DELTAS AND SWAMPS

Enclosed by coastal barriers, the Gippsland Lakes have been modified in outline by erosion and deposition around their shores, and it is convenient next to consider the forms produced by deposition of sediment within the lagoon environment.

Sediment has been carried into the lakes from a number of sources, the most important being the rivers and creeks which have brought, and are still bringing, clay, silt, and to a lesser extent sand, into the lakes (e.g. Figure 11D). In addition, sand has been washed or blown across the coastal barriers by wave and current scour; a small quantity may have been carried in by tidal action through the artificial entrance. Erosion of the marginal bluff has yielded a variety of sediment from gravel and sand to silt and clay.

It is likely that volume and regime of runoff and the nature and quantity of sediment yields from the rivers have been changed by the impact of man's activities, notably the clearance of natural vegetation and the introduction of grazing and cultivation, which resulted in 'soil erosion' in parts of the river catchments. A remarkable change has taken place along the Avon River in historical times. In 1850 Wilkinson surveyed the river, which then had a relatively deep and narrow meandering channel, bordered by scrub-covered levee banks and broad reedy backswamps. In the eighteen-sixties it was navigable by steamers as far as Redbank, about 18 kilometres upstream, but subsequently it began to shallow as the result of increasing sediment yield following erosion in the river catchment and along the channel banks (Coode 1879). As Stratford the channel is now broad and braided, with shoals of sand and gravel between high eroded banks, and the sanded watercourses extends downstream beyond the Clydebank bridge. In recent decades, floodwaters coming down the Avon have continued to extend this sedimentary infilling downstream. In October 1977 a survey by Robert Marshall indicated river depths of less than a metre in a sector 4 kilometres downstream from Clydebank bridge, then gradual deepening to more than 2 metres in the lower reaches, within 3 kilometres of Lake Wellington. Within a few months, much of this shoal sand had been disturbed by wave action, and some of it arrived on the shores at Marely and Strathfieldsaye, where beaches were widened by sand accumulation (Bird 1972a). In a similar way, sand carried by Mitchell floodwaters into Jones Bay is delivered subsequently to the shore near Point Lardener (Plate 19), and sand discharged by Tambo floodwaters builds up beaches on adjacent parts of the shoreline of Lake King.

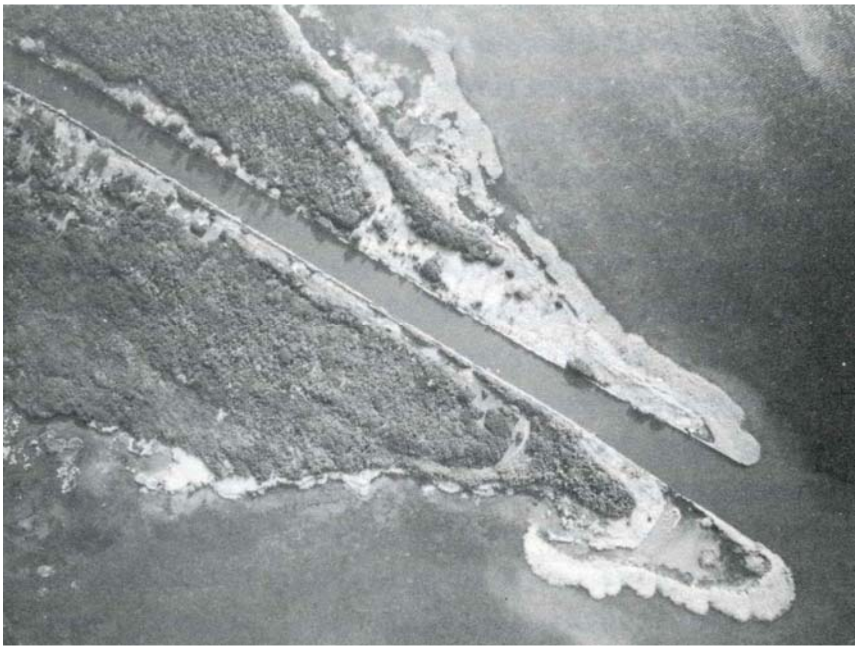

Plate 13 – Latrobe delta (ECF Bird)

Plate 14 – Tambo delta (N Rosengren)

In the eighteen-sixties there were newspaper reports that navigation in the Latrobe, Mitchell, and Tambo rivers was being impeded by the accumulation of bars of silt and sand deposited off the river mouths by successive floods. Rawlinson (19863) thought that such siltation was likely to increase as the result of deforestation panning for gold in the river catchments. The effects of gold mining, including degrading and sluicing of channel sediments, became a matter of concern in the late nineteenth century, particularly in the rivers draining into Lake King. Contemporary newspaper reports mention the increased cloudiness of river water charged with suspended sediment, and signs of more rapid rates of silting in the lower reaches of these rivers. In addition, it was thought that flooding had become more frequent, and more severe. In 1879, Coode remarked that the Tambo River had a navigable depth of at least 4.5 metres to a point about 17 kilometres upstream, but the bar off the river mouth was only 1.2 metres below the lake surface. Similar obstructions were present off the mouths of the other rivers. Between 1870 and 1912 the approaches to the Latrobe, the Mitchell, and the Tambo were regularly dredged to provide navigable channels, but with the decline of the steamer traffic it became less necessary to maintain deep approaches. In the early nineteen-hundreds gold mining also declined, and although no records were kept it appears that the rivers became cleaner, and that sediment yields were reduced: in 1907 the Director of the Geological Survey, E.J. Dunn, reported that the rate of advance depositional land was diminishing. Although some work is still necessary to maintain navigable waters for fishing boats and recreational craft, shoaling off river mouths after floods seems to be less of a problem than it was a century ago.

A modern impact of man’s activities is seen in the sediments deposited by the Latrobe as it enters Lake Wellington. In recent decades these have included solid pollutants, notably coal dust and ash residues from the Latrobe Valley power stations.

The pattern of deposition around the Gippsland Lakes is related partly to sources and routes of transportation, and partly to sedimentological environments determined by wind, wave, and current action and the effects of vegetation. The rivers have reclaimed sections of their previously drowned valleys by deposition of sediment, producing valley floors with levees and backswamps, and deltas (‘silt jetties’) protruding into the lakes. Elsewhere, the lakes shores have advanced by means of swamp land encroachment, particularly on sections sheltered from strong wind and wave action. The extensive swamp land west and south if Lake

Wellington has developed on shorelines that have been sheltered from waves generated by the prevailing westerly and south-westerly winds. Swamp land has also developed in sheltered inlets, along the margins of straits and narrow lagoons, and adjacent to river deltas.

