4286

SHORELINE VEGETATION, LAKES MANAPOURI AND TE ANAU

PRELIMINARY REPORT ON EFFECTS OF RECENT HIGH LAKE LEVELS

R.B. Allen, Botany Division, DSIR, Dunedin

A.F. Mark, Botany Department, University of Otago

20 January 1989

SUMMARY

Shoreline vegetation on Lakes Manapouri and Te Anau was inspected on January 16-17 1989 to assess damage caused by the prolonged high lake levels of September-November 1988, and the strong north-westerly winds that occurred during peak levels. Beach sediment removal and redeposition, together with wood debris deposition, have resulted in root undermining, bark abrasion, stem burial and forest floor scouring on most Te Anau beaches and deltas, with resultant toppling of many trees and saplings, and death of particularly sensitive plants, mainly celery pine and beech seedlings. Similar but less severe effects were recorded on some Manapouri beaches and deltas. Most ringbarked and fallen trees still appeared green and healthy, and there was little evidence of physiological damage due to prolonged root submergence or other effects of the high lake levels and storm. Much more substantial mortality than was apparent at the time of the survey is predicted. A further survey will be required to assess the full effects at a later date.

INTRODUCTION

Assessments of the tolerance to submergence and emergence of shoreline vegetation at Lakes Manapouri and Te Anau (Johnson 1972a, b; Mark et al. 1972) have been used to set guidelines for lake level management during hydro-electric operations (Mark and Johnson 1985). Prolonged flooding during 1975 exceeded these guidelines on Lake Te Anau, and resulted in mortality of forest and scrub along the shoreline (Mark et al. 1977).

The guidelines were again exceeded on both Lakes Te Anau and Manapouri, as a result of an extended period of high rainfall from mid September to early November 1988 (Fig. 1). Strong north-westerly winds occurred in late October - early November when lake levels were close to their peak. Lake Te Anau reached a record high level on November 4 at 205.11 m, which is 0.81 m above the guideline maximum. A day later Lake Manapouri reached 181.52 m, also a new record, 1.02 m above the guideline maximum.

This survey was financed by Electricorp ("without prejudice") to assess the effects of the 1988 flood and storm events on the

shoreline vegetation of the two lakes. Field work was carried out on 16 and 17 January 1989, with the assistance of Mr David Taylor, Department of Conservation, Te Anau.

METHODS

Beaches and stream deltas on both lakes were inspected for evidence of physical and physiological damage to plants. Records were also made of evidence of recent changes in shore and offshore morphology.

RESULTS

A general description is given of the effects of high lake levels and north-westerly winds, followed by summaries for individual sites.

a. General

Physical damage was evident on vegetation on both lakes. Bark abrasion on tree trunks up to 1.5 m above ground level was common, and particularly severe on Te Anau beaches exposed to the north-west, resulting from wave-carried wood debris ranging from tree branches to entire trunks. The small trees putaputaweta (*Carpodetus serratus*), celery pine (*Phyllocladus asplenifolius*) and tarata (*Pittosporum eugenioides*), as well as mountain beech (*Nothofagus solandri var cliffortioides*) saplings up to about 20 cm diameter, were frequently completely ringbarked. However, small trees of kowhai (*Sophora microphylla*), manuka (*Leptospermum scoparium*) and Hall's totara (*Podocarpus hallii*), and mature mountain beech trees, generally were more resistant to abrasion, and seldom sustained bark loss over more than half the trunk circumference. Exposed roots, mainly of beech trees, also lost up to half of their bark.

On several Te Anau beaches exposed to the north-west, small trees of manuka and kowhai growing on the beach were toppled by the effects of undermining, wind, and wave action. On some particularly exposed beaches, beech saplings and several mature beech trees at the forest edge had also collapsed. This effect was much less marked on Manapouri, where most beaches are less exposed.

Around both lakes, mortality of saplings and small trees was most evident in celery pine, which had completely brown, dry foliage on many plants growing along or close to forest margins. On several Manapouri beaches, mountain beech seedlings and small saplings at the forest edge were also dead, and others had bronzed foliage suggestive of imminent death. Dead tutu (*Coriaria arborea*) plants were recorded along the Manapouri shoreline just south of its outlet at Pearl Harbour.

