else a 50 m esplanade with a restriction on any deleterious activities over the remainder of the fringing vegetation. If peat substrates are present our recommendations will increase accordingly.

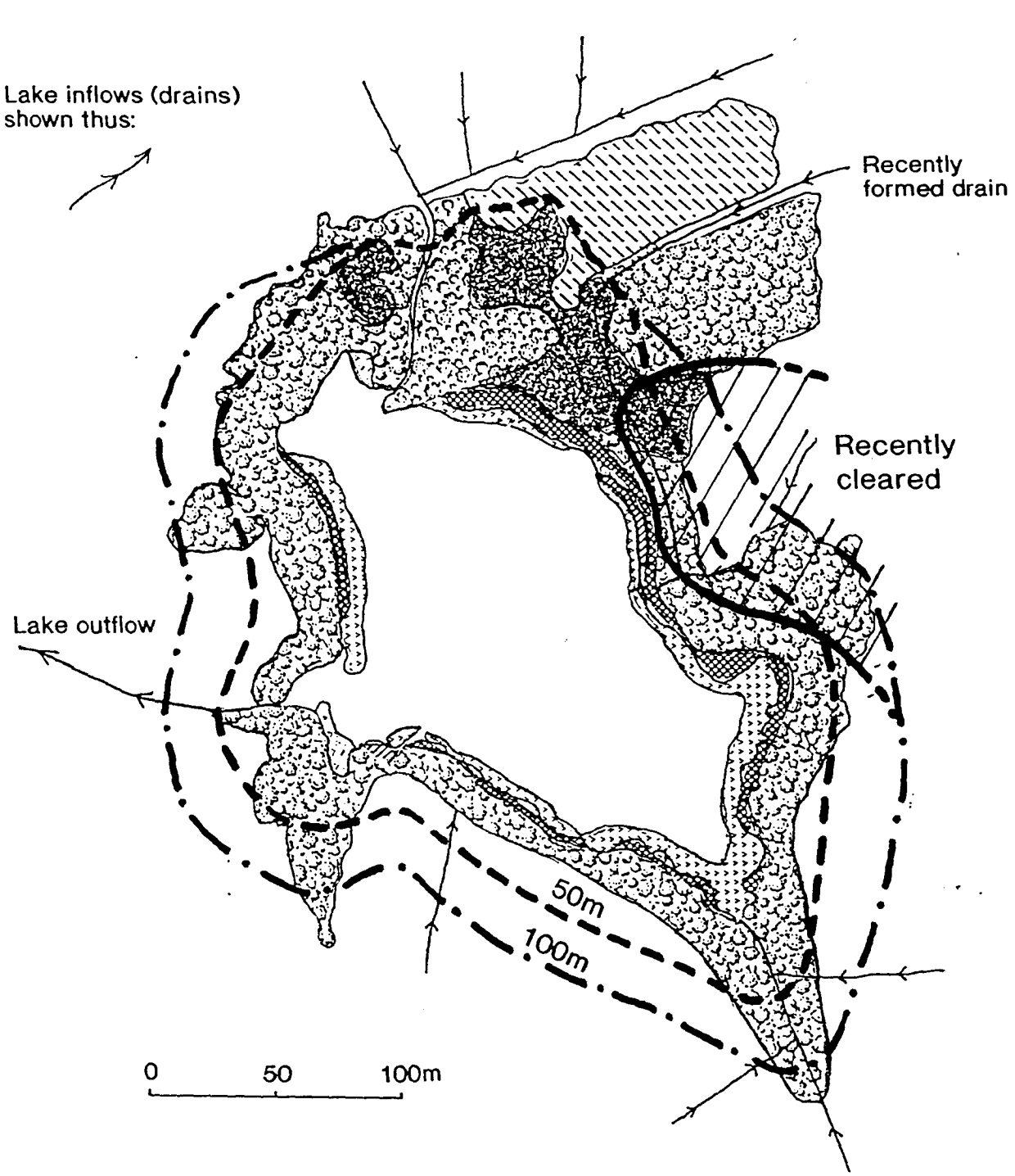
In addition we would recommend if possible linking the two significant remnant kahikatea stands to the lakes marginal vegetation. A 50 m esplanade almost does it. These trees are 80 - 100 years old so they are a valuable natural feature, especially if supplementary plantings could be made to link the remnants visibly to the Reserve. Serpentine Lakes offer an excellent opportunity for conserving a range of different natural values: peat lake, wetland, swamp forest. Moreover, if the buffer is wide enough, we do not see any reason why we couldn't redevelop a true acid bog margin on the Eastern side of Serpentine North. This possibility would need to be looked at in greater detail during subsequent investigations, but we would like to draw attention to the sobering statistic that of the vast area which was once Moanatuatua Bog, a mere 70 ha remain in natural vegetation, and this is very difficult to access. It would be an exciting project to develop more restiad bog, but we could not guarantee to keep our space requirements to less than 500 m for this and land acquisition would be expensive: Of course, even to keep Lake Serpentine North in perpetuity may well need a drainage restriction over a zone well in excess of 100 m. We will have to look at that problem later.

