Poa clelandii
Dwarf Tussock

M.D. White
Cassia
calicantha
Nth
Bound
near

PAINKALAC CREEK WETLANDS AND FLOODPLAIN ENVIRONMENTAL STUDY

PREPARED FOR THE

PAINKALAC CREEK VALLEY STUDY STEERING COMMITTEE

BY:

ECOLOGICAL HORTICULTURE PTY. LTD.
BIOSIS RESEARCH PTY. LTD.
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SCAT ENVIRONMENTAL AND WASTE TREATMENT CONSULTANTS

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Plate 1. View from the Great Ocean Road, looking south east to the Aireys Inlet lighthouse, showing the Painkalac Creek estuary, coastal cliffs and dune shrubland.

PAINKALAC CREEK WETLANDS AND FLOODPLAIN ENVIRONMENTAL STUDY

ECOLOGICAL HORTICULTURE PTY. LTD.

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1.0 SUMMARY

(i) An environmental study of the Painkalac Creek floodplain, Aireys Inlet, Victoria, was carried out in late 1989 and early 1990.

(ii) Aspects investigated included geomorphology, soils, hydrology and water quality, flora, fauna, visual landscape, land use, aboriginal heritage values, planning and development issues.

(iii) The study area has high regional geomorphological significance.

(iv) Eutrophication of the waterways and wetlands is a problem in the study area.

(v) Soil erosion is widespread, particularly that associated with roading and visitor impact in Lorne-Angahook State Park.

(vi) Fifteen indigenous vegetation communities are described of which two have state significance, while most of the remainder have regional significance.

(vii) Birds, reptiles and mammals were surveyed. One bird species (Rufous Bristlebird) has high regional or state significance. Two mammals (Broad-toothed Rat and Koala) have regional significance. Wetland habitat in the study area has regional significance.

(viii) The Painkalac Creek valley is a highly significant landscape within the Aireys Inlet locality. Its scenic qualities are important elements in the identity and amenity of the townships of Aireys Inlet and Fairhaven. Surrounding forested hills are an important contributor to landscape quality.

(ix) Several Aboriginal middens occur in, or just outside, the study area.

(x) Land use and planning policies, and land management practices are reviewed along with developments proposed in the study area.

(xi) Existing and potential environmental problems are identified, especially as they relate to the proposed developments.

(xii) Recommendations are made for the protection of significant areas, environmental values, and land management and also, in respect of proposed developments. Additional environmental studies required are identified.

2.0 INTRODUCTION

This environmental study was commissioned by the Painkalac Creek Valley Study Steering Committee which is comprised of the Geelong Regional Commission, Shire of Barrabool, Department of Conservation, Forests and Lands (Geelong Region) and Aireys Inlet and District Association. The need for the study arose from increased local pressure to improve recreation and tourist facilities, to allow residential development on private property and to provide additional fire safety areas. Findings from this study are intended to provide base-line data and recommendations affecting the revised Structure Plan for the area, a major planning document currently in preparation by the Geelong Regional Commission.

In July 1989, Ecological Horticulture Pty Ltd, in conjunction with Biosis Research Pty Ltd and Context Pty Ltd, was commissioned by the client to carry out the environmental study. The brief was as follows:

1. Provide a detailed assessment of the area to determine its conservation value based on the following:

   (i) Flora
   (ii) Fauna
   (iii) Visual assessment
   (iv) Classification and significance of the area
   (v) Water quality
   (vi) Soils

2. Provide a comprehensive assessment of current land use and recreation in the area, including an assessment of the effects of these on the above features.

3. Provide a detailed assessment of the likely environmental effects of:

   (i) Residential or tourist development (on Allen's Land)
   (ii) A pedestrian link along the creek valley or other provision of public access
   (iii) The establishment of a cricket oval and associated facilities in the study area
   (iv) Filling part of the area adjacent to the Great Ocean Road, for use as a fire safety area.

4. Make recommendations for the future use of various parts of the study area and for purchasing any land for public ownership, with regard to the likely environmental effects, State Conservation policies and the Adopted Aireys Inlet to Eastern View Structure Plan Policies.

5. Identify any alterations considered necessary to the Adopted Aireys Inlet to Eastern View Structure Plan policies.

The general methods employed by the consultants in carrying out this study have been to review existing information, conduct field work to collect data, and to consult with the local authorities, the community and individuals with a knowledge of the biophysical resources of the area. Detailed methodologies are given in each section. We present the results of the study here and make recommendations in accordance with our findings and the study brief.

3.0 THE STUDY AREA

The coastal township of Aireys Inlet is approximately 120km south-west of Melbourne, at the eastern limits of the Otway Ranges (see Map 1). Painkalac Creek, which arises in the Ranges, flows into Loutit Bay on the west side of the township. The study area is the lower reaches of Painkalac Creek from the coast, northwards approximately 2.7 km, to the boundary of the Lorne-Angahook State Park.

The study area is largely comprised of the low-relief, alluvial floodplain and estuary of Painkalac Creek which is formed from Quaternary sediments (LCC 1973). Lower slopes of Cretaceous sandstones and mudstones (LCC 1973) occupy a very small part of the extreme north of the study area just outside Lorne-Angahook State Park. The southern limit of the study area is the crest of the high, steep-sided Quaternary calcareous-siliceous dune which flanks the coast; Painkalac Creek periodically breaks through this sand barrier to the sea. The maximum elevation of the study area is 15 m, in the extreme north abutting Lorne-Angahook State Park.

The area has a mild maritime climate and an average 724 mm of rain per annum measured at Eastern View, some 4 km west of Aireys Inlet (Australian Bureau of Meteorology 1977). Highest falls are in the months of April to November; the wettest month is August (average 86mm) and the driest is January (average 31mm). The Aireys Inlet area is in the rainshadow of the Otway Ranges.

Additional information on the physical environment and the biology of the study area is contained in the various sections of this report.

4.0 PHYSICAL ENVIRONMENT

4.1 Methodology

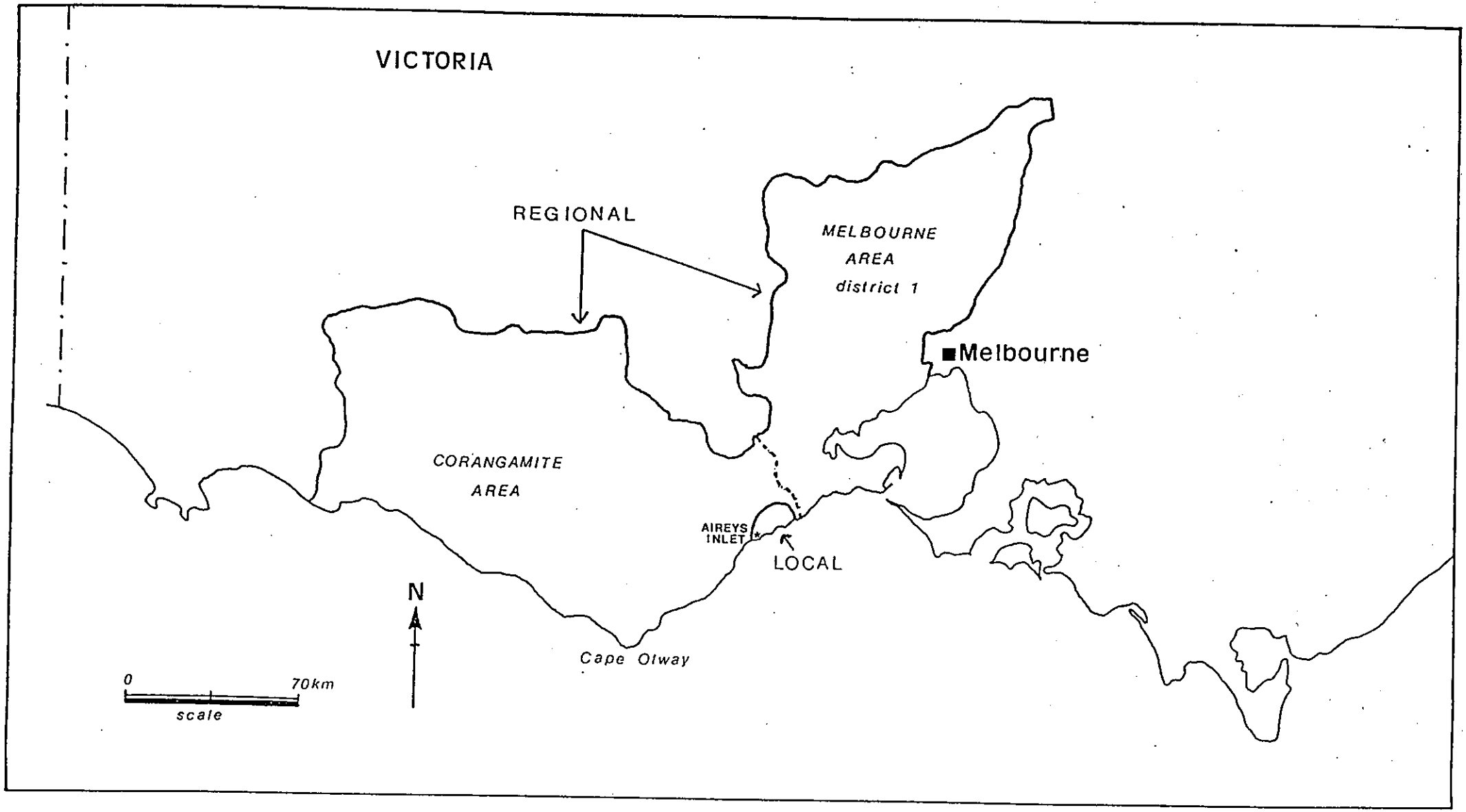
A review of documents covering the soils and geomorphology of the study area, Pitt *et al.*, (1977) and Pitt (1981), provided the primary sources of data for the study. A two day field-trip in the area on 25-26 October 1989 was devoted to field inspections covering as much of the study area as possible in order to confirm findings from the literature, to establish major soil types and landform elements and to provide an assessment of land degradation in the study area.

Aerial photographs were provided by the Geelong Regional Commission. Stereo pairs were not available at the required scale, and therefore aerial photo interpretation was limited to using stereo pairs at a smaller scale and a single colour aerial photograph at 1:25 000.

The soils are classified according to Northcote's Factual Key designations (Northcote 1974).

The land systems mapped by Pitt *et al.* (1977) and Pitt (1981) provided the basis for the three broad map units outlined in the study. The first unit encompasses the saltmarsh and herbfield area south of the Great Ocean Road and the *Poa* tussock-grassland north of the bridge, the second covers the grazed floodplain between Bambra Road and Painkalac Creek and the third unit covers the *Eleocharis* - *Myriophyllum* - *Villarsia* freshwater swamp north of Boundary Road.

Map 1. The study area, showing the location of Aireys Inlet in a regional context and the boundaries used for significance assessment



4.2 Geomorphological Setting

The South Victorian dissected fault blocks of the Otway Ranges, as described by Jenkin and Rowan (in press), are comprised of Lower Cretaceous feldspathic sandstone and mudstone. Painkalac Creek rises in these ranges to the north of Lorne. The creek then flows through the dissected South Victorian coastal plains (Jenkin and Rowan in press), on highly variable Eocene sediments of clayey silt, sand and gravel. The study area is situated within these coastal dissected plains on the Painkalac Creek floodplain. The creek flows to the sea past dunes which form the South Victorian barrier complexes (in press).

The mouth of Painkalac Creek is characterized by the presence of an intermittent sand barrier, its configuration and the hydrological regime are described in Section 4.7.1.

4.3 Map units

The map units recognized are summarized in Table 1 and described below.

Table 1. Map unit descriptions (physical environment)

MAP UNIT		DESCRIPTION
1	Geomorphology:	Estuary and lower floodplain
	Soils:	Saline, grey gradational soils
	Vegetation:	*Poa* grassland and saltmarsh
2	Geomorphology:	Floodplain
	Soils:	Yellow and yellow-brown sodic duplex soils
	Vegetation:	Pasture
3	Geomorphology:	Broad, seasonally-flooded drainage basin at extreme upper reaches of floodplain.
	Soils:	Grey, gradational soils
	Vegetation:	*Eleocharis* - *Myriophyllum* - *Villarsia* freshwater swamp

MAP UNIT 1:
(Comprising Areas A and B, Map 5)

Saline, grey gradational soils of the *Poa* tussock-grassland and saltmarsh of the estuary.

Soil description

These soils are derived from Recent Quaternary estuarine sand and silt sediments and organic matter. The surface texture is an organic silty clay to silty clay-loam overlying a grey and yellow mottled B horizon. Northcote's Factual Key designation (Northcote 1974) is Gn4.52.

Environment

The intermittent influx of estuarine saline water limits the development of soil structure thus imparting low mechanical strength. The tidal influence decreases further inland which is reflected in the absence of salt tolerant plant species. Soil permeability is low and site drainage is very poor. According to Pitt *et al.* (1977), these sodic subsoils with high saline groundwater tables are prone to soil compaction and structure decline.

MAP UNIT 2:
(Comprising Area C, Map 5)

Yellow and yellow-brown sodic duplex soils of the Painkalac Creek floodplain.

Soil description

The soils of the floodplain have a sandy-loam surface horizon which is typically dark-grey. This overlies a bleached A_2 horizon of sandy loam to sandy clay loam with occasional ironstone nodules occurring at the base of the horizon. The B horizon is a yellow-brown clay exhibiting brown and grey mottles at about 30cm, an indication of poor drainage. Sandy clay material is encountered at approximately 110cm.

Further up the valley on the creek terraces, remnants of a former floodplain, and to where the influence of the lower slopes of the lateritic plateau begin, the soil becomes more of a yellow-brown sodic duplex. The A horizon is a very dark-grey sandy loam over a dark-grey sandy clay loam A_2 horizon. This overlies a yellowish brown sandy clay of moderate structure with blocky smooth-faced peds. The B horizon is heavily mottled with black, grey and red mottles indicating seasonal waterlogging. At about 120 cm a calcareous clay parent material is encountered as described by Pitt (1981). Northcote's Factual Key designations include Dy5.22, Db4.31 and Dd4.22 (Northcote 1974).

Environment

This area is not subject to influxes of saline estuarine water. The soils of the floodplain are prone to soil salting, however, from a high, saline groundwater table. Some salt-tolerant plant species were identified on the floodplain. The sodic nature of the clay subsoils makes them prone to dispersion, and gullying and tunnel erosion can be a problem.

It is evident from the literature and field observations that the internal drainage (soil permeability) of the present floodplain is moderate for the A horizon, however the mottled clay B horizon indicates slow permeability, with the horizon remaining saturated for periods of a week or more. Site drainage overall is poor to imperfect (see Table 2 for an explanation of technical terms). In low-lying areas of the floodplain the water drains away very slowly in relation to supply, causing seasonal ponding, with all horizons remaining wet for periods of several months.

Site drainage for the creek terraces further north ranges from moderately well drained to imperfectly drained. Water is being removed slowly in relation to supply due to a shallow water table, lack of slope gradient and a dispersive sodic clay subsoil (Pitt *et al.* 1977). These soils are prone to compaction and sheet erosion.

MAP UNIT 3
(Comprising Area D, Map 5).

These soils were not investigated in detail but previous studies (Pitt *et al.* 1977, Pitt 1981) indicate these are grey, gradational soils similar to those in the estuary area except this is a freshwater environment. Northcote's Factual Key designation is Gn4.52

Soil description

The soils of this wetland site are permanently saturated and as such permeability is low and site drainage very poor.

Table 2. Definition of soil drainage terms (from McDonald *et al.* 1984)

INTERNAL SOIL DRAINAGE	
Class	**Definition**
Very poorly drained	The water table remains at or near the surface for most of the year
Poorly drained	All horizons remain wet for periods of several months
Imperfectly drained	Some horizons are wet for periods of several weeks
Well drained	Some horizons may remain wet for as long as one week after water addition
Rapidly well drained	No horizon is normally wet for more than several hours after water addition

EXTERNAL SOIL DRAINAGE	
Class	**Definition**
No run off - very slow	Free water on surface for long periods, or water enters soil immediately. Soils usually either level to nearly level or loose and porous
Slow	Free water on surface for significant periods or water enters soil relatively rapidly. Soils usually either nearly level to gently sloping or relatively porous
Moderately rapid	Free water on surface for short periods only, moderate proportion enters soil
Rapid	Large proportion of water runs off, small proportion enters soil. Water runs off nearly as fast as it is added. Soils usually have moderate to steep slopes and low infiltration rates
Very rapid	Very large proportion of water runs off; very small proportion enters soil. Water runs off as fast as it is added. Soils usually have steep slopes and low infiltration rates.

4.4 Geomorphological significance

The floodplain, estuary and associated features of Painkalac Creek have *high regional* geomorphological significance for the following reasons (N. Rosengren pers. comm.):

- Well developed floodplains and estuaries are rare in the eastern Otway Ranges.
- Blind estuaries are rare in the Otway Ranges.
- The channel morphology of Painkalac Creek and features of the floodplain are evidence of a different former course for the stream. This reflects a different past hydrological regime and higher sea level.
- The floodplain is likely to contain a range of sediments that would yield valuable fossil-pollen evidence, enabling reconstruction of pre-historic vegetation patterns and climates.

4.5 Land degradation

The gravel roads which run at right-angles to Bambra Road, such as Beach Road, are eroding. Run-off concentrated along the road-side has caused deepening of the gutters to such an extent that parts of some roads have caved in. The erosion of road gutters is evident where run-off is channelled underneath the road, via a culvert, to emerge further down the slope. This kind of road drainage reduces the extent of erosion but does little to ameliorate the erosion problem.

The gutters along Bambra Road are silting up with deposits of fine brown sand. Disturbance to the soil (such as clearance and excavation and use of heavy machinery associated with road and house construction) increases the exposure of surface soil and the physical pressure on soil. These disturbances have resulted in sheet and gully erosion in the new residential blocks along Bambra Road with the eroded material being deposited in the gutter.

The report by Manning *et al.*(1979) on the Painkalac Creek catchment expressed concerns about the capacity of the soils of the slopes adjoining the floodplain to cope with an increase in the amount of effluent. There is eutrophication occurring along the hillside gutter of Bambra Road. Septic tanks at present do not appear to provide adequate on-site effluent disposal for this residential area, and it appears that this waste water finds its way into Painkalac Creek. Eutrophication is further discussed in Section 4.7.

Cattle access to Painkalac Creek, and a number of smaller drains and creeks on the floodplain, is causing erosion along the stream banks. Damage caused by cattle trampling removes vegetation and exposes the soil to water erosion and causes slumping of banks. This eroded soil material is continually adding to the sediment load of Painkalac Creek.

To a lesser extent, the fill from the fire access road running off the Great Ocean Road on the west side of the floodplain, is another source of sedimentation to the creek. Rainfall washes the clay from the road fill out over the floodplain and eventually into the creek.

The freshwater wetland is under threat from increasing amounts of sediment deposition. It is evident from field observations that sediment and run-off from the eroding Lorne-Angahook State Park carpark, and from adjoining roads, run directly into the freshwater wetland. A number of the walking tracks above the wetland area are incised from intensive foot traffic. These tracks would also add to the run-off and siltation and therefore increase the potential to fill-in and severely modify the wetland environment.

4.6 Potential Development Constraints

The capability of the floodplain to sustain an effective septic tank system is poor (Pitt *et al.* 1977).

The effective functioning of on-site effluent disposal fields is dependent on a number of physical factors, such as soil drainage, soil permeability and depth to rock. Soil drainage is important because, when soils are saturated, septic tank effluent cannot be absorbed. The purification of effluent is poor if oxygen is lacking from the soil. Therefore septic absorption fields are likely to fail if the ground is continuously waterlogged for more than two to three weeks (Goss *et al.* 1987). Measured soil permeability or hydraulic conductivity is a measure of the capacity of soil to transmit fluids. The surface soils of the present floodplain have a moderate permeability, however this advantage is reduced by a dispersive sandy clay B horizon which has a low hydraulic conductivity. The A horizon is not deep enough to provide effective effluent purification before it reaches the impeding B horizon layer.

The soils of the creek terraces and lower slopes have similar properties to the soils of the floodplain. The on-site effluent disposal capability is higher however, because of better site drainage. The number of septic tank systems it could sustain is limited by its position in relation to Painkalac Creek. Saturation of the area with waste water could result in effluent flowing laterally along the sand-clay interface and polluting the groundwater and eventually the creek. This would result in a similar situation to that now prevailing in the residential area along the adjoining slopes.

The silty and organic topsoil of the estuary area makes construction of roads and building footings difficult because of its low cohesive strength, particularly when wet. The high, saline groundwater table creates drainage problems for construction in this area also.

Soil horizons:

A: Saline, grey gradational soils, site drainage is very poor

B: Saline, grey gradational soils, site drainage is poor

C: Yellow and yellow-brown, sodic duplex soils, site drainage ranges from moderate to poor.

D: Grey, gradational soils, site drainage is very poor.

4.7 HYDROLOGY AND WATER QUALITY

4.7.1 Hydrology

The hydrology of Painkalac Creek and its barrier estuary is complex. The flows within the lower, tidally-influenced portions of the estuary cover most of the study area and are controlled not only by stream flows from upstream catchments, but also by the degree of closure of the sand barrier at the mouth. The size and height of the sand barrier controls estuary water level and the amount of salt water able to enter the estuary, either over the top and/or through it by diffusion. The height of the bar is determined by longshore drift patterns, tidal conditions (i.e. spring and neap), prevailing winds and catchment-derived streamflow.

Generally, the bar could be expected to be partially breached naturally at least four to six times per year on average, with total breaching occurring only under extensive flooding generated by heavy rainfall, say once every 10 years.

On top of this natural regime, the bar has been artificially breached over many years by upstream land owners (D. De Bean pers. comm.; J. Allen pers. comm.).

The Shire of Barrabool now has an agreement with the other management parties (Rural Water Commission and Department of Conservation, Forests and Lands) to excavate a channel through the bar if the normal water level reaches an agreed level which gives concern for flooding. This normally occurs in late winter/early spring when the river flows are highest and the bar height probably greatest due to the predominant south-westerly longshore sand drift.

No data on the sand barrier or tidal inflow conditions were available for this study, but the barrier condition can be seen to have an extensive influence on the water quality of the estuary waters; this aspect needs monitoring.

