Pencarrow Lakes

Conservation values and management

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Te Papa Atawhai

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Conservation values and management

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This document backgrounds the landscape, cultural and biological values of the area with an evaluation of threats and recommendations for management within the concept of the East Harbour Regional Park

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Cover photo: Lake Kohangatera by Jeremy Rolfe.

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Executive summary

The Pencarrow Lakes, Kohangapiripiri and Kohangatera, situated a mere 11 km from central Wellington as the crow flies, are currently controlled by Department of Conservation as Wildlife Management Reserves. With the firming up of proposals to establish an East Harbour Regional Park, administered by Wellington Regional Council, there is a need to review the significance of the lakes as representative wetlands and to outline management options that will ensure their proper protection. This report backgrounds the landscape, cultural and biological knowledge of the lakes ecosystem, provides an evaluation of the wetlands on a local and national scale and makes recommendations for their sustainable management in a situation of increasing public pressures.

The two lakes in their adjoining valley systems look superficially alike but actually differ in a number of details. It is argued that they should be considered as a single unit for conservation purposes and, that management considerations must be holistic, involving the entire catchments to the extent of including beach ridges which separate the lakes from Cook Strait. It is the "mountains to the sea" integrity of the "lakes block" that gives the wetlands a unique value in the Wellington region and a high national status.

For all their proximity to the capital city, they have fallen far behind many other New Zealand lakes so far as scientific knowledge is concerned. This, fortunately, also applies to their visitor profile with the result that today few wetlands in the country can boast the relatively unmodified state that Pencarrow lakes enjoy. The Regional Park proposal can be viewed as an opportunity to rescue, and indeed restore, these aquatic and semi-aquatic systems yet make them more available for public appreciation and education.

The review of their qualities reveals a richness of cultural features that include karaka tree dendroglyphs (unique on NZ mainland), hut sites and midden deposits as well as the first lighthouse in New Zealand. The lakes themselves are formed in drowned valleys that have been blocked off from the ocean by beach ridges still bearing the evidence of earthquake history in the region. Kohangapiripiri has been freshwater for at least 7000 years but the closing date of Kohangatera is still uncertain. The lakes, wetlands and raised beaches together support a wide range of native plants and animals, including ten species of significant plants, two of fishes and three rare wetland birds. Banded dotterel nest on the open sand, the only area in Wellington region where this occurs.

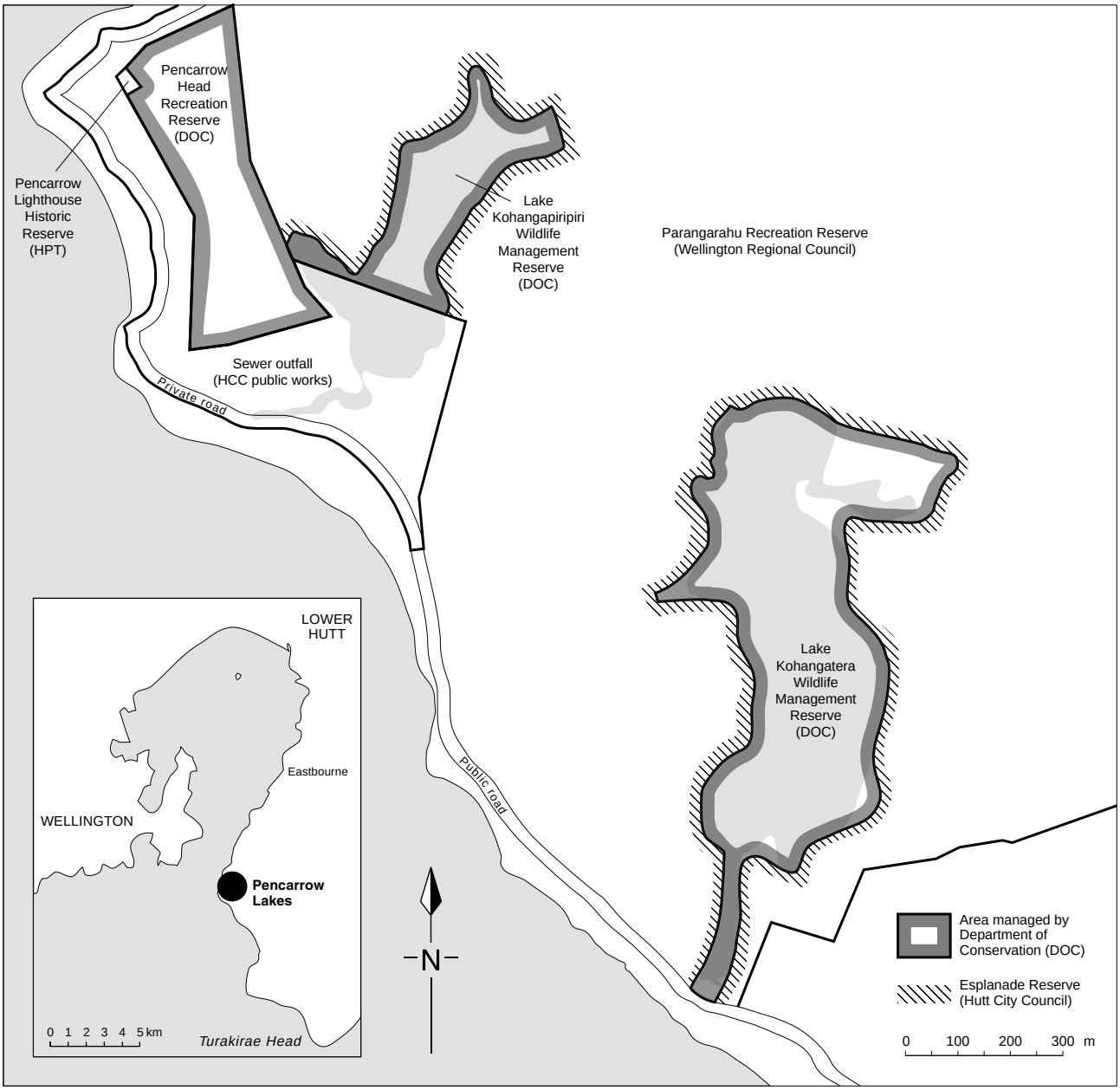
Management recommendations are focused on the protection of the whole system. They look forward to a time when farm stock have been excluded from the whole "lakes block", thereby allowing re-vegetation of not only the lake shores, but also the surrounding hill slopes. This should result in an improvement in water quality. To protect and enhance the valuable native fish fauna, one catchment of which exists without the intrusion of alien brown trout, modifications to the outflow stream culverts need to be undertaken to permit natural flushing to the sea. Control of noxious terrestrial weeds is outside the scope of this report but an invasive pondweed in Kohangapiripiri is serious and requires investigation for possible eradication. Management of sensitive plant communities on the raised beaches is stressed in the light of a potential rise in visitor numbers. These communities are likely to disappear if ever unrestricted vehicular access to Fitzroy Bay is allowed.

1. Introduction

Wetlands are New Zealand's overlooked natural spaces. More than 70 percent have been drained or severely modified by urban areas, agriculture or forestry, leaving the remainder as extremely precious natural heritage resources. One such heritage area is "Wellington's best kept secret"—the Pencarrow Lakes (Fig. 1).

This report covers the landscape, cultural and biological features of two coastal lakes in the Wellington Conservancy. Its purposes are to assess their conservation status, discusses their sensitivity to disturbance and make recommendations for their future management. It is presented at a time when the wider conservation and recreation values of the surrounding district are being seriously considered in the context of a proposed East Harbour Regional Park (WRC, 1995).

FIGURE 1: LOCATION AND SPATIAL EXTENT OF PENCARROW LAKES



The lakes, Kohangapiripiri ("a nest, clinging very strongly") and Kohangatera ("a nest, basking in the sun") occupy the seaward end of adjacent valleys immediately to the east of Pencarrow Head. They are shallow, slightly brackish and grade into extensive valley wetlands at their upstream ends. Being accessible to the public and currently part of a grazing lease, their vulnerability to disturbance is high. Hence future management should aim to protect and restore ecological communities.

Most of the open water of the lakes is a Wildlife Management Reserve under the control of the Department of Conservation except for the southern third of Kohangapiripiri which is a Hutt City designated drainage reserve. The lakes are surrounded by a 20 m esplanade reserve, largely in reed beds and in places not reaching dry land, controlled by Hutt City Council. This report includes comments on the upstream wetlands, the hill slopes and the ocean beaches since all contribute to the overall quality of the lakes and their biotic and landscape integrity. The majority of this adjacent land is within a block ("the lakes block") of 362 ha purchased by Wellington Regional Council in 1992 and managed under a grazing license to M. Curtis until 2004.

At the time of writing, the public has unrestricted access to the lakes on foot or bicycle but vehicle access is strictly limited and under the control of Hutt City Council. Public access to the sensitive lakes area is likely to be a crucial issue when the East Harbour Regional Park becomes a reality in the near future.