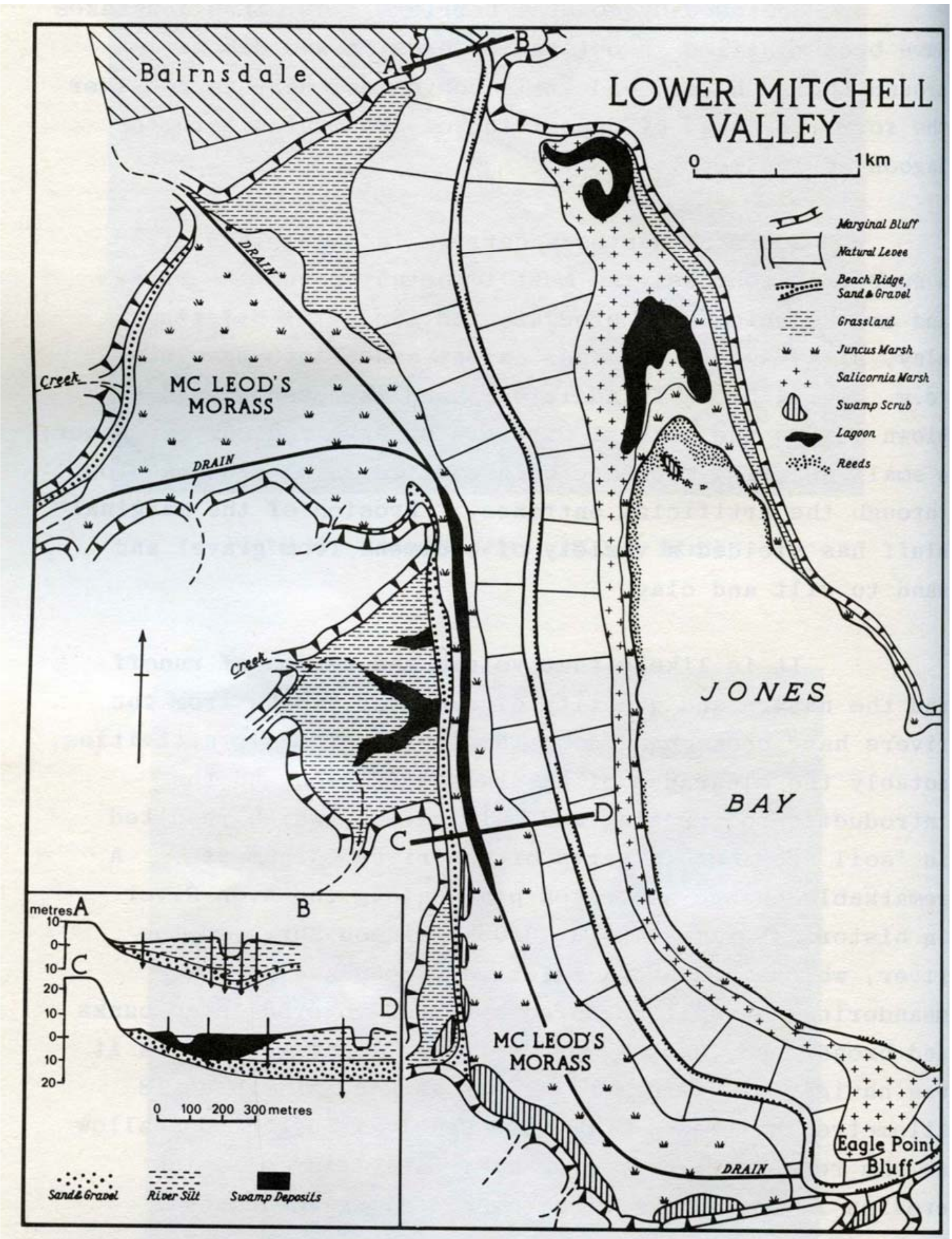

Figure 26

Some of the older lagoons have been reclaimed completely be sedimentation to form tracts of featureless low plain, as in the area that lay behind the prior barrier between Strathfieldsaye and Goon Nure (Figure 1). The broad plain of sandy silt south of Meerlieu is essentially an infilled Pleistocene lagoon with residual swamps and the swamp-filled tract of Backwater

Morass, where Toms Creek incised a channel that was later submerged, then invaded by swamp deposits. The present creek is narrow and up to 3 metres deep between steep swampy banks.

The coastal valleys of East Gippsland were deepened by river incision during Glacial phases of low sea level, then submerged to form inlets during subsequent transgressions. The branched configuration of Lake Tyers is an incised valley system which was submerged by the Holocene marine transgression; the tributary creeks are quite small, and the extent of reclamation by fluvial deposition remains limited. Within the Gippsland Lakes system, North Arm (the moth of Mississippi Creek) and the Newlands Backwater (the mouth of Forge Creek) are similar elongated inlets formed by submergence and largely unreclaimed: the creeks have built small deltas at their heads. The valleys of the Latrobe, Avon, Mitchell, Nicholson, and Tambo rivers were also submerged, but alluvial deposition has filled their channels to the level of the present valley floors. Borings made by the Country Roads Board to find suitable bedrock for the foundations of bridges built to carry the Princess Highway over each of these rivers penetrated river silts and swamp deposits, then sands and gravels lining the floor of a concealed channel. The section across the Mitchell valley at Bairnsdale (Figure 26) is typical: the floor of the old channel descends more than 15 metres below sea level at this point, and the fill consists of sands and gravels overlain by finer silts and clays deposited by the river in the course of reclaiming its submerged valley mouth. Downstream from Bairnsdale, beach sands and gravels at the base of the marginal bluff on the western side of the Mitchell flood-plain extend as a barrier across the mouths of tributary valleys and northwards as a spit into McLeods Morass, the backswamp west of the lower Mitchell (Figure 26). These clearly mark the former shoreline of Lake King, which has been outflanked and cut off from the lake by the building of the Mitchell valley floor and delta (Bird 1970).

It is difficult to decide how far marine submergence extended into East Gippsland river valleys, for the valley floors have been aggraded for many kilometres upstream. A possible indication is the pattern of river meandering, which is close and intricate upstream, giving place to more sweeping and gently curved meanders in the lower courses. This change occurs in the Latrobe below Longford, Redbank, the Mitchell below Bairnsdale, the Nicholson below the railway bridge, and the Tambo below Swan Reach. It is possible that the closer pattern of meandering indicates valley-floor aggradation uninterrupted by marine submergence, whereas the more sweeping reaches are deltaic, having grown across an area that was formerly submerged. The deltaic sections of the East Gippsland valley floors are therefore more extensive than the deltas which actually protrude from the present shoreline. They consist of valley floors with natural levees bordering the river channels, and adjacent backswamp depressions which are frequently inundated by floodwaters. Natural levees are built up by deposition during the floods which occur frequently in these valleys; when the river rises and overflows its banks, inundating the valley floor, the flow of water is most rapid along the line of the river channel, and much slower on either side. Sediment (Chiefly silt) carried by the floodwaters is relinquished at the borders of the channel where the water velocity diminishes, and only the finer sediment is carried out into the calmer water beyond. In this way, aggradation of the valley floor is most rapid adjacent to the river channel, and natural levees are built, sloping away laterally into backswamp depressions
Floored with clay deposited fro floodwaters and occupied by fen or swamp vegetation, which builds up peat. At Bairnsdale the natural levees rise 3 to 4 metres above the normal (dry weather) level of the Mitchell River. Downstream they decline gradually, sloping away to the west beneath the backswamp of McLeods Morass, where outflow from cobblers Creek is diverted southwards through tall *Juncus ingens* swamp, and to the east beneath the reedswamp and salt marsh the fringes Jones Bay (Figure 26).