The lower, and tidal sections of Painkalac Creek have freshwater supplied from a catchment of approximately 39.6 km^2. This includes the catchment of Distillery Creek covering about 17.7 km^2, which meets Painkalac Creek about 200m south west of the Old Coach Road crossing.

Flow gauging of Painkalac Creek was conducted by the State Rivers and Water Supply Commission at a station just upstream of Old Coach Road (Station number 235220), between the years of 1967 and 1974 (DNDE 1982). Records from this station indicate significant problems were encountered with monitoring high flows due to bypassing via an anabranch, plus problems of siltation of the gauging facilities making records unreliable (RWC 1989a). A new station was established immediately downstream of the dam site (station number 235232) in 1974, and good records exist through to the current period (RWC 1989b). This station does not cover the catchment of Distillery Creek.

Both catchments are predominantly forested and experience an average rainfall in the region of 600-700 mm year (LCC 1974). Prior to 1983 when records were started at the dam site, no official rain gauging was conducted in the area, with records at Anglesea and Lorne having to be relied upon (Tuddenham 1989).

The available data generally confirm that rainfall in the catchment has a fairly consistent pattern of maximum rainfall in winter-spring, followed by minimum rainfall in summer-autumn. The onset of wetter conditions is generally in late March or April (autumn).

The stream catchments are generally on fairly porous geologies of the lower Cretaceous felspathic sandstone and siltstones (Painkalac Creek), plus the Tertiary Lacustrine Paludal sediments of gravels, sands and clay (Distillery Creek). Consequently, the seasonality of flows mimics the rainfall pattern fairly well, with very low base flows in non-rain periods. Although the flows can be highly variable due to unseasonable falls, there is a definite trend for the streams to have nil or only nominal flows in the summer-autumn period. This ephemerality is fairly common for Victorian streams on rapidly draining soils and can extend from November into May.

However, this lack of surface flow may be compensated by a strong groundwater flow regime. Although there has apparently been no extensive groundwater hydrology studies undertaken, an indication of a very strong groundwater regime is recorded (Garlick and Stewart 1969) in a report to the Shire of Barrabool on water supply alternatives. The bore and testing program indicated a water supply almost good enough to be considered a viable alternative to the construction of the onstream reservoir.

The impact of the damming of Painkalac Creek in 1981 upon the seasonality of the surface flows has been to extend the period of nil or very low flow in autumn (despite some low flow releases), until the reservoir of 410 megalitres (Ml) is filled to overflowing. The length of this period of low flow downstream depends entirely on the degree of drawdown due to the high summer-autumn seasonal consumption, evaporation and losses to groundwater, plus the intensity of rainfall or runoff volume during the autumnal onset period. For example the flows of 357 Ml in a three day period in May 1978 would rapidly refill the reservoir to overflowing, but in May 1977 the maximum daily flow was only 8.4 Ml/day following an extended dry spell.

A very important issue concerns the magnitude of the 1 in 100 year (1%) flood flows, especially in relation to deciding the appropriateness of any building or development on or near the floodplain. With respect to high or flood flows, the maximum recorded instantaneous flow was 4051 Ml/day ($Q = 46.88\ m^3/sec$) on September 22, 1976. Given that this was generated from only about 69% of the catchment due to the exclusion of Distillery Creek catchment from the gaugings, it is strongly recommended that analysis of the flood frequency and identification of the 1% probability level for the flood plain be undertaken. (A stream management hydrologist or engineer would be responsible for such an undertaking which is outside the brief of the present study).

From the low-flow summer-autumn data and indications that the bar is likely to remain intact for most of the summer-autumn period, concern is expressed that there is likely to be little exchange (or dilution) of waters in the estuary during the period of highest occupancy. This would be likely to exacerbate any water quality problems that may arise from inputs of treated sewage effluent, sullage or contaminated runoff. As such, the most adverse water quality conditions in the estuary may be experienced in the period of highest water use. This is discussed further in Section 4.7.2.

4.7.2 Water Quality

The water quality of Painkalac Creek in the study area has not been comprehensively studied, despite a number of sampling programs that have been undertaken over the last 13 years. Being a predominantly brackish-saline estuary that periodically reverts to freshwater, it is important that any sampling program examines all the factors likely to affect the water quality.

These factors include:

(i) The state of the sand barrier and whether it has been breached, overtopped or indeed totally blocked, thus determining the amount of marine intrusion into the estuary. For instance, if a saline intrusion had become trapped for some time, there would be a strong likelihood of deoxygenation at the fresh-salt interface furthest inland.

(ii) The quality and quantity of the natural catchment flows, both high and low.

(iii) The quality of runoff from the urbanized land under rainfall conditions.

(iv) The quality of the water from local drains carrying treated sewage and/or sullage discharges.

(v) Prevailing weather conditions.

(vi) The seasonal population of the area.

WATER QUALITY MONITORING

There have been five water quality monitoring programs undertaken along Painkalac Creek by different agencies and people, none of which appear to give a comprehensive understanding of the processes within the estuary, or the water quality. The programs undertaken are:

(i) Rural Water Commission monitoring at the Painkalac gauging station site (No. 235232) between October 1976 and May 1987. Sampling was undertaken monthly on basic water quality parameters such as temperature, dissolved oxygen, turbidity, electro-conductivity and flow as part of the program. The data are too extensive to publish in this report but are available for perusal at the Rural Water Commission (RWC 1989c).

(ii) Catherine Yule (1978) studied the water quality at five sites on Painkalac Creek upstream and downstream of the dam site. As part of an integrated study looking at the potential impact of the construction works on the stream fauna, she looked at the inorganic ionic composition as well as temperature, suspended solids, dissolved oxygen and pH. The data are reproduced here from her report showing the ionic composition (Appendix 4). As well as collecting the above data, information on the detritis quantities was collected at each site.

(iii) The Shire of Barrabool has conducted two sampling programs, the first concentrating on *E. coli* at three sites between June 1977 and September 1981 (see Table 3). The second program of bi-monthly sampling at the same three sites started in May 1987 and continues through to today. This program sampled for biochemical oxygen demand, anionic surfactants and ammonia-nitrogen as well as for *E. coli*. The results from this program are given in Table 4.

(iv) The EPA have conducted two programs of sampling, both concentrating on the drainage inputs to the creek. The first looked at the water quality of the Fairhaven Drain while the second program looked at the inputs to the swamp at Alan Noble Reserve, south of the Great Ocean Road and just outside the present study area (EPA 1987).

(v) Aireys Inlet and District Association undertook a sampling program on the Aireys Inlet Drain to complement the EPA's first program, as a preliminary to town- planning and drainage appeals. Testing was conducted for BOD, *E. coli*, nitrate-nitrogen and total phosphorus on three occasions.

4.7.3 Discussion of Results

The sampling programs of the RWC (1989) and Yule (1978) give a fairly good insight as to the water quality of the input streams of Painkalac Creek and probably also Distillery Creek. It is apparent that the water generally has a higher electro- conductivity than, for example, an inland stream. There is also a trend for higher levels of conductivity in periods of low flow than in high flow, due primarily to dilution (Hynes 1970).

The source of higher salt levels could be attributable to the higher level of salts in the coastal rainfall compared to inland and also the natural corrosive processes in the catchment (Bayley and Williams 1973). These salts, as well as those marine salts derived through or over the sand barrier, contribute to the strong brackishness of the estuary. It is of interest to note the high levels of chloride detected by Yule (1978) (range 91-243 g/m^3, mean 142 g/m^3) in the streams, are a factor that will have a bearing on one of the parameters tested downstream (anionic surfactants).

From the RWC (1989) results, high turbidity levels under rainfall conditions (e.g. 385 FTU, 22/1/79) suggest that the soils of the catchment are highly erosive and are generally transported as two fractions - dispersive solids (e.g. as detected by the turbidity test) and as settleable solids (i.e. sands, etc.).

The colloidal or dispersed fraction will be generally transported to the estuary where, in an agglomeration process due to the influences of higher salinity, it will settle onto the bed of the estuary. This material can readily be resuspended under higher flow conditions and transported to sea. The settleable sands will generally remain in the estuary, be deposited on the flood plains or settle in the water supply reservoir upstream.

Another point of concern highlighted by Yule (1978) was the dependence of the instream invertebrate communities on the supply of detritus into the lower parts of the streams. The damming of Painkalac Creek will have cut off most of this supply, on which the invertebrate fauna rely for food. Such a depletion is likely to have an impact on the supply of food up the food chain to the fishery resource for which Painkalac Creek is renowned (Ministry for Conservation 1982, MacMillan *et al.* 1987), reflecting possibly in lower numbers of fish in the estuary. This potential problem should be investigated further.

Looking at the results of the first of the two sampling programs conducted by the Shire of Barrabool (Table 3) it can be seen that the levels of *E. coli* (an indicator of urban pollutants) are higher near the Bambra Road-Beach Road sampling site but generally decrease towards the mouth. However, it is important to stress that the levels encountered generally meet the Environment Protection Authority's (1988) water quality criteria of a geometric mean of 200 org/100 ml, for primary contact such as swimming. The *E. coli* levels found in the second phase are consistent with those found in the first phase at the mouth and the Great Ocean Road main bridge, but did show signs of increasing at the Bambra-Beach Roads site. This is consistent with the consultant's field observations of enriched wastewater flows in open drains and seepage through road cuttings at the point of the clay/sand interface in several locations.

The analyses for anionic surfactants (a main constituent of detergents) in the second phase are suspect, as levels greater than 0.2 g/m^3 are only found in streams with significant urban catchments. The high levels recorded (e.g. 3.7 g/m^3 at the Great Ocean Road bridge, 6/4/89) could therefore be due to probable high levels of chloride (from both catchment and sea), which have a known interference with the test method (APHA 1987, Marshall 1983). Similarly, there appear to have been problems with the biochemical oxygen demand testing on at least two occasions, with quoted results of less than 10 g/m^3 being recorded. Such results do not give a definitive description of the conditions, particularly when the average levels (without the two results above) are generally less than 2 g/m^3.

Generally, the BOD levels recorded (an indicator of organic pollution levels) are well within the recognized limits of the range for natural streams and could be regarded as having minimal organic pollution, whether from natural or urban sources. However, some higher levels (greater than 5 g/m^3) recorded at the Great Ocean Road bridge and Bambra Road sites indicate that at times there are organic loadings from the urbanized areas that impact on the estuary. Similarly, the ammonia - nitrogen levels show a wide range of variation (<0.05-3.1 g/m^3), from those which could be regarded as being at natural levels, to those which would indicate levels of waste inputs. Without testing of the coincidental levels of phosphorus and other nitrogen status, it is hard to paint a clearer picture of the nutrient status. The results do not auger well for the future, for as development progresses and more wastes are directed to the estuary, eutrophication conditions are more than likely to occur.

With regard to the testing programs, it is perhaps also unfortunate that none of the sampling programs included analysis of dissolved reactive phosphorus (as phosphate), plus coincidental recording of temperature, dissolved oxygen, conductivity or salinity profiles in the estuary. This information, together with flows and records of the sand barrier activity, would have clarified the processes affecting water quality in the estuary.

It is recommended that any new or ongoing sampling program should include these parameters.

The results of the EPA programs and those from the Aireys Inlet and District Association confirm what is generally known - that the local drains are carrying reasonably low levels of treated effluent. This is indicated by the low BOD's and generally low *E. coli* levels, considering raw septic effluent normally has a level of 10^5-10^6 organisms/100 ml. The source of these discharges is obviously from both domestic and commercial premises, where either septic tank and soil absorption systems or septic and sand filter/treatment plants are used to treat the wastes off-site.

Overall, from the results to hand, despite the deficiencies in the various monitoring programs, it can be said that although there are definitely wastewaters being directed to the estuary, these do not appear to be having a significant impact on the estuary at present. This statement is qualified by the fact that the deficiencies in the programs may mean that the true picture is not being detected, particularly at the critical time of summer and autumn - i.e. maximum occupation of tenements coupled with periods of lowest flow.

However, there may also be some logical explanations for the apparent lack of impact of the wastes on the estuary. The first is the fact that most of the wastes discharge to either wetlands or marshy margins of the flood plain rather than directly to the estuary. Research work has shown that such wetlands are very efficient `treatment cells' and can act as nutrient sinks (Finlayson *et al.* 1986, Bavor *et al.* 1981). However, the effectiveness of smaller wetlands can be taxed under higher flow conditions but the benefits of wastewater assimilation, particularly during the late spring, summer and autumn, should not be overlooked. It is recommended that the wetland `treatment cells' be made more effective at the main drainage outlet points, e.g. made larger by revegetation with indigenous plants.

Another factor which mitigates the effect or degree of pollutants entering the estuary is the climatic conditions usually encountered during the time of highest occupation of the town. The extensive dry period with high evaporation and irradiation, helps to lessen the quantity of wastes entering the river through evapo- transpiration, and what does reach the river undergoes strong oxidation and irradiation, a factor that lowers bacterial and organic levels through exposure to ultra-violet light and metabolic processes in a well oxygenated water body.

Without these mitigating effects and that due to dilution, the estuary would be in a poor condition due to the polluting inputs. Again, sufficient indication is given by some of the results such as the 54,000 orgs/100 ml *E. coli* reading (BOD of 6 g/m^3) at the Bambra Road site (5/6/87), that waste inputs can and will have an impact at certain times. As the development of the area proceeds it will be paramount that a reticulated sewerage scheme is developed to limit this impact. The post Ash Wednesday development has seen the building of more premises with off-site discharge of wastes after treatment. Although the attenuation given by the wetlands appears to be currently effective, this capacity should not be relied upon. The lead time to bring a sewage reticulation scheme to fruition will be at least two to five years and further subdivisions or major developments should not be considered until it is available. Government policy support for provision of sewerage reticulation can be found in the State Environment Protection Policy - Waters of Victoria (EPA 1988). Clauses 40 a and 40 c *inter alia* of that policy state:

40. Provision of sewerage

(a) Responsible authorities shall ensure new subdivisions of land are provided with sewerage at the time of sub-division or that the allotments created by the subdivision are capable of adequately treating and retaining domestic wastewater within the boundaries of each allotment.

(c) Sewerage shall be provided as soon as possible to all existing subdivisions of land where domestic wastewaters cannot be adequately treated and retained within the boundaries of each allotment. Where possible, sewerage shall be provided prior to the commencement of building works. High priority should be given to sewering existing sub-divisions where building works have already commenced.

Care must be taken to ensure that the design of the sewerage reticulation scheme gives the creek *full* protection from effluent discharge otherwise its primary aim will be defeated. In particular, the design of the pumping stations at or close to the flood plain should ensure that the pump wells have at least a day's storage, so that in the event of breakdown or power failure there is sufficient storage to prevent discharge to the creek. Facilities such as high level telemetry alarm and auxiliary pumping capacity should also be considered. Similarly, any relief structures in the system should have telemetry alarms.

Treatment of the effluent in the sewerage reticulation scheme must also preclude any option of discharge of effluent back to the estuary. In this regard it is understood that the current design proposes to rely upon a lagoon system, whereby evaporation is the principal disposal mechanism.

In the interim, before the establishment of the sewerage reticulation scheme, it will be encumbent on the EPA and the Shire of Barrabool to ensure that every domestic, commercial or public waste-treatment facility performs to the optimum, and where possible, utilizes any on-site disposal capacity.

4.7.4 Summary of Water Quality

The water quality of the estuary of Painkalac Creek in the study area is generally good, meeting the water quality criteria for primary contact for the period of existing records. However it is apparent that occasional discharges from the surrounding urban developments lower this quality sufficiently to give rise for concern about the potential adverse impact of a fully developed scenario without sewerage reticulation.

5.0 VEGETATION SURVEY

5.1 Methods

5.1.1 Field work

Botanical field work was carried out on the 6 and 7 of December, 1989. Data were collected from 36 circular quadrats of 30 m diameter. In each quadrat all vascular plant species were recorded and assigned a visually-assessed cover/abundance value from the modified Braun-Blanquet scale (Gullan 1978):

+ cover 5%, few individuals
1 cover 5%, any number of individuals
2 cover 5-20%, any number of individuals
3 cover 20-50%, any number of individuals
4 cover 50-75%, any number of individuals
5 cover 75-100%, any number of individuals

Notes were made on the environment and other features of relevance in the vicinity of each quadrat. Plant species not recorded from within quadrats were also listed to compile a comprehensive floristic inventory.

Several plant species recorded in the study area by Mary White (pers. comm.) but not seen during this study, were added to the inventory of species.

Taxonomic nomenclature follows Forbes and Ross (1988) or Carr (unpubl.) (orchids).

5.1.2 Data storage and analysis

All quadrat data have been stored permanently on magnetic disc at Ecological Horticulture Pty Ltd and with the Flora and Fauna Survey Group, Department of Conservation, Forests and Lands, Kew. Analysis was in the form of a computer-based numerical classification procedure, coupled with hand-sorting, as outlined by Gullan (1978).

This produces a two-way table which contains all species that occurred in more than 35% of quadrats and arranges them according to quadrat similarity and plant groups commonly found in association.

The two-way table (Table 6) is set out in the following manner:

The numbers across the top represent quadrat sites, each vertical column of figures represents a list of the species found at one site, and each horizontal row of figures represents all the sites at which a given species was recorded.

If a species occurred in less than 35% of quadrats but its occurrence was ecologically significant, it was also included in the table.

Table 6. Two-way table of vegetation communities recorded in the Painkalac Creek floodplain study area, Aireys Inlet, Victoria, December 1989

* Denotes introduced species

	COMMUNITIES	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	QUADRATS	DD 11 99 00 25 45	DDDDD 11111 99999 00000 23344 33414	DDDDD 11111 99999 00000 22233 12557	D 1 9 0 2 6	D 1 9 0 4 5	D 1 9 0 4 3	DD 11 99 00 33 06	D 1 9 0 4 2	DDDDD 11111 99999 00000 23334 92890	D 1 9 0 3 1	DDD 111 999 000 255 734	D 1 9 0 4 7	DD 11 99 00 44 89	DDDD 1111 9999 0000 2555 8012	D 1 9 0 4 6
2979	Ruppia polycarpa	53														
2197	Mimulus repens	+1	1	1 +												
1076	Distichlis distichophylla	1	1211	13211	3	1	1			1 ++1		1				
3449	Triglochin striata	21	1 2	2								+	2			
3100	Selliera radicans		11 11	111+1	1											
3001	Samolus repens		33124	23121	1	1	1	21								
3012	Sarcocornia quinqueflora		433+4	2+ +												
1826	Juncus kraussii		+1212	52253	1	2	1	11		1		1				
1772	Isolepis cernua		+11 1	+ 1						1		+			1	
2640	*Polypogon monspeliensis		+11 1	+1 +1	1	+	1	+		1		1+				
2834	Puccinellia stricta		11 1	11												
297	*Aster subulatus		11	+1 12	1			+		+		1				
2553	*Plantago coronopus		1311	3211	1	2						11				
3203	*Sonchus asper		1+ 1	+		+		1	1	++2					1 +	
329	*Atriplex prostrata		++ 1	1+ 1			1	2							+	
2418	*Parapholis incurva		1+ 1	2		+				+		1				
848	*Cotula coronopifolia		1+ +	+ 11				1				+11				
4444	Epilobium billardierianum ssp. bill.		1+ +	11		1	2	1+		2		1 1				
247	Apium prostratum		1+ 1	12 11	1											
1702	*Critesion marinum		+1							+ 1		1				
151	Agrostis avenacea		1 1	2+11	1							1	1	+	1	+
3107	Senecio gloneratus		1	+ 1	1					+ 11					+	
2060	*Lotus hispidus		111+	1 2		2		1		12112	1	111	1		1 1	+
2605	Poa poiformis		12+	2 +2	2	5	1		2			1				
1782	Isolepis nodosa		1	12+4	+	1	1	1	2	+ 1		12			1	
705	*Centaurium tenuiflorum		1	11	+	1			+	1 +						
2092	Lythrum hyssopifolia		1	1			1			1		111				
3204	*Sonchus oleraceus		1	+ 1	+			+	1	1++1	+	+			1++1	
1830	Juncus ?pallidus		1	1						1		1			11	
2239	Myoporum insulare			+		1			2	1+					+	
1139	Eleocharis acuta		1							+		554			1	
1389	Gahnia filum		1	21	1	1										
1036	Dichondra repens			1 +					1	1 11					1	
2497	Phragmites australis			1				55		1					1	
1987	Leucopogon parviflorus			1					2	111						
4445	Epilobium billardierianum ssp. ciner.			1 +	1	1				2						
2561	*Plantago lanceolata			+				1	1	31 2					11 1	
223	*Anagallis arvensis			1		1			1	11111	+				+	
623	Carex appressa						1	1				22	1		1 3	
1432	Geranium retrorsum								1	1 1	1				1+	1
1956	Leptospermum juniperinum									+ +2+			2	+	23	
2600	Poa labillardieri							1		54342	1	11			4 11	
1616	Helichrysum dendroideum				1		1			1113+					21	
1692	*Holcus lanatus				+	1	1			11112	2	122	+		22+3	1
1748	*Hypochoeris radicata								+	2 12					11+1	1
105	Acaena anserinifolia									2211	1				11	
770	*Chrysanthemoides monilifera									332	1				1	+
2179	Microlaena stipoides									1123					1211	
2381	Oxalis exilis									1++		1			+1	
2959	*Rubus procerus									1+ 1	1				1 1	
57	Acacia melanoxylon									321					1211	
1307	Eucalyptus ovata						1								41	
100	Acacia verticillata									2					222	
2777	Pteridium esculentum				+			1			5				1211	1
1775	Isolepis fluitans												+	2		
211	Amphibromus recurvatus											21	2	2		
1146	Eleocharis sphacelata													14		
3448	Triglochin procera											+		33	1	
3521	Villarsia reniformis												1	51		
3873	Myriophyllum simulans													44		
1779	Isolepis inundata												1	1	1	
2153	Melaleuca squarrosa												3	1	2	
1323	Eucalyptus viminalis														44	1
1317	Eucalyptus sideroxylon													4		4

5.1.3 Vegetation terminology

The terminology used for the vegetation classification follows Gullan *et al.* (1981) viz:

Community: A collection of one or more quadrats with floristic and environmental affinities. The communities may represent highly discrete vegetation types with sharp boundaries, or more-or-less arbitrary divisions drawn for convenience along a floristic continuum to delimit vegetation.