Wave action and scouring by wood debris resulted in the clearance of vegetation from the forest floor for several metres inside the forest edge at several beaches, where some regrowth was evident on stripped plants of kiokio (Blechnum sp. "brown scale") and crown fern (B. discolor). Cushions of mosses and other epiphytic vegetation had been similarly removed from logs on or close to the forest floor. Fresh accumulations of wood debris extended up to ten metres inside the forest edge on exposed beaches, covering walking tracks in several locations on both lakeshores.

Exposed beaches on both lakes, but particularly on Te Anau, showed distinct sediment transfer from east to west. This resulted in undermining and exposure of root systems, especially at the eastern end of beaches, in extreme cases to a depth of one metre and back to three or four metres from the forest edge. Undermining, probably assisted by strong winds, caused many stems to topple. There was corresponding burial of plant stems usually at the western end, and often the formation of a storm beach ridge along the top of the beach.

Deltas of many streams showed recent substantial accumulation of sediment to several metres off shore. This was particularly evident at the inlet of the upper Waiau River in Shallow Bay, Lake Manapouri, where several large gravel bars have formed on a wide delta projecting more than a hundred metres into the lake, and at the Delta Burn on Lake Te Anau. In the case of Shallow Bay the sediments have been derived from very substantial bank collapse, still active at the time of this survey, along the upper Waiau River course.

b. Individual sites

Te Anau

1. Brod Bay

Beech roots undermined for 2-3 m from forest edge. Bark abrasion up to 50% of circumference on many trees: up to 80% of outermost trees affected. Occasional toppled trees. Sand deposited on track behind beach.

2. Esk River

No fresh erosion of roots. Very little bark abrasion. Small celery pine trees have some brown foliage. Occasional manuka undermined and fallen but still alive.

3. Delta Burn

Undermining about 0.6 m deep exposing beech roots at east end of beach; much sand deposition towards west near top of beach. Negligible bark abrasion. Toppled 2 m tall kowhai, Neomyrtus

pedunculata, Hall's totara; the last had brown foliage.

4. Tutu Burn

Beech roots undermined to 1 m depth and 2 m in from forest edge. Bark abrasion on beech roots and trunks; also on stems and lower branches of small Hall's totara, Coprosma propinqua and miro (Prumnopitys ferruginea). Foliage stripped from kiokio on forest floor; epiphytes stripped from leaning trees on outer edge of forest.

5. Garden Point

Beech roots undermined at northern end of beach; sand deposition at top of southern end. Small trees at forest edge bent by debris; some bark abrasion on these and mature beech; ground cover, especially ferns, damaged. Miro 2 m tall with yellowing foliage; new foliage on mingimimngi (Cyathodes juniperina) dying.

6. Ettrick Burn, south side

Root undermining and toppling of a few large beech trees. Moderate bark abrasion on manuka on boulder beach and on beech at forest edge. Some epiphyte removal from logs; remaining seedlings established on logs often dead. A few beech saplings 2 - 3 m tall dead. Kiokio resprouting after foliage stripping. Crown fern cover damaged along outer forest edge; several plants with fresh regrowth.

7. Ettrick Burn, north side

Occasional manuka uprooted and dead on boulder beach. Root abrasion on beech, Coprosma linariifolia and miro at forest edge. Trees up to 10 cm diameter of beech and lancewood (Pseudopanax crassifolius) toppled and dead; dying similar-sized mapou (Myrsine australis) and kamahi (Weinmannia racemosa) with root systems rendered unstable.

8. Mainland shore opposite western tip of Doubtful Island

Beech roots undermined at east end of beach; associated beech seedlings dead; several toppled beech trees with brown foliage. Severe bark abrasion on beech, broadleaf (Griselinia littoralis) and kowhai trees; some ringbarked. On adjacent rocky shore bark abrasion on manuka, Gaultheria crassa and rata (Metrosideros umbellata); 2 m tall inaka (Dracophyllum longifolium) toppled and dead. Deep deposition of fine gravel at west end of beach, where there are several ringbarked but still living trees of beech, mahoe (Melicytus ramiflorus) and mapou; severe abrasion on all tree and shrub species.