2. Area description

2.1 LANDSCAPE

Land in the region of the Pencarrow Lakes has been tectonically active over the past 7000 years since the end of the post-glacial marine transgression (Cochran *et al*, 1999). The lakes occupy drowned valley systems exposed to Cook Strait. Each lake is separated from the sea by a gravel barrier and partially surrounded by wave-cut cliffs and stacks, indicating they were once inlets of the sea (Cotton, 1921). Views on the timing of closure by the gravel beaches, thus establishing the freshwater lakes, have ranged from "a long period ... prior to 1855" (Cotton, 1921) to "before the 1855 earthquake the valley [Kohangatera] was open to the sea" (Moar, 1950). Recent evidence, based on diatom frustules from sediment cores of up to 9.25 m depth at the head of L. Kohangapiripiri (Cochran, 1995), shows that this lake has been slightly brackish freshwater for at least 7000 years. During that time, incursions of fragmented marine diatoms occurred until 5850 years BP, suggesting a low barrier with storm events washing over into the lake (fragments indicating breakage by wave action). Since 5850 years BP, only occasional traces of marine fragments suggest exposure to heavy salt spray events. Today the barrier beach is over 50 m wide with a maximum height of 8.5 m above mean sea level (Cochran, 1995). Kohangapiripiri is currently only 1–2 m deep, having filled with sediment from a depth of more than 9.25 m since the time when it was an arm of the sea (the 9.25 core did not reach basement rock and the type of planktonic diatom frustules indicate deep water).

There is no equivalent study of Kohangatera. An early report (Northcote and Tiffen, 1848) mentions that Kohangapiripiri was freshwater whereas Kohangatera apparently was salt water (probably to taste! i.e. brackish). A surveyor's sketchbook (Field book 14, Brees, Tiffen or Whitehead?) dated 4 Feb 1844 shows Kohangatera as a "saltwater lagoon" yet without a direct outlet to the sea. The sea stack on its NE shoreline was marked as an island before the uplift of the 1855 earthquake. These glimpses of history support the view that the marine/freshwater history of the two lakes may have been very different.

Although these two linear lakes occupy adjacent parallel valleys and are often considered together as a unit ("the twin lakes ..." Stevens, 1974, p. 246), they each possess distinct characters such that the more they are studied, the more different they seem to become. Kohangapiripiri is the smaller, with an approximate area of 13 ha whereas Kohangatera has an open water area of about 17 ha. Cameron Creek, the catchment of Kohangapiripiri, includes 43 ha of wetland and drains intact bush and regenerating farmland. It originates on Mount Cameron (260 m), has a length of about 5 km and an area of about 280 ha. The Kohangatera catchment, Gollans Stream, extends north to Mount Lowry (373 m), a distance of 14 km and passes through undisturbed beech forest, a picnic area, a farm and about 150 ha of wetlands. Its total catchment area is about 1700 ha. The larger lake thus has a catchment six times larger than its neighbour. Both lakes have had a history of human influence which is likely to continue into the future but under a very different management concept. Lake morphometric details are listed in Appendix 1.

The 50 m beach ridge at Kohangapiripiri consists of the modern beach, the modern storm beach at 5 m and an older high beach with steep seaward front thought to be raised in 1855. The original beach gravel is covered by windblown sand (Cochran, 1995). Both higher beaches support sensitive plant and invertebrate communities and provide a breeding area for banded dotterel and variable oystercatcher. At Kohangatera the beach ridge system is 420 m wide and better developed (Stevens, 1973) although extensively modified on the ocean side by sand quarrying . Here, both the modern storm beach and the 1855 ridge are present, as well as a higher ridge (possibly dating from 1460) with a crest 7.6 m above mean sea level, separated from that of 1855 by an abandoned lake outlet channel. The high ridge is notable for the presence of a nationally threatened plant, *Muehlenbeckia ephedroides*.

Lake levels fluctuate markedly but only rarely are the ocean barriers breached. In summer months the outlet channels are often dry and even when levels rise to fill these channels, as normally occurs in winter, seepage through the beach gravels normally accounts for the entire drainage. Breaching during flood events is more frequent from Kohangatera than from Kohangapiripiri, the latter sometimes persisting for several years without breaching (Frank, pers. comm.) and indeed there is no evidence of this lake breaching for perhaps five years. A 1941 aerial photo (Department of Survey and Land Information) shows Kohangapiripiri draining directly into the sea but since then the beach has aggraded strongly (Matthews, 1980), presenting a barrier which today, even after rainfall that will breach Kohangatera, extends about 80 m south of the road. Breaching events are vitally important for the freshwater fish fauna of the two catchments, as discussed under 3.5 below but, unfortunately, no records of breaches have been kept. Perhaps with the advent of a permanent Park Ranger, this can be rectified.

The surrounding hills represent what Cotton (1921) regarded as the "Wainui platform", submaturely dissected, and tilted westward as is the Baring Head platform. On the eastern side of Gollans Valley the Wauinui platform hills reach 105 m, on the western side only 55 m. Here, between the two lakes, is a plateau 800 m wide (Cotton, 1921).The surrounding hills are currently grazed by stock (both sheep and cattle) with patches of regenerating shrubs and gorse in the gullies.

2.2 HUMAN HISTORY

Evidence of Maori occupation as far back as the 'Archaic period' is discussed by Palmer (1963). Prior to uplifts in 1460 and 1855 the lakes would have been considerably deeper and more extensive than today and certainly navigable by canoe. Hut sites have been identified on a tombolo area at the northern end of Kohangatera (Keyes, 1970) and oven deposits in the raised beaches of both lakes have yielded information on species taken as food. The history of Maori tribes occupying the area is sketchy. Not until the early 19th century is there a clear picture with Ngati Ira occupying the Fitzroy Bay area until about 1925 when defeated by Ngati Awa from Taranaki. Outlying Maori villages around Wellington were abandoned by 1860 and it is probably that people were leaving Fitzroy Bay about that time.

Excavated oven deposits in the beaches have included a number of shells of present day species, seal and kiore bones. Of particular interest are the presence of huia mandibles and kakahi shells (freshwater mussel, *Hyridella menziesi*) at the Kohangapiripiri site but not the Kohangatera site. Both sites contain evidence of workshop activity with adzes, cutting flakes, drills and chisels (Palmer, 1963). The Kohangatera area contains twice as many terraced sites as Kohangapiripiri, suggesting that it was more sheltered from wind and food cultivation was easier.

A number of small groves of mature karaka trees that occur around the margins of the upper reaches of both lakes are presumed to be associated with seasonal occupation by Maori. (Best, 1942: 53). Those at the head of Kohangapiripiri are particularly noteworthy for the presence of dendroglyphs, an extremely rare form of Maori art on the main islands of New Zealand (Keyes, 1968). Keyes identifies at least two tree trunks with carved features, some identifiable as "fish" motifs. His interpretation of the largest (48 cm long) is that it could represent a killer whale (*Orcinus orca*). It is suggested that the glyphs were made immediately prior to any European influence. Keyes (1970) also draws attention to a possible "tuahu" at the northern end of Kohangatera on the true right.This stone wall feature is within the Esplanade Reserve and might have served as some kind of shrine at a time when lake levels were higher.

Early European settlement had little direct impact on the lakes area. Beech forest was continuous down Gollans valley to the region of the head of the lake (Bagnall, 1972: 13). Captain W. B. Rhodes owned land along the ridge to Pencarrow and grazed cattle there in the 1840s. The first effort to provide a navigation beacon on Pencarrow Head was made in 1842. After this wooden pyramid was destroyed in a storm and then a shed with a light in the window proved unsatisfactory, the existing hilltop lighthouse was constructed (the first in New Zealand) and commenced

operating in 1859. Apart from the lighthouse and ancillary buildings, no European dwellings appear to have been built on the hills surrounding the lakes until M. Curtis erected a tourist facility on the ridge east of Kohangatera in the 1990s.

Throughout the 20th century, cattle and sheep on two farm blocks (Gollans Farm and Orongorongo Station) have grazed the hills surrounding the lakes, with access to the lake shorelines for water. In recognition of its landscape and biological significance, the Wellington Regional Council succeeded in purchasing the "Lakes Block" from Orongorongo Station in 1992 with a view to ultimately offering it some protection under the proposed East Harbour Regional Park. An interim grazing lease was issued to M. Curtis, which expires in 2004. Gollans Valley farm has remained in private ownership up to the time of writing the present report.

In the 1960s the then Hutt Valley Drainage Board extended the coast road south of Eastbourne as far as Kohangatera to service its Hutt Valley sewage disposal system and ocean outfall which is located immediately west of the Kohangapiripiri outlet stream. The hard-fill roadway across both lake outlet streams, bridged by concrete pipes, was completed as far as the east side of Kohangatera stream by 1969 (aerial photo 3/9/69). A small concrete building, formerly a pumping station to extract water for the sewage scheme, remains on the southwestern shore of Kohangapiripiri. The only other building in the area is a corrugated iron woolshed erected by M. Curtis on the raised beach flat east of the Kohangatera outlet stream.