Character species: A species that occurs frequently and consistently in the quadrats of a community. It is often a useful indicator species of that community - alone or when considered with a suite of other character species. Depending on the data set, character species usually occur in upwards of 25% of quadrats.

5.1.4 Vegetation mapping

Vegetation of the study area was mapped according to the vegetation classification, field knowledge and reference to the available air photo of the study area. At that scale (1:10 000) insufficient resolution was available to delimit all units or communities, hence the vegetation map (Map 2) is provisional.

5.1.5 Assessment of significance

Significance in the biological context has a similar meaning as in general use: *significant* is defined as meaning noteworthy or of considerable importance (Oxford Dictionary). Sites of botanical significance, for example, being areas where features of the vegetation meet defined botanical criteria.

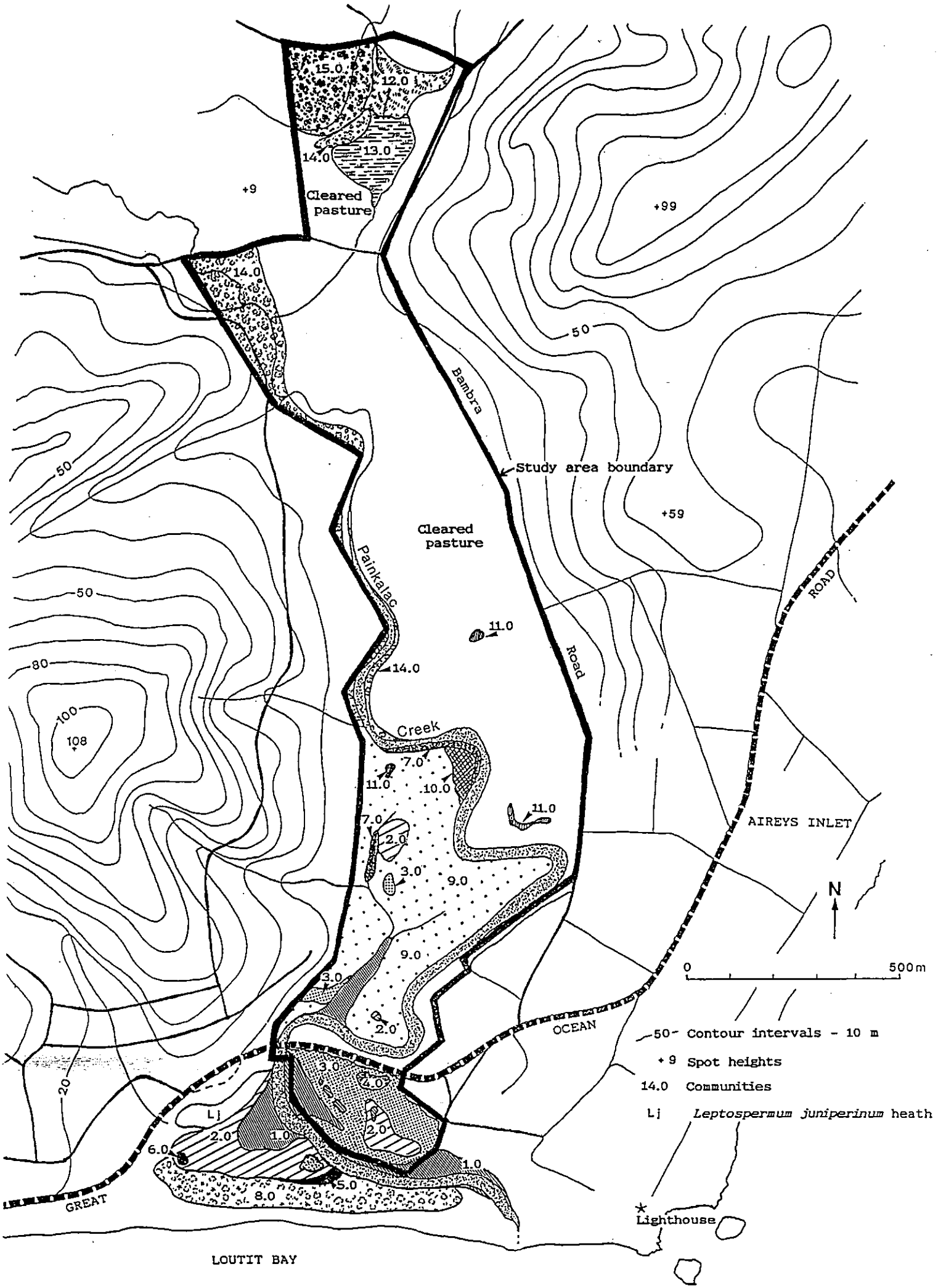
These assessments are independent of land-use classifications (e.g. biological reserves) or land ownership (e.g. public or private), instead being an assessment of the qualities of the remnant indigenous vegetation in the context of its current distribution, conservation status and integrity.

Significance has two components - scale and degree. The assessment of *degree* of significance (e.g. high or moderate) is based on the values of the site in relation to the overall distribution, condition or importance of sites possessing these values - within the range delineated by the *scale* of reference, i.e. national, state, regional or local. In general usage, scale and degree are combined into levels of significance denoted by scale alone. In the context of the present study the following areas apply to the scale of significance (see Map 1):

Local: Shire of Barrabool

Regional: Aireys Inlet falls within the Land Conservation Council Melbourne Study area, District 1, for which Beauglehole (1983) has made an assessment of the conservation status of the flora. Biogeographically however, the Aireys Inlet - Anglesea area is in the Otway Ranges which forms part of the LCC Corangamite Study area for which Beauglehole (1980) has also made conservation assessments for the flora. Therefore, the assessment of Regional significance in this report covers those parts of the broad Otway Ranges region which fall within the Melbourne and Corangamite LCC Study Areas.

State: Victoria.



Map 2. Location of vegetation communities sampled in the Painkalac Creek floodplain study area December 1989

Plant species

The assessment of significance of plant species recorded from the site during this study is based on the application of one or more of the following criteria:

- Formerly widespread in Victoria, but now seriously depleted in Victoria or the region through habitat destruction or degradation;
- Uncommon or rare in Victoria;
- Remnant population(s) with important information content on floristics of regional vegetation;
- Potentially valuable source of propagation material for revegetation or species-enrichment planting locally;
- Taxonomically, ecologically or biogeographically interesting.

Vegetation communities

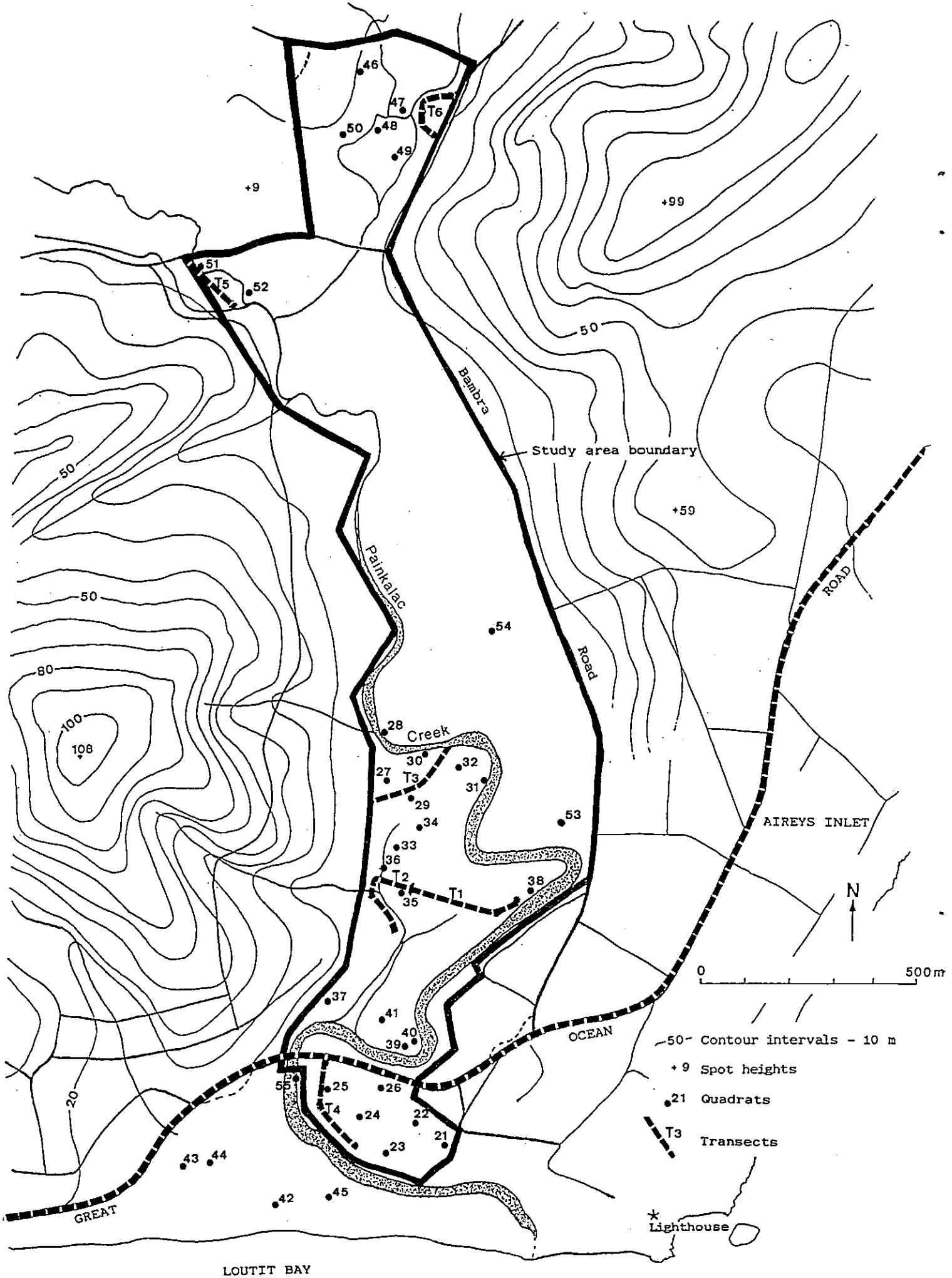
The significance of the vegetation communities identified during this study have been assessed according to the following criteria:

- Distribution and abundance in the study area, the region and in Victoria;
- Degree of depletion since European settlement;
- Their reservation status - representation in biological reserves;
- Vulnerability to weed invasion;
- Number and ranking of significant species occurring in the community;
- Extent of contiguous vegetation of comparable floristic composition and structure.

Sources of information include the botanical literature, but in particular Beauglehole (1980, 1983, in prep.) and Carr and Robinson (1989). Further information was gained from communication with other botanists (especially Mary White of Anglesea) and from our unpublished records. The results are presented in Section 5.2 and Appendices 1 - 3.

5.1.6 Limitations

Although the time of year of vegetation sampling was ideal for many seasonal species, some lacked fertile material, preventing identification to species level thus the generic name only is given. Time allocated to sampling also limited the extent of the survey. The floristic inventory is therefore not necessarily complete.



Map 3. Quadrat sites and mammal sampling transects in the Painkalac Creek floodplain study area, December 1989

5.2 Vegetation of the study area

5.2.1 Plant species

Statistics for the vascular flora of the study area are given below in Table 5. The species are listed in Appendix 1 under families and genera; the list is not intended as a definitive inventory of the flora.

Table 5. Statistics for the vascular flora recorded in the Painkalac Creek floodplain study area, Aireys Inlet, Victoria, December 1989.

Total number of species recorded	299
Number of indigenous species	185 (62%)
Number of exotic species	114 (38%)

5.2.2 Vegetation communities

Fifteen vegetation communities are recognized in the study area:

Community 1.0: Submerged Saline Herbfield

Community 2.0: Saltmarsh Complex

Community 3.0: *Juncus kraussii* (Sea Rush) Herbfield

Community 4.0: *Baumea juncea* (Bare Twig-rush) Herbfield

Community 5.0: *Poa poiformis* (Coast Tussock-grass) Grassland

Community 6.0: *Typha* (Cumbungi) Herbfield

Community 7.0: *Phragmites australis* (Common Reed) Grassland

Community 8.0: Coastal Dune Shrubland

Community 9.0: *Poa labillardieri* (Common Tussock-grass) Grassland

Community 10.0: *Pteridium esculentum* (Common Bracken) Herbfield

Community 11.0: *Eleocharis acuta* (Common Spike-rush) Herbfield

Community 12.0: *Melaleuca squarrosa* (Scented Paperbark) - *Leptospermum juniperinum* (Prickly Tea-tree) Shrubland

Community 13.0: *Eleocharis sphacelata* (Tall Spike-rush) - *Myriophyllum simulans* (Water-milfoil) - *Villarsia reniformis* (Running Marsh-flower) Freshwater Herbfield

Community 14.0: Riparian Complex

Community 15.0: *Eucalyptus sideroxylon* (Red Ironbark) Open Forest

5.2.3 Community descriptions

The summary sheets which follow - derived from the two-way table (Table 6) - are presented as the primary means for describing the vegetation communities. The information on each sheet is as follows:

- Community name and structure
- Character species - species that occur consistently in the community, along with their frequency of occurrence
- Cover/abundance (C/A) value
- Floristic-richness and weed composition
- Altitude
- Environment

At least one vegetation community (heathland adjoining the Great Ocean Road west of the bridge) was not sampled because of time limitations.

Table 8 summarizes the information for each community and gives additional information including pre-European and current distribution, number and ranking of significant species, vulnerability to weed invasion, degree of disturbance and/or degradation in study area, reservation status in region, botanical significance and references for each community.

COMMUNITY SUMMARY SHEETS

Community 1.0: Submerged Saline Herbfield

Character Species	%Freq	C/A
Ruppia polycarpa	100	4
Triglochin striata	100	2
Mimulus repens	100	1
Lepilaena cylindrocarpa	50	2
Potamogeton pectinatus	50	2
Distichlis distichophylla	50	+

No. of Quadrats: 2 (24, 55)

Structure: Open herbfield of submerged aquatic macrophytes.

Environment: Shallow, seasonally inundated depression in saltmarsh and the estuary of Painkalac Creek with seasonally, strongly fluctuating water levels; water brackish from 10 to at leat 100cm deep; becoming hypersaline in shallow saltmarsh pools (before drying out in late spring or early summer). Fine, silty clay soils.

Altitude: Mean 0m

Mean Floristic Richness: 4 species per site

Mean Weed Composition: 0 species

Community 2.0: Saltmarsh Complex

	Character Species	%Freq	C/A
✓	*Samolus repens*	100	3
✓	*Sarcocornia quinqueflora*	100	3
✓	*Juncus kraussii*	100	2
✓	*Distichlis distichophylla*	80	1
	**Lotus hispidus*	80	1
	**Plantago coronopus*	80	1
✓	*Selliera radicans*	80	1
✓	*Isolepis cernua*	80	1
	**Polypogon monspeliensis*	80	1
✓	*Poa poiformis*	60	1
	**Sonchus asper*	60	1
✓	*Apium prostratum*	60	1
✓	*Puccinellia stricta*	60	1
✓	*Epilobium billardierianum* ssp. *billardierianum*	60	+

No. of Quadrats: 5, (23, 33, 34, 41, 44)

Structure: Mostly herbfield

Environment: Infrequently inundated flood plain and estuarine flats; sub-saline conditions; adjacent to *Poa labillardieri* grassland at higher levels. Dark, organic-rich,silty loams to cracking, dark grey clay loams.

Altitude: Mean 1.6 m, range 0.5 - 2 m

Mean Floristic Richness: 21 species per site

Mean Weed Composition: 7 species per site, 5% cover.

* An asterisk denotes exotic species.

Community 3.0: *Juncus kraussii* (Sea Rush) Herbfield

	Character Species	%Freq	C/A
✓	*Juncus kraussii*	100	4
✓	*Distichlis distichophylla*	100	2
✓	*Samolus repens*	100	2
✓	*Selliera radicans*	100	1
✓	*Poa poiformis*	60	2
	**Plantago coronopus*	80	2
✓	*Isolepis nodosa*	80	2
✓	*Agrostis avenacea*	80	1
	**Polypogon monspeliensis*	80	1
	**Aster subulatus*	80	1
✓	*Apium prostratum*	60	1
	Centaurium spicatum	60	1
✓	*Sarcocornia quinqueflora*	60	1
	**Atriplex prostrata*	60	1

No. of Quadrats: 5 (21, 22, 25, 35, 37)

Structure: Dense herbfield

Environment: Infrequently inundated with brackish water. Relatively dry upper margins of estuary and creek flats. Waterlogged, organic-rich clay loams to drier, cracking grey sandy clay loams.

Altitude: Mean 1.0, range 0.5 - 2.0 m

Mean Floristic Richness: 24 species per site

Mean Weed Composition: 7 species per site, 5% cover.

Community 4.0: *Baumea juncea* (Bare Twig-rush) Herbfield

Character Species	%Freq	C/A
Baumea juncea	N/A	5
Distichlis distichophylla		3
Poa poiformis		2
Agrostis avenacea		1
Gahnia filum		1
Juncus kraussii		1
Samolus repens		1
Selliera radicans		1
Sonchus ?hydrophilus		1

No. of Quadrats: 1 (26)

Structure: Dense herbfield

Environment: Relatively dry upper reaches of estuarine flats. Sandy clay loams subject to infrequent or rare inundation with brackish water.

Altitude: 1.0 m

Floristic Richness: 19 species per site

Weed Composition: 6 species per site, 5% cover.

Community 5.0: *Poa poiformis* (Coast Tussock-grass) Grassland

Character Species	%Freq	C/A
✓ *Poa poiformis*	N/A	5
✓ *Juncus kraussii*		2
**Lotus hispidus*		2
✓ *Melaleuca lanceolata*		2
**Plantago coronopus*		2
✓ *Distichlis distichophylla*		1
✓ *Gahnia filum*		1
✓ *Helichrysum dendroideum*		1
✓ *Isolepis nodosa*		1
✓ *Myoporum insulare*		1
✓ *Samolus repens*		1
✓ *Epilobium billardierianum* ssp. *billardierianum*		1
✓ *Epilobium billardierianum* ssp. *cinereum*		1

No. of Quadrats: 1 (45)

Structure: Dense tussock grassland

Environment: Zone between dune shrubland and saltmarsh apparently subject to rare inundations with brackish water. Well structured brown loamy soils.

Altitude: 1.0m

Floristic Richness: 23 species per site

Weed Composition: 10 species per site, 5% cover.

Community 6.0: *Typha* (Cumbungi) Herbfield

	Character Species	%Freq	C/A
✓	*Typha domingenisis*	N/A	5
✓	*Epilobium billardierianum* spp. *billardierianum*		2
✓	*Epilobium hirtigerum*		2
✓	*Juncus subsecundus*		2
✓	*Carex appressa*		1
	**Festuca arundinacea*		1
	**Melaleuca parvistaminea*		1
✓	*Samolus repens*		1

No. of Quadrats: 1 (43)

Structure: Dense herbfield

Environment: Seasonally inundated with freshwater in extreme upper zone of saltmarsh. Silty, clay-loam soils.

Altitude: 3m

Floristic Richness: 17 species per site

Weed Composition: 6 species per site, 10% cover

Community 7.0: *Phragmites australis* (Common Reed) Grassland

Character Species	%Freq	C/A
✓ *Phragmites australis*	100	5
✓ *Juncus kraussii*	100	1
✓ *Samolus repens*	100	1
✓ *Epilobium billardierianum* ssp. *billardierianum*	100	1
✓ *Eucalyptus ovata*	50	1
✓ *Helichrysum dendroideum*	50	1
✓ *Gynatrix pulchella*	50	1
**Atriplex prostrata*	50	2
**Vicia tetrasperma*	50	2
**Rumex crispus*	50	1
**Lotus pedunculatus*	50	1
✓ *Poa labillardieri*	50	1

No. of quadrats: 2 (30, 36)

Structure: Grassland

Environment: Seasonally waterlogged drainage lines or margin of creek with +/- permanent inundation of fresh or slightly brackish water. Organic-rich, grey, silty clay-loam soils.

Altitude: Mean 2.5m, range 2 - 3 m.

Mean Floristic Richness: 16 species per site

Mean Weed Composition: 9 species per site, 20% cover.

Community 8.0 Coastal Dune Shrubland

Character Species	%Freq	C/A
✓ *Isolepis nodosa*	N/A	2
**Lagurus ovatus*		2
✓ *Lepidosperma gladiatum*		2
✓ *Leucopogon parviflorus*		2
✓ *Melaleuca lanceolata*		2
✓ *Myoporum insulare*		2
✓ *Poa poiformis*		2
✓ *Stipa flavescens*		2
✓ *Acacia sophorae*		1
✓ *Elymus scabrus*		1
✓ *Carpobrotus rossii*		1
✓ *Muehlenbeckia adpressa*		1
✓ *Olearia axillaris*		1
✓ *Pimelea serpyllifolia*		1
✓ *Pteridium esculentum*		1

No. of Quadrats: 1 (42)

Structure: Open shrubland with a dense herbaceous field layer

Environment: Moderately steep, northerly aspect of secondary dune. Deep, calcareous sandy soils. Burnt in 1983.

Altitude: 7m

Floristic Richness: 35 species per site

Weed Composition: 13 species per site, 10% cover

Plates: Plate 2

Plate 2. View north-west from coastal dune showing Coastal Dune Shrubland in foreground, saltmarsh complex (before and beyond water of creek) and the township of Fairhaven in the background. Note invasion of environmental weeds in foreground (**Polygala myrtifolia* (Myrtle-leaf Milkwort) and **Lagurus ovatus* (Hare's Tail) - grass at left).

Plate 3. *Poa labillardieri* (Common Tussock-grass) Grassland in Area B with scattered shrubs of *Helichrysum dendroideum* (Tree Everlasting) and *Cassinia aculeata* (Common Cassinia).

