Conservation of Maritime Vegetation and the Introduction of Submerged Freshwater Aquatics

V. J. CHAPMAN

Professor of Botany, University of Auckland, New Zealand
(Box 2175, Auckland)

In this particular contribution emphasis is placed upon two factors which are of material importance in consideration of any island ecosystem, though it is true they have even wider implications. Islands, however, are relatively small areas of land and interference or alternation of the ecosystem therefore tends to be more pronounced in its effect. The conservation of maritime vegetation concerns both low and high islands, whereas the arrival of exotic freshwater plants requires the existence of freshwater lakes which are primarily restricted to high islands. Although this symposium is essentially directed at the smaller islands of the Pacific, nevertheless it is felt that what is happening in the New Zealand Islands has important lessons.

Conservation of Maritime Vegetation

The retention of some portion of the marine coast and the sublittoral is becoming of increasing importance in more developed island areas of the Pacific. These islands are also the more accessible to man by either boat or plane, and generally there is development of a tourist trade. An increasing attraction of the tourist trade is the advent of the skin-diver and underwater swimmer who finds the tropical waters far more exciting than the colder temperate waters. Parties from New Zealand have already visited New Caledonia and the New Hebrides, whilst the sport is extremely popular in the Hawaiian islands and also within the Great Barrier Reef area of Australia. Whilst many underwater clubs are now turning to more serious biological study of this newly explored environment, very many indulge in highly selective fishing so that one or two species only are persistently removed from the ecosystem. In New Zealand the crayfish have been a particular object of assault. Whilst it may be argued that the removal of a few species is not serious, we have surely by now learnt enough from the removal of one or two terrestrial species, especially birds of prey, to know that an entire food chain can be disrupted by this kind of activity.

The situation in certain areas has already become sufficiently serious for conservation steps to be taken and underwater marine parks have been reserved off Florida, in the Bahamas and in the Great Barrier Reef. In New Zealand the situation has become sufficiently serious for a proposal to be put before the Government to establish the first marine park there. So far marine parks have been established in areas of heavy visitation, but one obvious proposition is to establish them in relation to marine biological laboratories. This, in fact, is the New Zealand proposal, where the Government has been asked to reserve a length

of about two miles of coast, including an off-shore island, and the reservation to be from high tide mark to 1/2 mile off shore. There is, of course, no desire to interfere with the pleasures of skin and SCUBA diving, but we hope that those indulging will, as in big game reserves, take only their cameras and not their spear guns. In this way it is hoped that for a limited stretch of coast-line the ecosystem will remain untouched and will be available for scientific study. At present an underwater group has laid down a series of underwater quadrats on the Poor Knights Islands and this area, which has produced some intensely interesting records, will probably also need to be reserved. Marine parks and reserves are a new concept in conservation, but if samples of island ecosystems are to be preserved it is not too soon to ask the necessary authorities to set aside such areas. In many cases we have come to preserve terrestrial ecosystems too late. It is still not too late to preserve samples of marine ecosystems strategically located across the Pacific. In setting these areas aside it is important to secure the agreement of any local skin diving group and also that of local fishing interests; at least this is our experience in New Zealand. Approval and agreement by these groups will undoubtedly make supervision of such marine parks much easier.

Introduction of Aquatics

In the larger island ecosystems there may be extensive lakes and the biological organisms in such lakes form a specific part, albeit well-defined, of the island ecosystem as a whole. Most of these lakes will have commenced their existence as oligotrophic waters and with the passage of time they will pass, some more rapidly, some more slowly, into the eutrophic condition. This is particularly true of static lakes, but we know rather less about the changes in the case of impounded waters produced by man either for hydro-electric purposes or as water storage for water supply to cities and towns or for irrigation. In these lakes the water may be in movement as it is drawn off or it may form part of a river system, as in the Waikato series of lakes in New Zealand (fig. 1). There is, therefore, the problem of introduced exotics into relatively static bodies of water, such as Lakes Rotorua and Rotoiti in New Zealand, or into moving bodies of water. With moving bodies of water transfer of an introduced aquatic can well proceed down-stream: This will not occur with static bodies of water but there are other means of transfer, such as birds and man himself, as we shall see.