9. Snag Burn, eastern side of delta

Bark abrasion on manuka on beach. Encroachment of gravel into swamp behind storm beach; large logs deposited at top of storm beach. At east end of delta roots of beech, kahikatea (Dacrycarpus dacrydioides) and associated small trees undermined to 1 m deep and 2 - 3 m back from forest edge; Carmichaelia grandiflora shrub on root plate dead. Toppled kowhai and beech 25 cm diameter.

10. Narrows, east end

Localised minor undermining and sediment redepostion on storm beach at east end; a few toppled manuka and kahikatea saplings, and bark abrasion on small trees of Hall's totara and Neomyrtus pedunculata. Most vegetation at forest edge appears undisturbed although there is a water level mark 1.5 - 2 m up many stems. Some bark abrasion due to movement of resident logs within the forest edge on the levee separating lake and swamp, but no evidence of scouring of forest floor vegetation.

11. Glaisnock River, north side of river mouth

No damage evident.

12. Lugar Burn

Light bark abrasion from logs deposited on storm beach.

13. Eglinton River

Many toppled and abraded manuka on beach; most tree lupin (Lupinus arboreus) mutilated and dead. Substantial gravel deposition at top of beach; several flax (Phormium tenax) clumps here pushed over and partly buried with some roots exposed. No log debris.

Manapouri

1. Fairy Beach

Root undermining 0.3 m deep and 1.5 m wide along most of beach; at east end young beech undermined to 0.6 m depth and 5 m from forest edge; moderate bark abrasion on small trees of beech and Hall's totara. Peppertree (Pseudowintera colorata) sapling dead, epiphyte cushions removed from logs, patches of kiokio defoliated or uprooted. Light sand and wood debris depostion up to 10 m inside forest edge. Gravel deposition behind adjacent boulder beach; also moderate undermining and abrasion at forest edge here.

2. Safe Cove

Sand deposition among manuka at top of beach. No other effects apparent.

3. "TV" beach

Root undermining 0.3 m depth and 3 - 4 m back from forest edge; minor defoliation of kiokio and crown fern on forest floor; small celery pine saplings moribund and dead. Minor bark abrasion on inaka and beech on adjacent rocky shore; some dead inaka seedlings here. Considerable accumulation of sand at beach crest.

4. Freeman Burn

Minor root undermining and sand deposition on boulder beach.

5. Awe Burn

Minor undermining and bark abrasion.

6. Grebe River

Minor undermining and bark abrasion. Logs deposited and forest floor scoured up to 10 m inside forest edge. Lancewood and beech seedlings dying; occasional saplings crushed by logs. Lower foliage dead on many beech saplings up to 2 m tall.

7. West Beach

Severe undermining at west end of beach to 0.6 m depth and 3 m into forest edge; occasional toppled trees. Ground vegetation scoured to 5 m inside forest edge. Fallen kowhai and beech saplings at forest edge; many dead beech seedlings. On gravel beach at east end many saplings and seedlings ringbarked, as well as trees of putaputaweta, wineberry (Aristotelia serrata), tarata and kaikomako (Pennantia corymbosa) up to 25 cm diameter. Much gravel and debris deposition at top of beach.

8. Stockyard Cove

Minor undercutting of clumps of rushes and adjacent forest edge.

9. Head of Hope Arm

Very minor surface scouring amongst kowhai saplings and korokio (Corokia cotoneaster) shrubs at east end of beach. Minor undermining of beech trees at western end with dead beech seedlings along the edge of the root plate. Debris accumulation to 10 m inside forest edge; some forest floor scouring and dead beech seedlings. Moderate bark abrasion on manuka on adjacent boulder beach.

10. George Bay

Bark abrasion on manuka on beach; dead beech, celery pine, miro and Hall's totara seedlings and dying mingimingi shrubs associated with sand deposition on upper beach. Abundant debris deposited up to 30 m inside forest edge, widespread abrasion of beech trunks, some scouring of forest floor.

11. Motuau (west of Shallow Bay)

Sand removed from west end of beach and deposited at east. Much large log debris up to 4 m inside bush edge. Beech and other tree saplings at forest edge ringbarked; severe abrasion on larger stems. Some dead celery pine and beech saplings.

12. Ruby Beach

Root undermining to 0.5 m depth and 1.5 m width at western end with occasional toppled beech saplings. Much log debris at forest edge; none within. Some bark abrasion on small kowhai at forest edge. Several beech seedlings and saplings at forest edge dead and dying. Depostion of fine gravel at beach top from about 200 m eastwards; gravel and wood debris penetrate forest edge up to 3 m from about mid point of beach eastwards.