The deltas

The deltas that protrude into the lakes (Bird 1962a) are essentially extensions of these natural levees, silt at the mouths of rivers. They are comparable in configuration with the silt jetties built by distributaries of the Mississippi River to produce the complex digitate 'birds foot' section of the Mississippi delta, but they do not show the repeated branching ('crevassing') typical of the Mississippi jetties (Russell 1936). It is remarkable that these relatively small

East Gippsland rivers have been able to build silt jetties that protrude far out into the lakes, and the circumstances in which they have done so requires further analysis.

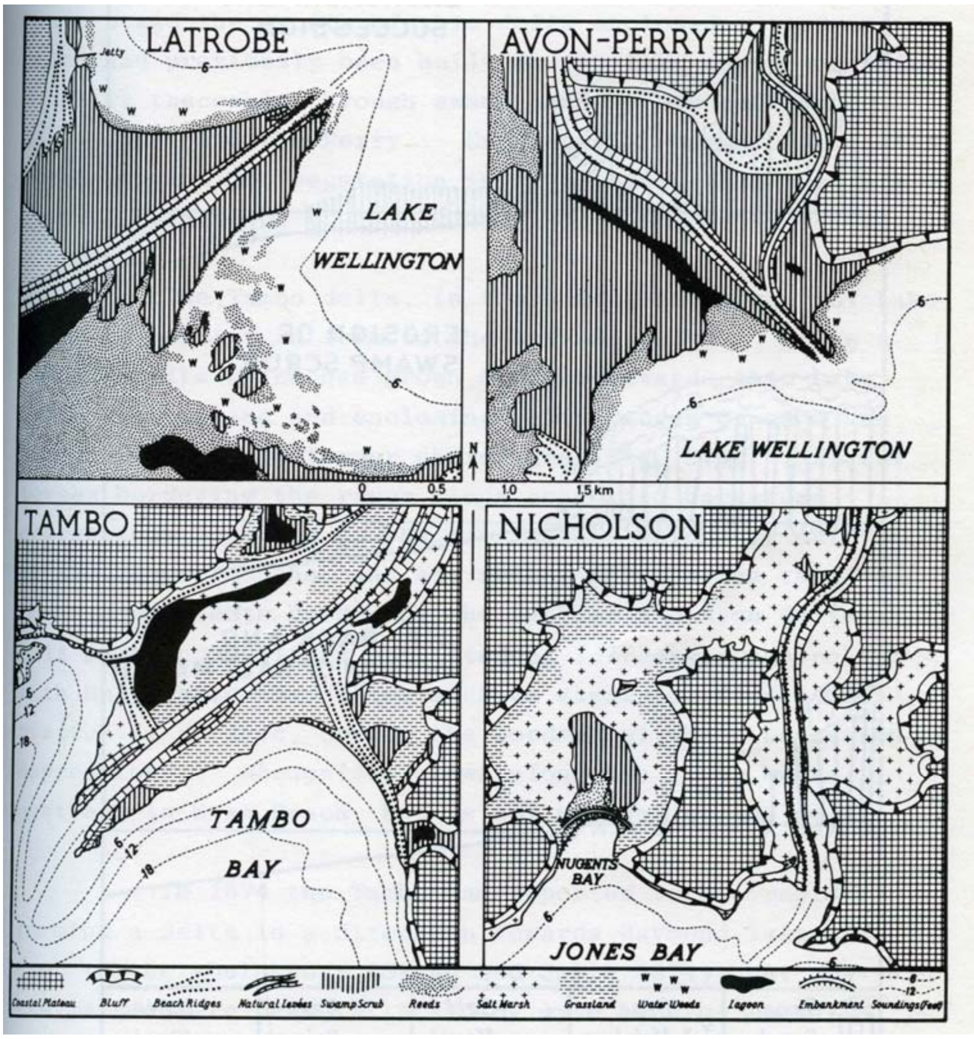

Figure 27

The Latrobe delta (Figure 27) is a cuspate delta at the south-western corner of Lake Wellington, built into a part of the lake that is sheltered from the prevailing westerly winds, but open to the easterly winds that frequently occur. Low natural levees bordering the Latrobe River culminate in silt jetties that protrude into Lake Wellington, the delta being covered by dense swamp scrub (mainly swamp paper-bark, (*Melaleuca ericifolia*) with a few red gums (*Eucalyptus tereticornis)* on the rivers banks. Extensive reedswamp, dominated by the common reed (*Phragmites australis)* and reed mace (*Typha angustifolia*) occupies the backswamp depressions, and the delta is bordered by a reed fringe, chiefly *Phragmites*, which is spreading out into Lake Wellington (Plate 13). River silt is trapped by the reeds and built on to the delta, which is growing by prolongation of the jetties at its mouth and by marginal accretion along the shoreline. The reed extends into water up to 2 metres deep, but at their inner margin sedimentation has built up the land surface to a level at or slightly above the calm-weather level of Lake Wellington, and here the reedswamp gives place to colonising swamp scrub dominated by *Melaleuca ericifolia.* Beneath this dense scrub there is a shallow interlacing root network which binds the soft lacustrine sediments. On the surface a mat of twigs, leaves, and decaying bark forms brushwood peat, but underneath there is black silty clay rich in organic matter and containing fragments of *Phragmites* straw and rhizomes, a relic of a former reed-swamp community now replaced by swamp scrub. Immediately below this is a soft wet blue or black mud (a mixture of silt, clay, and organic matter), so weak that the surface ‘raft’ of brushwood peat and scrub roots will quake beneath the weight of a man.