2.3 LAKE WATER CHARACTERISTICS

Standard limnological parameters have not been established for either of the Pencarrow Lakes. This is an extraordinary state of affairs for such significant freshwater features so close to the capital city. To my knowledge, the only attempt to measure some of these parameters was made by Michele Frank, a Master of Science student at VUW from 1991 to 1993, who has kindly made her data available (Appendix 1, Appendix 2).

Although no detailed bathymetry has been done, Frank's study indicates that both lake-beds are essentially flat, with Kohangapiripiri having a firm sandy base with a maximum depth of 1.8 m whereas Kohangatera has a soft organic base with slightly deeper water reaching 2.1 m maximum. Between April 1991 and March 1992, water levels in Kohangatera fluctuated through a range of 0.53 m, while those in Kohangapiripiri varied by only 0.30 m. During the extremely dry summer months of 2000/01 a wide expanse of exposed lake-bed was visible in the western arm of Kohangapiripiri, suggesting much greater fluctuation than during Frank's study period, but no water depth measurements were taken at the time.

Lake Kohangapiripiri waters were transparent throughout Frank's study period with a secchi disc visible to the lake bottom. On the other hand, the secchi disc values in Kohangatera waters varied considerably from a low of 0.72 m during an algal bloom in January, to being visible to the bottom in July. The mean secchi disc value (12 months) for Kohangatera was 1.42 m. In comparison with other shallow coastal New Zealand lakes, this clarity is relatively high, for instance Ellesmere, where water clarity is often less than 0.2 m (Gerbeaux & Ward, 1991). High winds, a regular feature of the Pencarrow environment, are likely to re-suspend bottom sediments in Kohangatera and thus reduce its clarity. Waters of both lakes are stained yellow-brown.

A one-off water chemistry analysis was carried out in April 1990 with the results shown in Appendix 2 (kindly supplied by M. Frank). Two other lakes are included for comparison, Lake Pounui, in the western Wairarapa, and Lake Ellesmere, at the base of Banks Peninsula. The Pencarrow lakes should be regarded as 'slightly brackish' water (see also comments on diatom frustules, p. 6), with a high level of sodium and chloride ions indicating the influence of salt-laden winds. Concentration of the suite of sea water ions is lower than in comparable marine-influenced New Zealand coastal lakes such as Ellesmere and Forsyth. These data show that Kohangatera is nearly twice as salty as Kohangapiripiri. Nutrient concentrations are lower than expected from catchments devoted in part to farming and rich in waterfowl. Concentrations of all ions were slightly higher in Kohangatera then Kohangapiripiri in this one-off survey.

It should be noted that an old domestic refuse tip site exists in a tributary of Gollans Stream and that there is potential for leachate from this site to reach the lakes. It does not appear to constitute a threat to wildlife values.

The study carried out by Frank included a monthly assessment of chlorophyll a to monitor for algal bloom conditions and provide data on the trophic status of the lakes. Seasonal patterns were broadly similar in the two lakes, although concentrations were always higher in Kohangatera. A summer maximum occurred in January or February, with a secondary winter peak in June. The summer peak in Kohangatera coloured the water green. In general the chlorophyll a levels are not nearly as high as would be predicted from the nutrient levels and so there is potential for blooms to develop over summer. However, there is not always a simple relationship between nutrient levels and blooms, especially where dense beds of aquatic macrophytes can develop (Mitchell, 1971) as in this case. A long-term study would be necessary to establish the nature of the macrophyte flora in the Pencarrow Lakes, its fluctuations and whether there is a pattern of alternation between these rooted plants and the phytoplankton. Such a study would shed light on the complex interrelations between plant productivity, invertebrate densities, waterfowl and fish dynamics. To date there is almost no quantitative knowledge of the macrophyte flora and its cycles of productivity in the Pencarrow Lakes.

Using OECD criteria based on chlorophyll a concentration, Frank calculated the trophic status of the two lakes. This suggests Kohangapiripiri should be regarded as borderline oligotrophic/mesotrophic, with Kohangatera defined as mesotrophic.

2.4 FLORA

Although the vegetation of hill-slopes surrounding the lakes is highly modified by more than 150 years of burning and grazing, the wetlands and beaches still support highly indigenous plant communities in a relatively unmodified state, some of which are not represented elsewhere in the region.

Fortunately, due to the interest of a number of different botanists and other investigators since the late 1940s, understanding of the plant life must be almost complete. This section reviews existing knowledge and provides an inventory of significant plants in both wetland and barrier beach flora. (See Appendix 3 for species list.)

Lucy Moore (1945) reported on a walk down Gollans Valley, citing the presence of sea holly, *Eryngium vesiculosum*, a locally significant species of wetland herb. Neville Moar (1949, 1950) provided the first detailed information on vegetation of the Gollans Valley mire. Although focused mainly on the swamp upstream of the open water, many of the wetland plants are, of course, also found around the shorelines of the lakes themselves. He recorded the presence of the indigenous jointed wire rush or oioi (*Leptocarpus simplex*), a salt-marsh or estuarine species as giving an indication of the previous marine history of the inlet, and listed many other wetland plants. Ruth Mason (1950) gave a brief account of a visit to Kohangapiripiri, mentioning a number of wetland and beach species. Tony Druce accumulated a species list from repeated visits between 1975 and 1992, which is updated by the Wellington Botanical Society's list 1994. David Clelland's survey of Unprotected Natural Areas of the Wellington Region (1984) is particularly helpful since it concentrates on the treatment of rare or uncommon plants found at each lake site. This survey draws attention to the early stages of wetland succession represented at Pencarrow Lakes. Mike Orchard studied the ecology of plant communities on the raised beaches (1995) and, finally, Barbara Mitcalfe (1997) has prepared a report for the Protected Natural Area Programme on the upper Kohangapiripiri swamp and southeastern wetland arm of Kohangatera.

From the way the data have been recorded, it is not always possible to be sure whether plants were found within the Lakes Reserve areas, in the wetlands above or on the beaches and cliffs of the coastal zone. This report attempts to apportion the species to their respective sites on the basis of more detailed accounts or, failing that, on their known ecological requirements. Appendix 3 presents a species list of indigenous vascular plants, based on the references above and split into three sections: true aquatics (i.e. species of open water); semi-aquatics (i.e. those on wet margins in variable water levels); and species that occur on the raised beaches. A total of 79 species are represented, 61 from within the Lakes Reserves so far as can be determined.

Of the nine species of true aquatic plants, two are regarded as regionally threatened: *Lepilaena bilocularis*, a delicate, submerged summer-green herb and *Ruppia polycarpa* or horse's mane weed, another submerged herb which produces long flower stalk spirals. Moar (1950) referred to a dense community of a submerged alga, one of the charophytes (i.e. *Nitella* or *Chara*, he seems unsure which). No other study mentions these freshwater algae.

Three regionally threatened species have been recorded in the semi-aquatic flora: *Crassula kirkii, Glossostigma diandrum* and *Ranunculus macropus*. These are all endemic species except *G. diandrum* which also occurs in Australia. Apart from *R. macropus*, (swamp buttercup) which is a typical buttercup, they are low mat-forming wetland plants. Also noteworthy in the semi-aquatics are five species of plants classified as 'Locally Significant': *Eryngium vesiculosum* (sea holly), *Glossostigma elatinoides*, *Gratiola sexdentata, Limosella lineata* (mudwort) and *Scheonoplectus validus* (formerly *Scirpus lacustris*, lake clubrush). Thus a total of ten significant plant species are reported from within the Wildlife Management Reserves.

Although it is not totally clear from some of the records whether the plants occur in one or both lakes, or indeed, whether they are found in the esplanade strips or in the swamps upstream, it seems that two, (*Lepilaena bilocularis* and *Elatine gratioloides*, are known only from Kohangapiripiri).

Fifteen of the 61 lake or lake margin plants are endemic species, the remainder being natives shared with Australia. Apart from the water buttercup, the wetland vegetation is essentially free from invasion by adventive plants.

These botanical surveys have identified no nationally threatened species (as determined by de Lange *et al.*, 1999) within the Wildlife Management Reserves. However, one such species, *Mazus novae-zeelandiae*, is known from the raised beach zones. The presence of the leafless prostrate shrub, *Muehlenbeckia ephedroides*, a naturally uncommon species, on the high beach ridge of Kohangatera, is of particular interest since it represents one of only two known populations in the Wellington Conservancy. This species occurs at the eastern end of the beach in the area currently under a grazing lease to M. Curtis.

