# Plant communities of the Monaro lakes

J.S. Benson and S.W.L. Jacobs

*Benson, J.S. & Jacobs, S.W.L., (National Herbarium of New South Wales, Royal Botanic Gardens, Sydney, NSW, Australia 2000) 1994. Plant communities of the Monaro lakes.* Cunninghamia *3(3): 651–676.* Four wetland plant communities were defined from a cluster analysis of plant species recorded from 65 lakes in the southern Monaro region, Southern Tablelands of New South Wales (c. Lat. 36° 00'–37° 00' S Long. 148° 30'–149° 20' E). 110 plant species (including 19% exotic) were recorded from the lakes and their strandlines. Several species were collected for the first time on the Southern Tablelands. Altitude, size of lakes and permanence of water appear to be the main factors directly or indirectly determining floristic variation between the lakes, whereas substrate appears not to be important in this regard. We postulate that wave action on large lakes may limit the survival of floating-attached waterplants. Further study is required to establish the importance of lake size and shape, and salinity on species distribution. A number of lakes judged to be in sound condition or containing significant species are proposed for conservation.

## Introduction

Over the last 25 years there have been a number of botanical, limnological and waterfowl surveys of wetlands in south-eastern Australia. Jacobs and Brock (1993) review the literature on wetland studies in southern (temperate) Australia and provide an assessment of the classification systems used. Other major contributions include a survey of the coastal saltmarsh plant communities in New South Wales by Adam et al. (1988), the review of wetlands in Victoria by Norman and Corrick (1988), the review of Tasmanian wetlands by Kirkpatrick and Tyler (1988), and the description of Tasmanian wetland plant communities by Kirkpatrick and Harwood (1983).

There is limited documentation of the waterplants growing on the Tablelands compared to the coastal wetlands in New South Wales. Exceptions include the peat swamps on the Southern Tablelands (Hope & Southern 1980), and a number of Northern Tablelands wetlands (Briggs 1976, Bell 1992) which are also subject to current research on the seedbank dynamics of wetland communities (Brock & Britton in press, M. Brock pers. comm.). The vegetation of the alpine and subalpine swamps in Kosciusko National Park were documented in Wimbush and Costin (1979a & b).

The aim of our survey was to record the waterplants growing in the lakes on the tableland tract of the southern Monaro region (Costin 1954), to classify the wetland plant communities, suggest possible explanations for the distribution of those plant communities and their constituent species, comment on the conservation status of the wetland communities, and make suggestions on how to improve conservation.

## The study area

The survey concentrated on the near-permanent (rarely dry), intermittent (often seasonally dry) and ephemeral (occasionally full) lakes on the tableland tract of the southern Monaro from Bullanamung Lake (Lat. 36° 00' 15"), 28 km north of Cooma, to Green Lake (Lat. 37° 01' 35"), 15 km south of Bombala. These lakes would be classified as Mountain Lakes and Swamps, (a) perennial lakes and (c) ephemeral

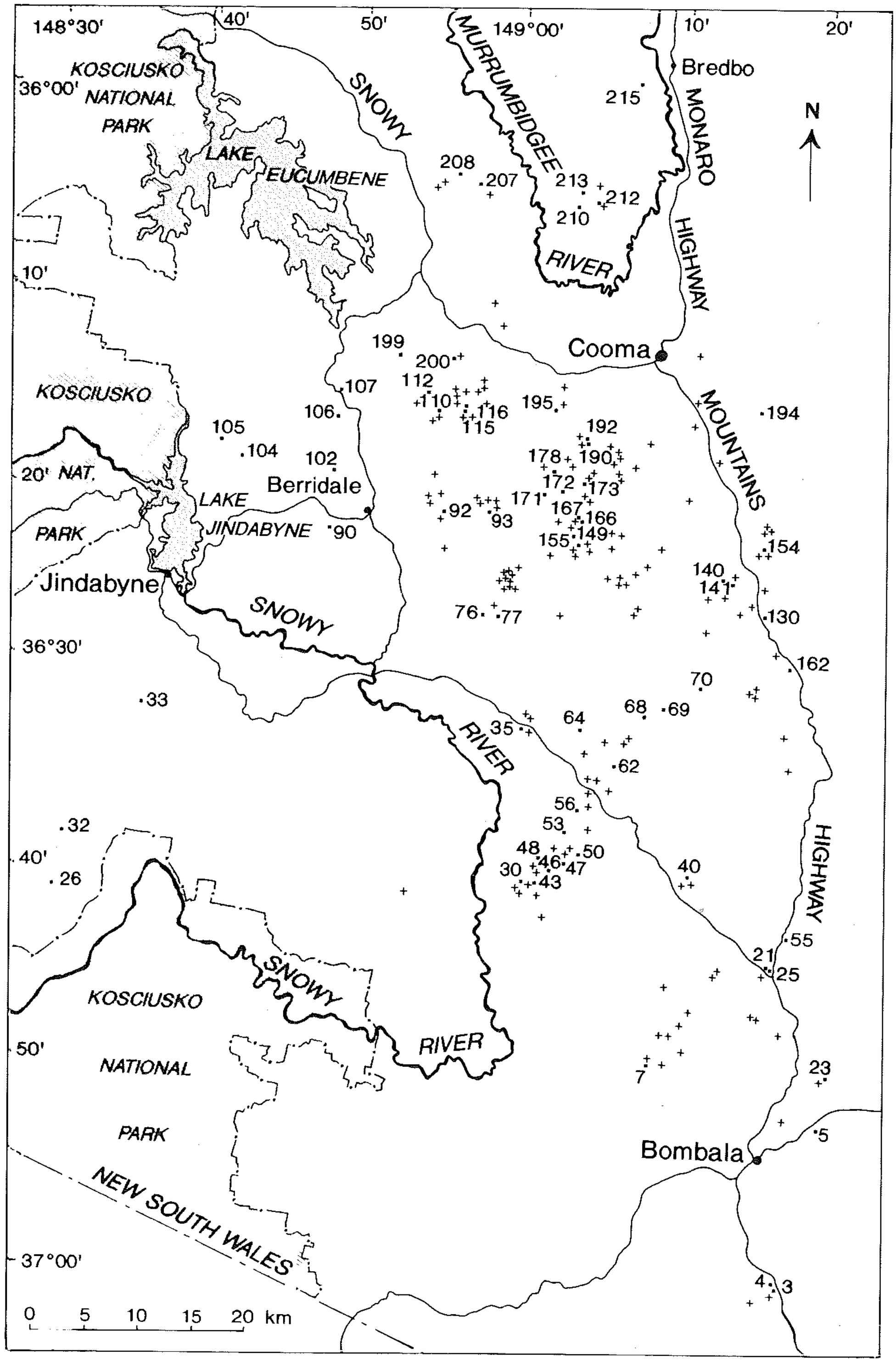



Figure 1. Distribution of the 215 lakes on the southern Monaro; the 65 lakes sampled during this survey are numbered (see also Appendix 1).

lakes/swamps, in the classification suggested by Jacobs and Brock (1993). The region is bounded in the east by the South Coast and Kybean Ranges and in the west by the steep eastern escarpment of Kosciusko National Park (Figure 1). Glacial lakes and swamps in the alpine tract of the Monaro (Kosciusko National Park), or wetlands formed by depositional processes such as backswamps, were not included in the survey.

Most of the lakes are between 800 and 1100 m altitude. The lowest elevation of 760 m (lakes 1–3 Figure 1, including Green Lake) was recorded south of Bombala and the highest elevation of 1220 m on the Monaro Range near Middlingbank north of Berridale (lake 199, Figure 1). Rainfall ranges from 450 to 700 mm per annum with falls mainly in the winter (Costin 1954). Temperatures are cold in winter and mild in summer.

The land-use history of the region is summarised in Benson (1994). Most lakes are on private land that has been grazed by sheep and/or cattle for over 100 years. The intensity of grazing has probably varied from property to property. Little is documented about the extent of lake bed cropping in the region, but discussions with landholders indicate that it has been limited compared to the level of cropping on the lake beds of inland New South Wales.

## Geomorphology

The Monaro lakes fall within the 'lentic tablelands' wetland geomorphological definition of Pressey and Harris (1988). Of the 215 lakes on the Monaro, the majority (185, or 86%) are on Eocene basalt; 17 (8%) are on granitic rock types; 4 (2%) are on sedimentary or metamorphic rocks; and 9 (4%) are at the junction of basalt and granitic rocks (Appendix 1). The lake beds are composed of varying depths of dark-grey cracking clays often incorporating carbonate nodules (Pillans 1987).

The most likely explanation for the formation of the Monaro lakes is the process of deflation during the last ice age (Pillans 1987). Lakes on basalt terrain in the midlands of Tasmania are also considered to have formed by deflation (Kirkpatrick & Tyler 1988). Similarly formed lakes are those on the undulating pampa in Argentina and Uruguay in South America (Soriana 1992). Since deflation lakes tend to occur in landscapes dominated by grassland vegetation, the climatic and soil property requirements for the maintenance of grassland — low precipitation, periodic droughts and heavy textured soils (Benson 1994) — are also important for maintenance of the lakes. Such a climate leads to frequent drying out of the lakes, and accumulated sediments on the lake beds are blown away in dry times. Most of the Monaro lakes have aeolian sediment 'shadows' spreading from their eastern shores. These are composed of clay pellets formed during lake-bed surface drying (Pillans 1987). Lake lunettes are rare.

The largest and deepest lakes in the study area dry out only during prolonged drought. Some of these are situated at the junction of basalt flows and granite (examples include Maffra, Boundary, Buckleys and Cootralantra Lakes). Their origin may not be solely due to deflation. During volcanic activity in the Eocene, basalt flows may have dammed valleys and formed depressions in the landscape. These could subsequently have developed into lakes (G. Taylor pers. comm.).

## Methods

### Data collection

Lakes and wetland depressions greater than one hectare are shown on the 1:25 000 scale topographic maps covering the region (Land Information Centre, Department of Conservation and Land Management 1971–1988). We numbered the lakes from south to north (Figure 1), and their size, altitude and substrate (Australian Geological Survey 1964) were documented (Appendix 1). Artificial dams or impounded lakes were excluded from the survey.