Community 9.0: *Poa labillardieri* (Common Tussock-grass) Grassland

Character Species	%Freq	C/A
✓ *Poa labillardieri*	100	5
**Lotus hispidus*	100	2
✓ *Helichrysum dendroideum*	100	2
**Holcus lanatus*	100	1
✓ *Acacia melanoxylon*	80	2
✓ *Acaena anserinifolia*	80	2
✓ *Microlaena stipoides*	80	2
**Bromus hordeaceus*	80	1
**Chrysanthemoides monilifera*	80	3
**Sonchus oleraceus*	80	1
✓ *Dichondra repens*	80	1
✓ *Distichlis distichophylla*	80	1
✓ *Leptospermum juniperinum*	80	1

No. of Quadrats: 5 (29, 32, 38, 39, 40)

Structure: Dense tussock grassland with occasional shrubs.

Environment: Floodplain, apparently with watertable near surface: grey sandy or silty alluvial clay-loam or brown clay-loams.

Altitude: Mean 3 m, range 2 - 5 m

Mean Floristic Richness: 32 species per site

Mean Weed Composition: 15 species per site, 15% cover.

Plates: Plate 3

Community 10.0: *Pteridium esculentum* (Common Bracken) Herbfield

Character Species	%Freq	C/A
✓ *Pteridium esculentum*	N/A	5
**Holcus lanatus*		2
**Chrysanthemoides monilifera*		1
✓ *Clematis aristata*		1
✓ *Poa labillardieri*		1
**Lotus hispidus*		1

No. of Quadrats: 1 (31)

Structure: Dense herbfield

Environment: Elevated, well-drained site on alluvial floodplain, more elevated than surrounding *Poa labillardieri* grassland; friable sandy clay-loam soils.

Altitude: 4 m

Floristic Richness: 11 species per site

Weed Composition: 6 species per site, 6% cover

Community 11.0: *Eleocharis acuta* (Common Spike-rush) Herbfield

Character Species	%Freq	C/A
✓ *Eleocharis acuta*	100	5
**Holcus lanatus*	100	2
✓ *Lythrum hyssopifolia*	100	1
**Cotula coronopifolia*	100	1
**Leontodon taraxacoides*	100	1
**Lotus hispidis*	100	1
**Rumex crispus*	100	1
**Briza minor*	100	1
**Plantago coronopus*	100	1
**Polypogon monspeliensis*	100	1
✓ *Carex appressa*	67	2
✓ *Montia australasica*	67	2
✓ *Amphibromus* sp.	67	1
✓ *Poa labillardieri*	67	1
✓ *Isolepis nodosa*	67	1

No. of Quadrats: 3 (27, 53, 54)

Structure: Dense herbfield

Environment: Seasonally inundated depressions (freshwater) or drainage lines on floodplain; some subjected to cattle grazing. Dark grey clay-loam soils.

Altitude: Mean 6m, range 5 - 7m

Mean Floristic Richness: 25 species per site

Mean Weed Composition: 13 species per site, 15% cover

Community 12.0: *Melaleuca squarrosa* (Scented Paper-bark) - *Leptospermum juniperinum* (Prickly Tea-tree) Shrubland

Character Species	%Freq	C/A
✓ *Melaleuca squarrosa*	N/A	3
✓ *Myriophyllum simulans*		3
✓ *Juncus procerus*		3
✓ *Leptospermum juniperinum*		2
✓ *Amphibromus recurvatus*		2
✓ *Baumea tetragona*		2
✓ *Juncus pauciflorus*		2
✓ *Myriophyllum amphibium*		2
✓ *Triglochin striata*		2

No. of Quadrats: 1 (47)

Structure: Open shrubland with well developed field layer of amphibious herbs

Environment: More or less permanently inundated or waterlogged with fresh water, on margins of Community 13.0. Peaty loam soils.

Altitude: 6 m

Floristic Richness: 27 species per site

Weed Composition: 4 species per site, 2% cover.

Community 13.0: *Eleocharis sphacelata* (Tall Spike-rush) - *Myriophyllum simulans* (Water Milfoil) - *Villarsia reniformis* (Running Marsh-flower) Freshwater Herbfield

Character Species	%Freq	C/A
Myriophyllum simulans	100	4
Villarsia reniformis	100	3
Triglochin procera	100	3
Eleocharis sphacelata	100	2
Amphibromus recurvatus	50	2
Isolepis fluitans	50	2
Amphibromus archeri	50	2
Montia australasica	50	1
Isolepis inundata	50	1
Melaleuca squarrosa	50	1

No. of Quadrats: 2 (48, 49)

Structure: Dense amphibious or aquatic herbfield

Environment: Seasonally inundated fresh water swamp to about 1 m deep; usually drying out completely by the end of summer (J. Allen pers. comm.)

Altitude: Mean 6 m, range 6m

Mean Floristic Richness: 8 species per site

Mean Weed Composition: 0 species per site

Plates: Plate 4

Plate 4. Freshwater herbfield (Area D Map 2); in foreground *Myriophyllum simulans* (Water Milfoil) and *Juncus procerus* (Tall Rush); to the right with yellow flower *Villarsia reniformis* (Running Marsh-flower) and in the background *Eleocharis sphacelata* (Tall Spike-rush).

Plate 5. View looking west from lighthouse over southern part of study area. Painkalac Creek is seen in the middle-ground with residential development of Fairhaven behind. The Otway Ranges are visible beyond.

Community 14.0: Riparian Complex

Character Species	%Freq	C/A
✓ *Eucalyptus viminalis*	50	4
✓ *Eucalyptus ovata*	50	2
✓ *Microlaena stipoides*	100	2
**Holcus lanatus*	100	2
✓ *Acacia melanoxylon*	100	1
**Cirsium vulgare*	100	1
**Hypochoeris radicata*	100	1
✓ *Pteridium esculentum*	100	1
**Sonchus oleraceus*	100	1
✓ *Acacia verticillata* var. *vertic.*	75	2
✓ *Poa labillardieri*	75	2
✓ *Pomaderris asper*	75	1
✓ *Rubus parvifolius*	75	1
**Trifolium repens*	75	1
**Bromus diandrus*	75	1
**Plantago lanceolata*	75	1
**Vicia sativa* ssp. *sativa*	75	+
✓ *Leptospermum juniperinum*	50	2
✓ *Helichrysum dendroideum*	50	2
✓ *Gynatrix pulchella*	50	2
✓ *Carex appressa*	50	2
✓ *Geranium retrorsum*	50	1
✓ *Adiantum aethiopicum*	50	1
**Anthoxanthum odoratum*	50	1

No. of Quadrats: 4 (28, 50, 51, 52)

Structure: Woodland to open forest of complex structure

Environment: Relatively well-drained alluvial terraces or steep banks as well as bed of creek. Brown clay-loam soil.

Altitude: Mean 7 m, range 6 - 8 m

Mean Floristic Richness: 42 species per site

Mean Weed Composition: 16 species per site, 10% cover

Community 15.0: *Eucalyptus sideroxylon* (Red Ironbark) Open Forest

Character Species	%Freq	C/A
✓ *Acacia verticillata* var. *vertic.*	N/A	5
✓ *Eucalyptus sideroxylon*		4
✓ *Acacia verniciflua*		3
✓ *Goodenia geniculata*		2
✓ *Eucalyptus viminalis*		1
✓ *Danthonia geniculata*		1
✓ *Chionochloa pallida*		1
✓ *Dichelachne micrantha*		1
✓ *Dipodium punctatum*		1
✓ *Gahnia radula*		1
✓ *Gonocarpus tetragynus*		1
✓ *Lomandra filiformis sens. lat.*		1
✓ *Poa sieberiana*		1
✓ *Pteridium esculentum*		1
✓ *Lomandra filiformis* ssp. *coriacea*		1

No. of Quadrats: 1 (46)

Structure: Open forest with dense shrub, and sparse field layer

Environment: Dry slopes and ridges. Poorly-structured, light grey, sandy clay-loams

Altitude: 9 m

Floristic Richness: 40 species per site

Weed Composition: 10 species per site, 5% cover.

5.3 Significance of vegetation

5.3.1 Significant species

A total of 30 significant plant species have been recorded for the study area (10% of the indigenous species recorded). Of these, 27 are regarded as significant in a regional context, and three are significant in a local context.

One species (*Eragrostis parviflora*, Weeping Love-grass) has not previously been recorded for the Otway Ranges region by Beauglehole (1980), Beauglehole *et al.* (1977) or M. White (pers. comm.).

Significant plant species are listed, with relevant data, in Table 7.

5.3.2 Significant vegetation communities

Overall, the indigenous vegetation of the study area is highly significant. Two communities are rated as significant at the state level: Community 9.0, *Poa labillardieri* (Common Tussock-grass) Grassland and Community 13.0, *Eleocharis - Myriophyllum - Villarsia* Freshwater Herbfield. Of the remaining communities, nine have regional significance, with one community (2.0, Saltmarsh Complex) having high regional significance. The remaining communities have local significance. All indigenous vegetation in the study area has at least local significance. No botanical significance is ascribed to the exotic vegetation of the grazing land on the floodplain.

The significance of the vegetation communities is summarized in Table 8 with supporting information.

6.0 VERTEBRATE FAUNA

Mammals, reptiles and amphibians were surveyed for the Painkalac Creek wetlands and floodplain study area; bird species were not recorded.

Additional information concerning faunal species in the study area was obtained from the *Environmental Plan for Painkalac Creek Catchment* (Manning *et al.* 1979), from notes compiled by the Aireys Inlet and District Association (AIDA) and from a wetland bird list compiled by local ornithologists, Mrs Pauline Reilly and Ms Claire Roberts.

6.1 Methods

Mammals, reptiles and amphibians were surveyed at Painkalac Creek between 23-27 October 1989. Another survey was carried out for reptiles and amphibians on 17 January 1990 when conditions were warmer.

6.1.1 Field surveys

Mammals

Small ground-dwelling mammals were surveyed by systematic trapping using Elliot traps. Traps were set out in pairs at approximately 10 m intervals along six transect lines (Map 3) The transects were oriented so as to cover the largest diversity of habitat types available at the site:

Transect 1 - *Poa labillardieri* tussock grassland - 20 traps

Transect 2 - *P. labillardieri* and *P. poiformis* tussock grassland and *Eleocharis acuta* sedgeland - 20 traps

Transect 3 - *P. labillardieri tussock grassland - 25 traps*

Transect 4 - *Leptospermum juniperinum* heath, and saltmarsh complex - 25 traps

Transect 5 - Remnant riparian forest - 20 traps

Transect 6 - *Melaleuca squarrosa - Leptospermum juniperinum* shrubland - 20 traps.

These six sites were surveyed for small mammals over a total of 445 trap-nights. One trap-night is a measure of trapping effort and represents one trap left open for one night. Traps were left open for four consecutive nights with the exception of Transect 4 which was trapped for only two nights.

Nocturnal animals were surveyed by spotlighting. Although bats were observed while spotlighting, these were not recorded. A total of 2.5 hours was spent spotlighting in the woodland at the northern part of the Painkalac Creek study site on 23 and 25 October.

Daylight observations of larger mammals were made. Indirect evidence of the presence of mammals such as footprints, scats, diggings, dreys and feeding scars were recorded.

Birds

Bird species were not surveyed as comprehensive bird lists already exist for the site.

Reptiles and Amphibians

Reptiles were surveyed by active searching on 25 October 1989 and on 17 January 1990.

Amphibians were surveyed by active searching during the daylight and by identifying calls during the evenings of 24 October and 17 January.

6.1.2 Defining Significant Species

The significance of fauna species was assessed at national, state, regional and local levels. The national and state ratings for significant species were taken from published lists which are recognized by the scientific community as well as by government bodies. Because new biological information on some species is now available and lists are only published periodically, it is sometimes necessary to update the significance ratings. As lists of regionally significant fauna are not available, we assessed regional significance according to our own criteria and consultation with other biologists.

National Conservation Status

Status ratings for mammals, birds, reptiles and amphibians are a composite of international and Australian ratings, and are designated thus: Endangered (coded as E), Vulnerable (V) and Rare (R). The ratings have been obtained from the International Union for the Conservation of Nature (IUCN) Red Data Book (IUCN 1986) and from the list produced by the Council for Nature Conservation Ministers (Burbidge and Jenkins 1987). The latter list only contains species regarded as endangered.

State Conservation Status

State conservation status lists for vertebrate taxa have been prepared by the Department of Conservation, Forests and Lands using the IUCN protocols, as modified by Ahern (1982). Allocation of these ratings was done by the Department of Conservation, Forests and Lands using a 'consensus' approach. This involves the use of panels of biologists involved in research on the various taxa (Leigh Ahern, National Parks and Wildlife Division, Department of Conservation, Forests and Lands, pers. comm.). Listings were published in "Conservation in Victoria. 1: Plants and animals at risk." (Department of Conservation, Forests and Lands 1987). The following definitions of status categories are based on that document:

A. Endangered

These species are under extreme threat, because their populations are small, or because much of their habitat has been destroyed. These are likely to become extinct in the near future unless immediate action is taken.

B. Vulnerable

These species are also under considerable threat, and are likely to become extinct in the near future unless necessary action is taken immediately.

C. Restricted distribution, rare or both

Some species are under threat because they have a restricted distribution statewide. Species which occur in only a few locations as well as those occurring as a few small isolated populations would be included in this category.

D. Indeterminate, possibly threatened

This category includes species about which little is known but which are presumed to have small populations or are likely to be restricted in distribution.

E. Requiring careful monitoring

These are species which may not be under threat at present, but may become so.

F. Presumed extinct

These species were present in Victoria at the time of European settlement and are now presumed to be extinct.

Regional Conservation Status

The biogeographic region in which the study area occurs is the Otway Ranges area, extending from Anglesea to west of Cape Otway, and inland to the western volcanic plains. There are no published lists for species of regional significance. Regional status for fauna was assessed by consulting experts familiar with the area, referring to the literature, and by drawing upon our previous field experience.

Local Conservation Status

All native faunal species are considered to be of local significance. However, *local significance* is used here to indicate that a species or habitat is of particular interest in the context of the local area (Aireys Inlet, Fairhaven and the Painkalac Creek valley).

6.1.3 Defining Significant Habitats

The evaluation of habitat value does not have any rigid guidelines. A habitat can have high value for any or all of the following reasons:

- It is a representative or remnant vegetation community.
- It constitutes a wildlife corridor.
- It contains important breeding sites.
- It has unusual ecology or community structure.
- It has high species-richness.

6.1.4 Classification and significance of wetlands

Different methods were used to classify and to assess the significance of wetlands identified at the site. The first classification method was devised by Corrick (1982) which sorts wetlands into categories and sub-categories based on salinity, depth and vegetation characteristics.

To assess the significance of the Painkalac wetlands, the Wetlands Resource Assessment Package (WRAP) (ABRG 1988) was used. WRAP takes into account biological factors such as Corrick's data, the significance of flora and fauna and the the degree of naturalness. Treaties and listings, scientific values and other non-biological values are also taken into account.

6.2 Results

Common names are used in the text wherever possible; these follow Menkhorst (1987) for mammals, Emison *et al.* (1987) for birds, Cogger (1983) for reptiles and Littlejohn (1987) for amphibians. Scientific names for mammals and birds are listed in Table 9 and Appendices 5, 6 and 7. Scientific names for reptiles and amphibians follow Cogger *et al.* (1983).

MAMMALS

Trapping Survey

The results of the trapping survey are given in Table 10. Five species of mammals were identified: the House Mouse (*Mus musculus*), Swamp Rat (*Rattus lutreolus*), Bush Rat (*Rattus fuscipes*), Brown Antechinus (*Antechinus stuartii*) and Broad-toothed Rat (*Mastacomys fuscus*). All of these species are native, except for the House Mouse.

The species trapped at Painkalac Creek are common and widespread (Strahan 1983) except for the Broad-toothed Rat. Hair analysis carried out by S. Laidlaw (Department of Biological Sciences, Deakin University) confirmed the species identification.

Table 9. List of mammal species known to occur within the Painkalac Creek study area, Aireys Inlet, Victoria, December 1989.

COMMON NAME	SCIENTIFIC NAME
Brown Antechinus	*Antechinus stuartii*
Koala	*Phascolarctos cinereus*
Common Ringtail Possum	*Pseudocheirus cinereus*
Common Brushtail Possum	*Trichosurus vulpecula*
Eastern Grey Kangaroo	*Macropus giganteus*
Swamp Wallaby	*Wallabia bicolor*
Swamp Rat	*Rattus lutreolus*
Bush Rat	*Rattus fuscipes*
Broad-toothed Rat	*Mastacomys fuscus*
House Mouse	*Mus musculus*
Dog	*Canis familiaris*
Fox	*Vulpes vulpes*

Spotlighting

Nocturnal mammals observed while spotlighting included two Koalas (*Phascolarctos cinereus*), seven Common Ringtail Possums (*Pseudocheirus peregrinus*) (including one back-young) and one Common Brushtail Possum (*Trichosurus vulpecula*). One unidentified macropod was heard moving.

Observations

A group of 15-20 Eastern Grey Kangaroos (*Macropus giganteus*) was regularly seen in the *Poa labillardieri* tussock grassland along Painkalac Creek (Plate 3). Numerous tracks and feeding and resting sites throughout the grassland indicate that kangaroos regularly use this area. The native grassland together with the pasture area probably comprises most of the group's home range.

A Swamp Wallaby (*Wallabia bicolor*) was also observed in the *Poa labillardieri* tussock grassland. Dog prints were seen along the road at the western edge of the study site and numerous Fox scats (containing seeds of Boneseed (**Chrysanthemoides monilifera*)) were seen in the *Poa* tussock grassland (G. Carr pers. comm.).

BIRDS

One hundred and twenty-nine species of birds have previously been recorded for the study area by P. Reilly and C. Roberts (Appendices 5 and 6).

REPTILES AND AMPHIBIANS

One Blotched Blue-tongued Lizard (*Tiliqua nigrolutea*) was found on the north face of the dunes at the southern end of the study area. Several Garden Skinks (*Lampropholis guichenoti*) were observed in the riparian forest to the north and along Painkalac Creek.

Three species of frogs were identified by their calls in the wetland in the northern part of the study area. These are the Pobblebonk Frog *(Limnodynastes dumerilii*), Common Froglet *(Ranidella signifera*) and the Southern Brown Tree Frog (*Litoria ewingii*). The first two species were heard calling along Painkalac Creek and a Southern Brown Tree Frog was observed in the southern part of the study area.

6.2.1 Significant mammal species at Painkalac Creek

Unless otherwise specified, the following information about mammalian significant species is summarized from Strahan (1983), Watts & Aslin (1981) and from Manning *et al.* (1979).

Broad-toothed Rat

Although the Broad-toothed Rat was once widespread in southeastern Australia, it now appears to be a relict species which survives in isolated colonies. It inhabits a range of habitats from alpine heathlands to coastal tussock grassland characterized by cool, wet conditions and dense vegetation. Its present distribution includes southern and eastern Victoria, eastern New South Wales and the western half of Tasmania. The range of the Broad-toothed Rat is not as discontinuous as once believed and the species is not considered to be threatened in Victoria or in New South Wales (Wallis *et al.* 1982).

However, the distribution of Broad-toothed Rats is not easily assessed since individuals are difficult to live-trap (Wallis *et al.* 1982). The reason for this is uncertain and it may be due to low densities, trap-shyness or diet (i.e. traditional baits may be inappropriate). Alternately, low numbers may be due to a scarcity of suitable habitats, predation, low reproductive rates or to competition with other native and introduced rats.

Broad-toothed Rats have been recorded from dense tussock grassland (*Poa* sp.) at Parker Cove near Cape Otway but have not been recorded from the Painkalac Creek area before; its capture is the only one recorded between the Parker River near Cape Otway, and Sherbrooke Forest, east of Melbourne (Atlas of Victorian Wildlife, Wildlife Management Branch, Department of Conservation, Forests and Lands). This species is considered to be of *regional* significance.

Koala

During this study, Koalas were observed in riparian forest in the north-western part of the area.

Koalas originally occurred within Angahook-Lorne State Park but they disappeared from the area. Thirty to fifty individuals were released into the area in 1977, 1982, 1987 and 1988 in an effort to re-establish viable populations (Mr V. Hurley, Wildlife Planner, Geelong Region, Department of Conservation, Forests and Lands, pers. comm.). Numbers have not been monitored after each release and there is some question as to whether the habitat within Angahook State Park is still suitable for Koalas, especially since the occurrence of extensive bushfires in the area in 1983. The main food trees in the area are *Eucalyptus viminalis* and *E. ovata.*

Because of the destruction of eucalypt forests containing their food species, present-day populations of Koalas are restricted to small patches of discontinuous habitat. The Koala is listed by the Department of Conservation, Forests and Lands as "Requiring careful monitoring" (Category E) in Victoria. Although this listing would normally indicate that the species was of State significance, we believe that the status of koalas in Victoria does not warrant State significance, especially for re-introduced populations. We view this population as being of *regional* significance.

Bats

Bats were not surveyed during this study. Little is known about the bat species occurring in the area, but significant species may be associated with the wetland and forest habitats.

Eastern Grey Kangaroos

The group of Eastern Grey Kangaroos present at Painkalac Creek is notable because it probably represents a stable social unit. The Painkalac Creek study area comprises most of the group's home range, although kangaroos may use adjacent forest as a refuge during the warmer months. The kangaroos are easily approached and are familiar to many of the residents of Aireys Inlet. The resident group is of *local* significance.

6.2.2 Significant bird species at Painkalac Creek

The following bird species have been recorded in the study area by local ornithologists. Information on significant birds is summarized from Manning *et al.* (1979) and from Emison *et al.* (1987).

Rufous Bristlebird (*Dasyornis broadbenti*)

The Rufous Bristlebird has a discontinuous distribution along the western coast of Victoria. It occupies dense coastal vegetation, tea-tree thickets and wire grass from Torquay to the mouth of the Murray River in the Otways. The Rufous Bristlebird feeds from the ground under dense scrub cover. In the study area, it occurs in the dune shrubland and in thickets of coast wattle.

The Rufous Bristlebird is classified as "Restricted, rare or both" (Department of Conservation, Forests and Lands 1987). Its range has probably been reduced due to clearing practices and to predation by feral dogs and cats, and by inappropriate fire regimes. It is a species of *high regional* significance or perhaps *state significance*.