The beach ridges have their own intrinsically important flora. The ridge at Kohangapiripiri is by far the best example and has recently been investigated by Mike Orchard (1995). Although largely (>85%) bare sand surfaces, endemic species dominate the plant cover on an area basis. Just over 2% of the area surveyed consisted of exotic plants compared with almost 9% for native species. Top cover species (in order of abundance) include *Raoulia hookeri, Disphyma australe*, *Desmoschoenus spiralis, Carex pumila and Pimelia urvilleana*, all natives. Apart from *Mazus novae-zeelandiae*, which is classified as nationally threatened, the beach ridges support two regionally significant plants, *D. spiralis* and *Einadia allanii*; and two locally significant species, *Spinifex sericeus* and *Zoysia minima*.

Plant community descriptions have been compiled by Moar (1949) and Clelland (1984) for the lakes and upstream wetlands. However, it is unclear how many of these communities actually occur within the limits of the Wildlife Reserves. The swamp communities represent an earlier stage of succession from estuarine to freshwater than other swamps in the region (Clelland, 1984). Orchard (1995) provided an analysis of the plant communities on the beaches at Kohangapiripiri. Frank (1993) identified 27 vegetation types along the Fitzroy Bay foreshore, including both beach ridge systems and estuary zones of the lakes.

2.5 FAUNA

At first sight the vertebrate fauna of the lakes seems to be reasonably well Documented. It certainly is in comparison with the invertebrates. However, further scrutiny of the records reveals a surprising lack of data for such an outstanding habitat so close to Wellington. For example, for fishes, the NIWA NZ Freshwater Fish Database differs from the DOC database in several important respects. Bird observations are probably reliable but there are no authentic records of frogs or reptiles specifically from within the Wildlife Management Reserves or their adjoining beaches. For the invertebrates, we have zooplankton records from Michele Frank's study, but data on other invertebrate groups are extremely patchy.

Birds

The Pencarrow Lakes provide excellent open water and wetland habitat for a number of waterfowl species. Parrish (1984) recorded a total of 28 bird species for the two lakes and mentioned several species of waterfowl and shags that breed

there, for some it was the only breeding habitat in the region. Common breeding species of waterfowl, normally present in large numbers, include black swan (*Cygnus atratus*) and mallard (*Anas platyrhynchos*), with some pukeko (*Porphyrio porphyrio*). Less common, but nevertheless widespread indigenous waterfowl species, include grey duck (*Anas superciliosa*) and Australasian shoveler (*Anas rhynchotis*). Two rare species of waterfowl reported from Kohangatera by Parrish are Australian bittern (*Botaurus poiciloptilus*) and spotless crake (*Porzana tabuensis*). Spotless crake were also listed for Kohangapiripiri. Non-wetland species of significance include California quail (*Callipepla californica*), NZ falcon (*Falco novaeseelandiae*) and kaka (*Nestor meridionalis*).

Many species of coastal birds are seen in Fitzroy Bay, but only two, banded dotterel (*Charadrius bicinctus*) (Coastal Resource Inventory, 1990) and variable oystercatcher (*Haematopus unicolor*) (P. Moore, 1993, pers. comm. to M. Frank) nest on the raised beaches. Black shag (*Phalacrocorax carbo*) are often seen overhead, passing back and forth from a nesting colony in a grove of karaka trees in lower Gollans Valley about 1 km above the head of Kohangatera (Powlesland & Reese, 1993).

Brown (1992) listed 30 bird species for the lakes, the notable additions to Parrish being NZ dabchick (*Poliocephalus rufopectus*) seen on Kohangatera and pied stilt (Himantopus himantopus) which was recorded in small numbers at the lakes. The species list for birds is included in Appendix 4.

Fish

New Zealand's endemic freshwater fish fauna is only now coming to be appreciated for its diversity and biological significance. In a lake and wetland reserve, they deserve high status. Furthermore, any catchment, and this applies to Kohangapiripiri, that lacks alien brown trout warrants special consideration. It is clear from the recorded data that the two Pencarrow Lake catchments support some notable freshwater fishes but, unfortunately, due to discrepancies in the fish databases, we cannot be sure what species are currently present in the lakes and their respective streams.

The DOC Fish Database (1999) records 3 species in the Pencarrow lakes with a further six species in the Gollans Stream catchment; a total of nine species of freshwater fishes in the two catchments. The most notable is the giant kokopu (*Galaxias argenteus*), a nationally threatened species, present in both lakes and their stream systems. On the other hand, the NIWA Freshwater Fish Database, compiled between 1963 and 1987, includes a total of six species.

Which fish are present today? The issue is complicated by the fact that many of these freshwater species are diadromous, i.e. needing to migrate between fresh and salt water to sustain their life cycle, whereas others can survive continuously in landlocked situations. With the intermittent breaching of the barrier beaches the diadromous species perhaps occur only spasmodically in the system. How long they survive will depend on the length of their life cycle and the seasonal opportunities for re-entry from the sea. For example, inanga (*Galaxius maculatus*, the common whitebait) is recorded in the DOC database for Gollans Stream but since it is short-lived, it could disappear in a year or two if the cycle is broken. On the other hand, both giant and banded kokopu (*Galaxius argenteus* and *G. fasciatus*) are long-lived,

maybe 20 years (McDowall, pers comm.), so that intermittent recruitment from the sea would be sufficient to maintain a resident population. These latter galaxiid species also landlock fairly easily whereas inanga does not.

The most significant features of the fish fauna of these lakes are the presence of the giant kokopu throughout both catchments and the dense population of bullies (*Gobiomorphus* sp.) in Kohangapiripiri (M. Frank, pers. comm.). The species identification of this bully needs to be confirmed because, although recorded as giant bully (*G. gobioides*) in the databases, it is far more likely to be common bully (*G. cotidianus*) according to McDowall (pers. comm.). Present understanding is that this bully population exists in the absence of the introduced brown trout (*Salmo trutta*). Reports of brown trout in Kohangatera and the Gollans valley catchment require confirmation. This species is not included in the NIWA database for the catchment but is listed on the DOC database. The previous farmer in Gollans Valley, Mr Turvey, is said to have noted its presence in the stream (Wolfenden, 1989).

The presence of a significant endemic freshwater fish fauna in these two stream systems highlights the need to maintain the natural cycle of beach breaching during periods of high stream flows. Among the species recorded in the upper reaches of Gollans Stream are inanga (*Galaxius maculatus*), lamprey (*Geotria australis*), and redfinned bully (*Gobiomorphus huttoni*), all of which are obligatory diadromous species (McDowall, pers. comm.). None are threatened or rare species but their presence points to the need to consider the barrier beaches and their breaching cycles when discussing management of the lakes environment. For example, the bully is a common widespread species but requires a clear-water habitat with coarse cobble substrate. Hence it will not live in the lake or raupo swamplands and must migrate from the sea and through the lake and swamps to reach its habitats in the upper Gollans valley. Some would argue that the fish fauna, more than any other part of the fauna and flora, is the most significant natural component of the Pencarrow lakes. The life cycle requirements of these fishes stress the need to consider all aspects of the catchments from upper hill slopes to the ocean beaches in order to protect the integrity of lakes themselves.

Lizards and frogs

Herpetological records for the lakes are poorly Documented. No records of frogs appear in previous Documents on the biological resources of the Pencarrow Lakes. However, tadpoles were abundant in M. Frank's samples from Kohangapiripiri and have been identified as the widespread introduced golden bell frog, *Litoria raniformis*. Although tadpoles were not sampled in Kohangatera during her survey, frogs were heard calling from the shoreline.

Various species of skink and gecko are likely to be present amongst surrounding vegetation and on the cliff faces but have not been specifically reported from the Wildlife Management Reserve. Those that might be expected to turn up within the specified area, especially if re-vegetation is encouraged, would include green gecko, *Naultinus elegans*; common gecko, *Hoplodactylus maculatus*; common skink, *Oligosoma nigriplantare polychroma* and perhaps copper skink, *Cyclodina aenea*. Another possible species is the spotted skink, *Oligosoma lineoocellatum* which is known from nearby Baring Head. However, this is pure speculation, at present the nearest records for these species are the eastern coasts of Wellington Harbour and Baring Head (Miskelly, 1995).

Invertebrates

The invertebrate fauna of the lakes area has been almost completely ignored. Here we can cite only the unpublished results of Michele Frank's study, some comments in the coastal management report of Brown (1992) and publications of Brian Patrick on moths of the barrier beaches.

Zooplankton have been sampled by M. Frank from both lakes in 1991/2. Unlike the majority of freshwater lakes studied in New Zealand, where the dominant calanoid copepod in the plankton is a species of *Boeckella*, the Pencarrow lakes contain a different calanoid, *Gladioferens pectinatus*. The Australasian genus *Gladioferens* is unusual because the five known species are able to live in a wide range of salinities (Chapman & Lewis, 1976). They are thus normally associated with coastal estuaries or lakes. In New Zealand, *G. pectinatus* has been found in Lake Waihola (Otago), and Lakes Ellesmere and Forsyth (Canterbury). It is also known from estuaries such as the Avon-Heathcote in Christchurch and around Auckland. The same species is present in both Pencarrow lakes but with a remarkable difference in their abundance. The Kohangapiripiri population is considerably more dense than that in Kohangatera at all times of year. At times of minimum density, a 6 litre trap in Kohangatera will not pick up any specimens. Many other crustaceans must surely occur in the wetlands but are not recorded. Koura (*Paranephrops planifrons*) are present in the Gollans stream (DOC database).