DISCUSSION

Only on the most exposed beaches of Manapouri does physical damage and current death of plants approach the levels sustained on Te Anau beaches and stream deltas, a factor attributable to the different vulnerability of the two lakes to north-westerly winds.

Insufficient time has elapsed for physical damage to have resulted in death of any but the most sensitive species, mainly celery pine, or those plants whose damaged root systems cannot maintain a water supply adequate to satisfy canopy requirements. Most ringbarked and undermined plants still retain apparently healthy canopies. Nevertheless, all ringbarked and most toppled and substantially undermined plants will die. Bark abrasion on only part of the stem circumference should not be fatal in isolation from other stresses, as shown by old abrasion scars on many healthy shoreline trees.

The effects of prolonged root submergence, various degrees of root exposure by undermining, and root burial under newly-deposited sediments, are not yet evident. Mortality of shoreline plants following the high lake levels of April-June 1975 on Lake Manapouri was not evident until October 1975 (Mark et al. 1977). A similar 5-month period might be required before any physiological effects of the 1988 event appear, but its

occurrence during spring, rather than late autumn as in 1975, may affect the response time. The extent of damage resulting from the exceeding of guidelines in 1975 indicates that much higher mortality, similar for the shorelines of both lakes because of the almost identical flood levels and duration, will result from the 1988 event (Fig. 1).

CONCLUSION

Mortality attributable to the effects of prolonged root submergence is not evident at present. However, on the basis of the effects of the 1975 event (Mark et al. 1977), it is predicted that on most of the sites surveyed for this report storm damage combined with prolonged inundation should result within the next year in a largely continuous line of dead woody vegetation along the forest edge, including both the plants already dead as a result of ringbarking or collapse after undermining, and those ringbarked or fallen but as yet still green.

A further survey will be conducted in May or August 1989 to assess this prediction, followed by a detailed study similar to that conducted following the 1975 flood event on Lake Te Anau (Mark et al. 1977).

REFERENCES

Johnson, P.N. 1972a: Applied ecological studies of shoreline vegetation at Lakes Manapouri and Te Anau, Fiordland. Part 1: Vegetation of Lake Manapouri shoreline. Proceedings of the New Zealand Ecological Society 19: 102-119.

---------- 1972b: Applied ecological studies of shoreline vegetation at Lakes Manapouri and Te Anau, Fiordland. Part 2: The lake edge flora - habitats and relations to lake levels. Proceedings of the New Zealand Ecological Society 19: 120-142.

Mark, A.F. and Johnson, P.N. 1985: Ecologically derived guidelines for managing two New Zealand lakes. Environmental Management 9: 355-363.

Mark, A.F.; Johnson, P.N. and Wilson, J.B. 1977: Factors involved in the recent mortality of plants from forest and scrub along the Lake Te Anau shoreline, Fiordland. Proceedings of the New Zealand Ecological Society 24: 34-42.