Major environmental variables likely to influence the floristic composition of the lakes included size of lake, degree of permanence, altitude, geography and substrate. Approximately 70% of the large lakes (> 10 ha) and 16% of the more numerous small lakes (< 3 ha) were surveyed (Figure 2).

Sampling took place in February 1993 after a wetter than normal spring and summer (Bob Wilkinson pers. comm.) when the lakes were near-full. Some ephemeral lakes had already dried. This timing ensured that most aquatic species were flowering or fruiting.

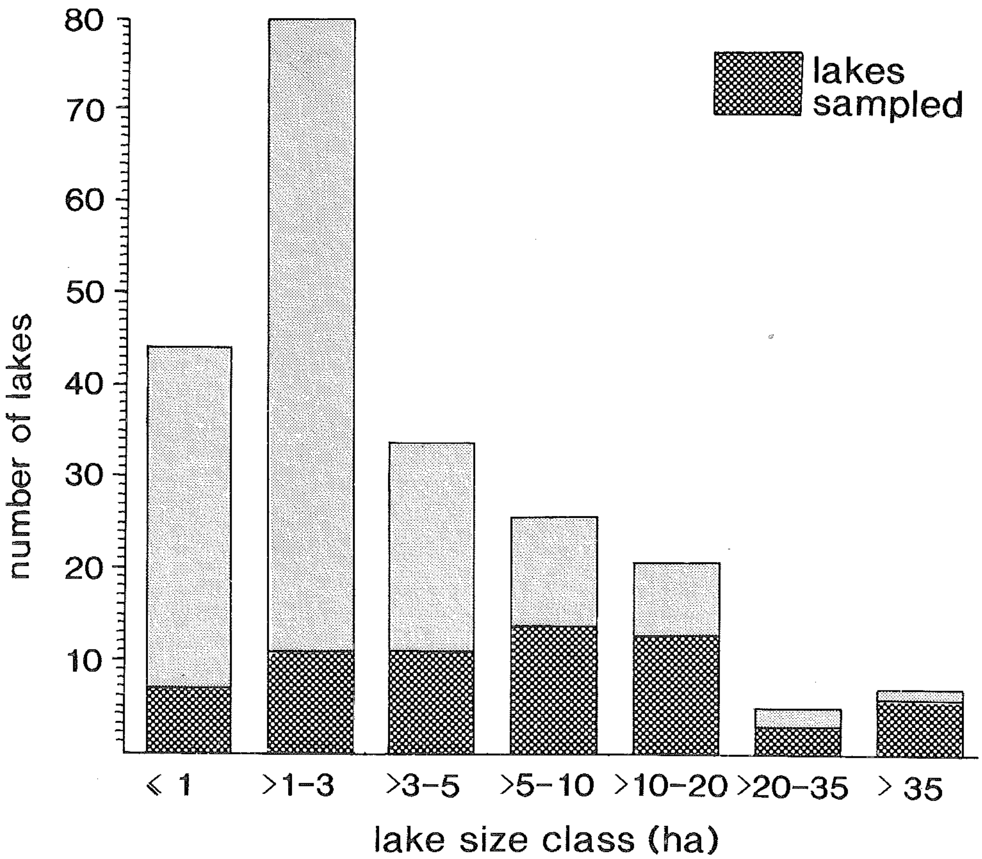



**Figure 2. Numbers of lakes in size classes showing the proportion of each class sampled.**

At each lake all species were recorded and assigned a cover rating on a six-point scale; 0–1, 2–5, 6–25, 26–50, 50–75, 76–100%. Species were recorded from both the water and the adjoining strandline, which varies in position and width as water levels rise and fall. Each wetland was treated as a single site — all plants on the strandline (regularly inundated section of the shoreline) and growing in the water were combined and treated together. Lakes were circumnavigated or traversed by foot. In deeper lakes several sorties were made from the shore and, in the largest, a small boat was used. Any sign or suggestion of vegetation in water was checked and identified. Standard-sized quadrats were not used and, sample size varied substantially, but this was not seen as a confounding factor because of the ease of dispersal of waterplants within water bodies. The lakes were sampled only once. Given the ephemeral nature of some of these lakes and the life cycle of many waterplants, the abundance and presence of some species would vary over time. We are confident, however, that most waterplant species from the lakes would persist and be recorded in future surveys.

## Data analysis

The sample sites and species were classified into floristic groups using an agglomerative hierarchical classification with the Kulcynski coefficient dissimilarity measure, and applying the flexible unweighted paired group arithmetic averaging (UPGMA) sorting strategy of PATN (Belbin 1993). The benefits of using the Kulczynski coefficient compared to other measures are discussed in Faith, Minchin and Belbin (1987). They found it was most robust to variations in assumed models of species response. The analysis incorporated the species cover rating data in a matrix of 65 sites by 110 species. Exotic species were included.

Selection of three floristic groups (Communities 2, 3 and 4) was made at the 0.85 dissimilarity measure. One group (Community 1) was selected at the 0.78 measure.

A two-way table was generated using the 2-step association measure on species and Kulczyski coefficient on sites (Belbin 1993). This aided in identifying common and indicator plant species in each UPGMA-selected floristic group. The mean plant species richness for the lakes selected into each floristic group (plant community) was calculated. The mean size of the lakes classified into the floristic groups was also calculated.

Hybrid non-metric multidimensional scaling (NMDS) using PATN (Belbin 1993) was used to ordinate the lake floristic data along three vectors. To test the nature of the environmental space being described by these vectors, simple relationships of the selected floristic groups (1-4) with the environmental attributes substrate, altitude and size of lake were investigated. Means and medians of altitude, lake size and geology were derived using the GSTA (group statistics) module of PATN.

## Results

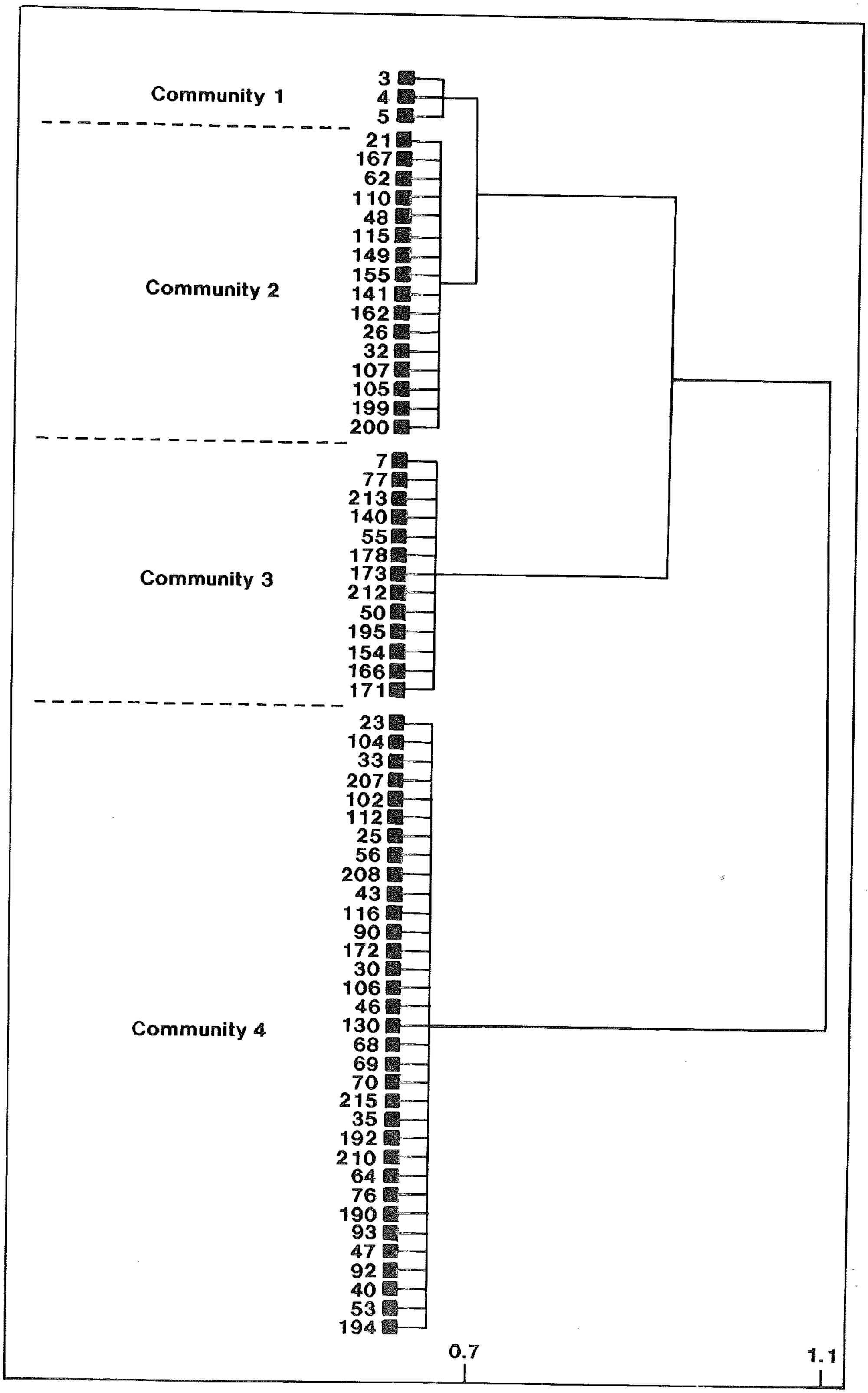
The numbered lakes shown on Figure 1 are those sampled in this survey. Figure 2 summarises the number of lakes in several size classes and the proportion of each class sampled. The classification of the sampled lakes into floristic communities is presented in Figure 3. Community classification is based on Kirkpatrick and Tyler (1988).