Brian Patrick (1992, 1998) has investigated the moth fauna of the Kohangapiripiri barrier beach in his search for geographic diversity in the day-flying moth *Notoreas*. These small brightly-coloured moths are, in one sense, the equivalent of butterflies due to their active, sun-loving lifestyle. Patrick (1998) has researched the coastal populations of this genus and discovered nine species around New Zealand. The Pencarrow species is unnamed. Its larvae feed on the sand *Pimelia*, (referred to as *P. urvilleana* by Orchard, 1995), which is well represented on this beach. The same moth species, a Wellington endemic, has been found at Titahi Bay, Te Humenga Point near Cape Palliser, at White Rock on the Wairarapa coast and also Onoke Spit and Ngapotiki fan (A Rebergen pers. comm.). Patrick (1992) recorded two other interesting dune-specialist moths on the Kohangapiripiri beach (*Ericodesma aerodana* and *Agrotis innominata* for which Wellington is the type locality).

Brown (1992) drew attention to the presence of the large dragonfly (*Uropetala carovei*) over the swampland at the northeastern end of Kohangatera. This primitive dragonfly, our largest species, is relatively common around the margins of forest or shrubland where it depends on shaded muddy seepages for its larval habitat. Its occurrence around the Wildlife Management Reserve is thus entirely predictable. A further 4 species of dragonfly plus two damselfly species would be expected at the Pencarrow Lakes.

New Zealand's freshwater mussel, kakahi (*Hyridella menziesi*), was clearly present in at least one of the lakes in pre-European times (Palmer, 1963). A shell was found on the shore of Kohangapiripiri during a survey for this report, and so this species is still present there today. Confirmation is required for Kohangatera.

3. Conservation significance

3.1 PREVIOUS STATUS OF PENCARROW LAKES

Numerous previous reports have stressed the conservation significance of the Pencarrow Lakes area (Biological Resources of the Wellington Region, WRC/QEII/DOC, 1984; Brown, 1992; Clelland, 1984; Coastal Resource Inventory, DOC, 1990; East Harbour Regional Park Management Plan, WRC, 1995; Mitcalfe, 1997; Parrish, 1984; Pencarrow Lakes Block Concept Development Plan, WRC, 1998; Stephenson, 1977). All regard the two lakes to be of high value due, in particular, to the unique aquatic habitat they provide within the wider Wellington region and to their proximity to the capital city. Although these values have been repeatedly stated, the management of the Reserves and their Esplanade strips over the last 50 years has taken little heed of prevailing threats (as discussed in Chapter 4 below). Fortunately, because these threats have had relatively minor impacts, and because other wetlands have suffered much greater impacts during these 50 years, the lakes are still extremely valuable ecosystems. It is the retention of their ecological integrity that gives the lakes their outstanding significance today.

Previous value rankings have placed the Pencarrow Lakes at the level of national significance. The WERI database (1982, Wetlands of Ecological and Regional Importance) ranked Kohangatera as "National" (rank 4) and Kohangapiripiri as "Regional" importance (rank 3). The SSWI database (1982, Sites of Special Wildlife Interest) likewise gave Kohangatera a "High" rating and Kohangapiripiri a "Mod-High" rating. Parrish (1984) explains that Kohangapiripiri was rated lower than Kohangatera "because of its smaller size and correspondingly lower numbers of birds; and less bird variety". He records birds and plants that are regarded as significant to the region and notes that these lakes are the best examples in the Wellington region. No nationally threatened species were cited for the lakes area. However, our understanding of threatened species has changed today, with the result that two 'Nationally Threatened' species occur in the area: giant kokopu in the Pencarrow Lakes Reserves and *Mazus novae-zeelandiae* on the raised beaches.

3.2 REVISED ASSESSMENT OF PENCARROW LAKES

The above value judgements for the lakes have not been challenged. Accumulated data since 1982 have only served to further strengthen the standing of these lakes.

In order to evaluate the conservation significance of Pencarrow Lakes they must be considered as a single entity. Together, these two parallel wetland valleys represent a unique ecosystem. As research knowledge has built up, it has become clear that they differ, considerably and the more they are researched the more evident that difference becomes. Today, with the emphasis on biodiversity, it is the future of the whole Pencarrow lakes ecosystem that should be considered. Arguments over whether one lake is less significant than the other simply cloud the issue. As representatives of a freshwater-coastal ecosystem (in the mountains-to-the-sea concept), these lakes are clearly unmatched within the Wellington

Conservancy. From a wider New Zealand viewpoint they are also unique, in the sense that no other coastal valley lakes, such as Tomahawk Lagoon or Lake Forsyth, support the particular biodiversity found at Pencarrow. Nor do they have relatively intact catchments and ocean beach ridges, which are still clothed in largely indigenous vegetation. It is interesting to note that in the seminal publication, *New Zealand Lakes* (eds Jolly & Brown, 1975), there is not a single mention of Kohangatera or Kohangapiripiri. They are indeed Wellington's "best kept secret".

4. Sensitivity to disturbance

In this section threats to the integrity of the entire Pencarrow Lakes ecosystem are discussed since it is not feasible to protect the Wildlife Management Reserves in isolation. The quality of the lakes and their biota depends on the quality of the upstream drainage areas as well as the nature of the barrier beaches that partially separate them from the ocean. Previous reports have drawn attention to the impacts of grazing stock, sand-quarrying operations, alien species, recreational activities and fire, but none stressed the risks inherent in the mismanagement of their ocean beaches.

4.1 INTRUSION OF FARMING INTO THE LAKES AREA

Moar (1950), who made the first in-depth study of the vegetation of Gollans Valley swamp, wrote "perhaps the most effective factor in altering the vegetation is grazing and trampling by cattle". Since then, every report that has been concerned with the protection of the natural values of the Pencarrow Lakes, draws attention to the damage perpetrated by cattle grazing and stresses the need for protection of the marginal vegetation. Thus it is indeed disappointing to record that, more than 50 years later, the cattle are still grazing and trampling the lake margins. Their impact during the dry summer of 2000/01 was probably greater than ever due to the extreme low water levels. Sheep also have access to the water edges. Apart from Moar (1950), no other Pencarrow Lakes report gives details of how cattle actually modify the vegetation. He noted that in the swamp, *Sparganium subglobosum* only occurred beyond the zone grazed by cattle. As if to counter this he also commented that the community of prostrate mat plants on the eastern margins have "... developed, at least in part, as a result of the grazing and trampling by stock".

There seems little doubt that cessation of stock access to the water is essential if the natural margins are to be restored. Not only would this allow the wetland plants to recover and establish in their appropriate habitats, but if stock were excluded terrestrial shrubs and trees of the riparian zone could also re-establish. In addition, restoration of the entire marginal ecotone would benefit all winged aquatic insects, such as dragonflies and caddis, which require sheltered lakeside vegetation for their adult stage. Waterways on pastoral farmland inevitably become enriched from the use of fertilizers and the runoff of animal excretory products. There is no way of measuring how much this influence has impacted on the Pencarrow Lakes but it is

clear from the water chemistry and chlorophyll a levels, discussed in 3.3 above, that Kohangatera, with its extensive farming catchment, has a higher trophic status than Kohangapiripiri. Brown (1992) pointed out signs of nutrient enrichment in the lakes and recommended that a water conservation order should be considered for these catchments to protect the outstanding intrinsic value of the wetlands. Exclusion of farm animals from the margins would lower the nutrient status of the water and also reduce the spread of weed seeds. Retiring the adjacent hill-slopes from grazing would restore the water quality still further.

4.2 PLANT PESTS

A recent report by Mitcalfe & Horne (1997) listed pest plants for the Wildlife Management Reserves. Field surveys were done during December. Twenty-eight species are recorded for Kohangapiripiri, four of which are regarded as potentially threatening to this site. These are mercer grass (*Paspalum distichum*), water buttercup (*Ranunculus trichophyllus*), sweet brier (*Rosa rubiginosa*) and gorse (*Ulex europaeus*). By far the most serious of these is the water buttercup, an invasive aquatic plant with the potential to engulf indigenous aquatic species and modify the entire water column. First recognised in this country (as *R. fluitans*) in 1906, it is a common and widely distributed water weed which is known for its intermittent appearance in shallow coastal lakes offering a firm sandy substrate (Gibbs, 1973). It is interesting to note that water buttercup was not mentioned in accounts by R. Mason (1950) and N. Moar (1950). Mason described, accurately and in detail, the aquatic flora of Kohangapiripiri. She stated that the native red pondweed (*Potamegeton cheesmanii*) "... occurs almost throughout the lake." Thus invasion of Kohangapiripiri by water buttercup must have taken place in the past 50 years. Waterfowl are likely vectors.