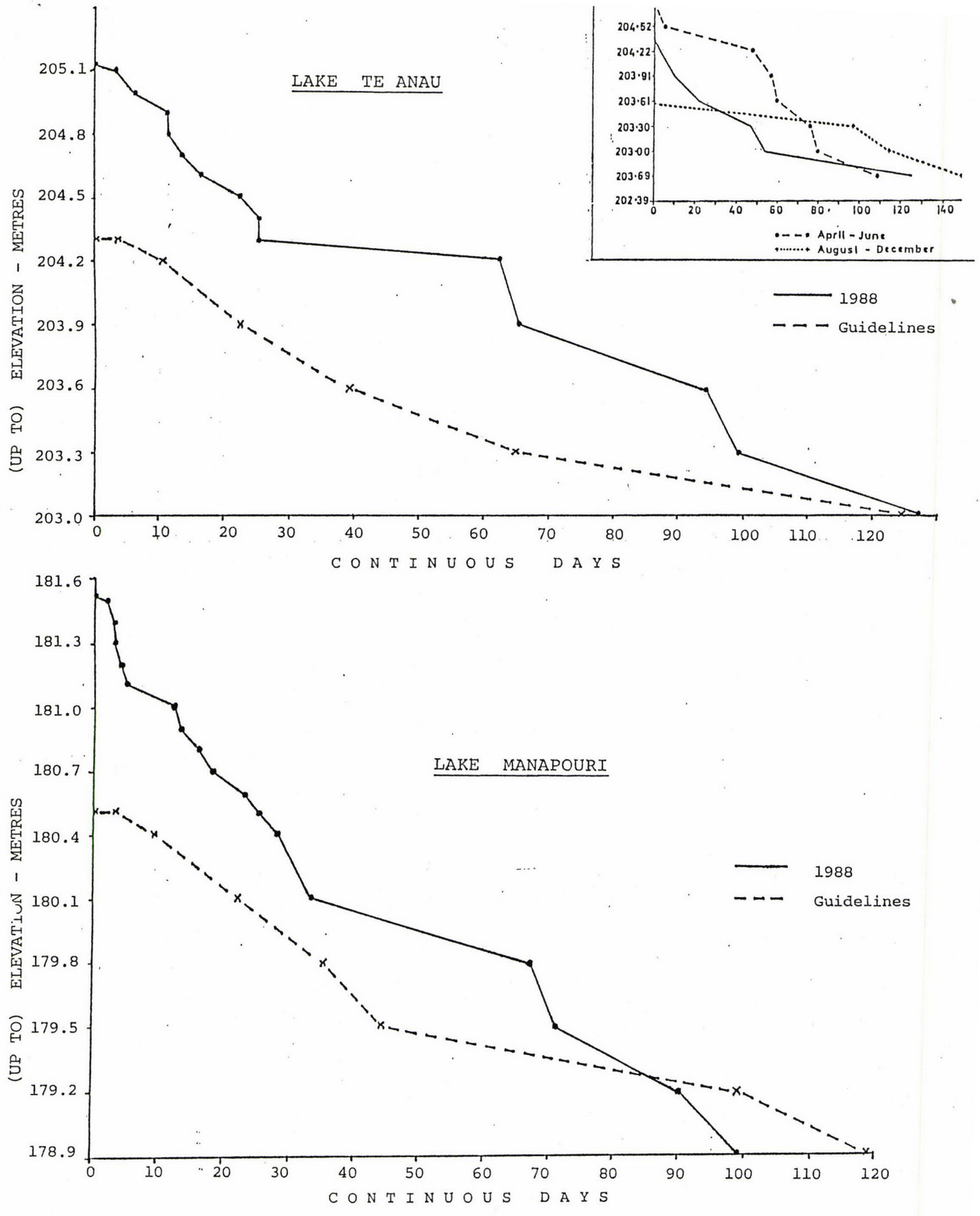


Figure 1. Guideline values for the high operating ranges of Lakes Te Anau and Manapouri compared with lake regimes for the September-December 1988 period. Comparable values for Lake Te Anau during the 1975 flood event (Mark et al. 1977) have been inserted.



Figure 5. Close-up of several beech saplings on the forest margin of Ruby Beach, Lake Manapouri showing a range in condition of their foliage. The central bush is obviously dead and has a severely damaged trunk and root system. The bronzed canopy on the left is associated with completely ring barked stems, as is the green canopy of the plant on the right. Predictably, all will be dead within a year.



Figure 3. Mature beech trees close to the lake margin at West Beach (north end), Lake Manapouri, that have been seriously damaged with bark rubbing by floating logs. Completely ring-barked trees will die in the short term whereas others probably will die prematurely as a result of this damage.



Figure 4. An isolated mountain beech tree upended on the forest margin at Brod Bay, Lake Te Anau. Removal of sand from the tree's shallow root system by the high lake levels caused such toppling of beech trees on fine sandy beaches along many such sections of both Lakes Te Anau and Manapouri. January 16, 1989.

PHOTOGRAPHS OF LAKESHORE DAMAGE TO FOREST
Lakes Manapouri and Te Anau, January 1989



Figures 1 and 2. Substantial removal of soil and gravel from the rooting zone of trees for a width of up to 10 m along the forest margin of Lake Manapouri's West Beach which is fully exposed to the prevailing westerly winds. This has caused serious and widespread damage through either toppling of trees or substantial exposure of roots. January 17, 1989.