**Table 1. Percentage frequency of plant species recorded in each wetland plant community and for all sites**

Community 1 = shallow freshwater herb-sedge marsh, low elevations
Community 2 = shallow freshwater herb-herb marsh, high elevations
Community 3 = shallow ephemeral freshwater herb-grass marsh
Community 4 = deep freshwater sedge-herb marsh
* = exotic species

| Species | Community (%) | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | All |
| *Agrostis avenacea* var. *avenacea* (Poaceae) | 100 | 87 | 100 | 91 | 92 |
| *Alisma plantago-aquatica* (Alismataceae) | 0 | 6 | 0 | 0 | 1 |
| *Amphibromus nervosus* (Poaceae) | 67 | 100 | 39 | 12 | 42 |
| *Asperula conferta* (Rubiaceae) | 0 | 6 | 0 | 0 | 1 |
| *Australopyrum retrofractum* (Poaceae) | 0 | 6 | 0 | 0 | 1 |
| *Azolla filiculoides* var. *rubra* (Azollaceae) | 0 | 12 | 0 | 3 | 5 |
| **Batrachium trichophyllum* (Ranunculaceae) | 33 | 0 | 0 | 3 | 3 |
| *Bolboschoenus caldwellii* (Cyperaceae) | 0 | 0 | 0 | 9 | 5 |
| *Brachycome radicans* (Asteraceae) | 33 | 25 | 8 | 3 | 11 |
| **Callitriche stagnalis* (Callitrichaceae) | 0 | 0 | 0 | 3 | 1 |
| *Cardamine tenuifolia* (Brassicaceae) | 0 | 0 | 8 | 3 | 3 |
| *Carex bichenoviana* (Cyperaceae) | 0 | 19 | 15 | 79 | 48 |
| *Carex gaudichaudiana* (Cyperaceae) | 0 | 12 | 0 | 0 | 3 |
| *Carex inversa* (Cyperaceae) | 0 | 0 | 0 | 6 | 3 |
| *Carex tereticaulis* (Cyperaceae) | 33 | 25 | 8 | 33 | 26 |
| **Centaurium erythraea* (Gentianaceae) | 0 | 0 | 0 | 6 | 3 |
| *Centipeda cunninghamii* (Asteraceae) | 66 | 44 | 69 | 15 | 35 |
| *Chenopodium glaucum* (Chenopodiaceae) | 0 | 0 | 8 | 30 | 17 |
| *Chenopodium pumilio* (Chenopodiaceae) | 0 | 6 | 8 | 0 | 3 |
| **Cirsium vulgare* (Asteraceae) | 0 | 0 | 15 | 6 | 6 |
| *Crassula helmsii* (Crassulaceae) | 66 | 44 | 23 | 85 | 62 |
| *Cyperus lhotskyanus* (Cyperaceae) | 0 | 6 | 0 | 6 | 5 |
| *Deyeuxia quadriseta* (Poaceae) | 0 | 12 | 0 | 0 | 3 |
| *Dichondra repens* (Convolvulaceae) | 0 | 0 | 0 | 3 | 1 |
| *Elatine gratioloides* (Elatinaceae) | 33 | 6 | 15 | 0 | 6 |
| *Eleocharis acuta* (Cyperaceae) | 100 | 100 | 69 | 73 | 78 |
| *Eleocharis atricha* (Cyperaceae) | 0 | 0 | 0 | 9 | 5 |
| *Eleocharis gracilis* (Cyperaceae) | 0 | 0 | 0 | 6 | 3 |
| *Eleocharis pusilla* (Cyperaceae) | 33 | 62 | 31 | 39 | 43 |
| *Eleocharis sphacelata* (Cyperaceae) | 100 | 0 | 0 | 0 | 5 |
| *Epilobium billardierianum* subsp. *cinereum* (Onagraceae) | 33 | 0 | 0 | 3 | 3 |
| **Festuca elatior* (Poaceae) | 0 | 0 | 0 | 3 | 1 |
| *Glossostigma elatinoides* (Scrophulariaceae) | 66 | 87 | 30 | 21 | 41 |
| *Glyceria australis* (Poaceae) | 33 | 0 | 0 | 0 | 1 |
| *Gnaphalium sphaericum* (Asteraceae) | 100 | 31 | 0 | 21 | 23 |
| *Helichrysum scorpioides* (Asteraceae) | 33 | 0 | 0 | 0 | 1 |
| *Hemarthria uncinata* var. *uncinata* (Poaceae) | 33 | 19 | 0 | 9 | 11 |
| **Holcus lanatus* (Poaceae) | 33 | 0 | 8 | 12 | 9 |
| **Hordeum marinum* (Poaceae) | 0 | 12 | 8 | 52 | 31 |
| *Hydrocotyle algida* (Apiaceae) | 0 | 0 | 0 | 3 | 1 |
| *Hydrocotyle peduncularis* (Apiaceae) | 100 | 88 | 8 | 30 | 43 |
| *Hypericum gramineum* (Clusiaceae) | 33 | 0 | 0 | 0 | 1 |
| **Hypochaeris radicata* (Asteraceae) | 0 | 0 | 8 | 3 | 3 |
| Blue green algae | 0 | 0 | 8 | 0 | 1 |
| *Chara* sp. | 66 | 37 | 15 | 67 | 49 |
| Green algae | 0 | 6 | 8 | 39 | 23 |
| *Isolepis fluitans* (Cyperaceae) | 66 | 0 | 8 | 0 | 5 |
| *Isolepis platycarpa* (Cyperaceae) | 33 | 31 | 69 | 27 | 37 |
| *Isolepis subtilissima* (Cyperaceae) | 33 | 0 | 0 | 0 | 1 |
| *Juncus articulatus* (Juncaceae) | 100 | 56 | 8 | 42 | 42 |

| | | | | | |
|---|---|---|---|---|---|
| *Juncus australis* (Juncaceae) | 66 | 50 | 0 | 30 | 31 |
| **Juncus bufonius* (Juncaceae) | 0 | 12 | 15 | 24 | 18 |
| *Juncus holoschoenus* (Juncaceae) | 33 | 19 | 0 | 0 | 6 |
| *Juncus* sp. (Juncaceae) | 66 | 37 | 0 | 12 | 18 |
| *Juncus subsecundus* (Juncaceae) | 66 | 12 | 15 | 18 | 18 |
| *Juncus usitatus* (Juncaceae) | 33 | 19 | 0 | 0 | 6 |
| *Juncus vaginatus* (Juncaceae) | 33 | 25 | 0 | 36 | 26 |
| *Lemna disperma* (Lemnaceae) | 33 | 6 | 0 | 9 | 8 |
| *Lepilaena bilocularis* (Zannichelliaceae) | 0 | 0 | 0 | 64 | 32 |
| *Lilaeopsis polyantha* (Apiaceae) | 66 | 12 | 0 | 6 | 9 |
| *Limosella australis* (Schrophulariaceae) | 33 | 37 | 62 | 88 | 68 |
| *Lythrum hyssopifolia* (Lythraceae) | 33 | 0 | 0 | 0 | 1 |
| *Marsilea angustifolia* (Marsileaceae) | 0 | 50 | 38 | 3 | 22 |
| *Marsilea drummondii* (Marsileaceae) | 33 | 12 | 15 | 6 | 11 |
| *Mentha diemenica* (Lamiaceae) | 0 | 12 | 0 | 3 | 5 |
| *Myriophyllum caput-medusae* (Haloragaceae) | 0 | 37 | 0 | 6 | 12 |
| *Myriophyllum simulans* (Haloragaceae) | 100 | 100 | 8 | 3 | 32 |
| *Myriophyllum verrucosum* (Haloragaceae) | 0 | 6 | 8 | 30 | 18 |
| *Neopaxia australasica* (Portulaceae) | 0 | 31 | 0 | 0 | 8 |
| *Nymphoides montana* (Menyanthaceae) | 66 | 0 | 0 | 0 | 3 |
| *Ottelia ovalifolia* (Hydrocharitaceae) | 0 | 19 | 0 | 0 | 5 |
| *Paspalum distichum* (Poaceae) | 0 | 0 | 8 | 3 | 3 |
| *Persicaria decipiens* (Polygonaceae) | 0 | 0 | 0 | 3 | 1 |
| *Persicaria maculosa* (Polygonaceae) | 0 | 19 | 31 | 6 | 14 |
| *Persicaria prostrata* (Polygonaceae) | 33 | 44 | 54 | 36 | 42 |
| **Phalaris aquatica* (Poaceae) | 0 | 6 | 0 | 0 | 1 |
| **Polypogon monspeliensis* (Poaceae) | 0 | 0 | 0 | 18 | 9 |
| *Potamogeton crispus* (Potamogetonaceae) | 33 | 19 | 8 | 6 | 11 |
| *Potamogeton ochreatus* (Potamogetonaceae) | 66 | 37 | 31 | 36 | 37 |
| *Potamogeton tricarinatus* (Potamogetonaceae) | 100 | 100 | 46 | 15 | 46 |
| **Potentilla anserina* subsp. *anserina* (Rosaceae) | 0 | 6 | 0 | 9 | 6 |
| *Pratia surrepens* (Lobeliaceae) | 100 | 25 | 0 | 0 | 11 |
| *Psoralea tenax* (Fabaceae) | 0 | 0 | 0 | 6 | 3 |
| *Puccinellia stricta* (Poaceae) | 0 | 0 | 31 | 30 | 22 |
| *Ranunculus inundatus* (Ranunculaceae) | 100 | 94 | 15 | 3 | 32 |
| *Ranunculus sceleratus* (Ranunculaceae) | 0 | 6 | 0 | 9 | 6 |
| *Ranunculus diminutus* (Ranunculaceae) | 0 | 37 | 15 | 97 | 62 |
| *Rorippa palustris* (Brassicaceae) | 0 | 0 | 8 | 3 | 3 |
| *Rumex brownii* (Polygonaceae) | 0 | 12 | 0 | 6 | 6 |
| **Rumex crispus* (Polygonaceae) | 33 | 37 | 23 | 52 | 42 |
| *Rumex tenax* (Polygonaceae) | 33 | 6 | 0 | 0 | 3 |
| *Ruppia megacarpa* (Potamogetonaceae) | 0 | 0 | 0 | 3 | 1 |
| *Ruppia polycarpa* (Potamogetonaceae) | 0 | 0 | 0 | 3 | 1 |
| **Salix alba* (Salicaceae) | 33 | 0 | 0 | 3 | 3 |
| *Schoenoplectus pungens* (Cyperaceae) | 0 | 0 | 0 | 24 | 12 |
| *Schoenus apogon* (Cyperaceae) | 33 | 6 | 0 | 12 | 9 |
| *Schoenus nitens* (Cyperaceae) | 0 | 0 | 0 | 3 | 1 |
| *Stellaria angustifolia* (Caryophyllaceae) | 0 | 31 | 8 | 6 | 12 |
| **Trifolium campestre* (Fabaceae) | 0 | 6 | 0 | 0 | 1 |
| **Trifolium dubium* (Fabaceae) | 0 | 0 | 15 | 15 | 11 |
| **Trifolium fragiferum* (Fabaceae) | 0 | 0 | 0 | 3 | 1 |
| **Trifolium glomeratum* (Fabaceae) | 0 | 0 | 15 | 3 | 5 |
| **Trifolium repens* (Fabaceae) | 0 | 19 | 23 | 18 | 19 |
| *Utricularia monanthos* (Lentibulariaceae) | 33 | 0 | 0 | 0 | 1 |
| *Vallisneria gigantea* (Hydrocharitaceae) | 66 | 0 | 0 | 0 | 3 |
| **Veronica anagallis-aquatica* (Scrophulariaceae) | 0 | 25 | 8 | 21 | 18 |
| *Villarsia exaltata* (Menyanthaceae) | 33 | 0 | 0 | 0 | 1 |
| *Viola hederacea* (Violaceae) | 0 | 0 | 8 | 0 | 1 |
| **Vulpia myuros* (Poaceae) | 0 | 0 | 0 | 3 | 1 |
| *Wolffia australiana* (Lemnaceae) | 33 | 6 | 0 | 3 | 5 |


Community 1
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Community 2
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Community 3
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Community 4
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0.7
1.1

## Floristics

A total of 110 species was recorded during the survey, of which 21 (19%) species were exotic (Table 1). Nomenclature follows Harden (1990–93).