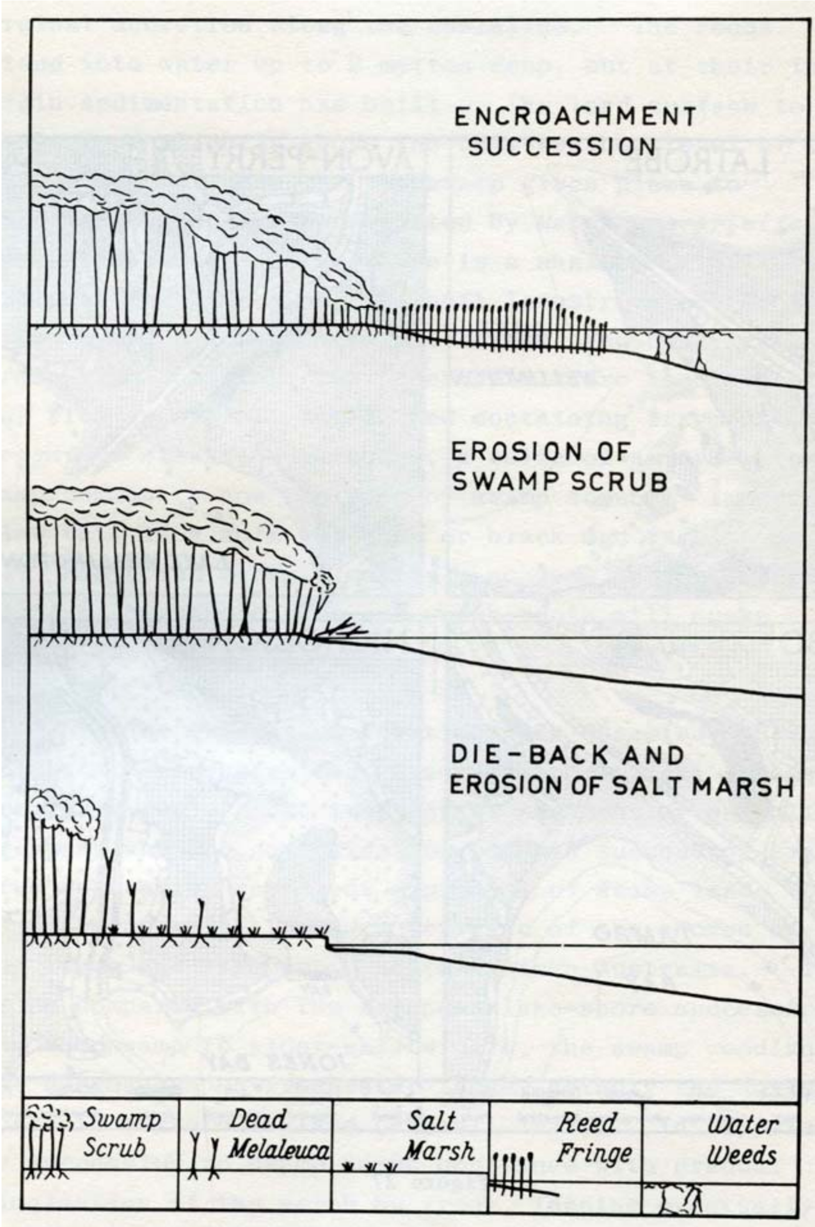

Figure 28

The vegetation zonation here described is an ecological succession that has geomorphological consequences (Figure 28). The trapping of sediment by shoreline reedswamp and its consolidation beneath succeeding swamp scrub vegetation represents a process of swamp land encroachment which is characteristic of the shores of many lakes and lagoons in south-eastern Australia. It may be compared with the European lake-shore succession from reedswamp to alder-sallow carr, the swamp woodland that encroaches on freshwater lakes, notably the Norfolk Broads in eastern England (Ranwell 1972). In Gippsland the succession to swamp scrub continues with gradual colonisation of the scrub by trees, leading eventually to the formation of mixed eucalypt forest typical of the coastal lowlands.

The Avon delta (Figure 27) is similar to the delta of the Latrobe, but rather smaller. Joined in its lower reaches by a tributary, the Perry River, the Avon flows into the north-west corner of Lake Wellington by way of a cuspate deltas. Reedswamp borders the shoreline and the same succession to swam scrub is demonstrable, associated with accretion of silt and clay to widen and prolong jetties that border the river mouth. At an early stage the growth of this delta enclosed a sand-spit which had previously been built on the lake shore and which is still traceable through swamp land at the confluence of the Avon and the Perry. Upstream, *Phragmites* dominates reedswamp and fen vegetation in broad backswamps that are generally flooded.

The Tambo delta, in the north-east corner of Lake King, is similar in form to the Latrobe delta. It is a cuspate delta which has grown south-westwards into Lake King, outflanking and enclosing beach ridges of sand and shingle with mark former shorelines (Figure 27). Natural levees bordering the river slope away into backswamp depressions occupied by shallow lagoons which dry out in the summer months, and are rather more saline than their equivalents bordering the Latrobe and Avon deltas. Salt marsh communities dominated by *Salicornia australis*, with halophytic associates such as *Juncus maritimus* and *Distichlis spicata*, occupy the borders of these backswamp depressions. *Phragmites* grows along the river banks upstream in Swan Reach, but is not present on the delta.

In 1874 the Tambo was reported to be ‘rapidly forming a delta in a direction towards Raymond Island’, i.e. to the south-west (Skene and Smyth 1874), but now its margins are being attacked by wave erosion. Anti-erosion works introduced in the nineteen-sixties have been only partially successful. Much of the shoreline is still receding, and has become irregular in outline, with the cutting of a broad bay on the western shore during the past twenty years. Trunks of dead red gums standing in Lake King mark the former extent of the delta (Plate 14), and it can be seen that the western jetty has been cut back farther than the eastern, being more exposed to strong waves generated by the prevailing westerly winds. Swamp scrub probably covered this delta under natural conditions, but most of it has been cleared or destroyed by grazing, and converted to the pastureland which is now being consumed by shoreline erosion. Compared with the Latrobe and Avon Deltas, the striking features is the absence of a shoreline reedswamp fringe.

The Nicholson is the smallest of the five main rivers that drain into the Gippsland Lakes, and it is probable that it once entered by way of Nugents Bay (Figure 27), which is bordered by well-marked valley-side cliffs. At a late stage, probably soon after the Holocene transgression attained the present general level, the river breached a narrow interfluve to find another outlet through a smaller valley system to the east. Natural levees have been built along the sides of the river channel and it is probable that a small delta was built out into Jones Bay, but this has been consumed by erosion, and the shoreline around the river mouth is still receding as the result of wave attack. *Phragmites* borders the lake shore in Nugents Bay, and is present along the river banks, but is missing from the receding shoreline around the river mouth.

The Mitchell delta is the most spectacular of the river deltas of the Gippsland Lakes (Figure 29), a long, digitate delta winding into the northern part of Lake King and consisting of silt jetties bordering the channel of the Mitchell River (Bird 1972). Its vegetation cover at the present time is mainly reclaimed pastureland, but there are patches of *Melaleuca ericifolia* swamp scrub, and some tracts of slat marsh. *Phragmites* is present sparely on the river banks, with larger clones near the river mouth, but it is missing from the outer shoreline of the delta which, like the Tambo, is being attacked by wave erosion (Plate 15). When it was originally surveyed in 1848 – 49 by Wilkinson and Smyth, the Mitchell delta was broader in outline than it is now, and much of the bordering shore was reedswamp-fringed. Comparison with outlines shown on modern air photographs shows that the delta area has been reduced from 2.68 million square metres in 1848 – 49 to 1048 million square metres in 1970, little over half its original extent (Bird and Rosengren 1971). Already the eastern part of the delta has been dissected into a chain of small islands, and if this is allowed to continue the Mitchell delta will wither and disappear within the northern jetty opposite Eagle Point Bluff during a river flood and a small delta has been built out into the shallow waters of Jones Bay.

