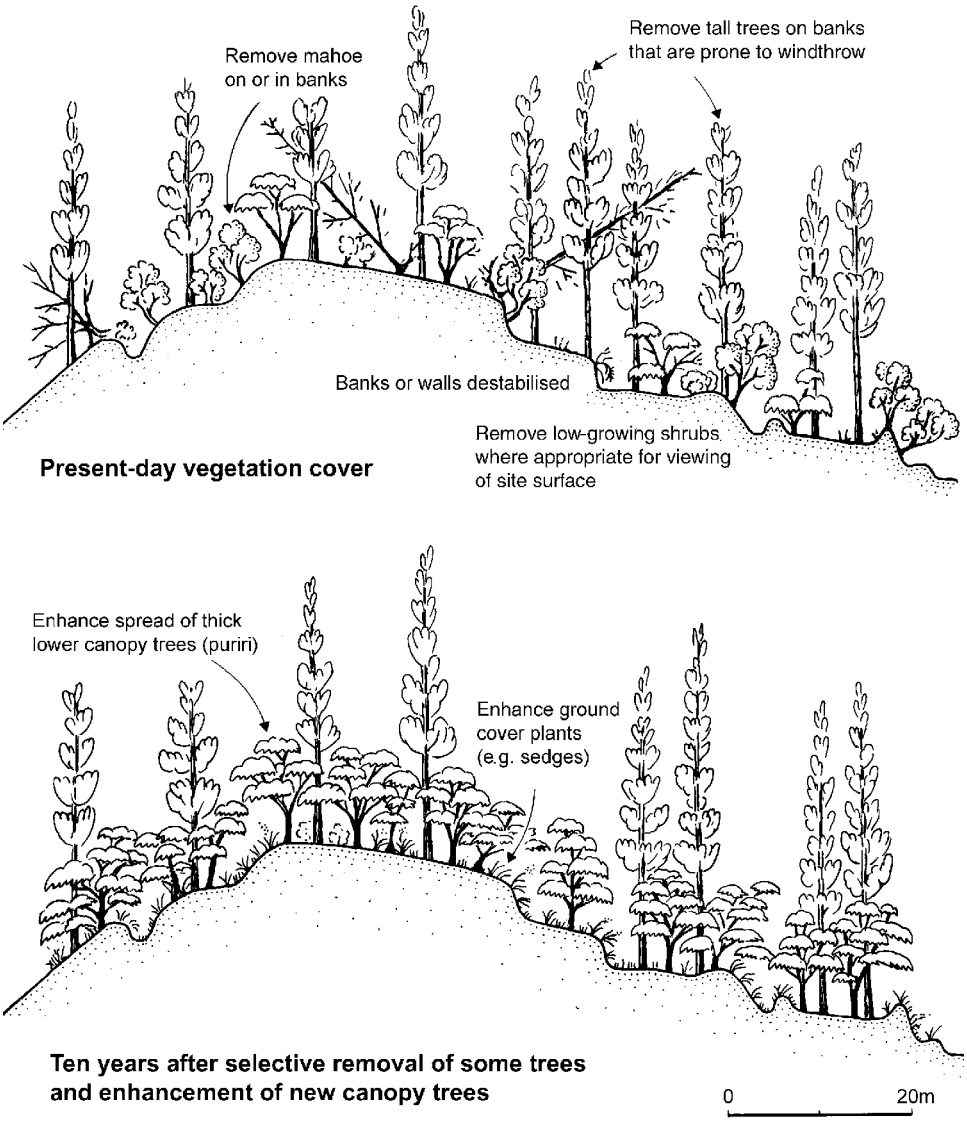

Figure 18. Suggestions for reducing risk from unstable trees (rewarewa), opening-out a gallery forest, and enhancing canopy and ground cover at Te Koru.

- If trees are potentially unstable (e.g. rewarewa or wattle), they should be removed according to specifications in a conservation plan.
- Allow for replacement canopy by planting in seedlings or allowing the growth of naturally adventive broad-canopied trees such as puriri or karaka (both culturally appropriate to sites).
- Protect the existing and future canopy trees in any site operations.
- In regenerating forest, remove trees that have the potential to grow bigger than 10 cm d.b.h. Removal should allow for canopy replacement with low density of stems per unit area if long-term forested cover is sought.
- Bare land or cleared land should not be planted in trees or shrubs, but suitable low ground covers should be planted either from seed or container seedlings.

2.2.9 Gallery forest and canopy maintenance

A gallery forest has wide-spaced mature trees with single boles which support a closed canopy. The concept can be seen in natural forests where the forest floor has been immersed in silt or gravel during floods or

Continue to next file: Part 5