The most commonly recorded native species were *Agrostis avenacea* (in 92% of sites), *Eleocharis acuta* (78%), *Limosella australis* (68%), *Crassula helmsii* (62%), *Ranunculus diminutus* (62%), *Carex bichenoviana* (48%), *Potamogeton tricarinatus* (46%), *Amphibromus nervosus* (42%), *Juncus articulatus* (42%) and *Hydrocotyle peduncularis* (43%).

The most common exotic species were *Rumex crispus* (42%), *Hordeum marinum* (31%), *Trifolium repens* (18%) and *Veronica anagallis-aquatica* (18%).

Native species recorded only once during the survey include *Ruppia megacarpa, R. polycarpa, Villarsia exaltata, Lythrum hyssopifolia, Isolepis subtilissima, Alisma plantago-aquatica* and *Australopyrum retrofractum*.

*Cardamine tenuifolia* was recorded for the first time in New South Wales and other native species including *Ruppia polycarpa, Myriophyllum simulans, Marsilea angustifolia* and an undescribed form of *Marsilea drummondii* were recorded for the first time on the Southern Tablelands. The exotic forb *Potentilla anserina* subsp. *anserina* was also recorded for the first time on the Southern Tablelands.

The submerged aquatic *Lepilaena bilocularis* and strandline sedge *Carex bichenoviana*, were found to be more common in the region than previously indicated from herbarium records.

## Wetland plant communities

The structure and species composition of the four wetland communities are described below. Dominant species are commonly recorded species with high cover ratings that may be found in more than one community. Indicator species are plants that are largely confined to one type of community.

### Community 1. Shallow freshwater herb-sedge marsh: *Myriophyllum simulans–Eleocharis sphacelata–Nymphoides montana–Pratia surrepens*

**Structure:** Tall emergent sedge layer over part of the lake. A large proportion of the surface of the lake is covered with floating-attached or emergent waterplants and there is usually a dense mat of forbs covering the strandline. (Figure 4.)

**No. samples:** 3

**Mean lake size:** 5 ± 1.5 ha.

**Mean no. native sp.:** 28 ± 4

**Mean no. exotic sp.:** 2 ± 1

**Dominant species:** *Myriophyllum simulans, Potamogeton tricarinatus, Eleocharis sphacelata, Nymphoides montana, Pratia surrepens, Hydrocotyle peduncularis, Eleocharis acuta, Agrostis avenacea.*

**Indicator species:** *Eleocharis sphacelata, Nymphoides montana, Pratia surrepens, Hydrocotyle peduncularis, Isolepis fluitans, Glyceria australis, Vallisneria gigantea* and *Utricularia monanthos.*

**Substrate and distribution:** Found in lakes on granitic and basalt substrates at lower altitudes (760–830 m) in the Bombala district. This area receives a higher rainfall than the rest of the study area.

**Figure 3 (left). Agglomerative classification of lakes (see Appendix 1 for lake numbers) by their similarity of plant composition selected at the 0.78 disassociation value. This analysis is based on cover ratings for both native and exotic species.**

**Comment:** Community 1 is restricted to small lakes (< 5 ha) in the far south-eastern section of the study area at relatively lower altitudes (a median at 760 m). It contains a high number of native species. Many of the species in Community 1 are also found in Community 2, but, within the study area, several species, such as the floating-attached *Nymphoides montana*, are confined to it.

### Community 2. Shallow freshwater sedge-herb marsh: *Myriophyllum simulans–Potamogeton tricarinatus–Eleocharis acuta–Glossostigma elatinoides–Amphibromus nervosus*

**Structure:** Short sedge layer over-topping a dense forb ground cover on strandline. Extensive emergent and floating-attached waterplants present on the surface of the lakes. (Figure 5.)

**No. samples:** 16

**Mean lake size:** 3 ± 2 ha.

**Mean no. native sp.:** 20 ± 5

**Mean no. exotic sp.:** 1 ± 0.9

**Dominant species:** *Myriophyllum simulans, Potamogeton tricarinatus, Eleocharis acuta, Glossostigma elatinoides, Amphibromus nervosus, Agrostis avenacea, Eleocharis pusilla.*

**Indicator species:** *Myriophyllum caput-medusae, Stellaria angustifolia, Neopaxia australasica, Ottelia ovalifolia, Carex gaudichaudiana.*

**Substrate and distribution:** Found in deflation lakes on basalt south of Cooma with a sub-group (lakes 26, 32, 107, 105, 199, and 200) in deflation lakes on granite near Berridale and Jindabyne. This community occurs at higher altitudes than the others in the study area, ranging from 880 m to 1220 m.

**Comment:** Community 2 is mainly recorded from small to medium, intermittent lakes (median 2 ha) at high altitudes (median 1030 m). These lakes contain a high native species richness with an abundance of the floating-attached waterplant *Potamogeton tricarinatus* and the submerged or emergent *Myriophyllum simulans*. Few exotic species were recorded from this community.

**Figure 4. The flora in Weddenjury Lake south of Bombala is grouped into Community 1 and contains several species not recorded in the other communities, including the floating-attached *Nymphoides montana* in the foreground.**

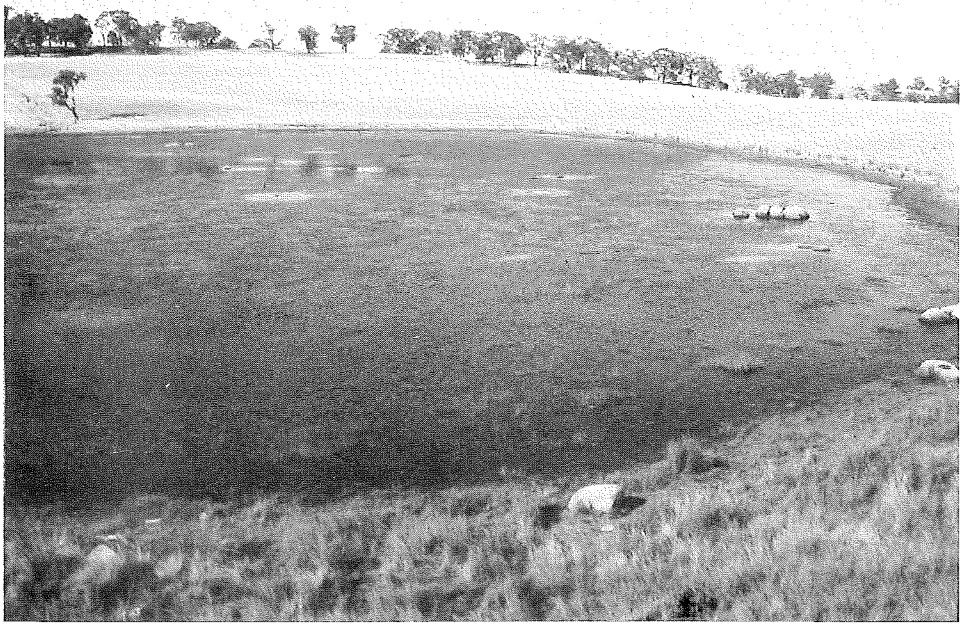

Figure 5. Boundary Lake at Bungarby shown here, and other lakes grouped under plant Community 2, contain abundant emergent, submerged and floating-attached waterplants. They are usually shallow and intermittently dry.

Figure 6. Plant community 3 is often confined to small ephemeral lakes. These contain low numbers of native species, often dominated by *Agrostis avenacea*, and heavily grazed by stock.

**Community 3. Shallow ephemeral freshwater herb-grass marsh: *Agrostis avenacea–Centipeda cunninghamii–Eleocharis acuta–Crassula helmsii–Isolepis platycarpa***

**Structure:** Mid-tall grass layer over sparse ground cover of forbs.

**No. samples:** 13

**Mean lake size:** 5 ± 4 ha

**Mean no. native sp.:** 11 ± 4

**Mean no. exotic sp.:** 1 ± 2

**Dominant species:** *Agrostis avenacea, Centipeda cunninghamii, Eleocharis acuta, Crassula helmsii, Isolepis platycarpa, Limosella australis, Persicaria prostrata.*

**Indicator species:** *Isolepis platycarpa, Centipeda cunninghamii.*

**Substrate and distribution:** Mainly growing on small ephemeral deflation lakes on basalt, ranging in altitude from 740 m to 1080 m. Distributed throughout the study area except for the far western section. (Figure 6.)

**Comment:** Compared to the other communities, lakes grouped under Community 3 contain an impoverished native flora and a high proportion of exotic plants on the strandline, which is often dominated by the native grass *Agrostis avenacea*. They also were recorded from small to medium sized lakes (median 5 ha) and high altitudes (median 990 m).

**Community 4: Deep freshwater sedge-herb marsh: *Carex bichenoviana– Ranunculus diminutus–Lepilaena bilocularis***

**Structure:** Open sedgeland over a low forbland on the strandline. Submerged waterplants more common than emergent plants in the lakes. Floating-attached waterplants absent. (Figure 7.)