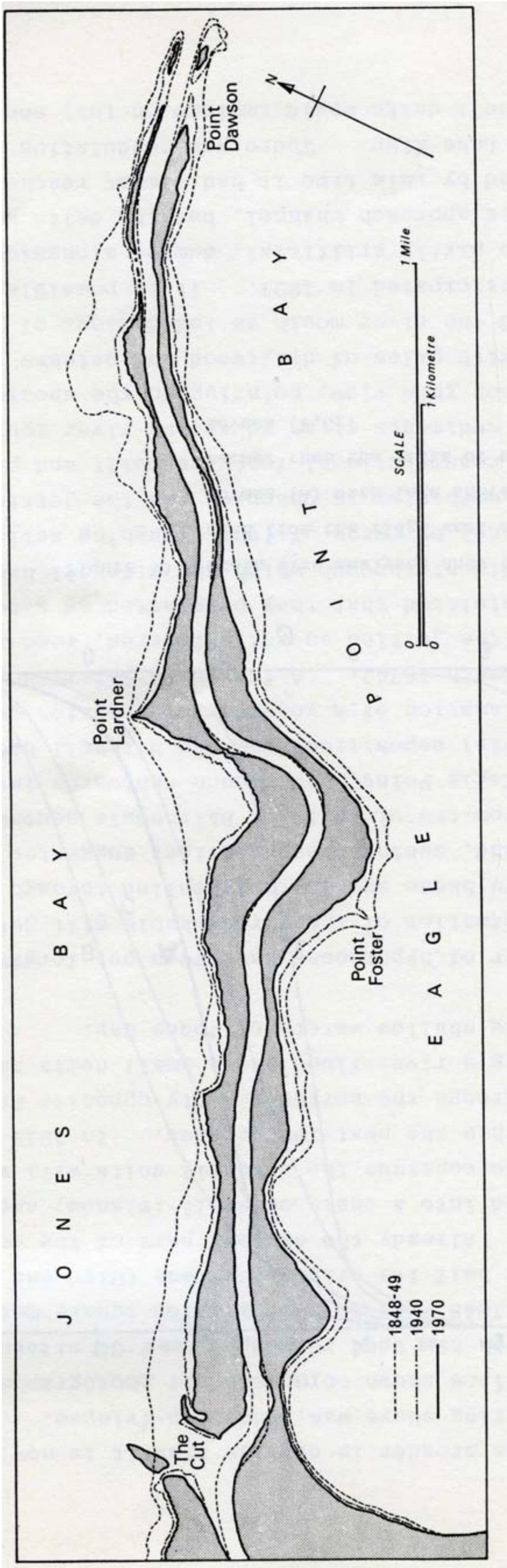

Figure 29 – Mitchell River silt jetties, 1848 - 1970

A number of hypotheses have been put forward to explain in formation of these remarkable silt jetties. In 1874, surveyors Skene and Smyth travelled through the Gippsland Lakes and, seeing these jetties, suggested that they had grown from the vicinity of Bairnsdale southwards to the bluff at Eagle Point, and thence eastwards into Lake King. Fluvial deposition from the Mitchell had thus achieved the reclamation of a considerable portion of Lake King (Skene and Smyth 1874). A few years later, Howitt (1879) described the jetties as well-timbered, reed-fringed features, and postulated that they originated as a tongue of lacustrine sediment through which the Mitchell had maintained a channel by means of 'the ploughing action of floods' but this mechanism is obscure, and the jetties are almost certainly constructional features built and prolonged by deposition of sediments at an advancing river mouth. Gregory (1903) took this view, pointing to the shoals of river sediment (with piles of driftwood and patches of reedswamp) beyond the river mouth as indications of the further growth anticipated in 1901. It is possible that these shoals were partly artificial, dumped alongside a repeatedly-dredged approach channel, but the delta was still growing and by this time it had almost reached the farther shore of Lake King. There was speculation as to whether the Mitchell delta would impinge on that shore and curve southwards, or whether the outflow from Jones Bay, fed by the Nicholson River, would deflect it southwards before it reached the shore. This was never settled, for prolongation came to an end early in the present century, and during the last fifty years there has been considerable erosion.

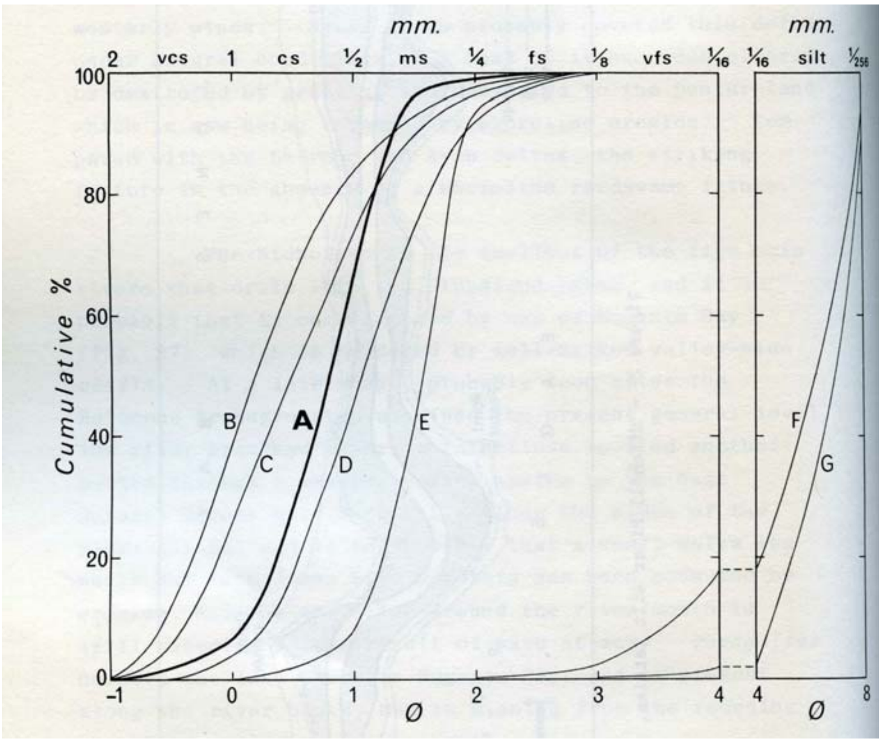

Figure 30 – Grain size analyses
show the affinity of sand from the ridge west of McLeods Morass (A) with lake shore beaches (B, C, D, E) rather than the silts of the Mitchell levees (F, G).

Another hypothesis, put forward by Clifford (1949) and revived by Jenkin (1968), was that the northern part of Lake King was submerged valley plain, and that the silt jetties were natural levees remaining partly exposed after general submergence. When the valley is flooded below Bairnsdale the river-side levees down to Eagle Point do look like silt jetties threading across a lake, but there are difficulties with Clifford's hypothesis. During the Last Glacial phase of low sea the Mitchell must have incised its course, dissecting the pre-existing valley floor and destroying any natural levees that may have bordered its channel on that earlier valley floor. Subsequent submergence carried the sea well into the lower Mitchell valley, forming the beach features west of McLeods Morass, which are contrasted with the natural levee sediments and similar to present lake shore beaches (Figure 30). When the Holocene transgression came to an end the present Mitchell delta must have started growth from the vicinity of Bairnsdale, across the western embayment of Lake King in the manner suggested by Skene and Smyth, to Eagle Point Bluff, and then eastwards. The hypothesis of submergence of natural levees is difficult to reconcile with the view that the sea rose above present level at the end of the Holocene marine transgression (e.g. Jenkin 1967): the last movement must have therefore been one of emergence, not submergence, to establish the present configuration (Bird 1970).