The inevitable process of eutrophication has, in recent years, been aggravated and its speed increased, by human agencies. In his effort to increase pasture production intensive top-dressing programmes have been adopted, especially in the more developed areas, and if top-dressing, whether aerial or terrestrial, is followed by heavy precipitation, some portion of the fertilizer, which is generally phosphate, runs off into streams feeding the lakes. In well-developed areas towns or cities may be sited alongside lakes, such as Rotorua in New Zealand, and on a larger scale around the Great Lakes in North America, and from such areas sewage, and in cases industrial waste, may have been poured into the lakes. Top-dressing and effluent from human habitation add nutrient to waters that were originally oligotrophic and the change to eutrophic conditions may be, and indeed has been, speeded up until disaster can intervene. The chance introduc-

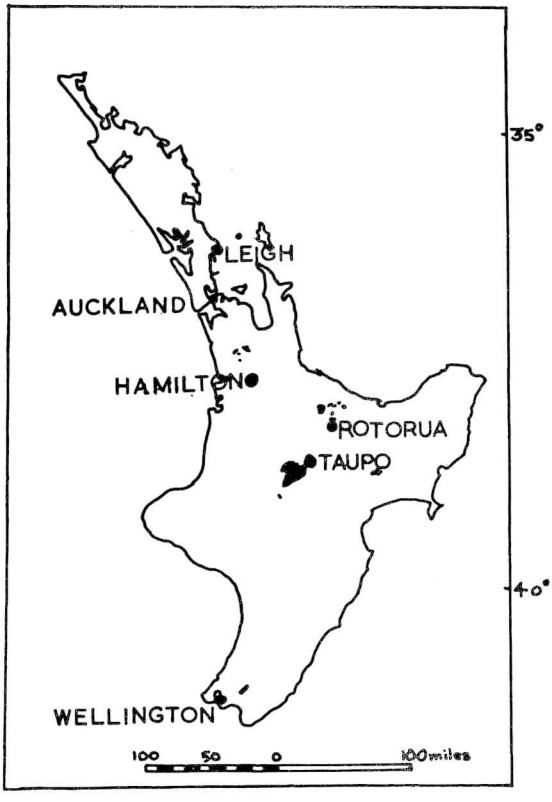

Fig. 1. Auckland and South Auckland area of New Zealand, and of the Rotorua and Hydro-electric Lake systems.

tion of an exotic into such waters may bring about a growth "explosion" and completely upset the existing ecosystem. Too late we then have to try and control what is happening, but the natural ecosystem has been interfered with beyond repair. The important thing is therefore to ensure that it does not happen. In most island ecosystems of the Pacific the situation may not yet be serious, but what is happening in New Zealand should serve as a warning.

The system of lakes in the thermal Rotorua area of New Zealand have long been known for their clear waters and excellent trout fishing, the trout having been introduced. Since 1956 the lakes have been becoming more cloudy and since 1961 the introduced aquatic, *Lagarosiphon major* (South African) has spread and formed belts of thick dense weed, often up to 1/4 mile or more wide and down to depths of around 14 ft. Anglers find it difficult to fish, boating enthusiasts find it impossible to launch and moor boats off shore, and swimming as a recreation has become impossible or highly dangerous. The weed itself was originally used in the adjacent hatchery to improve oxygenation of the water for fingerlings. It was then thought it would improve conditions in Lake Rotorua itself and was introduced for this purpose, and no-one foresaw what would happen. Not only has *Lagarosiphon* "taken over" the lake edge, it has eliminated the earlier

indigenous aquatic vegetation, and increased greatly the population of freshwater sponges and molluscs, one of the latter yielding a cercospora larva that induces a skin irritation in some bathers. An entirely new ecosystem has been produced.

The *Lagarosiphon* has now spread to Lake Rotoiti and has more recently been recorded in Lake Tarawera, Lake Taupo and the hydro-electric lakes. It seems fairly evident that spread from lake to lake may well take place on the propellors of pleasure launches or on their trailers as launch owners move their boats from one lake to another. This means of transfer is now regarded as sufficiently serious to justify some form of official action, though rigid control, with numerous launching ramps is virtually impossible.