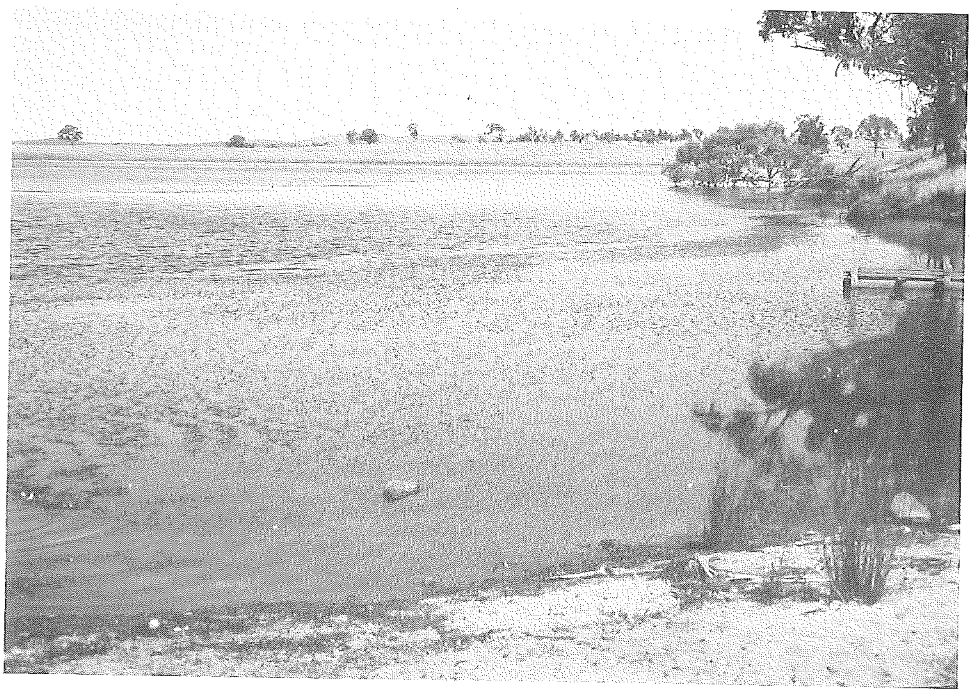

Figure 7. The 36 ha Black Lake is grouped into plant Community 4, which is mainly confined to large perennial lakes, lacks emergent or floating-attached plants, and contains submerged species rare in the other plant communities.

**No. samples:** 33

**Mean lake size:** 28 ± 42 ha

**Mean no. native sp.:** 16 ± 5

**Mean no. exotic sp.:** 2 ± 1

**Dominant species:** *Carex bichenoviana–Crassula helmsii–Limosella australis–Ranunculus diminutus–Lepilaena bilocularis.*

**Indicator species:** *Lepilaena bilocularis, Carex bichenoviana, Schoenoplectus pungens, Myriophyllum verrucosum.*

**Substrate and distribution:** Predominantly in large deflation or palaeo-lava-blocked lakes distributed throughout the study area on both basalt and granite. Altitude range 750 m to 1160 m. The most conspicuous aspect of the flora in the lakes classified under Community 4 is that they lack floating-attached waterplants and the emergent/ submerged *Myriophyllum simulans*, whereas the submerged *Lepilaena bilocularis* is often abundant.

**Comment:** Lakes grouped under Community 4 contain, on average, lower numbers of native species than lakes grouped under Communities 1 and 2 but greater numbers than lakes grouped under Community 3. Most of the lakes grouped under Community 4 are large (> 10 ha, median 16 ha) but there is a large deviation around the mean of 28 ha.

## Environmental determinants

The mean lake size of sites classified into Community 4 are larger than the sites classified under the other three communities. There was, however, no significant correlation at $p < 0.001$ for this conclusion in the GSTA analysis, although a large deviation was derived for lake sizes in Community 4 compared to the other communities. A few small lakes were classified into Community 4 and apparently this limited the degree of significance of the correlation.

The GSTA analysis also found no significant correlation between the distribution of the four communities to either geology or altitude. As mentioned above, several species are restricted to Community 1 at lower altitudes but this fact was not enough to cause the GSTA analysis to significantly correlate Community 1 to a vector that may reflect altitude.

## Discussion

The distributions of wetland plants in the lakes on the Monaro are sufficiently varied to allow for the delimitation of four plant communities. These communities, however, share many widely distributed, commonly occurring species, for example *Eleocharis acuta* and *Glossostigma elatinoides*. Such species indicate that the sites shared sufficient characteristics to justify being analysed together. The whole study area was within the geographic distribution of most of the wetland species recorded. There were a number of species with very restricted distributions in the study area (although they are commonly found elsewhere), for example *Ruppia megacarpa, R. polycarpa* and *Villarsia exaltata*. The presence of such species indicated that there could be some benefit from widening the study area in further studies so that wider geographical comparisons of wetland communities can be made.

The data suggest that Community 4 is most distinct from the other communities and there is a trend for this community to be confined to large lakes whereas small lakes could fall into any of the communities.

The distribution of communities 1, 2 and 4 on the Monaro does not appear to be influenced by substrate, since these communities are present in lakes on all the three geological types found in the study area. Higher temperatures and higher rainfall may explain why Community 1 is restricted to the south-eastern edge of the study area. This community shows some similarity in its floristic composition to the wetlands on basalt in the Guyra District of the Northern Tablelands of NSW. Species such as *Nymphoides montana*, *Glyceria australis* and *Eleocharis sphacelata* grow on the Northern Tablelands (Harden 1990, 1993) and elsewhere but are restricted to Community 1 on the Monaro.

Community 2, which is mainly composed of lakes with high numbers of native species, seems to be composed of small to medium-sized lakes that are shallow but not ephemeral. We expect that these lakes would dry out regularly but would probably fill each winter and stay full for much of the year. In contrast, most of the lakes classified under Community 3 appear to be very shallow and ephemeral. They are probably dry for most of the year and are often dominated by the grass *Agrostis avenacea*. Perhaps many of the plants recorded in the lakes classified under Community 2 cannot survive the drier conditions of the lakes classified under Community 3.

There is a correlation between lake size (and probably depth) and the presence or absence of certain floating-attached and emergent species. The large lakes in Community 4 may lack floating-attached waterplants because they contain stretches of water that are of sufficent length to allow large waves to develop. This wave action may damage plants at the surface and could lead to increased turbidity that would inhibit plant establishment in all but the shallowest sections of a lake. These shallower sections are quickly expanded as water levels drop and are subject to the most extreme wave action. The smaller lakes tend to be shallower than the large lakes and may be less turbid if wave action is minor, therefore a large proportion of the lake-bottom would receive sufficient light for plant growth — encouraging the growth of a greater number of floating-attached and emergent waterplants. *Lepilaena* and other submerged species may survive wave action in these large lakes because they have submerged pollination mechanisms — they can complete their life cycles under water.

Salinity levels in the lakes probably vary over time and between the lakes, though there are few data. As well as possible long-term cycles in salinity levels there may be short-term fluctuations associated with filling and evaporation. Based on our floristic data it appears that some lakes contain a greater proportion of salt-tolerant species than others. The more permanent lakes (which most often are the largest lakes) contain a higher number of salt tolerant species. The larger lakes in Community 4 do not dry out as often as the smaller lakes that were generally grouped under the other communities, therefore salt may accumulate. For example, the 20 ha Kiah Lake, which is situated north of Berridale, has dried out only four times in the last 60 years (J. Allen pers. comm.). Species such as *Lepilaena bilocularis*, *Myriophyllum verrucosum* and *Carex bichenoviana* may have higher salt tolerance than other species and this could explain their abundance in Community 4 and their rarity in the other communities.

The shape of lakes may also be a factor determining the presence of species. Lakes with gradual slopes and extensive areas of shallows may contain more habitat suitable for the survival of emergent species than those that are steep-sided. Even within the same plant community, variation occurs. Avon Lake (lake 56) and Maffra Lake (lake 35) are grouped into Community 4 on the basis of their shared floristics, yet Avon Lake lacks emergent species and Maffra Lake contains emergent species such as *Schoenoplectus pungens*.

Further research could test some of the hypotheses discussed above about the causes of species distribution in the Monaro lakes (salinity, wave action, lake shape). For example, it may be worth investigating the relationship between salinity, lake size and floristic composition. However, salinity readings that do not record fluctuation within years and between years will not be meaningful.

## Conservation, threats and management

At present no wetland on the Monaro is protected either in a conservation reserve or under a conservation management agreement. Most of the wetlands are on private land but some are in travelling stock reserves or are dedicated as water reserves. Some lakes have been cropped or drained. The largest lake on the Monaro, Beards Lake (lake 53), has been drained and is now dry (Figure 8). Most lakes are grazed when water levels are low and pugging of the edges of the lakes by stock may damage the plants.

Although we have no documentation on the pre-European composition of the lakes, many contain a high number of species. This indicates that management of some properties (or sections of them) is compatible with maintaining a range of wetland plant species. Lightly grazed properties, such as 'Quartz Hill' south of Cooma, contain several wetlands grouped under Community 2 that were recorded as being untrampled and rich in species. 'Quartz Hill' relies on native rather than improved pastures and uses less fertilizer than many other properties. We suggest that preventing over-stocking in lake catchments is a key way of limiting the flow of sediments and nutrients into the lakes.

As the majority of lakes are on private land a program aimed at educating landholders about their flora and fauna may be an effective means of ensuring that at least some wetlands are managed sympathetically. Conservation agreements between landholders and a suitable government agency would be a more secure way of protecting a select range of lakes. Such agreements should deal with matters such as limiting cropping on the lake beds, controlling stock access to lakes during periods when the lakes are vulnerable to trampling, and policing illegal game shooting.