There is good evidence that the Mitchell delta formerly bordered by shoreline reedswamp vegetation. In 1849 the first topographic survey of this area was made by John Wilkinson, and his field notebooks and maps (inspected by courtesy jetty covered by 'high reeds and scrub', and the lake shore fringed by 'very wet morass'. Examination of the lake floor just off the eroded northern shore of the delta, in Jones Bay, led to the discovery of anchored rhizomes and dead stems of *Phragmites*, which evidently constituted part of the 'very wet morass' spreading into the lake. The 1849 maps shows similar morass on the north-west shore of Jones Bay, where shoreline reedswamp persists at the present time. Relics of a former *Phragmites* community in the form of rhizome remains have also been found in lake-floor sediment under Eagle Point Bay, off the southern shore. Howitt's description, previously quoted, and Gregory's (1903) account suggest that these features persisted until the turn of the century, but reedswamp fringe has almost completely disappeared since then, and erosion has developed. By 1959 the delta was clearly in course of decay, and in places the shoreline hade receded more than 20 metres. Locally the shoreline has been damaged by driftwood accumulations, which are agitated by wave action in such a way as to scour out hollows in the silty cliffs (Bird and Rosengren 1971). At one point the southern jetty was little wider than the track which leads to the fisherman's settlement at the eastern end. Since 1962 walls and groynes of wood and stone have been built by the Public Works Department to safeguard this and other sections of the shoreline of the eroding delta, and the Soil conservation Authority of Victoria has experimented with introduced vegetation, including Townsend's cord grass, *Spartina townsendii,* in the hope of replacing the pre-existing vegetation fringe to protect the shoreline from wave attack. *Phragmites* persists sparsely along the river banks and there are larger clones near the eastern end of the jetties, but the ecological conditions which permitted extensive growth of shoreline reedswamp no longer exist. Much of the swamp scrub cover on the delta has been cleared and replaced by pastureland, and it is noticeable that where this splashed regularly by lake water along eroding shores, halophytic herbs such as *Mesembryanrhemum australe* and *Suaeda maritima*, and the salt grass *Distichlis spicata*, have colonised the pastureland. Similar evidence is seen on the eroded shores of the Tambo delta.

Large quantities of sediment (mainly silt and sand) are still brought down by the Mitchell, particularly during floods, but since the opening of the breach opposite Eagle Point Bluff much of it has been carried out to settle on the floor of Jones Bay. A small delta has been built, nut elongated jetties have formed (Plate 16). It appears that, within the Gippsland Lakes, silty jetty formation has deepened on the presence of a shoreline reedswamp fringe to trap a larger portion of the river sediment, outlining the developing form of the delta and affording some protection from wave attack: there is no such reedswamp to assist the growth of a new delta at The Cut. The Latrobe and Avon deltas, reedswamp-fringed, are still growing; The Mitchell delta having lost its former reedswamp fringe, is no longer growing, and it is likely that the eroding Tambo delta also formed river mouth. The elongated digitate form of the Mitchell jetties, compared with the smaller cuspate deltas of the other rivers, evidently reflects the fact that the north-western part of Lake King is very well sheltered from both westerly and easterly winds, whereas the deltas of the Latrobe, Avon, and Tambo have grown in face of stronger wind-generated wave action.

An unusual case of levee formation is seen along the sides of McLennan Strait, the channel that links Lake Wellington to Lake Victoria. Flow of water between the two lakes has been restricted by the development of the recurved spit that borders the eastern shore of Lake Wellington, but is sufficient to maintain a channel that has dimensions and for of a river channel. When the Latrobe and Avon are in flood, sediment-laden water passes eastwards through McLennan Strait. Marginal deposition has built low levees which culminate in small, swamp-fringed silt jetties at the eastern end, protruding into Lake Victoria.

Lake-shore swamps

(Figure 31)

Before proceeding to analyse the reasons for the disappearance of shoreline reedswamp from the deltas in Lake King, reference will be made to the evolution of lakeshore swamp land away from the river mouths. Swamp land is extensive south of Lake Wellington, where it attains a maximum width of six kilometres, and there a narrower tracts on the northern and western shores of this lake, notably between the Latrobe and Avon deltas; on the western shore of Lake Victoria either side of the eastern exit from McLennan Strait; and on other more limited sections of the lake shore, particularly in embayments and along the sides of narrow inlets and lagoons. The extent of swamp land is greatest on shores that are sheltered from waves generated by the prevailing south-westerly winds, and leas on shores exposed to that direction, which are typically bordered by beaches of sand or sand and shingle, often receding in face of strong wave attack. The extensive swamps south of Lake Wellington were formed in an area of sheltered and shallow lake water in the lee of the inner barrier, Lake Coleman being the largest of a series of residual lagoons isolated as swamp encroachment proceeded.

Swamp land bordering the Gippsland Lakes is usually covered by swamp scrub vegetation dominated by *Melaleuca ericifolis*, but considerable areas have been cleared and converted to pastureland for grazing sheep and cattle. Reedswamp is associated with swamp scrub in enclosed lagoons and on part of the lake shore (Plate 17), and it was widely spread around the lake shores in 1901, when Gregory travelled through the Gippsland Lakes by steamer (Gregory 1903). He concluded than the lakes were contracting as the result of swamp land encroachment, associated with sedimentation in shoreline reedswamp and colonisation by swamp scrub vegetation of land built up to lake level, the process inferred (Figure 28) from a study of the shores of the Latrobe delta. Swamp land encroachment was the still widespread when Gregory make his observations, but now it is restricted to small sections of the south-western shores of Lake Wellington and Lake Victoria, and to the north-western corner of Jones Bay. For the rest, erosion has become widespread. Lake-shore swamp land is being cut back by waves to expose the roots and papery-barked trunks of *Melaleuca ericifolia* communities, littering the shoreline with fallen trunks and branches (Plate 18). The onset of widespread shoreline erosion was first recorded by Hart (1922), but local residents say that it began several years earlier (cf. Bury 1954).

Plate 15 – Eroding shoreline, Mitchell delta (ECF Bird)

An examination of shoreline of many of the lagoons in south-eastern Australia (Bird 1965a) has shown that swamp scrub cannot colonise open water directly, except in the most sheltered conditions. As a rule it is preceded, and its early growth protected, by a reedswamp community typically dominated by *Phragmites;* occasionally, in sheltered situations around brackish lagoons, this is replaced by rushswamp dominated by *Juncus maritimus*. From Gregory's account it is deduced that lake-shore swamp land now being eroded was formerly (1901) bordered by shoreline reedswamp, and that encroachment of reedswamp on the lakes had led to the development of sedimentary land colonised by *Melaleuca ericifolia* scrub. It would be easy to underestimate the former extent of swamp land and reedswamp around the shores of the Gippsland Lakes. The northern shore of Sperm Whale Head, for example, shows erosion of cliffs of crumbling sand truncating the dune terrain (Plate 11), but local residents recall that swamp land fringed this shoreline early in the present century, the Gregory, seeing a swamp-fringed shore and no evidence of dune terrain, mistook this part of the inner barrier for a silt jetty. Small tracts of swamp persist in some of the embayments, but generally the swamp fringe has gone, and waves are attacking the dunes that lay behind it; the sand eroded from the dunes is spread along the shore, and accumulates locally as spits and forelands.