Lathams Snipe (*Gallinago hardwickii*)

Latham's Snipe breed in Japan and summer throughout eastern Australia between the Divide and the coast. This species prefers heavily vegetated freshwater wetlands and thus often occurs in areas not generally used by other species of waders. This type of wetland has been drained and cleared in many areas and, while not yet rare, the Latham's Snipe is vulnerable to further destruction of its habitat.

It is listed by the Department of Conservation, Forests and Lands (1987) as "Requiring careful monitoring". In addition, the habitat of Latham's Snipe is protected by the Japan-Australia Migratory Birds Agreement (JAMBA). JAMBA recognizes that certain species migrate between the two countries and it aims to protect the habitats of all species listed under the agreement. Because the Painkalac Creek area does not constitute critical habitat for this species, it is of *local* significance.

Peregrine Falcon (*Falco peregrinus*)

Although the Peregrine Falcon has been recorded at the study site, it probably only uses the area as a hunting site and thus is of *local* significance. The availability and protection of breeding sites are the critical factors in the survival of this species. This species is listed by the Department of Conservation, Forests and Lands (1987) as "Requiring careful monitoring".

Migratory Species

Four migratory species, the Curlew Sandpiper (*Calidris ferruginea*), Red-necked Stint (*Calidris ruficollis*), Greenshank (*Tringa nebularia*) and Sharp-tailed Sandpiper (*Calidris acuminata*), have been recorded in small numbers in the study site. All these species migrate to Victoria from the northern hemisphere each summer. They occur, often in relatively large numbers, on mudflats around freshwater or saline swamps; they feed by pecking or probing at the surface of mud or sand. The habitats of these species are also protected by JAMBA. These species are of *local* significance.

Southern Emu-wren (*Stipiturus malachurus*)

The Southern Emu-wren is a shy, sedentary species which occupies coastal saltmarshes, scrubby heathlands and the dense understoreys of stringybark forests. The species is found in Lorne-Angahook State Park and in the heathlands to the west of it from Gellibrand to Devondale. The range of the Southern Emu-wren is fragmented due to clearing. It is a species of *local* significance. It has not been recorded since the 1983 fires (P. Reilly, pers. comm.).

Satin Bowerbird (*Ptilonorhynchus violoaceus*)

Satin Bowerbirds occupy foothill gully forests, rainforests and wet scrub. In western Victoria, they occur in low numbers as far west as Devondale. This species is of *local* significance because its occurrence in the study area is close to the western edge of its distribution.

Ground Parrot (*Pezoporus wallicus*)

Ground Parrots no longer occur at the Painkalac site. This species has declined in southwestern Victoria; the last sighting of Ground Parrots at Aireys Inlet was in 1914 (Belcher 1914). The existing Otways populations occur in the Carlisle heathlands and at Blanket Bay, near Cape Otway.

Reptiles and Amphibians Occurring at Painkalac Creek

There are no published lists of reptiles and amphibians for the Painkalac Creek study site. The reptile and amphibian species that we recorded for the site are all of *local* significance.

6.2.3 Significant mammal species in the region

The following species were not observed in the area, but may occur there. Unless otherwise specified, the following information is summarized from Strahan (1983) and from Manning *et al.* (1979). Appendix 7 lists these species.

Swamp Antechinus (*Antechinus minimus*)

Disjunct populations of Swamp Antechinus are found in the wet heath and shrubland habitats in southern coastal and near-coastal Victoria from Wilsons Promontory to the South Australia border and further inland at Casterton and Dartmoor. The species inhabits *Poa* grassland and dune scrub areas. Suitable habitat for this species has been destroyed through industrial, mining and grazing activities.

The Swamp Antechinus has been trapped at Hutt Gully, northeast of Aireys Inlet (Wilson *et al.* 1986). As this species typically occurs in an area during the later stages of fire regeneration, its absence from the study site does not indicate that the habitat is unsuitable. It is a species of *regional* significance.

Feathertail Gliders (*Acrobates pygmaeus*) and Sugar Gliders (*Petaurus breviceps*)

The Feathertail Glider is widespread in tall eucalypt forests and in drier forest and woodland on the east coast. The Sugar Glider is locally common and may occur in high densities in open forest habitats where dense patches of *Acacia* are available. Sugar Gliders have been recorded in Angahook-Lorne State Park located to the north of the study area (Laidlaw and Wilson 1989). Feathertail and Sugar Gliders may occur in the remnant riparian woodland in the northern part of the study area but they are not easily seen. These species would be of *local* significance.

Southern Brown Bandicoot (*Isoodon obesulus*)

Southern Brown Bandicoots prefer scrubby areas or those with low ground cover which are occasionally burnt. Its former range has been reduced due to clearing, grazing and fire suppression. Southern Brown Bandicoots have been recorded in Angahook-Lorne State Park to the north and may occur in the *Poa* tussock grassland at the Painkalac site. It would be a species of *local* significance.

6.2.4 Ecological Significance of the study site

The major habitats identified and surveyed at Painkalac Creek consist of a saltmarsh complex, dune scrub, tussock grassland, sedgeland, remnant riparian forest and *Melaleuca squarrosa - Leptospermum juniperinum* shrubland. The eastern section of the study site contains open pasture which provides some habitat for birds. The importance of the different habitats to fauna is discussed below.

Mammals

The *Poa* tussock grassland provides suitable habitat for the Broad-toothed Rat, a species of regional significance. This species occupies habitats characterized by cool, wet conditions and dense vegetation cover. Swamp Rats also prefer wetter areas covered with grasses or sedges. Eastern Grey Kangaroos used the grassland area for feeding at all times and for resting during the cooler months.

Another important habitat for mammals is the remnant riparian forest in the northern part of the study site. Large numbers of Brown Antechinus and Bush Rats were captured here. Laidlaw and Wilson (1989) found the abundance of small ground-dwelling mammals to be higher in this habitat type than in open forest, woodland or heathland within Angahook-Lorne State Park. This was especially true for Bush Rats whose densities were related to the density and height of vegetation. They found the abundance of Brown Antechinus to be related to the height of the mid-storey vegetation. Koalas, a species of regional significance in the area, were found in *E. viminalis* and *E. ovata* trees; Common Ringtail and Brushtail Possums were also observed in the forest.

High densities of Swamp and Bush Rats were found in the *M. squarrosa - L. juniperinum* shrubland. This vegetation type provides suitable habitat for Swamp Rats which prefer wetter areas covered by heath, grass or sedge and for Bush Rats which prefer dense understoreys.

One Swamp Rat was captured in the dune scrub area in the southern part of the study area.

Birds

The Painkalac Creek study area provides important habitat for a wide diversity of birds. Some of these species are resident whereas others such as Latham's Snipe and several species of sandpipers are migratory and only spend part of the year at Painkalac Creek. The latter species are of local significance.

The most important habitats for bird species which require water for their feeding and resting requirements are the saline and freshwater wetlands. Open water areas provide food for grebes, pelicans, cormorants, ducks, swans, gulls and terns. The productive shallow margins fringed with vegetation are suitable habitat for herons, spoonbills, bitterns, rails, crakes, moorhens and native hens; the frequently exposed margins supply food for stilts, sandpipers, stints and dotterels. Reed-warblers, grassbirds and cisticolas are most often associated with the reedy vegetation fringing wetlands.

The remnant riparian forest also provides suitable habitat for a diversity of bird species. Species such as scrubwrens, fairy-wrens, fantails, robins, and thornbills prefer the shrubby understorey. Honeyeaters, flycatchers, cuckoos, whistlers, robins and species of raptors obtain food, nest sites and roost sites in the canopy layer. Cockatoos, rosellas, lorikeets, kingfishers and pardalotes are dependent on hollow limbs and trunks for nest sites.

The open habitat associated with the exotic grassland (pasture) at Painkalac Creek is used for feeding by lapwings, egrets, swallows, bushlarks and a number of raptor species.

Two significant species in the area prefer the grassy or scrubby vegetation communities associated with the coast. The Rufous Bristlebird, a species of high regional or state significance, is found in dense coastal or dune shrubland. The Southern Emu-wren is commonly associated with *Poa* grassland, coastal heath or dune shrubland; it is of local significance. Appendix 5 lists birds recorded in the different habitats in the study area.

Reptiles

Reptiles are not as sensitive to structural and compositional changes in vegetation but are influenced by the temperature and the amount of shelter found at a site. Reptiles were sighted on the dunes at the southern end of the site, along Painkalac Creek and in the riparian forest in the northern part of the study area.

Amphibians

Amphibians were found throughout the study area associated with Painkalac Creek or with the freshwater wetland in the northern part of the study site.

6.2.5 Significance of Habitat

The estuarine vegetation associations present at the mouth of Painkalac Creek are probably typical of those which occurred along the coastline from Aireys Inlet to Swan Bay to the east. These are becoming rare due to draining for agriculture and residential developmental. The relatively undisturbed condition of these habitats makes the Painkalac Creek area of high regional significance.

6.2.6 Classification and Significance of Wetlands

Two wetlands were identified at the site: A freshwater wetland located at the northern end of the study area and an estuarine wetland situated in its southern section.

Corrick classification

Corrick (1982) classified wetlands by their physical characteristics and estimated their frequency in his Port Phillip to Mt Emu Creek study area, from aerial photographs.

Using his method, the freshwater wetland and associated shrubland in the northern part of the site falls into Category 3 (*Shallow Freshwater Marshes*), Sub-category 4.1 (*herb-dominated*). This category accounts for approximately 17% of the wetlands in his study area.

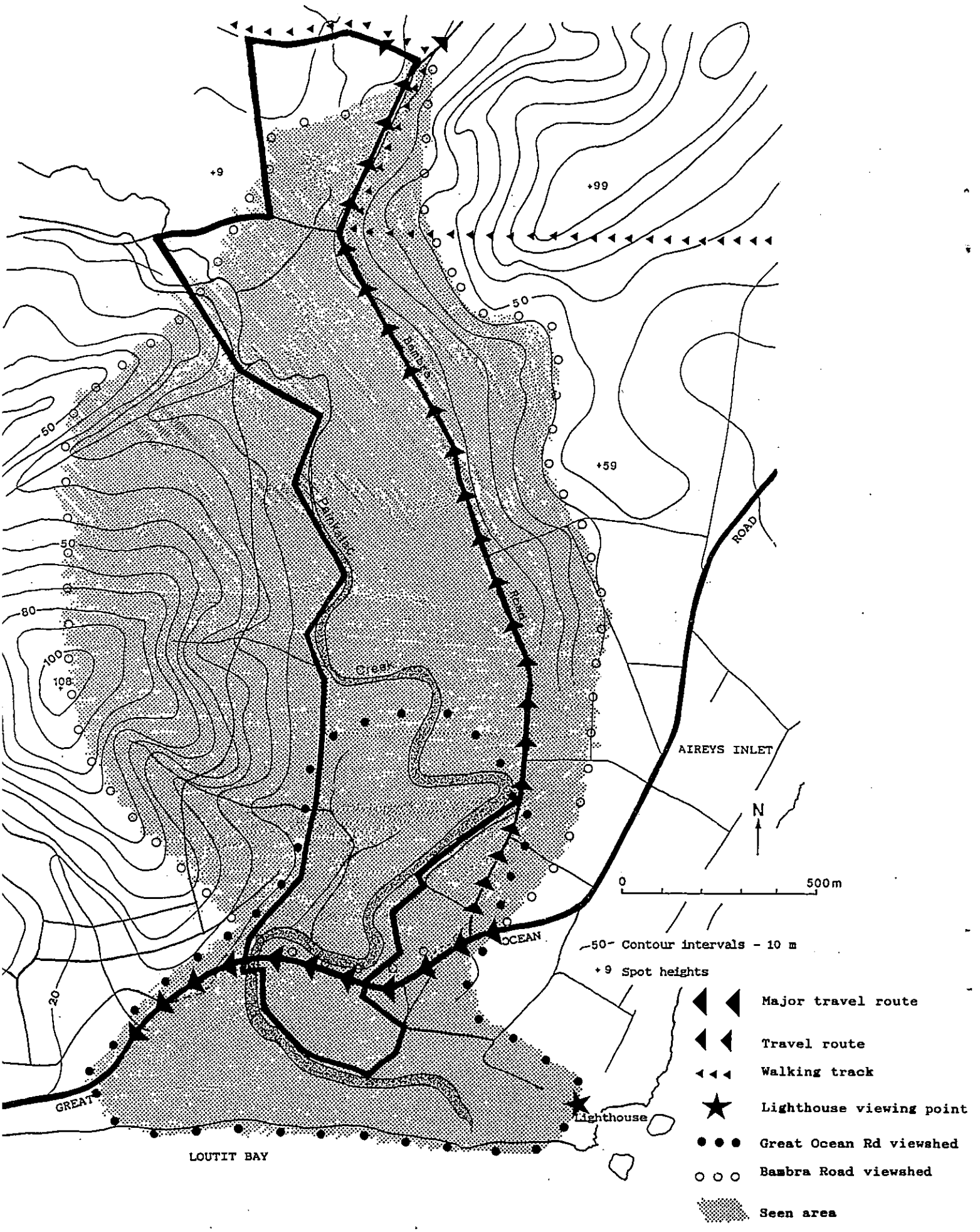
The saline wetland found in the southern part of the site consists of Corrick categories 6 (*Semi-permanent Saline Wetlands*) and 7 (*Permanent Saline Wetlands*). Sub-categories 6.2 (*salt meadow*) and 6.4 (*sea rush-dominated*) are represented by the saltmarsh complex, sedgeland and part of the *Poa* grassland. These are rare sub-categories accounting for 5% and 0% of the wetlands in his study area, respectively. Sub-category 7.1 (*shallow*) includes Painkalac Creek where it is substantially saline. This category accounted for 3% of the wetlands in Corrick's study area.

WRAP Conservation Value

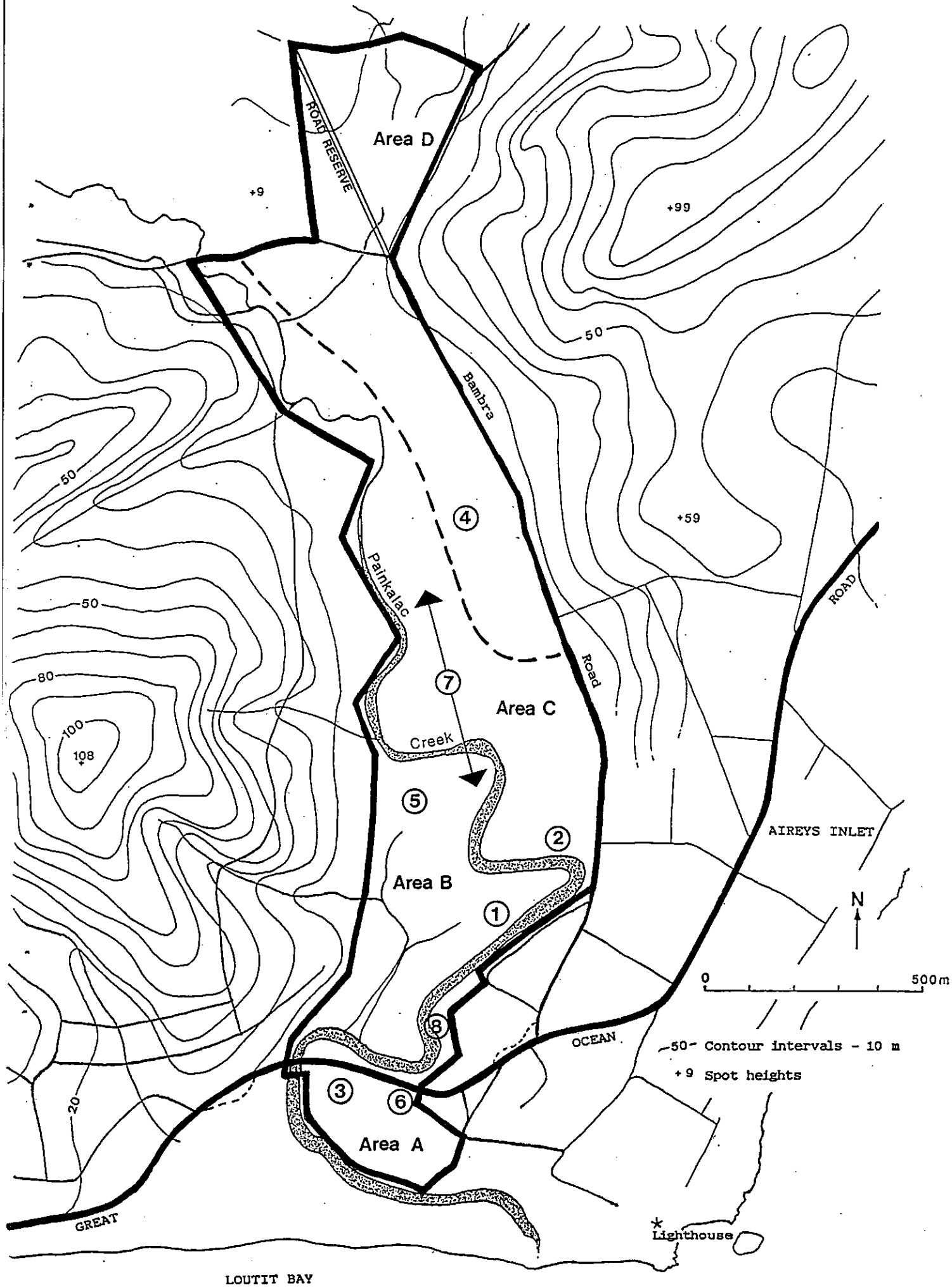
WRAP was used to obtain significance ratings for the Painkalac wetlands and to compare these to other wetlands in the South Western Region (ABRG 1988).

Under the Wetlands Resource Assessment Package, the freshwater wetland at Painkalac is rated as Significance Class B, Sub-category B.2 which indicates that it has plant species of Regional Endangered status (see Table 7) and has some Class C values (see below). Ten out of the 340 (3%) wetlands assessed fell into this sub-category.

The saline wetland at Painkalac Creek is rated as Significance Class C, Sub-category C.1. This indicates that it has some attributes or species of regional significance and that it is a rare Corrick category (i.e. forms <5% of wetlands in his study site). The significant species include plants (see Table 7) and the Broad-toothed Rat. Forty-two out of 340 (12%) wetlands assessed (by ABRG 1988) fell into this sub-category. Birds recorded in wetlands in the study area are listed in Appendix 6.



Map 4. Viewshed analysis of the Painkalac floodplain study area, December 1989.



Map 5. Location of development proposals in the Painkalac Creek floodplain study area, December 1989

7.0 VISUAL ANALYSIS

The project brief identifies Painkalac Creek valley as an important visual landscape element in the townships of Aireys Inlet and Fairhaven. The process of visual analysis involves a combination of field work and assessment to:

(i) identify the physical attributes of the place which together form the landscape

(ii) understand the factors that influence our perception of that landscape

(iii) assess the visual qualities of the landscape

(iv) consider the factors likely to make changes more acceptable or less apparent.

These techniques and their application to Painkalac Creek valley are described below.

7.1 Methods

7.1.1 Landscape analysis techniques

Analysis of the visual attributes of a landscape involves a step-by-step process as described below.

Regional landscape setting and context

An analysis of Victorian landscapes (Leonard and Hammond 1984) divided the State into nine broad *landscape character types*. The visual quality of each type was assessed to provide a checklist of the characteristics that contribute to visual quality. These 'frames of reference' provide a useful yardstick for assessing the quality of a particular landscape and comparing it to other similar landscapes.

The Painkalac Creek valley was looked at within its regional context and in relation to the *landscape character types*:

Landscape Units

The basic elements of all landscapes are land form and land cover. Land form refers to the topography or shape of both the land and water; land cover refers to types of land use and vegetation.

Broad areas with similar physical attributes - land and water forms, vegetation, land use - are identified and mapped (Map 5). Each unit can then be assessed in terms of visual quality, sensitivity etc.

Views

The nature of the landform combined with land use and vegetation determine the spatial form of a landscape, the degree to which it is visible from nearby areas, and the distance and extent of views within a landscape.

Visual quality

The physical characteristics of the landscape - landform, water features, vegetation - can be analysed to determine the visual quality of the whole landscape.

There have been many studies which attempt to understand the people's landscape preferences and how these preferences relate to the physical attributes of an area. In Victoria the most commonly used approach is based on the United States Department of Agriculture's Landscape Management System. This system has been applied to local conditions by the Department of Conservation, Forests and Lands (formerly the Forests Commission) and appears to have gained acceptance (Leonard 1984).

The key criteria considered to reflect visual quality are:

. naturalness
. diversity or variety of landform and spaces and vegetation
. presence of water
. compatible adjoining land uses
. lack of visible degradation
. positive special features (including transitory but typical weather conditions).

Assessing the impact of changes

The underlying principles of landscape management are to seek to retain the valued characteristics of a landscape, and improve existing adverse visual impacts. The degree to which changes will affect these valued characteristics depends on many inter-related factors such as:

. people's expectations and environmental sensitivities

. the available opportunities to view a landscape

. capability or the ability absorb change without a reduction in visual quality.

Expectations and sensitivity of visitors

Special attention needs to be paid to people's expectations and their likely sensitivity to environmental and aesthetic issues.

Visitors tend to have an image of the place before they visit, based on available information and their experience at that or similar places.

The aesthetic concerns vary within our community; those seeking a more natural environment in which to live, holiday or recreate are likely to be most sensitive to visual quality issues.

Within the Geelong region, Aireys Inlet is presented as a small coastal town within a natural setting.. The Painkalac Creek valley and the surrounding forests are the two elements that provide this natural setting. It is likely that visitors to and residents of Aireys Inlet will expect a highly natural environment and will be quite sensitive to landscape changes. This is confirmed by past community responses to proposals for recreation developments in the Painkalac Creek valley. Further attitude surveys could be carried out, but would probably confirm previous responses.

Opportunities to view the landscape

The opportunities available to view the landscape will influence perceptions of both the qualities and problems apparent with a landscape; the key factors are:

Viewing time and speed

The visual impact of changes to a landscape will increase as the viewing time increases. Views seen for a long time - such as from a viewing point, e.g. visitor centre, along the length of a travel route - will be more scrutinized. Within the Painkalac Creek valley such views would include vistas from the lighthouse and coastal reserve.