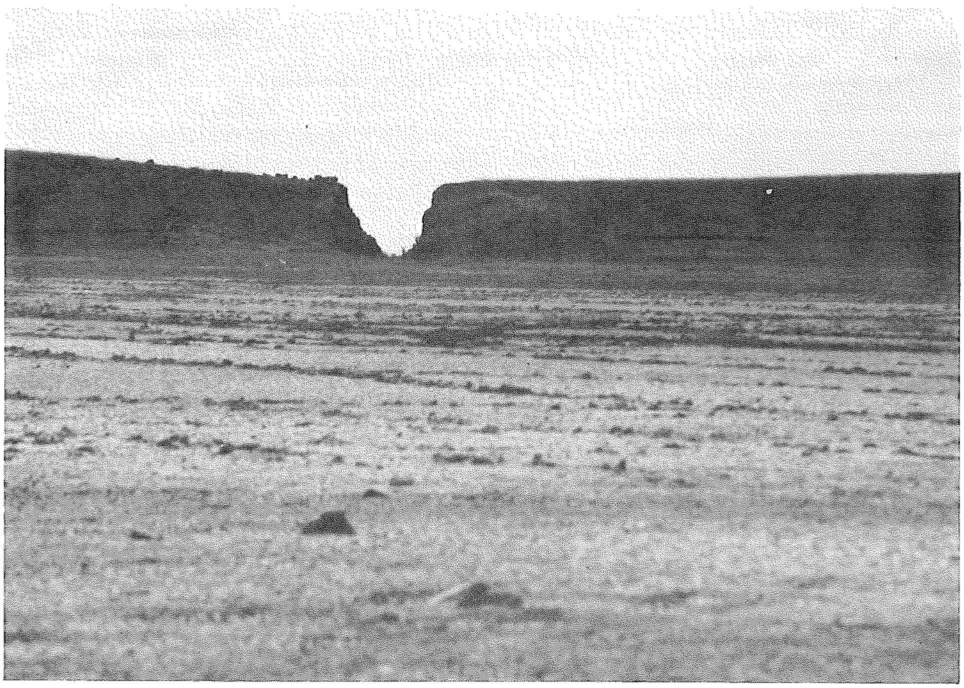

**Figure 8. A cut channel through a hill on the western side of Beards Lake has drained the largest lake on the Monaro.**

As we did not survey every lake in the study area, selection of lakes for conservation may not have covered all lakes of significance. Based on our data, a number of lakes worthy of protection are listed below. These lakes have been selected because they have a high species richness, contain significant species, are representative of a plant community, or contain few weeds and are not heavily trampled by stock.

- Lake 4: Weddenjury Lake (Figure 4), south of Bombala contains 29 species of native waterplants including several species restricted to this section of the study area (Community 1).
- Lake 149: This lake adjacent to the Cooma–Dalgety Road contains 30 native plant species and lacks signs of trampling at its edge (Community 2).
- Lake 105: Eucumbene Road north east of Jindabyne. 24 native species including *Ottelia ovalifolia*. Lightly grazed (Community 2).
- Lake 35 Maffra Lake: The greater portion of this lake is in a fenced-off travelling stock reserve. This area therefore provides an opportunity for a nature reserve to be dedicated with no cost for land acquisition. This lake contains large stands of the tall sedge *Bolboschoenus caldwellii* which was rarely recorded during the survey (Community 4).
- Lake 30: 'Snowleigh' near Bungarby. This lake appeared to be undisturbed by stock and had a relative species-rich flora (Community 4).
- Lake 46: 'Peters Park'. This lake was not pugged by stock and contained a high number of species (28 species) (Community 4).
- Lake 92: Carrolls Lake. This lake was fenced-off from stock and contained a large number of waterbirds (Community 4).

A number of other lakes in Community 2 could be considered for protection as they were recorded as being in a sound condition. All of the lakes in Community 3 contain few species and were heavily pugged by stock. Therefore none are recommended for conservation.

Surveys of other lakes in the study area may lead to further proposals for conservation, although the bulk of the unsampled lakes are small, ephemeral, and heavily disturbed and it is unlikely that these would contain features worthy of protection.

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**Appendix 1. Name, location, size, permanence, altitude, substrate and plant communities of the Monaro lakes, New South Wales**

LP = lake permanence (p = permanent (rarely dry), I = intermittent (seasonally dry), E = ephemeral (occasionally full) assigned to each lake sampled

Sub. = substrate (Tb = Tertiary basalt, G = granitic rocks, S = sedimentary and meta-sedimentary rocks)

NA = not assessed; * = lake sampled

| Lake no. | Lake name | Map sheet | Grid reference | Size (ha) | LP | Alt. (m) | Sub. | Plant comm. |
|---|---|---|---|---|---|---|---|---|
| 1 | | Craigie 100 000 | 698500 5898800 | 2 | NA | 760 | G | NA |
| 2 | | Craigie 100 000 | 700500 5899200 | 2 | NA | 760 | G | NA |
| 3* | Green Lake | Craigie 100 000 | 701100 5899800 | 3 | I | 760 | G | 1 |
| 4* | Weddenjerry Lake | Craigie 100 000 | 700600 5900600 | 5 | I | 760 | G | 1 |
| 5* | | Coolumbooka 25 000 | 705200 5915100 | 6 | I | 830 | Tb | 1 |
| 6 | High Lake | Coolumbooka 25 000 | 702000 5916000 | 3 | NA | 850 | Tb | NA |
| 7* | | Bukalong 25 000 | 689300 5921400 | 2 | E | 740 | Tb | 3 |
| 8 | | Bukalong 25 000 | 689400 5921600 | 1 | NA | 750 | Tb | NA |
| 9 | | Bukalong 25 000 | 690600 5921300 | 1 | NA | 750 | Tb | NA |
| 10 | | Bukalong 25 000 | 692400 5922700 | 2 | NA | 860 | Tb | NA |
| 11 | | Bukalong 25 000 | 690500 5924200 | 2.5 | NA | 870 | Tb | NA |
| 12 | | Bukalong 25 000 | 691200 5924200 | 3 | NA | 860 | Tb | NA |
| 13 | | Bukalong 25 000 | 692100 5924800 | 5.5 | NA | 880 | Tb | NA |
| 14 | | Bukalong 25 000 | 693000 5926100 | 3 | NA | 830 | Tb | NA |
| 15 | | Bukalong 25 000 | 699400 5925500 | 3 | NA | 870 | Tb | NA |
| 16 | | Bukalong 25 000 | 699200 5925700 | 2 | NA | 870 | Tb | NA |
| 17 | | Bukalong 25 000 | 691000 5928700 | 2 | NA | 760 | Tb | NA |
| 18 | | Bukalong 25 000 | 695700 5929800 | 1 | NA | 850 | Tb | NA |
| 19 | | Bukalong 25 000 | 696000 5930200 | 6.5 | NA | 850 | Tb | NA |
| 20 | | Bukalong 25 000 | 700400 5929600 | 2 | NA | 920 | Tb | NA |
| 21* | | Bukalong 25 000 | 700700 5930000 | 4 | NA | 890 | Tb | 2 |
| 22 | Green Lake | Cathcart 25 000 | 705500 5919500 | 11 | NA | 820 | Tb | NA |
| 23* | Black Lake | Cathcart 25 000 | 706100 5919900 | 36 | P | 820 | Tb | 4 |

**Appendix 1. (cont.)**

| Lake no. | Lake name | Map sheet | Grid reference | Size (ha) | LP | Alt. (m) | Sub. | Plant comm. |
|---|---|---|---|---|---|---|---|---|
| 24 | | Cathcart 25 000 | 701500 5923900 | 4 | NA | 820 | S | NA |
| 25* | | Cathcart 25 000 | 701300 5930100 | 3 | I | 880 | Tb | 4 |
| 26* | | Thredbo 50 000 | 632700 5940100 | 1 | I | 1170 | G | 2 |
| 27 | | Numbla Vale 50 000 | 666600 5938000 | 5 | NA | 800 | G | NA |
| 28 | | Numbla Vale 50 000 | 677800 5937900 | 4 | NA | 920 | Tb | NA |
| 29 | | Numbla Vale 50 000 | 677500 5938200 | 5 | NA | 920 | Tb | NA |
| 30* | | Numbla Vale 50 000 | 677800 5938700 | 16 | P | 920 | Tb/G | 4 |
| 31 | | Numbla Vale 50 000 | 678600 5938500 | 7 | NA | 940 | Tb | NA |
| 32* | | Numbla Vale 50 000 | 634300 5944500 | 1 | I | 1040 | G | 2 |
| 33* | Lake Jillamatong | Numbla Vale 50 000 | 642000 5956500 | 37 | P | 1100 | G | 4 |
| 34 | | Numbla Vale 50 000 | 678700 5953300 | 9 | NA | 880 | Tb | NA |
| 35* | Maffra Lake | Numbla Vale 50 000 | 678000 5953500 | 23 | P | 890 | Tb/G | 4 |
| 36 | | Numbla Vale 50 000 | 678500 5954800 | 4 | NA | 880 | Tb | NA |
| 37 | | Numbla Vale 50 000 | 678900 5954600 | 6 | NA | 880 | Tb | NA |
| 38 | Burns Lakes | Wangellic 25 000 | 692800 5938100 | 5 | NA | 930 | Tb | NA |
| 39 | Burns Lakes | Wangellic 25 000 | 693800 5938200 | 2 | NA | 930 | Tb | NA |
| 40* | Burns Lakes | Wangellic 25 000 | 693500 5938900 | 26 | P | 920 | Tb | 4 |
| 41 | Barkers Lake | Wangellic 25 000 | 679700 5935500 | 3 | NA | 890 | Tb | NA |
| 42 | | Wangellic 25 000 | 679200 5937600 | 4 | NA | 930 | Tb | NA |
| 43* | Island Lake | Wangellic 25 000 | 679200 5938700 | 15 | I | 960 | Tb | 4 |
| 44 | | Wangellic 25 000 | 679200 5939600 | 3.5 | NA | 940 | Tb | NA |
| 45 | | Wangellic 25 000 | 679000 5940100 | 5 | NA | 950 | Tb | NA |
| 46* | | Wangellic 25 000 | 680400 5939900 | 20 | P | 930 | Tb | 4 |
| 47* | | Wangellic 25 000 | 681900 5940400 | 11 | I | 940 | Tb | 4 |
| 48* | Boundary Line | Wangellic 25 000 | 679600 5941100 | 4 | I | 960 | Tb/G | 2 |