4.5 Lake Mangahia

4.5.1 Description

Lake Mangahia is regarded by the present investigators, as well as others (Chapman & Boubee, 1977) as one of the least modified lakes in the Waipa District, and we would therefore rank this as the most important of the five lakes as far as natural values are concerned.

The lake is surrounded by a complete woody fringe, mostly pussy willow - manuka, but with an excellent seven metre tall pure manuka stand along the northern edge. The vegetation under manuka and willow of lower stature is very diverse with many native herbaceous and woody species. Between this woody vegetation and the lake edge is an extensive floating mat dominated by flax, *Carex secta, Baumea*



Lake Mangahia

KEY

Vegetation type and % shoreline occupied

- *Typha* 10%
- *Eleocharis sphacelata* 91%
- *Phormium / Carex* 70%
- *Juncus*/rough pasture 7%
- *Salix cinerea* carr 95%
- *Leptospermum* scrub 26%
- *Rubus fruticosus* scrub 8%

Figure 5

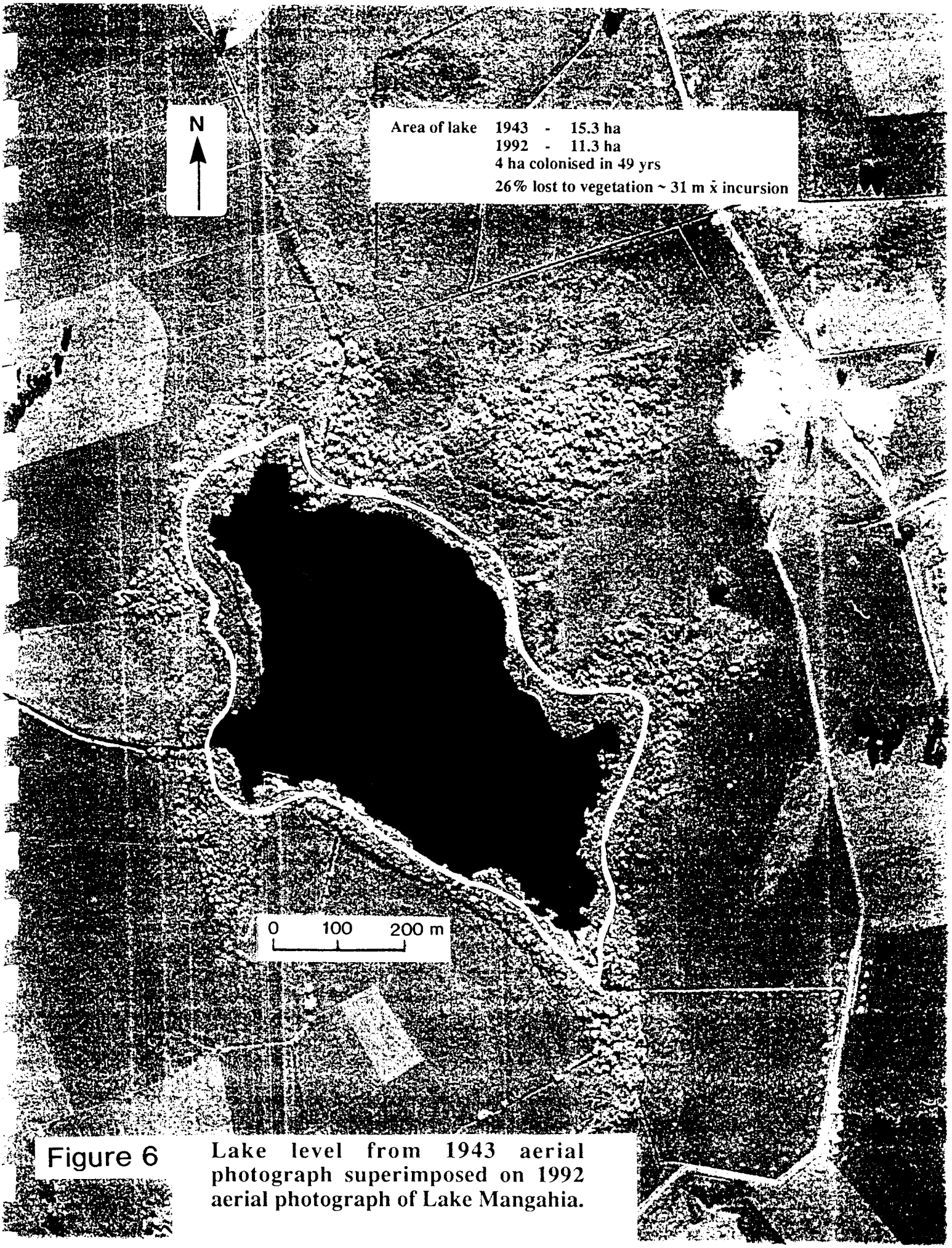


Figure 6 Lake level from 1943 aerial photograph superimposed on 1992 aerial photograph of Lake Mangahia.

rubiginosa, Sparganium subglobosum, Isachne globosa and the introduced *Paspalum distichum*. Apart from raupo, present near the drains to the east and west of the lake, the only emergent vegetation is dense healthy beds of *Eleocharis sphacelata.* The diverse marginal vegetation provides for a number of wetland birds, and fernbirds were also heard during the present survey.

4.5.2 Recommendations

Lake Mangahia is privately owned (by two offshore English). It is clearly used for duck shooting although it seems unlikely that permission is sought to do other than cross adjacent private land. Mangahia is currently being subjected to an intensity of marginal development and drainage which has not been seen for many years. The new landowner along the eastern margin has cleared extensive tracts of tall manuka this year, and earlier-cleared willow has now been set to grass. All cleared land is on peat. We are also concerned about the design of a new dairy shed oxidation pond and its proximity to the lake.

It was apparent on our first visit that the present open-water zone bears no relation to the true (recent historical) lake area. A substantial floating mat of vegetation fringes the lake, indicating rapid encroachment over the last few decades. The 1943 aerial photograph appears to show margins which are quite stable and long-established, but the 1992 aerial (see Figure 6) clearly shows a reduction in open-water of about 4 ha (mean linear encroachment about 30 metres). We recognise two possible triggers for the sudden advance of the marginal vegetation: either increased fertiliser use/dairy shed inputs, or else a deliberate lowering of the lake level by deepening the single outlet.