Plate 16 – The Cut, Mitchell delta, showing pattern of deposition in Jones Bay (N Rosengren)

In May 1928 the *Bairnsdale Advertiser* (15/5/28) reported that a 'mud island' had emerged just off Pelican Point, Sperm Whale Head. Measuring about 20 metres by 10 metres, it was soon consumed by the waves of Lake Victoria. According to Woolnough (1930) it resulted from the squeezing outward and upward of swamp deposits upon which a sandy foreland had been accumulating, fed by longshore drifting along the southern side of Lake Victoria. This is evidently a recurrent phenomenon, for on 3rd February 1977 a similar elongated mud island, 90 metres long and up to 8 metres wide, with a maximum height of about a metre above calm-weather lake level, emerged a short distance off Pelican Point. Its emergence occurred soon after minor earth tremors and a passing meteorite had been reported in East Gippsland, but it is not known whether these events were connected with the emergence of the mud island. As in 1928, the primary cause appears to have been the accumulation of sand off Pelican Point, compressing and squeezing up the marginal tongue of organic silty clay and shelly material. The process is similar to the generation of 'mudlumps' in the shallow sea off the growing arms of the Mississippi delta. The mud island in Lake Victoria was at once attacked by wave action, and within three days it had been eroded away. Sand accretion continues off Pelican Point, and it is likely that further mud islands will emerge from time to time in this part of Lake Victoria.

Swamp land bordering Lake Victoria and Lake King has been modified by increasing salinity (Bird 1962b). On the shores of Raymond Island, and along the margin of Boole Boole Peninsula south of Metung, wave erosion of swamp land has been preceded by 'die-back' of *Melaleuca ericifolia* and its replacement by salt marsh communities, typically with *Juncus maritimus* and *Salicornia australis* (Figure 28). Invasion of wave-splashed shorelines by salt marsh species is evidently a consequence of the high salinity that develops in Lake King, particularly during dry summers. In swamp land away from the lake shore there is further evidence of increasing salinity where enclaves of salt marsh, often enclosing unvegetated salt pans, have formed on land previously covered by swamp scrub vegetation. Dead sticks mark the former swamp scrub cover, and swamp scrub vegetation generally surrounds the salt marsh enclaves. The enclaves are best developed on Boole Boole Peninsula, on swamp land south of Eagle Point Bay, and in the swamps that border McLennan Strait (Figure 31). Investigations of these areas subject to inundation by brackish lake water when lake level is raised by strong winds or river flooding: the brackish waters remain until they evaporate, precipitating their salt content in the topsoil. In dry weather, strong winds lift clouds of fine peaty dust from these areas, thereby lowering the pan surface further. Bushfires may have contributed to removal of the swamp scrub, but the critical factor in the evolution of salt marsh enclaves has been increasing salinity: where a burnt area of swamp scrub receives fresh water flooding, as in backswamp areas along the river valleys, the *Melaleuca ericifolia* cover quickly regenerates.

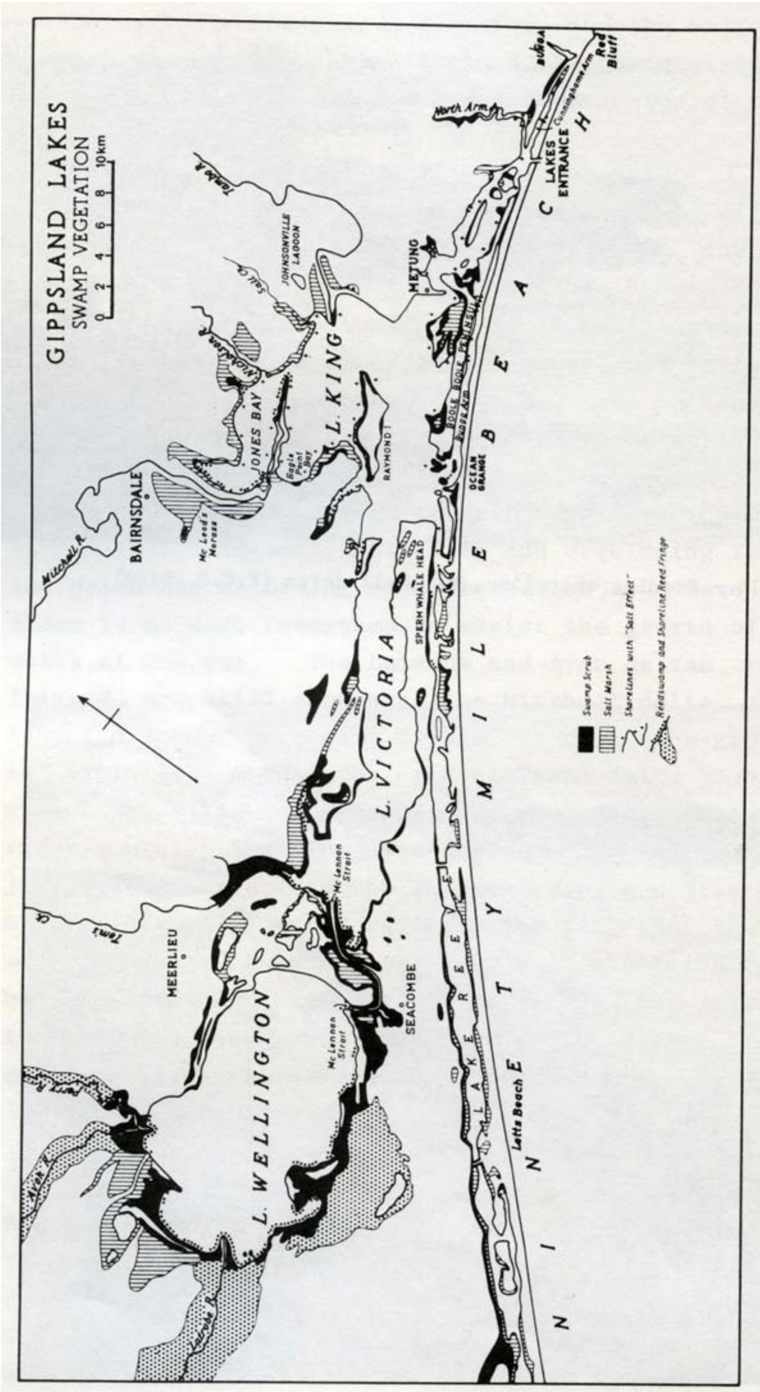

Figure 31

At Taylors Swamp (Figure 32) on the Boole Boole Peninsula, borings in one of the salt marsh enclaves showed that it had originally been a shallow lagoon between dune ridges, and that it had been invaded first by *Phragmites* swamp (there are relics of *Phragmites* in the sediment below the present surface), then by *Melaleuca ericifolia* swamp scrub, which formed a layer of brushwood peat over the whole area. The central part remained slightly lower, however, and subsequent inundations by brackish floodwaters and repeated precipitation of salt in the topsoil have built up salinity to levels which *Melaleuca ericifolia* cannot tolerate. Consequently, the swamp scrub has died back in the centre of the area and salt marsh (an outer *Juncus maritimus* and an inner *Salicornia australis* zone) surrounds a highly saline pan on which crystals of salt glisten when the surface dries out.