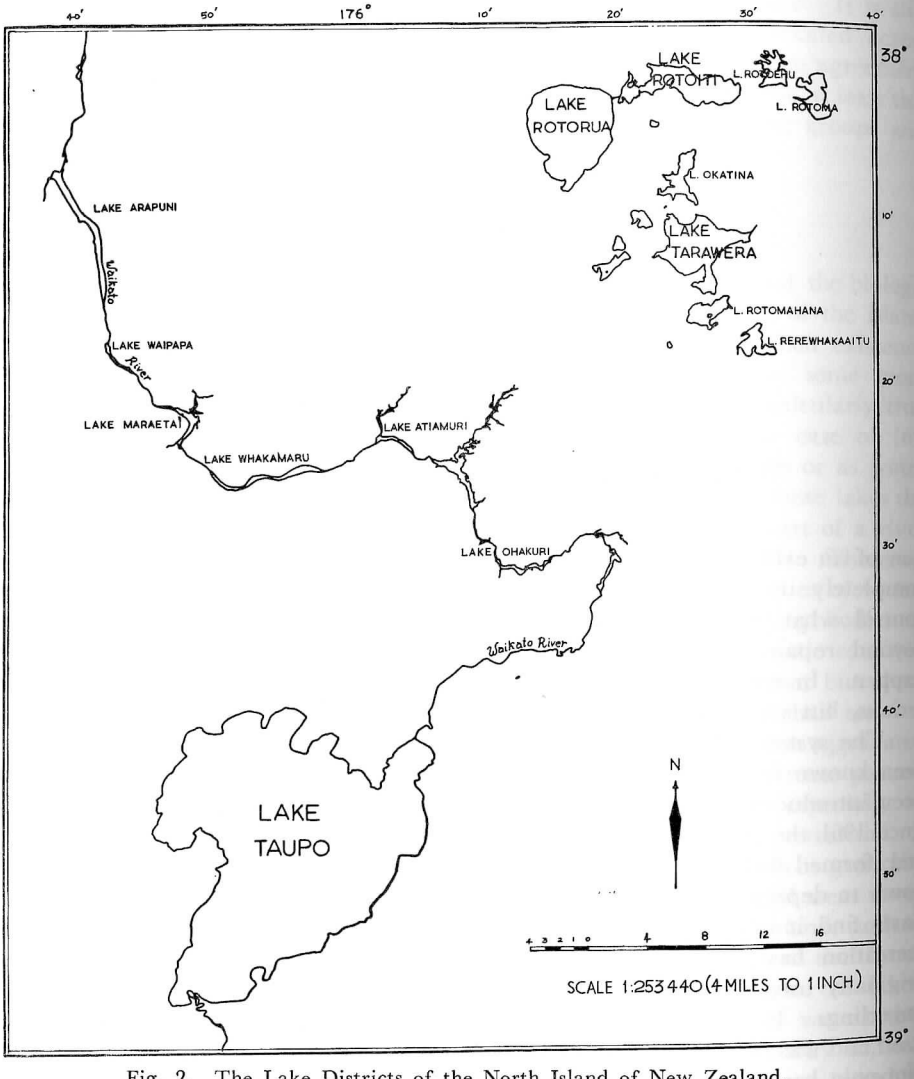

Fig. 2. The Lake Districts of the North Island of New Zealand.

At present the rampant weed is being controlled by a limited programme of diquat spraying. It is impossible now to eliminate the weed completely by diquat and the amount required to control a large area is such that those responsible are at present unwilling to sanction annual or biennial use of large quantities as no-one knows whether there is likely to be any long term cumulative effect of diquat on the ecosystem. There is also the ever-present possibility that death and decay of a large area of weed could result in liberating sufficient nutrient to promote a plankton bloom, though whether or not this occurred could depend on the time of year when the *Lagarosiphon* was killed, e.g. it could be less likely with an autumn kill than with a spring kill. Mechanical control is a further possibility but would be more expensive than diquat. Biological control is yet a further possibility and Chinese Grasscarp are still under consideration. This, however, means the introduction of yet another alien into the ecosystem, and it does not always work as evidenced by an earlier paper in this symposium (see Uchida).

In the hydro-electric lakes hornwort, *Ceratophyllum demersum*, has in the last few years spread as rapidly as *Lagarosiphon* in the Rotorua lakes. It is thought that it arrived as a result of the contents of a home aquarium being thrown into the river. It now occupies three lakes and will surely continue to spread downstream. In 1965 the amount collecting on the filter gates of one dam intake was so great the station had to close down for three days whilst it was removed. This, of course, affected the output of electricity. *Ceratophyllum*, although usually a floating weed, tends to have the lower portions buried in mud and it then virtually becomes semi-attached. Control by spraying is not easy because of the continuous water current that removes the diquat before it has had time to act effectively. Mechanical control would be feasible, and possibly also biological control since there is an aquatic snail of the genus *Marisia* that devours the weed. Here again a new element would be introduced into the already altered ecosystem. It will be seen that in New Zealand we have learnt some bitter lessons about the effects of eutrophication as a result of man's activities followed by the introduction of exotic aquatic plants. Now, in the largest lake, Lake Taupo, it has already been proposed to the Government that a buffer zone of trees around the shores and bordering all feeding streams should be established to catch surplus run-off. If this is done then the process of eutrophication can well be delayed, and exotic weeds, if introduced by chance may not thrive as they have done in the other lakes. At least this proposal for Lake Taupo is a serious attempt to preserve an existing ecosystem, and it may well be the solution to the preservation of fresh-water ecosystems in other islands of the Pacific.