As speed of travel increases the bolder forms and colours in the landscape become more dominant and the traveller tends to focus further and more directly ahead; at slower speeds the details are more able to be seen and the traveller is more likely to look to the side. Key tourist routes include the Great Ocean Road and roads to Lorne-Angahook State Park (Bambra and Distillery Creek Roads).

Viewing distance and angle

The distance of the viewer from the landscape, and their angle of view, are important factors in evaluating the likely impact of any changes. Some changes will be more apparent in the foreground, while others will only emerge in a more distant view.

Analysis of the visual sensitivity of an area attempts to encompass these factors by identifying areas seen from key travel routes and viewing points.

Ability to absorb impacts

The physical characteristics of the landscape determine to what degree it can absorb impacts. The key qualities are:

1. *Visual capability:* the ability of the landscape to absorb particular changes while retaining its positive qualities; this factor relates to:

   (i) the compatibility of the scale, form, texture, colour, etc. of the proposed changes with those of the natural landscape (or the visual dominance of any changes)

   (ii) the visual absorption or screening provided by landform and vegetation

2. *Physical capability:* the ability of the land to withstand impacts without unacceptable deterioration

3. *Management practices* associated with any changes.

The visual capability of a landscape will vary according to:

1. *Slope* - the steeper the slope, the more visible any changes and the more likely any change will be visible from a greater distance or over a larger area

2. *Dissection* - the more dissected a landform pattern the greater the ability of the landscape to screen any changes

3. *Vegetation* - the taller and denser the vegetation the greater the ability of the landscape to screen any changes.

Landscape management practices, such as retention or replanting of vegetation as a visual screen, can modify the visual capability of a landscape.

7.1.2 Landscape management objectives

Landscape objectives - the minimum standard to be achieved in landscape management - are proposed for the Painkalac Creek valley.

These objectives take account of the degree of *visual constraint* imposed by the visual quality, sensitivity, and visual capability of the landscape. The three levels of constraint identified are:

Level 1 : High constraint

* high visual quality
* high-moderate sensitivity
* low-moderate visual capability

Level 2 : Moderate constraint

* medium visual quality
* high-moderate sensitivity
* low-moderate visual capability

Level 3 : Low constraint

* low visual quality
* low sensitivity
* high visual capability

Three levels of management objective are proposed, based on the amount of alteration that can be tolerated within a landscape:

1. *Inevident alteration:* All changes to the landscape should be *visually inevident*. As many landscape values at Airey's Inlet are largely determined by the degree of naturalness, this objective requires that changes also be *environmentally inevident*. Temporary changes may be *apparent* for a defined period, after which they would be expected to conform with the *inevident alteration* objective.

2. *Apparent alteration:* Landscape changes may be *apparent* but also *subordinate* to the desired landscape characteristics. Changes may be *dominant* on a short-term basis.

3. *Dominant Alteration:* Changes may be *dominant* but should still reflect the desired visual characteristics of the landscape, incorporating lines, forms, colours and textures from the natural landscape to create the greatest possible degree of design harmony.

7.2 Field Survey

The method described above was applied to the Painkalac Creek study area. Field survey work was undertaken over two days in November 1989, and the subsequent analysis during December to March 1990.

The study area was examined and viewed from:

1. Key viewing points and tourist roadways - the Lighthouse (Plates 5 and 6), Great Ocean Road (Plate 1), the beach and coastal dune at the mouth of Painkalac Creek, (Plate 2), Bambra, Boundary and Distillery Creek Roads.

2. Public access points - River Road, fire safety area on the Great Ocean Road, both boat ramps into the estuary, and the fire access track on the west side of the creek valley

3. The town areas of Aireys Inlet and Fairhaven from a variety of roadways including Pearse, (Plate 7), Beach, and Aireys Roads, Bimbadeen and Wybellena Drives

The physical characteristics - land form and land cover - were described and the extent of views recorded. Landscape units were identified and checked during field work.

Plate 6. View north from the lighthouse showing the Painkalac Creek catchment in the background (Lorne-Angahook State Park) and Allen's land (green pasture) in the middle-ground.

Plate 7. View from Pearse Road, looking west over Allen's land (green pasture) to Painkalac Creek. *Poa* tussock grassland can be seen on the western side of the creek (brown vegetation) and Fairhaven (from lighthouse over southern part of study area. Painkalac Creek is seen in the middle-ground with residential development of Fairhaven behind. The Otway Ranges are visible beyond.

7.3 Landscape Analysis

7.3.1 Regional landscape context

Painkalac Creek valley extends from the *Coastal landscape Character type* to the *Southern Uplands type*, two of the nine landscape character types defined for Victoria (Leonard 1984).

The *Coastal landscape character type* is diverse, ranging from rugged cliffed coasts to extensive dunes or swampy estuaries.

The *Southern Upland type* is confined to the Otways and South Gippsland hills. The type is distinguished by deeply dissected terrain, and a climate strongly influenced by proximity to the ocean.

The Painkalac Creek valley could also be categorized as an 'agricultural landscape' (Leonard 1984). Combining the frames of reference for these three types provides a yardstick for evaluating the visual quality of Painkalac Creek valley within its regional context.

7.3.2 Community values

The communities of Aireys Inlet and Fairhaven comprise permanent residents, temporary residents and occasional holiday makers. Their perceptions of the landscape values of the study area should be considered along with those of visitors. No detailed investigation of their views has been undertaken; in fact such work is rare within Australian landscape assessment procedures although is often used in the United States.

Community responses to development proposals within the study area provide one indicator of their values. For example, a plan (BAC Landscape Consultants 1983) for an oval on the Shire Reserve (Area B, Map 5) and a series of boardwalks and other recreation facilities was rejected by the community after being publicly exhibited by the Shire (D. Welsh pers. comm.). The desire to protect the environment of Painkalac Creek valley was regarded as the key community concern.

A survey by Aireys Inlet and District Association (AIDA) in 1983 (AIDA 1984a & b) sought community input into the future of the district. The survey sought responses to a number of questions about the character of the area as well as views about the need for certain types of development.

The survey revealed strong support for 'conserving the area for its natural beauty and serenity' and 'preserving environmental features within the residential township areas'; there was little support for commercial or tourist development.

The questionnaire also sought reactions to a number of possible recreation and tourist developments within the study area. The development of improved public facilities (toilets, picnic and playground areas) on Painkalac Creek river flats, either upstream and downstream of Ocean Road bridge, was rejected by 68.4% and 64.4% of respondents respectively; only 13.8% and 19.3% supported this idea.

Recreational facilities strongly rejected included defined trail bike areas and a sporting complex. Although a majority of respondents rejected the idea of boating facilities on Painkalac Creek, a golf course, sports oval and bowling green, there was some support for each proposal (ranging from 34.5% for a sports oval to 29.4% for a golf course). Horse riding facilities were equally supported and rejected, and bicycle tracks supported by a majority.

None of the tourism proposals in the questionnaire were supported by a majority. The most favoured were improved traffic management for peak summer conditions through the township (35.3% supported, 46.2% rejected) and a by-pass ring road to reduce traffic (33.8% supported, 53.1% rejected).

Proposals for a tourist information centre, development of motel/hotel accommodation, expansion of private camping grounds and provision of public camping grounds were all strongly rejected.

Further survey work would be required to determine the currency of these views.

The Aireys Inlet to Eastern View Structure Plan (1982) gives statutory form to many of these community viewpoints.

A current proposal by the Aireys Inlet and District Action Group AIDAG (AIDAG 1989) to site an oval and other sporting facilities on the Shire Reserve (Area B, Map 5) may suggest a change in community values; however, this proposal has been made in response to the Shire's preferred location for the oval (adjacent to the Recreation Hall and tennis courts) which would involve the removal of part of a stand of ironbarks. While there may be disagreement within the community about the relative environmental values of Painkalac Creek valley and the stand of ironbarks, both community groups (AIDAG and AIDA) are seeking to protect areas perceived to be of environmental significance.

7.3.3 Viewshed analysis

Travel routes

Two important road travel routes cross the study area. The views available from these routes contribute to the overall recreational experience of visitors travelling through or stopping at Aireys Inlet.

The Great Ocean Road is an important tourist route, providing access to a range of townships along the Otways coastline and beyond. It is a highly regarded and promoted scenic route.

Bambra Road provides access from Aireys Inlet to the Lorne- Angahook State Park. Access to the Park is also available from the north (Bambra Road), east (Distillery Creek Road) and west (Old Coach Road). Bambra Road is also intended as the main bicycle access to Angahook (D. Welsh pers. comm.)

The main long-distance walking track is the Jan Juc to Moggs Creek Surf Coast Walk. This track links Lorne-Angahook State Park with the coast at Aireys Inlet via Distillery Creek Road, and then east along Boundary Road. The northern portion of the study area (that is Area D and the northern portion of Area C, Map 5) would be visible from this walk.

The areas visible from the Great Ocean Road, and Bambra Road and the Surf Coast Walk are shown on Map 4.

Viewing points

The lighthouse provides the best lookout point at Aireys Inlet. Virtually the whole study area is visible from the lighthouse and associated car park (Reserve Road) - see Plates 5 and 6. The landform and mature trees to the north of the lighthouse screens much of Aireys Inlet township from view (Plate 6).

7.3.4 Landscape units: Description and assessment

The Painkalac Creek study area comprises three major physiographic units - the coastal dune, cliffs and estuarine mouth of Painkalac Creek, the broad creek floodplain and the surrounding hills. These landforms are overlain by a variety of landcover types ranging from indigenous shrublands to housing.

As the landform is the dominant element, it forms the basis of the landscape units:

Landscape Unit	Landform	Land Cover	Area (refer Map 5)
Coastal	Dune & cliffs	Indigenous vegetation	Outside study area
	Estuary	Indigenous vegetation	Area A
Valley	Floodplain	Indigenous vegetation	Area B Shire Reserve
		Pasture	Area C Allen's property
		Freshwater swamp, forest, pasture	Area D McKenzie's land Lorne-Angahook State Park
Hills	Hills	Townships, forest	Outside study area

Coastal Landscape Unit

Characteristics

The coastal cliffs and steep frontal dune enclose the Painkalac Creek valley and its estuarine mouth. The Great Ocean Road traverses the valley, enabling travellers to see the natural grasslands and rural landscapes to the north and the estuary's expanse of water to the south (Plates 1 and 2).

The dramatic cliffs and lighthouse are a local landmark and a key focal point in many views of Aireys Inlet. The lighthouse is visible for some distance when approaching Aireys Inlet from Geelong along the Great Ocean Road, creating a sense of anticipation for the traveller. Approaching from Fairhaven, the lighthouse is seen as part of the whole coastal landscape - a dramatic combination of cliffs, dune, ocean and estuary (Plate 1).

The lighthouse is also an important focal element in many internal views within the Painkalac Creek valley; it is visible from Boundary Road in the northern part of the study area. The lighthouse is also an important lookout point, providing long distance views over Painkalac Creek valley to the Lorne-Angahook State Park to the north (Plates 5 and 6).

Visual analysis

Scenic quality: The Coastal Landscape unit is of *high* scenic quality due to the dramatic combination of coastal features that provide visual diversity, contrast in colour and form, and a wide expanse of water in the estuary. This landscape has a relatively high degree of naturalness, although the commercial area and housing on the floodplain are intrusive.

Sensitivity: This landscape unit is rated as of *high sensitivity* due to its visibility to people travelling along the Great Ocean Road - an important scenic travel route - and to those using the recreation resources and facilities on the coast and estuary. Map 4 indicates the extent of the viewshed available from the Great Ocean Road.

Visual capability: This landscape has a *low visual capability*, that is, a low ability to absorb or screen impacts. This is due to the degree of openness of the whole landscape unit, its lack of screening landforms or vegetation, and the relatively fragility of parts of this landscape to damage. The existing developments within the landscape unit - the commercial and housing areas and the fire safety area - demonstrate the difficulties of incorporating development into the area, and the importance of ensuring that any new development or redevelopment are designed to be compatible in scale, form and colour with the natural landscape attributes.

Landscape management objectives: There is a *high degree of constraint* imposed by the combination of high visual quality, high sensitivity and low visual capability. This implies that little alteration to the positive visual qualities of the landscape is likely to be accepted by the community.

The landscape management objective applied to the areas of predominantly natural landscape within the unit should be *inevident alteration.*

Any available opportunities to improve, redesign or screen existing developments should be undertaken in a such a way as to make them appear subordinate to the desired landscape characteristics.

Valley Landscape Unit

Characteristics

The Valley Landscape unit comprises three distinct areas (Map 5):

. natural grasslands on the Shire Reserve (Area B)

. pastures on the Allen property (Area C)

. the freshwater swamp surrounded by pasture and forest at the northern end of the valley (Area D).

The Valley Landscape unit is an expansive, relatively flat floodplain that contrasts strongly in form and colour with the surrounding Hills Landscape unit.

The natural grasslands (Areas A and B) and the pasture areas contrast distinctly in colour adding to the visual diversity within the landscape unit (Plate 7). The northern area is much more enclosed due to narrowing of the valley landform. The freshwater swamp (Plate 4) is an interesting landscape feature, and the visual quality of this area is enhanced by the diversity of vegetation forms.

The Valley Landscape unit and Hills Landscape unit combine to visually divide the townships of Aireys Inlet and Fairhaven, providing a distinct contrast between 'town' and 'country' (Plates 6 and 7). The travel route to Angahook along Bambra Road exposes virtually all of this landscape unit to view (see Map 4).

Visual Analysis

Scenic quality: Overall the Valley Landscape unit ranges from *high to moderate* scenic quality. The natural grasslands (Area B) and the freshwater swamp (Area D) have a higher degree of naturalness which enhances their visual quality. The degree of contrast between this unit and the forested slopes of the Hills Landscape unit enhances the visual quality of both.

Sensitivity: This landscape unit is rated as of *high sensitivity* due to its visual exposure to people travelling to Angahook along Bambra and Distillery Creek Roads. Map 4 indicates the extent of the viewshed from Bambra Road.

The landscape unit is also highly exposed to the adjoining residential areas; the community has expressed views about the importance of protecting the Painkalac Creek valley and this suggests that the local community would be very sensitive to changes in the Valley Landscape unit.

Visual capability: This landscape unit has a *low visual capability* at present due to its lack of screening vegetation. As the unit is relatively flat the landform provides no screening. Planting of trees within the unit could substantially increase the opportunity to screen any changes, although its continued exposure in panoramic views from the lighthouse would need to be carefully evaluated.

Landscape management objectives: There is a *moderate degree of constraint* imposed by the combination of moderate visual quality, high sensitivity and low-moderate visual capability. This implies that only limited alteration to the positive visual qualities of the landscape may be accepted by the community, especially in Areas B and D.

The landscape management objective applied to the areas of predominantly natural landscape (Areas B and D) within the unit should be *inevident alteration.*

Area C is a rural landscape already clearly modified from its natural form. The high sensitivity of this whole landscape unit suggests that the landscape management objective should also be *inevident alteration*. Increasing the visual capability of the landscape through the planting of screening vegetation would enable some additional development to be 'hidden' thus conforming with the proposed landscape management objective.

Hills Landscape Unit

Characteristics

The Hills Landscape unit is outside the study area but contributes substantially to the visual qualities of the Painkalac creek valley.

The Hills Landscape unit contains the main township and residential areas of Aireys Inlet and Fairhaven. The northern end of the valley contains little residential development and the slopes have virtually continuous forest cover (Plates 5, 6 and 7).

The Painkalac Creek valley is enclosed by the Hills Landscape unit to the east, west and north. This sense of enclosure works to focus attention on the valley itself. From many points the viewer's eye is drawn along the open grass and pasture lands on the floodplain to the forested hills to the north.

Residential development is expanding into the forested hills landscape; consolidation of the township to create a distinct 'edge' would enhance the visual qualities of the whole valley.

Visual Analysis

Scenic quality: The forested hills are of *high* visual quality due to their naturalness, contrasting form and colour to the open floodplain, and sense of enclosure. Where residential development appears to intrude into the forest, the visual quality is lower. Some of the newer/rebuilt parts of the township will be less intrusive as their garden plantings mature; however the size, scale and form of some developments will be difficult to screen.

Sensitivity: The Hills Landscape unit is moderately sensitive due to its visibility from travel routes along the Great Ocean Road and Bambra Road. Greatest sensitivity occurs in the upper end of the valley where the viewer expects a forest landscape and is surprised by the intrusion of development.

Visual capability: The Hills Landscape unit has a *moderate* capability where forest cover is retained. The slope of the land exposes a wider area to view than on a flat site; this is counterbalanced by the screening ability of the forest vegetation.

Landscape management objectives: There is a *moderate degree of constraint* imposed by the combination of high to moderate visual quality, moderate sensitivity and moderate visual capability.

Within the township areas the degree of alteration to the landscape means that the appropriate landscape management objective is *dominant alteration.* This means that changes may continue to dominate the natural landscape but should still reflect the desired visual characteristics of the overall locality and incorporate lines, forms, colours and textures from the natural landscape into the design of new developments, and the upgrading of existing developments.

Within the parts of the Hills Landscape unit that are still forested the landscape management objective should be *inevident alteration.*

8.0 ABORIGINAL HERITAGE

8.1 Methods

The landscape of the Painkalac Valley and associated coastal environments are places where Aboriginal occupation sites are likely to be found. Fresh water (further inland from the estuary), wetlands, rock platforms and small coastal rock shelters are all environments with a potential to provide a range of economic resources for the subsistence needs of an Aboriginal population.

The study brief did not seek information on Aboriginal heritage, however the consultants considered it essential to review the literature and undertake some limited field survey.

Brief inspections of key landscape units within the study area were made to check for the presence or otherwise of Aboriginal sites. Exposed or disturbed ground within the study area was examined to see if any Aboriginal cultural material was present. Dense vegetation cover over most of the study area meant that ground visibility was in general less than 1%. This poor level of visibility makes it nearly impossible to locate Aboriginal cultural material but does not preclude the likelihood of their existence.

Exposed areas in the coastal dunes just outside the study area were also briefly inspected and a number of shell middens noted. These sites have been previously recorded and listed on the Site Register of the Victoria Archaeological Survey. All these sites were visible in dune areas where the coastal vegetation has been disturbed and the dune sediments exposed and subjected to erosion.

8.2 Known sites

The Victoria Archaeological Survey holds records of seven Aboriginal middens on and near the dunes at the mouth of Painkalac Creek just outside the study area. Another site (a deflated midden with a large amount of stone material) was found further along the coast. These sites were recorded in 1983, although not as part of any detailed study. The investigation appears to have been confined to the coastal strip. Consequently the site recording forms only contain basic information with no analysis or interpretation.

Evidence from the recorded middens shows that a variety of coastal resources were exploited, including the species of shellfish found on the rock platforms. The presence of bivalves may indicate that shellfish were collected from the main channel sediments of Painkalac Creek.

8.3 Potential site locations

Further inland along the creek, other animals and plant foods would have been available. The creek supports a diverse population of fish. Black bream is very common and is present all year round, while many other fish such as mullet or Australian salmon can be found according to season (S. Seymour pers. comm.). In the colder months, eels flourish in the creek and migrate inland in late winter. Eels are known to have been an important food source for Aboriginal people living in other localities. At Lake Condah, for example, extensive systems of stone traps were constructed to collect the eels during periods of seasonal abundance.

The productive alluvial flats would have provided a diversity of edible plant foods, examples of which still exist (G. Carr pers. comm.). The wetlands also provide a habitat for a number of birds and small native animals. These may well have been hunted as part of the diet.

The productive alluvial flats would have provided a diversity of edible plant foods, examples of which still exist (G. Carr pers. comm.). The wetlands also provide a habitat for a number of birds and small native animals. These may well have been hunted as part of the diet.

A similar estuarine-coastal environment exists at Breamlea (between Torquay and Barwon Heads). Here, ten midden sites have been recorded inland from the coast along the estuary (G. Brennan pers. comm.). Considering the similarities between the two areas, it could be suggested that there are also likely to be cultural remains within the study area along the estuary and wetland fringes (R. Vanderwal pers. comm.). Inland campsites would have been close to the creek; in drier years campsites may have been on the banks of the creek, and in wet seasons such sites may have been situated on the more elevated slopes of the valley.

8.4 Need for further survey

There is a clear need for sensitivity to the presence of Aboriginal sites and those landscape units where sites are likely to occur. A detailed and thorough study is required to assess the extent, nature and significance of Aboriginal occupation of this eastern Otways coastline.

It is highly likely that more sites are located in the areas of undisturbed dunes. This has implications for both the management of this landscape zone and for any future developments which may have impact on the dune surfaces.

No archaeological survey has yet been carried out in the coastal hinterland. To gain a better understanding of the range and nature of Aboriginal sites in this area, such an archaeological study would need to encompass a broader area, including the estuarine environment.

9.0 SUMMARY OF SIGNIFICANCE OF NATURAL VALUES IN THE STUDY AREA

Geomorphology

The study area has high regional geomorphological significance.

Vegetation

A total of 30 significant plant species have been recorded for the study area. Of these, 27 are regarded as having regional significance and three as having local significance.

Fifteen indigenous vegetation communities are described of which two have state significance. Nine communities have regional significance, with one of these having high regional significance. The remaining communities have local significance.

All indigenous vegetation in the study area has at least local significance.

Fauna

One bird species (Rufous Bristlebird) has high regional or state significance. Two mammals (Broad-toothed Rat and Koala) have regional significance. All other native animals have local significance.

Habitat

The Painkalac Creek area has overall high regional significance as habitat.

Wetland habitat in the study area has regional significance.

Visual and Aboriginal sites

Area A (Map 5)

Visual landscape

The coastal landscape unit, of which this area is a part, is highly significant within the township of Aireys Inlet and the region. It is the key 'landmark' landscape that signifies Aireys Inlet. Its important visual qualities include the degree of naturalness of the estuary, the landmark of the lighthouse and the dramatic contrast of land and water forms. The coastal landscape unit is in the foreground of the vista from the lighthouse, an important viewing point within Aireys Inlet, and contributes to the scenic qualities of the Great Ocean Road that have made it a highly regarded scenic route.

Aboriginal sites

The coastal landscape unit contains a number of Aboriginal middens. There is insufficient comparative data available to assess their relative significance, however all such sites are protected from disturbance under Victorian law.