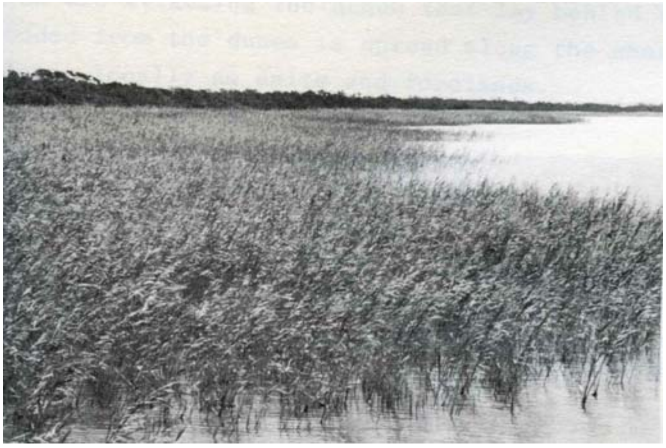

Plate 17 – Reedswamp encroachment, Lake Wellington (ECF Bird)

Plate 18 – Eroding swamp scrub land, Lake Victoria (ECF Bird)

A similar sequence of changes has occurred in other swamps that show die-back of scrub and replacement by salt marsh and salt pan. Analyses of the salinity of the soil solution under healthy *Melaleuca ericifolia*, compared with areas where it has die- back, showed that its limit of salinity tolerance lies in the range of 25º/oo to 30º/oo. In the areas where salt marsh plants have colonised soil salinity ranged up to 100V/oo, and a maximum of 180V/oo was recorded from the topsoil in the centre of one of the enclosed salt pans. Examination of salinity profiles beneath the salt pans indicated a diminution with depth (Figure 33). Salinity profiles under healthy *Melaleuca ericifolia* were contrasted neat the surface (generally less the 6º/oo) but similar depth, from which it was concluded that the accession of salt to the surface came from external sources by way of inundation and evaporation, rather than from any capillary elevation from saline deposits in the subsoil. The salinity increases has thus been derived from evaporation of flood waters from the lakes.

The deltas and swamps that border the Gippsland Lakes thus show evidence of changed conditions during the past decades. During the nineteenth century, following their discovery in 1839, the lakes were bordered by encroaching swamps and growing deltas, but during the present century there have been considerable changes, especially in swampy shores receding, following the disappearance of much of a former reedswamp fringe, and where there is evidence of damage to swamp vegetation by increasing salinity. The reasons for these changes will now be considered.

Plate 19 - The north shore of the Mitchell Delta at Point Lardner
Showing beach accretion on the western shore, the pattern of nearshore sand deposition, and irregular erosion in the background (N Rosengren)

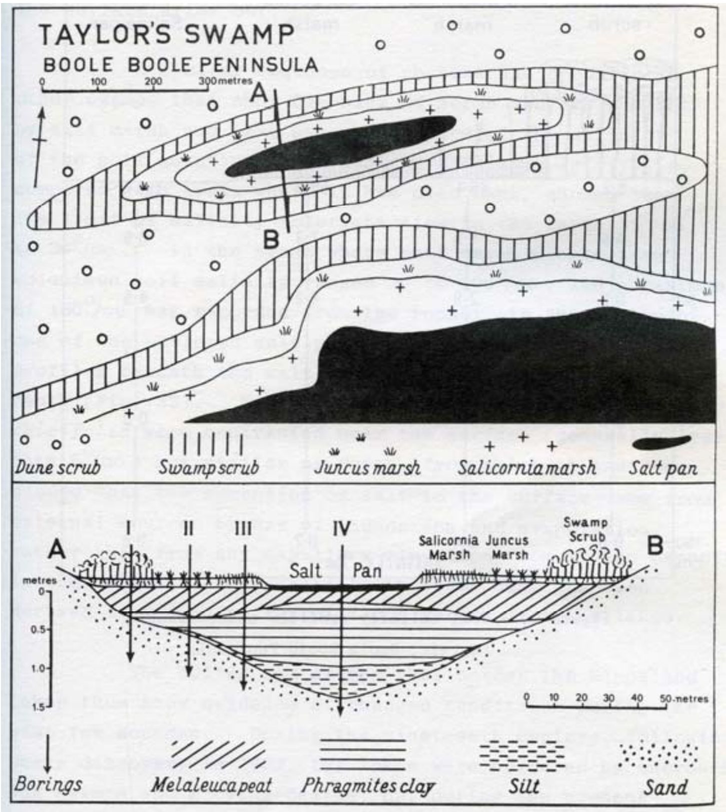

Figure 32

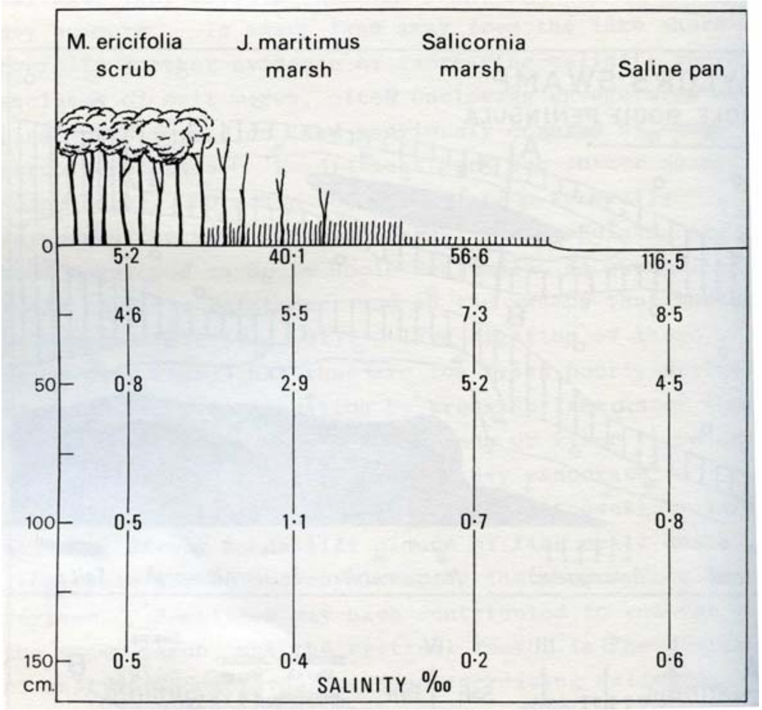

Figure 33 – Soil salinity profiles under swamp terrain, Boole Boole Peninsula