The problem was where to place the inner esplanade boundary: where is the 'real' lake edge? Our guidelines elsewhere use *Eleocharis* and *Baumea* as indicators of lake, but willow as being mostly on 'solid' (it is often solid peat) ground. Here at Mangahia there are coprosmas and willows floating on a mat of *Agrostis stolonifera* and *Carex*.

We decided to take substrate cores with the peat borer at several points along the margin. This study confirmed the 1943 lake-shore by

revealing fine-grained lake sediments immediately beneath the floating mat. We have therefore fixed the lake margin at the transition point from lake sediments to consolidated eutrophic wetland peat. Thus, at the narrowest point along the SE sector margin (Figure 5) the 1993 lake margin (outer boundary of *Eleocharis*) is 30 m from the fenceline; the historical (1943) margin is only 10 m from the fence and even 30 m from the 1943 lake edge consolidated peat (over lake sediment) is only 40 cm thick (possibly 100 - 150 years at the most). Mineralised ground is 40 m from the 1943 lake edge at this point.

Further to the north, the 'solid' peat is almost 40 m from the 1993 lake edge.

At this stage we do not know what the landowner intends to do with the recently cleared land. It cannot be drained without a pump. It could be covered with mineral soil or it could be converted to duck ponds. This is speculation, but there probably aren't any other options.

We did not have time within the present contract to investigate the margin in detail all round the lake, but since so much is peat, we have to recommend that 50 m minimum for the esplanade, with an option of a further 50 m of restricted drainage subject to further investigations. All drains should be converted to parallel channels well before the esplanade, lowering of the lake level should be prohibited (perhaps it should even be raised to prevent further advance of the floating fringe), and marginal planting of manuka etc should be considered. Mangahia is also an excellent choice for further enhancement with kahikatea planting (the habitat is ideal) and some dryland forest to grade into wetland.

Our minimum recommendation would be halting further occlusion of the lake and protecting the margin against erosion, nutrients and drainage. Mangahia deserves much more than this. There is probably only one other lake in the whole Waikato with similar values, and its future is uncertain.

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