Sweet brier, a terrestrial shrub, occurred in one patch on the margin and has the potential to spread if not controlled.

Forty-seven species of pest plants were recorded from the Kohangatera Reserve area (Mitcalfe & Horne, 1997). The majority are fully terrestrial farm weeds. Three species were highlighted as potentially threatening included: marram (*Ammophila arenaria*), tree lupin (*Lupinus arboreus*) and gorse. Although water buttercup was not recorded in Mitcalfe & Horne's shoreline survey, it was picked up by Orchard (1995) at Kohangatera, and so is apparently present in both lakes. Tree lupin seedlings were discovered near the road, east of the outlet. Lupin, gorse and other terrestrial noxious weeds need to be carefully monitored and controlled where necessary.

The absence of major (class B) noxious water weeds in Kohangatera is a point worth emphasising. These weed species are most likely to be introduced when carried by boats and trailers that have been used in other waterways. Invasive water weed species (e.g. *Elodea canadensis, Lagarosiphon major, Egeria densa*) occur in the region, some as close as the Wainuiomata Valley, and so there is a very real danger of fragments being carried into Kohangatera (or Kohangapiripiri) by human usage. Future management must recognise this by prohibiting any launching of recreational boats from trailers.

4.3 ANIMAL PESTS

Apart from the farm animals, the usual alien species of mammal are present around the lakes (Brown, 1992): rabbits, possums, hedgehogs, stoats, rats and, presumably mice. Parrish (1984) recommended controls on all wild animals should be maintained and increased wherever possible to protect breeding waterfowl. Brown (1992) noted rabbit and possum control may be required. Rabbit sign is especially noticeable amongst the cushion plants on the high beach ridges. If the Lakes Block is retired from grazing at the termination of the present lease, it will become more imperative to control herbivorous animal pests, including those above plus deer, goats and pigs, to allow unhindered re-vegetation of margins and hill-slopes to occur.

4.4 THE BEACH RIDGES

Although not included within the Wildlife Management Reserves the raised ocean beaches must be considered as an integral part of the lakes system. They represent three intrinsic conservation values: first, they preserve a unique record of historical uplifts; second they support a rare biotic community and third, they are the natural water-levelling mechanism for the lakes and the gateway for fish populations. To date, this third value has been totally ignored. It should be clear from section 3 above that to restore and protect both the freshwater fish fauna and the marginal semi-aquatic plant communities, it is vital that the natural breaching cycle of the lakes be maintained. The beaches are no longer in their natural state. Already they have been subject to sand quarrying operations and road building and the lake outflows are obstructed by concrete pipes under the roadways. Any interference with the natural erosion cycle is likely to disrupt potential fish migration and could lead to diadromous species becoming extinct in the catchment. In terms of the lifespan of giant kokopu, this could mean that fish present during the last survey (1987) may not be present today.

The intrinsic value of the raised beach community has been emphasised by Frank (1993), Orchard (1995), Parrish (1984) and Patrick (1998). In 1984, Parrish recommended "protection from stock and vehicular traffic, including motorcycles". Evidence of both these impacts is readily apparent today. So easily overlooked due to their low stature and scattered occurrence, the dune-colonising plants and their specific insect fauna are inherently prone to disturbance and difficult to re-establish. Cattle and sheep still trample the sensitive beach plants. To secure a future for this community, grazing stock must be excluded from the raised beaches. This applies to the beach ridges of both lakes. It should be stressed that the Kohangapiripiri beach is by far the most valuable for its in-situ biotic community much of which is relatively unmodified. The Kohangatera beach ridge has been destroyed on the seaward side by quarrying. However, it still supports the uncommon plant, *Muehlenbeckia ephedroides,* on its highest level. Human impacts are discussed in 4.5 below.

4.5 RECREATIONAL IMPACTS

One of the proposed objectives of the East Harbour Regional Park is "to provide for a wide range of outdoor recreational activities which are compatible with the park's natural and cultural heritage values..." (East Harbour Regional Park Management Plan, Pt 1, p. 6. 1995). At present the number of visitors to the Lakes area is severely limited by the restricted vehicular access to Fitzroy Bay (controlled by HCC) and the distance from car parks. Apart from those transported by M. Curtis for his tourism business, the majority arrive on mountain bikes. Although as many as 300 people may walk the coastal roadway on a fine Sunday (WRC 1998), very few of them make it all the way to Pencarrow Lakes, a distance of over 7 km. However, visitor numbers will surely increase as the park concept is realised and developed.

Despite these current limitations to human access, the sensitivity of the beach area is such that even the present low level of impact is unacceptable. The Kohangapiripiri dune area between the roadway and the sea is always criss-crossed by vehicle tracks and footprints, evidence that the signage is ineffective at preventing access. The author has, on several occasions, seen unregistered vehicles (farm bikes, quad bikes) on the Kohangapiripiri dune area. The present well-maintained fence between the road and the Kohangapiripiri high dune, together with an interpretation sign installed at the outlet of that lake is more effective. However, fencing materials are short-lived in that environment. Probably the most practical approach for keeping people off the beach surface is to provide a boardwalk with appropriate interpretation. The establishment of a resident park ranger should enable more thorough policing of vehicle access to these beaches. The ocean beach at Kohangatera has been severely modified by quarrying. Its restoration will depend on removing all grazing stock and active re-vegetation with local species. For this to succeed public access will have to be controlled here as well.

It is difficult to distinguish recreational impacts from stock impacts around the lake shores and wetlands because the stock damage overrides all other forms of impact. This will change if stock can be excluded at the termination of the present grazing lease. Actual and potential recreational impacts around the lakes include walking and mountain biking on formed tracks, boating and duck shooting. Use of lakeside tracks for non-vehicular traffic should not threaten ecosystem values. It will be necessary to provide access to the open water at several points by the construction of boardwalks and viewing platforms accompanied by suitable interpretation signs. Location of platforms needs to take account of the extreme winds of the area, accessibility along the proposed tracks and the ecological diversity they can present to the public.

Boating is extremely limited on the lakes at present and comprises the occasional kayak visitor. This is acceptable but boating needs to be carefully monitored. The present Management Plan (1995) makes no mention of recreational boating. It is suggested that the potential for boating and its impacts be recognised, particularly in relation to breeding species of waterfowl. From the outset, all powered craft should be excluded from both lakes.

Finally, the contentious issue of duck shooting. The designation "Wildlife Management Reserve" allows recreational shooting by permit on the lakes. This opportunity is taken up annually by a small band of dedicated shooters who hunt

on the lakes block under the auspices of the Wellington Wildfowlers Inc. (WWF). There are to be no permanent maimai structures and any temporary structures are to be removed by 15 July each year. Dogs are permitted but must be under the control of their owner at all times. It could be argued that this limited shooting keeps species like mallard from becoming over-dominant. On the other hand, the current "Recreational Reserve" designation gives no habitat protection. It must be said that the designation of the wetland system at Pencarrow as a reserve that affords no habitat protection is incompatible with its high wildlife values, which can be ranked as 'outstanding', and of national significance. Some debate is required to resolve this paradox.

4.6 FUTURE THREAT PROSPECTS

Threats that result from recreational use, as they exist under current policy, are discussed in 5.5 above but there are signs that a major escalation in public access could occur in future. This scenario could occur if: 1) there is a change of policy for the Regional Park which allows unrestricted vehicle access along the coast road to car parks in Fitzroy Bay, (Pencarrow Lakes Block Concept Development Plan, 1998, p. 8); or if 2) a major coastal roadway is developed in the future between Eastbourne and Wainuiomata (Eastbourne Herald, 27 July 2001, p. 3; Hutt News, 31 July 2001). Such a change would immediately place the lakes ecosystem, and especially the beach ridges, under severe threat from overuse by visitors. In fact it is difficult to see how the sensitive beach ridge community at Kohangapiripiri could possibly survive. Road access to Fitzroy Bay would also increase the opportunities for boating on the lakes.

Should this opening of public access take place, major protection work will be required for the dune surfaces. At Kohangapiripiri it would need to involve effective fencing and boardwalk systems while at Kohangatera public trampling would severely limit the possibility of re-vegetation of sand-quarried areas unless similar measures are taken.

A sealed two-lane roadway has the potential to impose severe restrictions on the ability of the streams to egress naturally across the dunes to the sea at times of high flow. Bridges would need to be designed with this in mind.

A change of ownership of the Turvey property in Gollans Valley could likewise threaten the integrity of the lakes in future and indeed even the viability of the Regional Park concept. If, for example, it remains in private ownership and is developed as a rural subdivision, threats to water quality will arise from new types of runoff reaching the stream. Another scenario is that an access road might be developed to reach the lakes block boundary, thereby allowing increased visitor access to the upper reaches of Kohangatera.