Area B (Map 5)

Visual landscape

Within the Valley landscape unit this area of natural grasslands has the highest visual qualities. It is rated as of high scenic quality due to its naturalness and the presence of water. The contrast between the valley and the surrounding hills add to the visual quality of the whole creek valley. It creates an important edge between town and country, separating the townships of Aireys Inlet and Fairhaven, and adding to the overall amenity of the locality. This landscape forms part of the viewshed seen by those travelling up Bambra Road to Angahook Park.

Aboriginal sites

No sites have yet been identified in the area, however it is likely to contain Aboriginal sites.

Area C (Map 5)

Visual landscape

Within the Valley landscape unit this area of pasture is rated as of moderate scenic quality. Like Area B it provides an important buffer between the two townships. The open valley contrasts with the enclosing, forested hills creating a distinctly non-urban setting. This landscape forms part of the viewshed seen by those travelling up Bambra Road to Angahook Park.

Aboriginal sites

No sites have yet been identified in the area, however it is likely to contain Aboriginal sites. Land management practices including ploughing and grazing may have already disturbed any sites.

Area D (Map 5)

Visual landscape

Within the Valley landscape unit this area of of high visual quality due to its naturalness, vegetation diversity and the presence of water.

Aboriginal sites

No sites have yet been identified in the area, however it appears likely to contain Aboriginal sites.

Overall visual significance

The Painkalac Creek valley is a highly significant landscape within the Aireys Inlet locality. Its scenic qualities are important elements in the identity and amenity of both townships, and contribute to the beauty and diversity of this section of the Otways coast. The retention of natural areas adds to its scenic value. Although outside our study area, the surrounding forested hills are an important contributor to the quality of this landscape.

10.0 LAND USE POLICIES

10.1 Land use and ownership

10.1.1 Land use

The predominant land uses within the study area are grazing, recreation and conservation. Whilst there are no residences within the study area, residential uses in the townships of Aireys Inlet and Fairhaven abut the eastern and western boundaries of the study area.

10.1.2 Land ownership

There is a diversity of land ownership in the Painkalac Creek valley. At the southern end of the study area much of the land is in public ownership including the Coastal Reserve (managed by the Aireys Inlet Foreshore Committee of Management) and Mellors Swamp which was acquired jointly by the GRC and Shire to ensure its conservation. Immediately north of the Great Ocean Road is the Painkalac Creek Reserve, owned by the Shire of Barrabool. The area north of Boundary Road is owned by the McKenzies, with the north-western corner being part of Lorne-Angahook State Park.

Various members of the Allen family own the freehold land which is bounded by Bambra Road to the east and Boundary Road to the north. Along the southern and part of the western boundary of this property is a stream reserve (zoned Public Open Space); the remainder of the western boundary is formed by Painkalac Creek.

10.2 Existing planning policies

10.2.1 Strategic and statutory controls

Planning documents

The 1982 Aireys Inlet to Eastern View Structure Plan provides a broad planning framework for the locality. With the Geelong Regional Planning Scheme, (GRC 1988 a) these policies form the basis for planning and development control.

The Structure Plan is a forward-planning document, setting the broad policy framework and raising some issues for further discussion for the Aireys Inlet locality. The Structure Plan recognises that the locality must be protected from indiscriminate tourist development. This is summed up in the Plan's regional and local aims which state in part:
"To protect a regionally significant area, unique in natural beauty and village like atmosphere ... and to recognise the desires of existing residents and property owners, and safeguard the integrity of the local environment" (GRC 1982)

The Geelong Regional Planning Scheme (GRPS) provides for the statutory and detailed control of the use and development of all lands within the nine municipalities of the Geelong region including the Shire of Barrabool. It is in three sections: State, Regional and Local. The majority of its provisions are contained within the Regional section of the Scheme.

In 1988 the Geelong Regional Commission released *Directions: The Geelong Region Development Strategy* (GRC 1988 b). This document is principally concerned with the economic development of the region and aims to expand the productive and employment-generating capacity of the area. Through a hierarchy of regional and local goals and sub-goals, the strategy seeks to attract new business, investment and visitors to the region. This commitment to growth in tourism may have implications for Aireys Inlet although any potential impacts do not appear to be addressed in the text. The policy for Aireys Inlet is to maintain its small scale coastal/bushland resort atmosphere with no residential expansion (GRC 1988 b).

Zonings

There are three zones in the GRPS that cover the study area:

. Rural Natural Features:

. Rural Floodland

. Public Open Space.

To the southern end of the study area the estuary (Mellors Swamp, Area A) is zoned Public Open Space (Foreshore and Stream Reserve). The Painkalac Creek Reserve is zoned Public Open Space (Public Park) with a stream reserve on both the southern and northern boundaries of the creek. Allen's property (Area C) is zoned Rural Floodland and Rural Natural Features (see Map 5).

There is an area zoned Proposed Public Open Space (Streamside Reserve) along the western boundary of Allen's property. The area to the north of Boundary Road (Area D) is zoned Rural Natural Features with a small area of Public Open Space (State Forest). A road reservation for a Proposed Arterial Road runs from the corner of Boundary and Distillery Creek roads in a north-westerly direction intersecting with Bambra-Aireys Road. This designation as "proposed arterial" refers to the GRC's designation not that of the VicRoads.

The townships of Aireys Inlet and Fairhaven are basically covered by Residential A zone. On the east side of the valley the Residential A zone extends northwards to Aireys Street; further north the land is zoned Rural Natural Features. On the western side of the valley the Residential A zone extends to the Wybellena Drive subdivision; the land further north is zoned Rural Natural Features.

Virtually the whole Painkalac Creek valley and surrounding hills (excluding the township and public open space zones) are protected by a Preservation Order.

The framework of policies and zones are briefly described below:

Environmental Policies

The Structure Plan aims to create a policy framework that protects the special natural assets of the locality. The wooded hills surrounding the settlements are regarded as a positive natural attribute that requires continued protection from urban development through inclusion in the Rural Natural Features zone.

The Painkalac Creek floodplain is seen as a tourism and recreation asset that must be protected from residential development through the GRPS (Structure Plan, 3.6 ii & iii). The Structure Plan proposes limited development in two special circumstances only - firstly where limited development rights are exchanged for title consolidation and secondly where development comprises part of a tourism development scheme, with only low-intensity recreation development south of Hartleys/Boundary Road (GRC 1982).

The GRPS provides a series of requirements (Clause 18) on all land designated 'rural'. This clause covers a wide range of matters including subdivision, house construction, tenement and contiguous ownership provisions.

Environmental controls are provided in Part 6 (Clause 27) of the Scheme. Several zones provide for the protection of significant landscape features which are of scientific importance or natural beauty and therefore form essential components of the heritage and character of an area. Such zones include Preservation Order Areas and the Rural Natural Features zone.

Rural Natural Features Zone

The Rural Natural Features is applied to land which has particular qualities relating to either natural features, significant landscape, habitat or a particular rural environment. The intention of the zone is to protect these qualities.

The Scheme specifies that land within this zone shall not be subdivided into lots of less than 60 hectares.

A permit is required for the construction of all buildings and works and for the removal of trees, native plants and natural objects. In determining whether to grant a permit the responsible authority is required to consider:

- preservation of the natural environment including any important landscape or conservation characteristics of the area
- retention of a buffer strip of vegetation near water courses, roads and property boundaries
- the need to control or regulate the siting, shape and height of any buildings or extensions
- protection of the setting of any natural objects or features from intrusive development.

Preservation Order Area

A Preservation Order Area has been overlain over the Rural Natural Features and Rural Floodplain zones. In addition to the environmental controls provided under the Rural Natural Features zone, the Preservation Order Area provides planning control over materials, external finishes and colours of buildings constructed within the Area, requiring that new buildings conform in appearance and character with adjacent buildings and the area generally.

Rural Floodland Zone

The Rural Floodland zone covers areas that are liable to significant inundation. The zone allows existing development and works to continue but establishes controls to ensure that new buildings or works take into account the hazards of the land.

The minimum subdivision size in this zone is also 60 hectares. No permit is required for a range of uses including animal husbandry, afforestation, agriculture and passive recreation. (Passive recreation is defined in the Scheme to mean the use of land for a public park, public gardens, foreshore reserve, or children's playground.)

Construction of buildings within this zone is prohibited in most circumstances. The exceptions include an outbuilding associated with agriculture or animal husbandry or a building intended for recreational use that is ancillary to an adjacent recreation use; there is no other suitable site for a building on the balance of a lot. Where the whole of a lot is within the zone, a permit may be granted for a house and outbuildings. A permit would be required for a range of uses including animal park, car park, minor sports ground, recreation buildings and produce stall.

In considering the use and development of any land in this Zone, the Responsible Authority shall have regard to the compatibility of the use or development with the known flood risk, likely degree of inundation, works required to prevent inundation (etc) and the important landscape characteristics of the area.

Residential Policies

The Structure Plan states that "Aireys Inlet has at least 25 years supply of residential land. Seen in the context of the need to conserve the Painkalac Creek floodplain and the wooded areas north of Aireys Street (West of the Great Ocean Road) it is impossible to justify additional residential zonings for Aireys Inlet" (GRC 1982).

The residential development policy adopted in the Structure Plan therefore requires that no additional areas are to be set aside for conventional residential development (GRC 1982). This is supported in the current Regional Development Strategy (GRC 1988b).

Provision of sewerage reticulation for Aireys Inlet and Fairhaven is sought in the Plan to service the residential areas.

Tourism Policies

The Structure Plan proposes that tourism development in the locality should be carefully planned and controlled through "positive development and use guidelines". Development of a tourist development master plan is proposed but has not yet been commenced (GRC 1982).

The tourism objectives of the Structure Plan highlight the importance of enhancing the tourist role of the Lorne-Angahook State Park (GRC 1982), while the proposed policies seek to do this by developing the Painkalac Creek valley.

Protection of the Painkalac Creek valley from conventional residential development is proposed as a key element in protecting its tourist potential. The Plan suggests a range of ways in which tourism could be further developed; these ideas were put forward for discussion and include:

- provision of further accommodation north of Boundary Road (since developed as 'The Glens' tourist farm cottages)
- a continuous open space spine/tourist corridor running from Distillery Creek picnic ground through Painkalac Creek floodplain to Aireys Inlet Beach
- a continuous public pedestrian link along the Painkalac Creek from the lagoon area north past Bimbadeen Road.

The overall theme would be in sympathy with the natural environment. Their model for such development was the Tidal River development (Wilsons Promontory National Park) which integrates low-cost tourist accommodation within a sensitive and attractive natural environment.

Another objective proposed is to overcome the seasonality problems which restrict the tourist potential of seaside tourist developments in Victoria. Thus the Creek valley is seen as an area that could provide activities all year round - activities such as horse riding, archery, boating, cycling, and sports. This objective conflicts with the primary Structure Plan objectives of protecting the environmental and landscape attributes of Painkalac Creek valley. The need to overcome "seasonality" is not argued in terms of the social or economic needs of the locality.

Public Open Space Policies

The Structure Plan proposes policies for the beaches in the Aireys Inlet locality and the lagoon area.

The lagoon (Area A, Mellors Swamp) is to be retained as a conservation area and not developed.

10.3 Land management practices

Fire Prevention

According to the captain of the local CFA unit, fire prevention in the creek valley consists of a combination of east-west 'slashes' across the valley, and a five-year rotational burn (i.e. one section per year). The exact details of 'burn boundaries' and siting of grass slashes is currently (Feb 1990) under review (Ross Gurvan, CFA, pers. comm).

Flood Regime

The Shire opens the mouth of Painkalac Creek around August each year D. Welsh pers. comm). Agreement has also been reached between the Shire and Rural Water Commission on a water level at which it can be opened. Mr Allen, an upstream landowner, has also been given permission to open the mouth of the creek should brackish water back-up as far as his property.

Drainage, Storm Water

Many of the storm water drains from the residential areas to the east of the study area drain into Painkalac Creek via open channels across Allen's land. The siltation of these channels has caused minor flooding along residential streets (D. Welsh pers. comm.).

Water and sewerage services

With reticulated water available to most of the residential areas adjoining the study area, pressure for connection to a sewerage system is growing. The EPA monitors the creek water quality (see Section 4.7).

10.4 Development proposals

Over the last ten years many new uses or developments have been proposed for Painkalac Creek valley. Many such proposals have sought to facilitate increased public use of the area, for nature-based activities or for active sport. The development of private land for residential purposes has also been sought. The search for a suitable site for a cricket pitch/oval within the township has been a component in many of these proposals.

The brief requires consideration of the environmental impact of a range of uses that could be introduced into the study area. Current proposals for such uses are described briefly below, and their respective locations noted on Map 5.

10.4.1 Past proposals

BAC Landscape Plan

In 1983 the Shire commissioned consultants (BAC Landscape Consultants) to prepare a landscape plan for Mellors Swamp and the Painkalac Creek Reserve.

The plan suggested two optional locations for a cricket oval (see Map 5). The preferred location was on the eastern side of Painkalac Creek Reserve (Area B, Map) linked to River Road by a footbridge, with a boardwalk along the western bank of the creek to link with 'fire access track' below Wybellena Drive (Site 1, Map 5). The only facilities to be provided were a pavilion and a 50- space car park between the oval and creek. Vehicle access to the pavilion and car park was proposed to be via a road bridge over Painkalac Creek (in effect an extension of Phillip Street).

The other option for the oval (Site 2, Map 5) required the acquisition of private land north of the Painkalac Creek Reserve; this was regarded as a 'high cost site' due to the need to purchase the land and fill the site.

The BAC Plan also proposed a system of boardwalks along the edge of the creek and swamp to enable greater public access to Mellors Swamp and Painkalac Creek Reserve. The boardwalks and tracks incorporated bird hides and a small jetty, and the landscaping of the information/fire safety area.

The BAC Plan was exhibited for three days in 1983, but the community response was quite negative, with many comments seeking a more conservation-oriented plan for the creek. The Council decided not to implement the proposal (D. Welsh pers. comm.).

Pescott Plan

In 1986 an environmental effects statement (Pescott 1986) was prepared on a proposal to develop an oval, car park and picnic areas in the Mellors Swamp area (Site 3, Map 5). The proposal entailed filling much of the land between Inlet Crescent, the Great Ocean Road and the lower reaches of Painkalac Creek. The proposal was abandoned due to community opposition.

10.4.2 Current proposals

Residential development of Allen property

The Allen property (Area C, Site 4 on Map 5) is bordered by Boundary Road to the north and Bambra Road to the east. The western and southern boundaries of the site are formed by Painkalac Creek.

The land was originally subdivided into small lots and offered for sale in 1888; titles were never issued for these small lots and the land is now held in twelve titles of approximately 10 acres each. The land is held by various members of the Allen family and is not in one tenement. According to a concept plan drawn up in May 1988, 102 housing allotments would be situated on a crescent and six courts running from Bambra Road towards the creek. The planned development also includes open space to the west (along the creek), playing fields (including a cricket oval) and tennis courts at the southern end of the property (Gerner and Sanderson 1988).

AIDAG Plan

In October 1989, the Aireys Inlet & District Action Group (AIDAG) proposed that a sporting complex be developed on the West side of the Painkalac Creek Reserve (Site 5, Map 5) at the end of the existing fire access road. Their proposal includes an oval, a 12 x 20m pavilion, six tennis courts, a site for a possible future bowling green, and parking for 310 cars. Of those car spaces, 200 are located adjacent to the proposed oval and tennis courts, and the remaining 110 would be on Allen's property to the north of the Reserve. An extension of Beach Road (west of Bambra Road) would be required to provide access to this car park; a footbridge would provide pedestrian access from this car park to the sporting facilities. Roadworks would also be required to the north of Wybellena Drive.

Due to the need to provide road access, sewerage, lighting and a footbridge, the Council would be concerned at the overall cost of this proposal (D. Welsh pers. comm.).

Expansion of the Fire Safety Area

The Shire of Barrabool has proposed an extension to the existing Disaster Safety Area located at the corner of Inlet Crescent and the Great Ocean Road (Site 6, Map 5). Their proposal would extend the area and widen the road shoulder by approximately three metres. Cut and fill would be required and the resultant embankment regularly slashed. This would enable increased emergency parking along the Great Ocean Road. Pegs and a padlocked chain would be placed along the edge of the road reserve to prevent use of the area for parking at other times.

Pedestrian link along the creek

The Structure Plan recommends establishing a continuous pedestrian link along the valley (Site 7, Map 5). The brief requires assessment of this and any other proposals to facilitate access to any and all parts of the Study Area.

The BAC Landscape Plan (1983) proposed a number of tracks and boardwalks on the Shire Reserve and Mellors Swamp. AIDAG (1989) have proposed a walking track link from the beach to Lorne-Angahook State Park using the fire access track along the western side of the study area and extending along the edge of their proposed oval, across Painkalac Creek via a footbridge, and then following the creek northwards along its eastern bank (i.e. Allen's land).

Landscaping and access improvements at rear of shops

A landscape and planting plan has been recently prepared by the Shire to improve the appearance of the group of shops on the Great Ocean Road (opposite the fire safety area) (Site 8, Map 5). It would involve construction of a track at the rear of the Hardware Store linking the Great Ocean Road to River Road, plus planting with local native species to help screen the rear of the shops. These proposed improvements were a policy initiative of the Structure Plan. The plan has been supported by AIDA.

Painkalac Creek wetlands

A 1989 submission from Pauline Reilly, a local resident, proposes that the valley floor be engineered so as to create an enhanced habitat for water birds and other wetland-related species (AIDA 1989). The installation of floodgates would be required to keep the water level high (without interfering with the septic systems of developments on the creek flats on Great Ocean Road). The creation of a more convoluted creek bank and islands of various sizes would enhance habitat opportunities. Appropriate plantings would further enhance the area, and permit the introduction of unobtrusive bird hides, walking tracks and canoe 'trails'. Participation in the Land for Wildlife scheme or the introduction of covenants on free-hold land within or abutting the valley floor are suggested to assist in the protection of wildlife habitats. No slashing, burning or fill would be allowed on the wetland areas. Keeping the area wet all year round would provide an excellent firebreak.

10.5 Recreation in the Shire and the study area

Most of the development proposals for Painkalac Creek valley seek increased recreational use of the study area. This section of the report considers the existing data on recreation needs and provision within the Shire of Barrabool and Aireys Inlet.

10.5.1 Trends in recreation participation

National surveys of recreation participation in 1986 and 1987 are starting to provide a comprehensive data base. Some emerging trends include a movement away from formal or organized sports; most of the ten most preferred recreation activities are home-based or informal outdoor activities such as gardening and walking (DASETT 1989). Many municipal studies are revealing that the membership of sporting clubs is dropping but the demand for casual use of sporting facilities is increasing, resulting in a demand to get access to club facilities.

Regionally, the 1984 Geelong Regional Commission's *Recreation Strategy Plan* reported participation patterns similar to those revealed in national surveys. It concluded that there was scope for 'the upgrading, expanding and more intensive use of existing facilities' (GRC 1984). This was seen as particularly important in the case of football/cricket facilities, tennis courts and halls/indoor venues. A number of suggestions were offered as to how such a rationalization might be assisted.

The Shire of Barrabool's *Community Profile* (1986) covered recreation and other community needs, and proposed a recreation policy for the Shire. Based on a needs survey conducted in 1985, the study reported that 'the majority of participation in recreation on a regular basis occurs in non-organized activities' (Shire of Barrabool 1986). The most popular activities were beach usage (67% of respondents), swimming (51%), surfing (40%), tennis (32%) and fishing (19%).

The Aireys Inlet population is not typical, due to its size and the seasonal visitation by weekenders and tourists who may have quite different recreation needs from the permanent residents. While the Shire-wide needs study provides a general picture, further detailed investigation would be needed to carefully document the recreation needs of these different groups within the Aireys Inlet community. This could be incorporated within the Shire of Barrabool's proposed 1990 recreation needs study.

The Shire's recreation policy (Shire of Barrabool 1986) provides a basis for the planning and provision of recreation services and facilities. It supports the principle of equal access for all to recreation resources, while endorsing the concept of user pays as the basis for funding of most facilities. The policy emphasizes that priority will be given to ensuring that the Shire's Reserves and developments are environmentally acceptable and attractive to users, and propose a continual program of planting appropriate trees and shrubs.

10.5.2 Recreation activities and facilities in the study area

Present recreational use of the study area includes walking, bird-watching, picnicking and water-based activities such as fishing, canoeing and boating. Motor boats using the estuary and creek are restricted to an 8km per hour speed limit. The estuary (Area A) provides a safe, protected swimming area for family use (H. Dickson pers. comm).

Facilities available to support these recreation activities include two boat-launching ramps (one each on the east and west ends of the estuary), toilets and picnic tables on the foreshore reserve.

The Lorne-Angahook State Park at the northern end of the study area offers a wide range of recreation opportunities including walking tracks, scenic drives and lookout points, camping and picnic areas. The freshwater swamp (Area D, Map) is used for bird watching.

A long distance walking track - Jan Juc to Moggs Creek Surf Coast Walk - links the northern end of the study area (and Lorne-Angahook State Park) with the coast via Boundary Road (Shire of Barrabool n.d.).

10.5.3 Need for additional recreation opportunities and facilities

The major community facility at Aireys Inlet is Roadknight Hall and the two adjoining public tennis courts. According to the Structure Plan, the site is large enough to accommodate a range of additional community facilities (GRC 1982). A wider range of facilities is available at Anglesea including football and cricket grounds, netball courts, a golf course and bowling greens.

Information on desired improvements or additions to facilities were sought through the 1985 recreation needs survey (Shire of Barrabool 1986). Ideas for Aireys Inlet included:

- improvements to tennis courts (21 requests; represents 4.2% of those respondents who participated in this activity in the Shire)
- bowling green (5; 4.5%)
- football (2; 1.4%)
- construction of a cricket ground (10; 5.8%)
- beach improvements (33; 3.8%)
- bike riding paths (12; 3.1%)
- bushwalking (19; 4.8%)

To meet the needs of local children the Education Department has allocated funds to upgrade the primary school oval (D. Welsh pers. comm.).