**Appendix 1. (cont.)**

| Lake no. | Lake name | Map sheet | Grid reference | Size (ha) | LP | Alt. (m) | Sub. | Plant comm. |
|---|---|---|---|---|---|---|---|---|
| 49 | | Wangellic 25 000 | 681900 5941100 | 2 | NA | 970 | Tb | NA |
| 50* | | Wangellic 25 000 | 683300 5941200 | 14 | I | 960 | Tb | 3 |
| 51 | | Wangellic 25 000 | 682300 5941700 | 3 | NA | 960 | Tb | NA |
| 52 | Washpool Lake | Wangellic 25 000 | 680900 5941700 | 5 | NA | 950 | Tb | NA |
| 53* | Beards Lake | Wangellic 25 000 | 681700 5943000 | 215 | E | 950 | Tb | 4 |
| 54 | | Wangellic 25 000 | 684100 5943500 | 4 | NA | 960 | Tb | NA |
| 55* | | Glen Allen 25 000 | 702700 5933100 | 5 | I | 920 | Tb | 3 |
| 56* | Avon Lake | Teapot & Wangellic 25 000 | 683100 5945300 | 117 | P | 950 | Tb | 4 |
| 57 | | Teapot 25 000 | 684100 5945600 | 3 | NA | 930 | Tb | NA |
| 58 | Dukes Lake | Teapot 25 000 | 684300 5947000 | 24 | NA | 960 | Tb | NA |
| 59 | | Teapot 25 000 | 686200 5947100 | 6 | NA | 1000 | Tb | NA |
| 60 | | Teapot 25 000 | 684600 5948600 | 21 | NA | 970 | Tb | NA |
| 61 | | Teapot 25 000 | 684000 5948800 | 2 | NA | 970 | Tb | NA |
| 62* | | Teapot 25 000 | 686600 5949400 | 2 | I | 990 | Tb | 2 |
| 63 | | Teapot 25 000 | 683900 5950500 | 4 | NA | 950 | Tb | NA |
| 64* | | Teapot 25 000 | 683500 5952900 | 6 | I | 920 | Tb | 4 |
| 65 | | Teapot 25 000 | 685800 5951700 | 12 | NA | 930 | Tb | NA |
| 66 | | Teapot 25 000 | 687600 5951600 | 4 | NA | 960 | Tb | NA |
| 67 | | Teapot 25 000 | 687900 5951900 | 3 | NA | 970 | Tb | NA |
| 68* | Boundary Lake | Teapot 25 000 | 689600 5954000 | 8 | I | 990 | Tb | 4 |
| 69* | Coopers Lake | Teapot 25 000 | 691400 5954700 | 19 | P | 980 | Tb | 4 |
| 70* | | Teapot 25 000 | 694900 5956600 | 1 | I | 1000 | Tb | 4 |
| 71 | | Teapot 25 000 | 700000 5956000 | 1 | NA | 1090 | Tb | NA |
| 72 | | Teapot 25 000 | 699800 5956200 | 2 | NA | 1100 | Tb | NA |
| 73 | | Teapot 25 000 | 700300 5956400 | 1 | NA | 1100 | Tb | NA |

**Appendix 1. (cont.)**

| Lake no. | Lake name | Map sheet | Grid reference | Size (ha) | LP | Alt. (m) | Sub. | Plant comm. |
|---|---|---|---|---|---|---|---|---|
| 74 | | Nimmitabel 25 000 | 702900 5948500 | 2 | NA | 1020 | Tb | NA |
| 75 | | Nimmitabel 25 000 | 702500 5951600 | 1 | NA | 1080 | Tb | NA |
| 76* | Buckleys Lake | Berridale 50 000 | 674400 5963900 | 40 | P | 980 | Tb/G | 4 |
| 77* | | Berridale 50 000 | 675800 5963800 | 2 | E | 960 | Tb | 3 |
| 78 | | Berridale 50 000 | 675600 795964900 | 1 | NA | 940 | Tb | NA |
| 79N | | Berridale 50 000 | 677000 5966900 | 1 | NA | 900 | Tb | NA |
| 79S | | Berridale 50 000 | 677000 5966800 | 1 | NA | 900 | Tb | NA |
| 80 | | Berridale 50 000 | 676600 5966900 | 1.5 | NA | 900 | Tb | NA |
| 81 | | Berridale 50 000 | 676400 5967100 | 1 | NA | 900 | Tb | NA |
| 82 | | Berridale 50 000 | 676000 5967800 | 3 | NA | 900 | Tb | NA |
| 83 | | Berridale 50 000 | 676400 5967700 | 1.5 | NA | 900 | Tb | NA |
| 84 | | Berridale 50 000 | 676700 5967700 | 2 | NA | 900 | Tb | NA |
| 85 | | Berridale 50 000 | 677200 5967900 | 3 | NA | 900 | Tb | NA |
| 86 | | Berridale 50 000 | 676400 5968100 | 2 | NA | 920 | Tb | NA |
| 87 | | Berridale 50 000 | 676200 5968400 | 1 | NA | 940 | Tb | NA |
| 88 | | Berridale 50 000 | 677800 5968700 | 3 | NA | 920 | Tb | NA |
| 89 | | Berridale 50 000 | 671000 5970500 | 1 | NA | 820 | Tb | NA |
| 90* | Coolamatong Lake | Berridale 50 000 | 660100 5972600 | 41 | P | 900 | S | 4 |
| 91 | | Berridale 50 000 | 670300 5973300 | 1 | NA | 840 | Tb | NA |
| 92* | Carrolls Lake | Berridale 50 000 | 670600 5974000 | 5 | I | 840 | Tb/G | 4 |
| 93* | Salt Lake | Berridale 50 000 | 675200 5973700 | 10 | P | 900 | Tb/G | 4 |
| 94 | | Berridale 50 000 | 675900 5974000 | 1 | NA | 900 | Tb | NA |
| 95 | | Berridale 50 000 | 669500 5975000 | 1 | NA | 860 | Tb | NA |
| 96 | | Berridale 50 000 | 669500 5975200 | 1 | NA | 860 | Tb | NA |
| 97 | | Berridale 50 000 | 670500 5975600 | 1 | NA | 860 | Tb/G | NA |

**Appendix 1. (cont.)**

| Lake no. | Lake name | Map sheet | Grid reference | Size (ha) | LP | Alt. (m) | Sub. | Plant comm. |
|---|---|---|---|---|---|---|---|---|
| 98 | | Berridale 50 000 | 674100 5975100 | 1 | NA | 900 | Tb/G | NA |
| 99 | | Berridale 50 000 | 674400 5975000 | 1 | NA | 900 | Tb | NA |
| 100 | | Berridale 50 000 | 675100 5974800 | 1 | NA | 900 | Tb | NA |
| 101 | | Berridale 50 000 | 675700 5974500 | 1 | NA | 900 | Tb | NA |
| 102* | Kiah | Berridale 50 000 | 660300 5977900 | 20 | P | 900 | S | 4 |
| 103 | | Berridale 50 000 | 670100 5977500 | 4 | NA | 860 | G | NA |
| 104* | Lake Bullen-balong | Berridale 50 000 | 651700 5979500 | 19 | P | 1140 | G | 4 |
| 105* | | Berridale 50 000 | 649800 5980700 | 3 | I | 1160 | G | 2 |
| 106* | Hugundara Lagoon | Berridale 50 000 | 660900 5983200 | 6 | I | 980 | G | 4 |
| 107* | | Berridale 50 000 | 661100 5985400 | 1 | I | 1080 | G | 2 |
| 108 | Wishing Lake | Berridale | 670100 5982700 | 2 | NA | 1040 | Tb | NA |
| 109 | | Berridale 50 000 | 670500 5982900 | 1 | NA | 1060 | Tb | NA |
| 110* | | Berridale 50 000 | 670500 5983400 | 2 | I | 1060 | Tb | 2 |
| 111 | | Berridale 50 000 | 668500 5984100 | 3 | NA | 1060 | Tb | NA |
| 112* | Cootralantra Lake | Berridale 50 000 | 669700 5985100 | 95 | P | 1040 | TB/G | 4 |
| 113 | | Berridale 50 000 | 672800 5982900 | 1 | NA | 1040 | Tb | NA |
| 114 | | Berridale 50 000 | 673600 5982800 | 1 | NA | 1020 | Tb | NA |
| 115* | | Berridale 50 000 | 673000 5983300 | 1 | I | 1040 | Tb | 2 |
| 116* | Killmacoola Lagoon | Berridale 50 000 | 673000 5983800 | 24 | P | 1000 | G | 4 |
| 117 | | Berridale 50 000 | 675100 5983800 | 2 | NA | 1000 | Tb | NA |
| 118 | | Berridale 50 000 | 672300 5984100 | 1 | NA | 1040 | Tb | NA |
| 119N | | Berridale 50 000 | 672100 5984600 | 0.5 | NA | 1040 | Tb | NA |
| 119S | | Berridale 50 000 | 672200 5984400 | 1 | NA | 1040 | Tb | NA |
| 120 | | Berridale 50 000 | 672200 5985100 | 2 | NA | 1040 | Tb | NA |

**Appendix 1. (cont.)**

| Lake no. | Lake name | Map sheet | Grid reference | Size (ha) | LP | Alt. (m) | Sub. | Plant comm. |
|---|---|---|---|---|---|---|---|---|
| 121 | | Berridale 50 000 | 673200 5985200 | 11 | NA | 1040 | Tb | NA |
| 122 | | Berridale 50 000 | 674300 5985200 | 2 | NA | 1040 | Tb | NA |
| 123 | | Berridale 50 000 | 674700 5985500 | 3 | NA | 1040 | S | NA |
| 124 | | Berridale 50 000 | 674900 5985800 | 3 | NA | 1040 | S | NA |
| 125 | | Myalla 25 000 | 694900 5961800 | 2 | NA | 1080 | Tb | NA |
| 126 | | Myalla 25 000 | 681800 5963800 | 3 | NA | 990 | Tb | NA |
| 127 | | Myalla 25 000 | 688800 5963900 | 0.5 | NA | 1040 | Tb | NA |
| 128 | | Myalla 25 000 | 689100 5964300 | 4.5 | NA | 1030 | Tb | NA |
| 129 | | Myalla 25 000 | 698700 5963300 | 3 | NA | 1090 | Tb | NA |
| 130* | | Myalla 25 000 | 700600 5964100 | 6 | I | 1050 | Tb | 4 |
| 131 | | Myalla 25 000 | 695300 596500 | 1 | NA | 1100 | Tb | NA |
| 132 | | Myalla 25 000 | 697200 5965300 | 1 | NA | 1020 | Tb | NA |
| 133 | | Myalla 25 000 | 700000 5964900 | 1.5 | NA | 1060 | Tb | NA |
| 134 | | Myalla 25 000 | 686200 5967300 | 1.5 | NA | 1080 | Tb | NA |
| 135 | | Myalla 25 000 | 686900 5966900 | 2 | NA | 1080 | Tb | NA |
| 136 | | Myalla 25 000 | 687400 5966800 | 4 | NA | 1080 | Tb | NA |
| 137 | | Myalla 25 000 | 687000 5967300 | 4 | NA | 1080 | Tb | NA |
| 138 | | Myalla 25 000 | 688800 5967800 | 1 | NA | 1110 | Tb | NA |
| 139 | | Myalla 25 000 | 690100 5968200 | 2 | NA | 1100 | Tb | NA |
| 140* | | Myalla 25 000 | 697100 5966900 | 9 | E | 1000 | Tb | 3 |
| 141* | | Myalla 25 000 | 698100 5966500 | 6 | I | 1020 | Tb | 2 |
| 142 | | Myalla 25 000 | 698300 5966700 | 3 | NA | 1000 | Tb | NA |
| 143 | | Myalla 25 000 | 700700 5966100 | 2.5 | NA | 1020 | Tb | NA |
| 144 | | Myalla 25 000 | 683200 5969300 | 1.5 | NA | 1040 | Tb | NA |