In sum, ease of human access is likely to become the major factor in the conservation management of Pencarrow Lakes. They are nationally significant wetlands today largely because of their difficult visitor access. To protect this unique environment in the face of a massive increase in visitor pressure will be the main challenge facing the new Regional Park.

4.7 FIRE

The danger of uncontrolled fire is always an issue in a predominantly grassland area that is prone to summer drying. Parrish (1984) drew attention to the need for fire prevention. The East Harbour Regional Park Management Plan prohibits recreational barbecues and fires. The usual argument for retention of stock on grassland conservation areas is that grazing decreases risk of fire. If the hill slopes at Pencarrow are retired from grazing this danger will escalate during the transitional years as re-vegetation develops, and could threaten the integrity of the wetland vegetation. Since the end result is highly desirable for overall restoration of the catchment area, this risk will have to be recognised and appropriate fire precautions taken.

The Pencarrow Lakes Block Concept Development Plan (1998, p. 10); recommends provision of fire breaks around wetlands and lakes in their Option 1: "allow steeper parts to revert to gorse and scrub". This recommendation needs to be considered very carefully in the context of the landscape values of the area. For instance, a wide horizontal "fire break" around the lakes would totally defeat the aims of re-vegetating the riparian zones. Maintenance of a few open ridge-line "fire breaks" may be more acceptable.

4.8 THE CONCEPT OF CATCHMENT INTEGRITY

The present report emphasises the need to consider the whole catchment when debating the quality and protection of the lakes themselves. The Regional Park concept allows for this holistic approach and provides a unique opportunity to restore a wetland into as close to original condition as possible. The lakes are recognised as valuable because they are *relatively* undisturbed. This does not imply pristine conditions. It does imply that restoration efforts should be aimed at the entire catchment from headwaters to the sea. Such an integrative approach provides the opportunity to reverse some of the impacts of hill farming and beach modification.

5. Summary and recommendations

5.1 VALUE STATEMENTS

- There is ample landscape, historical and biological evidence to give Pencarrow Lakes a national conservation significance. In this context, both lakes should be considered together as an ecological unit, not ranked separately as was done in the WERI (1982) and SSWI (1982) evaluations.
- Clelland (1984) refers to the lakes as the "centrepiece of the proposed Pencarrow regional Park". This is a valid assessment of their importance within the concept of an East Harbour Regional Park since the combination of historical, cultural and biological values is unique within the Wellington Region.
- The "Wildlife Management" reserve status clearly undervalues an ecosystem that is of national importance. It is recommended that serious consideration should be given to upgrading this status in order to confer a higher level of habitat protection.

5.2 SPECIAL FEATURES AND RESEARCH POTENTIAL OF THE LAKES

- Based on existing data, the trophic status of Kohangatera is higher (mesotrophic) than Kohangapiripiri (oligo-mesotrophic). This difference may be related to the extent of farming in the Gollans Valley catchment. It is recommended that further studies on the water chemistry and trophic status be pursued to provide a water quality baseline. This will permit monitoring of change in the catchment, whether it be a reduction in farming or a change to rural development. The analysis should include ions that might indicate if leachate from an old tip site is reaching the lake.
- Research based on sediment coring has been undertaken for Kohangapiripiri. It has yielded information on the history of the lake and its diatom flora over the past 7000 years. The data reveal that it has been fresh (slightly brackish) water during this time. There are suggestions that the sequence of events may have been very different in Kohangatera. It is recommended that every effort be made to encourage similar research at Kohangatera.
- Research on the aquatic biota of the two lakes has emphasised their ecological differences. The nature of their respective catchments is likely to be responsible but historical factors cannot be ruled out. It is surprising, considering their proximity to Wellington and road access, that our current knowledge of Pencarrow lakes ecology is so sketchy. It is recommended that research projects on their fauna and flora be encouraged.
- The indigenous freshwater fish fauna of these lakes and catchments is one of their prime biological values. However, the species data are out-of-date and the records inconsistent. It is recommended that a comprehensive fish survey be undertaken, to establish the composition of the current fauna and to determine whether alien brown trout are resident in one or both catchments.

- Lake breaching events caused by periods of high rainfall, whereby the lakes overflow through their barrier beaches into the ocean, are rare and have possibly not occurred at Kohangapiripiri for many years. Since these overflow events and their seasonal timing are crucial for sustainability of the diadromous fish populations in the catchments, it is recommended that they should be monitored and recorded in future.

5.3 MANAGEMENT RECOMMENDATIONS

- Management that is restricted to the Wildlife Management Reserves alone can achieve little. It is recommended that a holistic approach is needed which considers the catchment as a whole and the beach ridges between the lakes and the ocean. This will require a cooperative approach from the three Authorities responsible.
- Water quality in both lakes is good. Nevertheless, a policy aiming at restoration of a more pristine quality can be achieved by minimising the impact of farm animals in the catchments. Steps to achieve this are practical within the Lakes Block. It is recommended that grazing should cease on the majority, or all if possible, of the hill slopes surrounding the lakes to encourage natural re-vegetation.
- Grazing stock, cattle in particular with free access to the lake margins have been degrading the lakeshore vegetation despite repeated recommendations to exclude them over the past 50 years. This recommendation is strongly endorsed here, yet again.
- Active revegetation is recommended around the lake shorelines to establish groves of taller trees close to the water. Ideal species would be cabbage tree (*Cordyline australis*) and karaka (*Corynocarpus laevigatus*). The other local shrub and tussock-forming species should establish naturally.
- A maximum of three public viewing platforms, connected to the shore by boardwalks, are suggested for the lakes. It is recommended that these be located as follows: Kohangapiripiri—from the point on western shore just north of the "western inlet"; Kohangatera—extending through swampland near the outlet stream on the western shore; Kohangatera—near the vestigial sea stack at the northeastern end. In addition to providing views and interpretation for visitors, extended platforms would enable sampling of aquatic fauna and flora to be carried out without the need for a boat.
- It is recommended that the existing, but unused, concrete shed on the southwestern shore of Kohangapiripiri (in drainage reserve) be removed to restore the natural profile of the esplanade strip.
- The raised beaches, in their natural state, allowed breaching of the lakes to the sea whenever flooding occurred. This natural cycle is irregular and vital to the sustainability of the freshwater fish fauna. It is noted that the present outlet culverts and road embankments have the potential to obstruct the natural outflows from the lakes and the inward migration of larval fishes. It is therefore recommended that open piled causeways be considered to replace the existing outlet pipes under the roadway in order to permit more natural scouring by the outlet streams.

5.4 THREAT MANAGEMENT

- Under the grazing lease, stock have been gaining access to the raised beaches. It is recommended that stock be totally excluded from the raised beach surfaces of both lakes as soon as possible.

- Under a Regional Park concept, with stock excluded, the most serious threat to the integrity of the lake and beach ecosystems is people. The endemic lakeside and dune vegetation is sensitive to trampling, especially on the beaches. The high quality of these habitats today is primarily due their remoteness, in terms of walking distance, and the resulting very low visitor numbers. Any change to present policies, such as a through road, or provision for car parking in Fitzroy Bay, will escalate the damage. It is recommended that boardwalks be used to protect sensitive beach and lakeshore habitats and that posts be inserted along the roadways to deter vehicular traffic from leaving the formed road. Additional measures will be required to restrict people's access to the beaches during breeding times of banded dotterel.

- The most serious weed issue is the invasion of Kohangapiripiri by the adventive water buttercup, *Ranunculus trichophyllus* (formerly known in New Zealand as *R. fluitans*). This plant represents the only major aquatic or semi-aquatic weed species in the otherwise highly natural lakes. It can take over most of the open water area during early summer. It is recommended that the impact of this weed be researched and that possible control methods be considered.

- To minimise the risk of introducing additional water weed species it is recommended that power boats and all boat trailers be prohibited. Limited kayak recreation on the lakes, at times that will not conflict with waterfowl breeding, is acceptable.

- Contour tracks that follow the lake esplanade strips are acceptable to encourage public access along the shorelines of both lakes to reach the upper swamplands as shown in WRC Concept Development Plan, 1998. This would involve a track along the western shoreline of Kohangapiripiri and the eastern shoreline of Kohangatera. However, it is strongly recommended that vehicles be banned from these tracks and that vegetation be allowed to regenerate so as to form a closed canopy over the tracks in some places.

- The Wellington Regional Council has imposed a ban on all recreational barbecues and fires. This is strongly supported here. However, the siting of any fire breaks needs to take heed of the visual quality of the landscape and the establishment of a natural continuum of riparian vegetation as referred to in above. A circum-wetland fire break is not recommended.