**Appendix 1. (cont.)**

| Lake no. | Lake name | Map sheet | Grid reference | Size (ha) | LP | Alt. (m) | Sub. | Plant comm. |
|---|---|---|---|---|---|---|---|---|
| 145 | | Myalla 25 000 | 681600 5970100 | 2 | NA | 1030 | Tb | NA |
| 146 | | Myalla 25 000 | 683300 5970100 | 3 | NA | 1040 | Tb | NA |
| 147 | | Myalla 25 000 | 684600 5970200 | 12 | NA | 1020 | Tb | NA |
| 148 | | Myalla 25 000 | 686700 5970100 | 7 | NA | 1040 | Tb | NA |
| 149* | | Myalla 25 000 | 683500 5970500 | 7 | I | 1020 | Tb | 2 |
| 150 | | Myalla 25 000 | 684500 5970600 | 16 | NA | 1020 | Tb | NA |
| 151 | | Myalla 25 000 | 691300 5969900 | 2 | NA | 1090 | Tb | NA |
| 152 | | Myalla 25 000 | 700100 5968400 | 6 | NA | 1000 | Tb | NA |
| 153 | | Myalla 25 000 | 700900 5968500 | 1 | NA | 990 | Tb | NA |
| 154* | | Myalla 25 000 | 700700 5969200 | 8 | E | 1000 | Tb | 3 |
| 155* | | Myalla 25 000 | 683400 5971400 | 2 | I | 1020 | Tb | 2 |
| 156 | | Myalla 25 000 | 686100 5971400 | 16 | NA | 1020 | Tb | NA |
| 157 | | Myalla 25 000 | 687500 5971300 | 2 | NA | 1050 | Tb | NA |
| 158 | | Myalla 25 000 | 701000 5970900 | 4.5 | NA | 1000 | Tb | NA |
| 159 | | Myalla 25 000 | 701700 5970800 | 2 | NA | 980 | Tb | NA |
| 160 | | Myalla 25 000 | 701400 5971700 | 3 | NA | 990 | Tb | NA |
| 161 | | Myalla 25 000 | 682700 5972300 | 4.5 | NA | 1010 | Tb | NA |
| 162* | Racecourse Lake | Kydra 25 000 | 703300 5958400 | 6 | I | 1090 | Tb | 2 |
| 163 | | Kydra 25 000 | 701900 5959500 | 1 | NA | 1090 | Tb | NA |
| 164 | | Jillimatong 25 000 | 681600 5972500 | 2 | NA | 1020 | S | NA |
| 165 | | Jillimatong 25 000 | 683300 5972700 | 7 | NA | 1010 | Tb | NA |
| 166* | | Jillimatong 25 000 | 683900 5972700 | 6 | I | 1000 | Tb | 3 |
| 167* | | Jillimatong 25 000 | 683500 5973400 | 1.5 | I | 1020 | Tb | 2 |
| 168 | | Jillimatong 25 000 | 694100 5974300 | 3 | NA | 990 | Tb | NA |

**Appendix 1. (cont.)**

| Lake no. | Lake name | Map sheet | Grid reference | Size (ha) | LP | Alt. (m) | Sub. | Plant comm. |
|---|---|---|---|---|---|---|---|---|
| 169 | | Jillimatong 25 000 | 684600 5974700 | 2 | NA | 960 | Tb | NA |
| 170 | | Jillimatong 25 000 | 684300 5974900 | 13 | NA | 960 | Tb | NA |
| 171* | Green Lake | Jillimatong 25 000 | 680400 5975400 | 3 | I | 990 | Tb | 3 |
| 172* | Arable Lake | Jillimatong 25 000 | 682100 5975600 | 16 | P | 980 | Tb | 4 |
| 173* | | Jillimatong 25 000 | 684200 5976300 | 5 | I | 900 | Tb | 3 |
| 174 | | Jillimatong 25 000 | 684500 5976800 | 6 | NA | 950 | Tb | NA |
| 175 | | Jillimatong 25 000 | 685000 5977000 | 2 | NA | 940 | Tb | NA |
| 176 | | Jillimatong 25 000 | 687700 5976700 | 2 | NA | 980 | Tb | NA |
| 177 | | Jillimatong 25 000 | 687600 5976900 | 2 | NA | 980 | Tb | NA |
| 178* | | Jillimatong 25 000 | 681400 5977400 | 4 | I | 1080 | Tb | 3 |
| 179 | | Jillimatong 25 000 | 689100 5977700 | 2 | NA | 930 | Tb | NA |
| 180 | | Jillimatong 25 000 | 696800 5977700 | 1.5 | NA | 930 | Tb | NA |
| 181 | Tinkers Lake | Jillimatong 25 000 | 680600 5978300 | 0.5 | NA | 1000 | Tb | NA |
| 182 | | Jillimatong 25 000 | 683300 5977900 | 1.5 | NA | 920 | Tb | NA |
| 183 | | Jillimatong 25 000 | 682700 5978500 | 1.5 | NA | 950 | Tb | NA |
| 184 | | Jillimatong 25 000 | 686700 5978400 | 4 | NA | 920 | Tb | NA |
| 185 | | Jillimatong 25 000 | 687600 5978600 | 1.5 | NA | 920 | Tb | NA |
| 186 | | Jillimatong 25 000 | 687500 5978900 | 12 | NA | 920 | Tb | NA |
| 187 | | Jillimatong 25 000 | 686600 5979500 | 3 | NA | 920 | Tb | NA |
| 188 | | Jillimatong 25 000 | 690500 5979600 | 1 | NA | 920 | G | NA |
| 189 | | Jillimatong 25 000 | 684100 5979900 | 6 | NA | 930 | Tb | NA |
| 190* | | Jillimatong 25 000 | 684700 5980100 | 4 | I | 940 | Tb | 4 |
| 191 | | Jillimatong 25 000 | 683800 5980600 | 2 | NA | 950 | Tb | NA |
| 192* | | Jillimatong 25 000 | 684400 5980500 | 15 | P | 940 | Tb | 4 |

**Appendix 1. (cont.)**

| Lake no. | Lake name | Map sheet | Grid reference | Size (ha) | LP | Alt. (m) | Sub. | Plant comm. |
|---|---|---|---|---|---|---|---|---|
| 193 | | Jillimatong 25 000 | 694400 5981300 | 4 | NA | 920 | Tb | NA |
| 194* | Thurbergal Lake | Jillimatong 25 000 | 701000 5982400 | 7 | I | 870 | Tb | 4 |
| 195* | | Jillimatong 25 000 | 681600 5983100 | 1 | E | 900 | Tb | 3 |
| 196 | | Jillimatong 25 000 | 682500 5983600 | 1 | NA | 920 | Tb | NA |
| 197 | | Jillimatong 25 000 | 694700 5983400 | 2 | NA | 880 | Tb | NA |
| 198 | | Jillimatong 25 000 | 682200 5985200 | 2 | NA | 910 | Tb | NA |
| 199* | | Eucumbene 50 000 | 666900 5988600 | 1 | I | 1220 | G | 2 |
| 200* | | Eucumbene 50 000 | 671900 5988200 | 4 | P | 1000 | Tb | 2 |
| 201 | | Eucumbene 50 000 | 672800 5988400 | 4 | NA | 1000 | Tb | NA |
| 202 | | Eucumbene 50 000 | 676800 5991100 | 7 | NA | 910 | Tb | NA |
| 203 | | Eucumbene 50 000 | 676200 5993300 | 4 | NA | 980 | Tb | NA |
| 204 | | Eucumbene 50 000 | 675500 6003300 | 2 | NA | 1200 | Tb | NA |
| 205 | | Eucumbene 50 000 | 670700 6004200 | 1 | NA | 1140 | Tb | NA |
| 206 | Long Lake | Eucumbene 50 000 | 67130 6004600 | 15 | NA | 1140 | Tb | NA |
| 207* | Rocky Lake | Eucumbene 50 000 | 674800 6004400 | 6 | I | 1160 | Tb | 4 |
| 208* | O'Neills Lagoon | Eucumbene 50 000 | 672800 6005400 | 18 | P | 1120 | Tb | 4 |
| 209 | | Cooma 25 000 | 694300 5987800 | 3 | NA | 850 | Tb | NA |
| 210* | Muddah Lake | Murrumbucca 25 000 | 684000 6002100 | 18 | P | 1000 | Tb | 4 |
| 211 | | Murrumbucca 25 000 | 686200 6002200 | 1.5 | NA | 1000 | Tb | NA |
| 212* | | Murrumbucca 25 000 | 685800 6002500 | 2 | E | 1000 | Tb | 3 |
| 213* | | Murrumbucca 25 000 | 684400 6003400 | 5 | E | 1010 | Tb | 3 |
| 214 | | Murrumbucca 25 000 | 686000 6003700 | 1.5 | NA | 1010 | Tb | NA |
| 215* | Bullanamang Lake | Murrumbucca 25 000 | 690400 6013500 | 4 | I | 750 | G | 4 |