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Appendix 1

LAKE MORPHOMETRICS

(from M. Frank (1995) with permission)

	LAKE KOHANGAPIRIPIRI	LAKE KOHANGATERA
Latitude °S	81.31	80.35
Longitude °E	65.40	66.26
Altitude (m)	2-3	2-3
Lake surface area (ha)	13	17
Maximum length (km)	0.6	0.8
Maximum width (km)	0.2	0.3
Maximum depth (m)	1.8	2.1
Length of wetland (km)	2.0	2.5
Area of catchment (ha)	280	1700
Length of major stream (km)	5	14
Total area of wetlands (ha) (incl. lakes)	60	170
Major axis of lake	NNE	N

Appendix 2

WATER CHEMISTRY DATA

(from M. Frank (1995) with permission)
From samples taken on 2/05/90 with comparative values from Lake Pounui (Lawless, 1982) and the range from two large coastal lakes on Banks Peninsula (Stout, 1975). Units g/m^3

	KOHANGAPIRIPIRI	KOHANGATERA	POUNUI	ELLESMERE & FORSYTH
Chloride	150	280	32.5	1540–5700
Sodium	90	180	22	720–2000
Potassium	4.2	6.2	0.9	32–60
Magnesium	11.4	18	3.2	100–307
Fluoride	0.1	0.2	0.08	—
Bromide	0.42	0.88	0.1	—
Calcium	5.1	9.8	5	48–104
Sulphate	20	29	7.1	225–645
Ammoniacal N – NH4	0.05	<0.04	0.28	<0.005–0.48
Nitrate N – NO3	0.07	<0.05	<0.01	<0.02–0.3
Soluble P	<0.06	<0.06	0.02	<0.01–0.11
Total hardness (as Ca CO3)	60	99	26	38–135

Appendix 3

INDIGENOUS PLANT SPECIES LIST

Note: This list is compiled from the literature. It is not possible to determine precise sites of previous records, hence there is no guarantee that the species listed below are exclusively from within the Lakes Reserve and esplanade strip boundaries. Non-wetland species have been excluded from Parts I & II. The author reference is the first to report the plant at the Lakes.

(e) = endemic species

PART I **True Aquatic Plants** (in open water or floating)

Azolla filiculoides	Pacific azolla	Mason, 1950
Lepilaena bilocularis (K'piripiri only)		Mason, 1950
Lemna sp.	duckweed	Mason, 1950
Myriophyllum propinquum	milfoil	Moar, 1950
M. triphyllum (e)	milfoil	Clelland, 1984
Nitella sp.	(or is it *Chara* sp.?)	Moar, 1950
Potamegeton cheesmani	red pondweed	Mason, 1950
P. ochreatus	blunt pondweed	Moar, 1950
Ruppia polycarpa	horse's mane weed	Mason, 1950
Wolffia australiana	watermeal	Mason, 1950

PART II **Semi-aquatic Plants** (emergents, marginal swards under variable water levels)

Apium prostratum var *filiforme*	native celery	Moore, 1945
Baumea rubiginosa		Druce, 1992
Blechnum minus	swamp kiokio	Moar, 1950
Carex flagellifera (e)		Druce, 1992
C. geminata (e)		Clelland, 1984
C. secta (e)	purei, niggerhead	Moar, 1950
C. virgata (e)		Moar, 1950
Centella uniflora	centella	Moar, 1950
Cortaderia toetoe (e)	toetoe	Moar, 1950
Cotula coronopifolia	batchelor's button	Moar, 1950
Crassula kirkii (e)		Clelland, 1984
Cyperus ustulatus	giant umbrella sedge	Moar, 1950
Elatine gratioloides (K'piripiri only)	waterwort	Clelland, 1984
Eleocharis acuta	sharp spike sedge	Moar, 1950
Epilobium pallidiflorum	willow herb	Moar, 1950
Eryngium vesiculosum	sea holly	Moore, 1945
Glossostigma diandrum		Clelland, 1984
G. elatinoides		Mason, 1950
Graticola sexdentata		de Lange, 1990
Hydrocotyle heteromeria (e)	waxweed	Druce, 1992
H. hydrophila (e)		Druce, 1992
H. novaezelandiae (e)		Druce, 1992

H. pterocarpa		Druce, 1992
Isolepis cernua	slender clubrush	Druce, 1992
I. inundata		Druce, 1992
I. nodosa	nobby clubrush	Druce, 1992
I. prolifer		Druce, 1992
Juncus australis		Druce, 1992
J. caespiticus		Druce, 1992
J. gregiflorus		Druce, 1992
J. maritimus var *australiensis*	sea rush	Druce, 1992
J. pallidus		Moar, 1950
J. planifolius		Druce, 1992
Leptocarpus similis (e)	oioi, jointed rush	Moore, 1945
Lilaeopsis novae-zelandiae (e)		Moar, 1950
Limosella lineata	mudwort	Mason, 1950
Phormium tenax	harakeke, NZ flax	Moar, 1950
Polygonium sp.		Mason, 1950
Ranunculus acaulis	sand buttercup	Orchard, 1995
R. amphitrichus	waoriki	Moar, 1950
R. glabrifolius		Druce, 1992
R. limosella		Clelland, 1984
R. macropus (e)	swamp buttercup	Mason, 1950
R. reflexus (e)	hairy buttercup	Druce, 1992
Sarcocornia quinqueflora	glasswort	Orchard, 1995
Schoenoplectrus validus	lake clubrush	Mason, 1950
Spargonium subglobosum	burr reed	Druce, 1992
Trichochin striata	arrow grass	Druce, 1992
Typha orientalis	raupo	Mason, 1950

Part III **Raised Beaches:** terrestrial sand plants (all ex Orchard, 1995)

Apium prostratum var	native celery
Carex pumila	
Calystegia soldanella (e)	sand convolvulus
Colobanthus muelleri (e)	
Cyperus ustulatus	giant umbrella sedge
Disphyma australe australe (e)	NZ iceplant
Desmoschoenus spiralis (e)	pingao
Einardia triandra	
Mazus novae-zeelandiae (e)	
Muehlenbeckia ephedroides (e)	
M. complexa (e)	pohuehue
Pimelia urvilleana (e)	
Plagianthus divaricatus (e)	saltmarsh ribbonwood
Raoulia hookeri (e)	scabweed
Senecio lautus ssp. *lautus*	
Spinifex sericeus	
Spergularia media	sea spurry
Zoysia minima (e)	

Appendix 4

ANIMAL SPECIES LIST

Birds

List based on Brown, 1992, for birds seen within the lake reserves, immediate surroundings or beaches. (e) = endemic species

Alauda arvensis	skylark
Anas platyrhynchos	mallard
Anas rhynchotis	NZ shoveler
Anas superciliosa	grey duck
Anthus novaeseelandiae	pipit
Ardea novaehollandiae	white-faced heron
Branta canadensis	Canada goose
Botaurus poiciloptilus	Australasian bittern
Carduelis chloris	greenfinch
Carduelis carduelis	goldfinch
Charadrius bicinctus (e)	banded dotterel
Circus approximans	Australasian harrier
Cygnus atratus	black swan
Gerygone igata (e)	grey warbler
Emberiza citrinella	yellow hammer
Halcyon sancta	New Zealand kingfisher
Himantopus himantopus	pied stilt
Haematopus unicolor (e)	variable oystercatcher
Hirundo tahitica	welcome swallow
Larus dominicanus	southern black-backed gull
Callipepla californica	California quail
Passer domesticus	house sparrrow
Phalacrocorax carbo	large black shag
Phasianus colchicus	pheasant
Poliocephalus rufopectus (e)	NZ dabchick
Porphyrio porphyrio	pukeko
Porzana tabuensis	spotless crake
Prunella modularis	dunnock
Rhipidura fuliginosa	fantail
Sturnus vulgaris	starling
Tadorna variegata (e)	paradise shelduck

Frogs

Litoria raniformis	golden bell frog

Freshwater Fish

From DOC database for Pencarrow lakes and Gollans Valley stream.

*Species recorded in the NIWA database.

**Anguilla dieffenbachii* (e)	longfinned eel
Anguilla australis (e)	shortfinned eel
**Galaxias argenteus* (e)	giant kokopu
Galaxias maculatus (e)	inanga, whitebait
**Galaxias fasciatus* (e)	banded kokopu
**Geotria australis*	lamprey
**Gobiomorphus cotidianus* (e)	common bully
**Gobiomorphus gobioides* (e)	giant bully
**Gobiomorphus huttoni* (e)	redfin bully
Salmo trutta	brown trout

Molluscs

Hyridella menziesi (e)	kakahi, freshwater mussel
Potamopyrgus antipodarum	freshwater snail

Arthropods: Crustaceans

Gladioferens pectinatus	calanoid copepod
Paranephrops planifrons (e)	koura, freshwater crayfish

Arthropods: Insects

Agrotis innominata (e)	coastal owlet moth
Ericodesma aerodana (e)	moth, larvae on *Pimelia*
Notoreas sp. (e)	undescribed coastal moth on *Pimelia*
Opogona omoscopa	moth
Stathmopoda rubophaga	moth
Uropetala carovei (e)	large dragonfly