One facility sought over many years has been a home ground for the Aireys Inlet Cricket Club (AICC). The Club presently practices in nets on the McKenzie property adjoining the northern end of the study area. At present all their matches are played away. There are several options to meet the need for a home ground. One is the construction of an oval next to the Roadknight Hall; this option has the support of the Shire and some of the community but has attracted considerable local opposition from other sections of the community as it would involve the loss of a stand of ironbarks. The Shire would prefer to provide a home ground for AICC at Anglesea by adding a cricket pitch to an existing oval adjacent to the Anglesea Cricket Club's ground. This is the lowest cost option (D. Welsh pers. comm.).

The Shire also supports provision of a walking/canoe/bike network and series of bird hides in the Painkalac Creek valley.

The Department of Conservation, Forests and Lands (DCFL) has recently completed a resource document to provide background data for the forward planning of Lorne-Angahook State Park (Vose *et al.* 1987). Funding has been approved for the appointment of a project planner to prepare a planning study for the Park. This study is expected to commence in April 1990 and will examine many issues, including access to the Park. At present DCFL would be concerned about any increased access to the Park via Painkalac Creek valley (R. Stone pers. comm.).

11.0 ENVIRONMENTAL IMPACTS

11.1 Existing environmental problems

Hydrology and soils

Eutrophication from residential developments upslope and soil erosion associated with roading and recreation are problems affecting water quality, vegetation and fauna, and specific habitats (e.g. the freshwater swamp adjacent to the Lorne-Angahook State Park, threatened by siltation). Recreational values are apparently so far unaffected by water quality.

The potential for flooding may constrain some proposed developments on the floodplain (Allen's land) pointing to the need for a study on the potential for a 1/100 year flood.

Vegetation

Environmental weed invasions (Carr 1988) are currently the greatest threat to the native vegetation in the study area, and over time they are likely to eliminate most of the vegetation. Some communities are much more vulnerable than others to weed invasion. Some of the most serious weed species (Carr and Yugovic 1989) include **Chrysanthemoides monilifera* (Boneseed), invading *Poa* grassland, **Polygala myrtifolia* (Myrtle-leaf Milkwort) and **Leptospermum laevigatum* (Coast Tea-tree), invading the coastal Dune Shrubland and *Melaleuca armillaris* (Giant Honey-myrtle) invading the coastal heath (which was not sampled during this study).

Many of the most serious weeds have escaped directly from cultivation in nearby residential gardens or Shire or VicRoads plantings along the Great Ocean Road. The most serious or potentially serious weed species in the study area, for which control or elimination is mandatory to preserve vegetation values, are listed in Table 12 with relevant data.

Other environmental impacts leading to degradation of biological values include:

- Mowing of the *Poa* grassland for a firebreak which exacerbates weed invasions or potentially reduces faunal habitat values.
- Eutrophication of creek from septic tank run-off which favours weed invasions and causes or contributes to algal bloom- development.
- Erosion which leads to siltation of creek and wetland communities - from roads and tracks (e.g. to birdhide in Lorne-Angahook State Park) - see also Section 4.5 and 4.7.
- Potential isolation of vegetation remnants by development.

Fauna

Habitat degradation, predation by introduced carnivores and human activity are probably the most significant environmental problems occurring in the study area. Habitat degradation is a result of past and present land management practices and weed-invasion. Within the tussock grassland, fire management practices (i.e. slashing) have led to the destruction of habitat.

Signs of foxes and dogs were observed in the study area, for example along the fire access track to the west of the Painkalac site; these carnivores may exert some predation pressure on the native ground-dwelling species, although no evidence of this was obtained during the study. Presently, the effects of human activity (e.g. trampling) are probably minimal within the site because of its relative inaccessibility.

Visual landscape

There are a number of developments within the study area which are incompatible in scale, form and colour with the visual qualities of the Painkalac Creek Valley.

The commercial developments adjacent to the Great Ocean Road are an unfortunate intrusion into the coastal landscape. Improving the appearance of this commercial area would have economic benefits, add to the amenity of the township, and better respect the high visual qualities of the coastal and estuarine landscape. The proposals for improving this area contained in the Structure Plan have not yet been implemented; a current proposal for planting along the creek frontage to screen the rear of the shops would be of benefit but needs to be incorporated into an overall scheme.

Improving the appearance of the fire safety area is a more difficult problem due to the differing design parameters imposed by its two functions - that of a refuge during a serious fire and as a tourist information and stopping point. It physically intrudes into the estuary and wetland, and its lack of vegetation makes it a barren and unattractive place for visitors.

Many of the township's roads are aligned directly down the slopes of the hill, creating a stark visual scar. Examples include the road to the lighthouse (Reserve Road), and a number of roads on the eastern side of the valley.

The extension of housing northwards on the hills surrounding Painkalac Creek valley is slowly and irreversibly changing the character of the area. Closer attention to the design, scale and siting of new housing development within the residential zone is essential if their visual impact is to be minimized.

Aboriginal sites

Several midden sites along the coast are subject to continuing erosion, despite some fencing to restrict access. The car park next to the boat ramp on the eastern side of the estuary is located on top of a midden. These sites are outside the study area and are within the coastal reserves managed by a Foreshore Committee. Works are required to protect these sites and to reduce further damage.

The potential for damage to other yet undiscovered sites in the study area is quite high should any works of activities be undertaken that disturb the surface of the soil. More detailed site survey work is essential to provide the required information base.

11.2 Potential impacts of proposed developments

Hydrology and soils

Considerable potential exists for serious eutrophication of waterways and wetlands without a sewerage scheme to effectively dispose of effluent. This would be likely to have a serious impact on the instream vegetation and fauna and cause problems for residents such as algal blooms. The recreational amenity of the estuary for swimming etc. could be prejudiced by unacceptable *E. coli* counts.

Soil erosion will continue to be a problem and any development that involved exposing mineral soil could contribute to siltation and seasonal turbidity of the creek.

Vegetation

Several of the proposal developments would incur loss of significant vegetation south of the Great Ocean Road (in the proposed fire safety area) and, north of the Great Ocean Road (the oval and public access on Council land - the area carrying *Poa* tussock-grassland). Development in or near areas with significant vegetation would also be likely to exacerbate weed invasion of adjoining vegetation as sites for weed colonization were created, enhancing 'edge effects' and increasing the available sources of weed seeds. Increased residential development would also provide additional sources of seed of cultivated garden plants (source of many highly significant weeds (Carr 1988)) to colonize in nearly indigenous vegetation, especially as a result of seed dispersal by birds. This could be circumvented by agreements or covenants preventing the cultivation of invasive environmental weed species.

Further eutrophication of the creek or estuary resulting from increased residential developments would be likely to detrimentally effect the instream flora and fauna. This could occur as a result of algal blooms 'smothering' other aquatic vegetation or the 'fertilizer' effect differentially affecting plant or animal species.

Fauna

The major impact on fauna from the proposed developments (see Section 10.4) would be the destruction of habitat to some degree. Any development in areas of native vegetation at Painkalac Creek would have a direct impact on the terrestrial habitats. Effects on aquatic systems are more likely to take the form of bank erosion and stream siltation caused by construction activities. Habitat destruction could also occur as a result of increased access to the area or of development adjacent to it. Trampling of vegetation and the removal of firewood are examples of the types of indirect effects which may occur.

Increased human activity may have a direct effect on fauna by causing desertion of home ranges or nesting sites, trampling of runways and nesting sites or young, or by increasing predation of native fauna by dogs and cats. An indirect effect of improving access would be an increase in the density of introduced predators (dogs and foxes) and also rats and mice with consequent predation or competition with native fauna. Proposals which encourage access by foot or by boat (e.g. tourist development, access track) are likely to cause this type of disturbance. The long-term effects of continued disturbance to the habitat are weed-invasion, erosion and siltation.

In the long-term, the use of boardwalks as access routes would have less impact than footpaths. However, construction activities would cause some habitat destruction and would possibly result in bank erosion and creek siltation. It is possible that pedestrians and their pets would not confine their activities to the boardwalk; they may use it to gain access to the more remote areas within the wetland.

Fauna Management Issues

In order to maintain the existing diversity of faunal species, future management should be directed towards maintaining the indigenous vegetation at Painkalac Creek. Short- and long-term vegetation management is therefore compatible with the preservation of fauna habitat.

Visual landscape

Serious impairment of the landscape values of the area could follow developments.

Aboriginal values

Further destruction or disturbance of Aboriginal sites could occur, especially in the area seaward of the Great Ocean Road.

12.0 RECOMMENDATIONS

12.1 Future use and development of the study area

12.1.1 Protection of significant areas

- Areas identified as being of state or regional significance should be retained and no development should be permitted within these areas.

- The effects of erosion should be investigated throughout the study area. Siltation of the freshwater swamp, for example could be ameliorated by sealing the surrounding roads and improving the bird-hide access track in Lorne-Angahook State Park.

- Weed management should be implemented. Environmental weed species, as identified in this report, should be controlled and/or eliminated in the study area.

  The significance of this issue should not be seen in isolation as only affecting the study area. Environmental weed invasions are by far the most serious conservation problem threatening the regional flora and fauna, but they also have economic ramifications (e.g. for tourism). Urgent attention is required at all levels - the community, Shire and the Department of Conservation, Forests and Lands - to tackle this problem. As a first step the local community (including potential new residents) and agencies (e.g. Shire of Barrabool, VicRoads) should cease the cultivation of ornamental or utilitarian environmental weed species.

- In areas where environmental weeds have been planted (e.g. along the Great Ocean Road west of the bridge over Painkalac Creek), these should be removed and indigenous plantings should replace them. A general policy of planting indigenous species should be adopted. Note: Some so-called indigenous species (e.g. *Leptospermum laevigatum* Coast Tea-tree) are in fact exotic).

- Slashing in the *Poa labillardieri* tussock grassland should cease; this practice exacerbates weed invasions and reduces faunal habitat.

- If any development is to proceed on private land (Area C), then access to the creek should be restricted.

- The Department of Conservation, Forests and Lands should enter negotiations with Mr. McKenzie regarding the exclusion of stock and revegetation of the margins of the freshwater swamp (Area D, Map 5). The banks of Painkalac Creek should be protected from grazing.

- No motorized craft should be allowed in the creek and no special boating facilities should be provided. Passive recreation only should be permitted, including fishing and non-motorized boating, south of the Great Ocean Road. Access should be restricted to the creek north of the Great Ocean Road.

- The Painkalac Creek wetlands should not be altered - a change from the present natural features and vegetation would be likely to attract some species (e.g. waterbirds, waterfowl) at the expense of the original fauna.

- No more indigenous vegetation should be alienated for fire safety refuges in the study area.

- The Proposed Arterial Road reservation within Area D would, if implemented, damage the significant vegetation communities within Area D. It is recommended that the Shire and GRC review this reservation with a view to its deletion from the GPRS.

. Vegetation and habitat management guidelines should be adopted for use by the Shire and other land management bodies for all of the significant communities identified in this report.

12.1.2 Proposed developments

After reviewing the known development proposals within the study area and considering their potential environmental effects the consultants make the following recommendations about their acceptability on environmental grounds.

Area A: Mellors Swamp should be protected from any further development:

. Development of an oval or other sporting areas is totally inappropriate given the overall environmental significance of this area.

. Extension of the fire safety area should not be permitted.

. The existing boat ramps at the eastern and western ends of the estuary should not be improved or expanded, and motorized craft should no longer be permitted to use these ramps or the estuary.

Area B: The Painkalac Creek Reserve should be protected from any further development:

. Past and present proposals to locate sporting grounds on this area are not supported due to its environmental significance

. Development of walking tracks and board walks are not supported due to the environmental sensitivity of the area

. The fire access track along the western edge of the floodplain currently allows vehicle and pedestrian access along the western side of the valley; continued vehicle access is not supported (except for emergency purposes), and pedestrian access should be limited if possible.

Area C: Construction of buildings on this section of the floodplain would impact on the visual quality of the Painkalac Creek landscape. Under existing planning controls the owner has some opportunity to develop the land. The proposal to develop a 102 lot residential subdivision is not supported, nor is the development of sporting grounds as part of the residential development. The proposed subdivision would create a substantial extension of the township and goes against the policies of the Structure Plan; it would require rezoning of the land.

12.1.3 Tourism and recreation development

Tourism development of Painkalac Creek valley should be strictly limited:

. The tourism development ideas contained in the Structure Plan (Area 5) are not compatible with the environmental values of the valley.

- Development of a continuous public pedestrian link along the creek from the lagoon to Boundary Road is not supported. Such a link would only be acceptable if it avoided access to areas of significant vegetation and habitat. Two possibilities requiring further investigation are: (i) a track from the Great Ocean Road along the east side of the creek (between the creek and rear of shops), along River Road and northwards along Bambra Road or via a negotiated easement through the Allen property or private land to the east of Bambra Road to link with the Jan Juc to Moggs Creek Surf Coast Walk; (ii) a similar route, but crossing the creek in Area C and negotiating an easement through private property or within the road reservation of Bimbadeen Drive.

- Concentration of land or water based activities on the lagoon/Mellors swamp is not supported. No further access should be provided to the lagoon/Mellors swamp area, and current access points should be redesigned and replanted to reduce car access along the fire access track (except in fire emergencies).

- Development of uses such as archery or sporting grounds are not supported.

- A public open space management plan should be prepared for the existing Reserves (Areas A and B) and proposed new open space areas (e.g. to the north west of Wybellena Drive - Amendment R5). It should also consider use of road and other utility easements to make linkages and the opportunities for negotiated access agreements on private land (Johnston 1988). This planning process should be linked to the current forward planning study about to commence for Lorne-Angahook Forest Park.

12.2 Land management

12.2.1 Water quality

- A study of the instream fauna is required. The effects of the damming of Painkalac Creek on invertebrate fauna should be studied.

12.2.2 Landscape management

- The Painkalac Creek valley requires a consistent set of landscape management objectives to guide developments and works.

- Views of the valley from external viewing points need careful protection and management to ensure developments do not intrude. The viewsheds from the lighthouse, Great Ocean Road and Bambra Road should be protected through the careful siting and design of all permitted developments outside the residential zones. This is provided for within the Preservation Order Area.

- Protection of the village quality of the two townships is mentioned in the Structure Plan. While the townships are outside our study area they do impinge on the Painkalac Creek landscape. Development on the hill slopes to the south of Aireys Road is starting to intrude into the valley landscape.

- A set of guidelines should be prepared and adopted by Council to assist in the implementation of the Preservation Order Area controls and to encourage sensitive development within the residential and commercial zones adjoining the Painkalac Creek valley.

- Council may also wish to seek an extension of the Preservation Order Area over the whole of Aireys Inlet to establish development controls over siting, design, colour, etc. within the non-rural zones.

In preparing these guidelines consideration should be given to the following matters:

- Continuing to contain the residential areas of the townships within defined boundaries, and seeking an increase in density rather than an expansion of residential zones
- Carefully managing the indigenous vegetation remaining within the township areas and encouraging replanting with *locally* indigenous species to ensure Aireys Inlet retains and enhances its natural setting
- Encouraging additional planting to screen and soften the visual impact of existing developments
- Location of structures and thinning or removal of vegetation along the skyline detracts from the landscape quality of the valley; this is occurring within the residential zones on forested hill slopes. Planning guidelines should aim to avoid skylining through the careful location of structures, avoiding clearing corridors of vegetation up to and into the skyline, controlling the actual height and location of buildings.

12.3 Further investigations

12.3.1 Hydrology

Further hydrological studies are required to determine flood frequencies and the magnitude of 1 in 100 year flood flows with respect to development proposals. The critical balance between saline and freshwater in the estuary should be investigated, particularly with regard to its effect on the significant vegetation.

12.3.2 Instream fauna

Any new or ongoing water quality sampling program should include recording of temperature, analyses of dissolved reactive phosphorus, dissolved oxygen and conductivity or salinity profiles in the estuary.

12.3.3 Erosion

The potential eutrophication effects of wastewater should be monitored, particularly with regard to proposed developments - sewerage reticulation will need to be carefully planned.

12.3.4 Aboriginal sites

An Aboriginal sites survey should be undertaken prior to any further works that will disturb the land surface occurring within the creek valley (i.e including track construction, clearing or planting schemes). Such a study would aim to locate sites, predict the archaeological sensitivity of the whole area and assess the significance of any sites within the context of Aboriginal occupation of the eastern Otways area.

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Table 3. Summary of results of *E. coli* water monitoring program conducted by the Shire of Barrabool (1977 - 1981) in Painkalac Creek, Aireys Inlet.

Year	Month	(Mouth) Sample 1	(Bridge) Sample 2	(Duck Pond) Sample 3
1977	June	6	34	27
	August	0	2	44
	November	13	14	3
1978	January	0	0	0
	May	41	20	198
	June	106	107	86
	December	850	680	620
1979	January	123	149	460
	February	0	0	0
	May	12	21	5
	July	11	10	0
	September	16	70	820
	October	3	32	370
	December	6	3	90
1980	January	180	186	184
	February	12	10	100
	April	40	21	0
	June	270	400	350
	October	4	2	6
1981	January	11	0	3
	March	5	36	167
	April	0	11	24
	June	16	20	26
	September	80	70	0
Geometric Mean (6m)		16	19	27

NB: All result organisms/100 ml.

Table 4. Summary of water quality monitoring program conducted by the Shire of Barrabool (1977 - 1981) in Painkalac Creek, Aireys Inlet.

	7/7/82	5/5/87	2/7/87	2/6/88	18/8/88	13/10/89	8/12/88	9/2/89	6/4/89	1/6/83	19/10/89	$\bar{X}1$	$\bar{X}2$	6m
Site 1														
Mouth of Painkalac Ck														
$B.O.D._5$	0.8	-	-	1.8	2	1	1.5	<1	<10	<1	<10	1.41	3.79	
NH_3:N	<0.05	-	-	1.4	<0.1	3.1	0.42	0.28	0.071	<0.01	0.07	0.68		
AN.S.	0.6	-	-	0.5	0.27	1.1	<0.1	<0.1	0.23	0.16	0.2	0.36		
E. coli	<5	-	-	<2	104	-	0	4	-	400	170			16
Site 2														
Main Road Bridge														
B.O.D	1.5		<2	0.6	8	<1	<1	4	<10	-	<10	2.50	4.23	
NH_3N	<0.05		1.3	1.0	0.2	0.37	0.4	<0.1	<0.01	-	0.4	0.43		
AN.S	0.6		0.14	0.25	0.27	0.72	0.1	0.32	3.7	-	0.3	0.71		
E. coli	<5	<2	10	<2	130	-	38	<2	-	-	200			12
Site 3														
Bambra/Beach Road														
B.O.D.	1.0	6	<2	0.5	6	<1	<1	7	<10	1	<10	2,8	11	
NH_3N	<0.05	0.33	1.2	0.7	0.1	0.32	0.44	1.1	0.21	0.01	0.6	0.46		
AN.S.	0.02	0.22	0.22	0.26	0.08	0.43	<0.1	1.5	0.39	0.4	0.2	0.35		
E. coli	30	54K	20	<2	96	-	84	80	-	2000	170			134

Table 6. Two-way table of vegetation communities recorded in the Painkalac Creek floodplain study area, Aireys Inlet, Victoria, December 1989

* Denotes introduced species

	COMMUNITIES	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	QUADRATS / SPECIES	DD	DDDDD	DDDDD	D	D	D	DD	D	DDDDD	D	DDD	D	DD	DDDD	D
		11	11111	11111	1	1	1	11	1	11111	1	111	1	11	1111	1
		99	99999	99999	9	9	9	99	9	99999	9	999	9	99	9999	9
		00	00000	00000	0	0	0	00	0	00000	0	000	0	00	0000	0
		25	23344	22233	2	4	4	33	4	23334	3	255	4	44	2555	4
		45	33414	12557	6	5	3	06	2	92890	1	734	7	89	8012	6
2979	Ruppia polycarpa	53														
2197	Mimulus repens	+1	1	1 +												
1076	Distichlis distichophylla	1	1211	13211	3	1	1			1 ++1		1				
3449	Triglochin striata	21	1 2	2								+	2			
3100	Selliera radicans		11 11	111+1	1											
3001	Samolus repens		33124	23121	1	1	1	21								
3012	Sarcocornia quinqueflora		433+4	2+ +												
1826	Juncus kraussii		+1212	52253	1	2	1	11		1		1				
1772	Isolepis cernua		+11 1	+ 1						1		+			1	
2640	*Polypogon monspeliensis		+11 1	+1 +1	1	+	1	+		1		1+				
2834	Puccinellia stricta		11 1	11												
297	*Aster subulatus		11	+1 12	1			+		+		1				
2553	*Plantago coronopus		1311	3211	1	2				+		11				
3203	*Sonchus asper		1+ 1	+	+			1	1	++2					1 +	
329	*Atriplex prostrata		++ 1	1+ 1			1	2							+	
2418	*Parapholis incurva		1+ 1	2		+				+		1				
848	*Cotula coronopifolia		1+ +	+ 11				1				+11				
4444	Epilobium billardierianum ssp. bill.		1+ +	11		1	2	1+		2		1 1				
247	Apium prostratum		1+ 1	12 11	1											
1702	*Critesion marinum		+1							+ 1		1				
151	Agrostis avenacea		1 1	2+11	1							1	1	+	1	+
3107	Senecio glomeratus		1	+ 1	1					+ 11					+	
2060	*Lotus hispidus		111+	1 2		2		1		12112	1	111	1		1 1	+
2605	Poa poiformis		12+	2 +2	2	5	1		2			1				
1782	Isolepis nodosa		1	12+4	+	1	1	1	2	+ 1		12			1	
705	*Centaurium tenuiflorum		1	11	+	1			+	1 +						
2092	Lythrum hyssopifolia	1		1			1			1		111				
3204	*Sonchus oleraceus		1	+ 1	+			+	1	1++1	+	+			1++1	
1830	Juncus ?pallidus	1		1						1		1			11	
2239	Hyoporum insulare			+		1			2	1+					+	
1139	Eleocharis acuta		1							+		554			1	
1389	Gahnia filum		1	21	1	1										
1036	Dichondra repens			1 +					1	1 11					1	
2497	Phragmites australis			1				55		1					1	
1987	Leucopogon parviflorus			1					2	111						
4445	Epilobium billardierianum ssp. ciner.			1 +	1	1				2						
2561	*Plantago lanceolata			+				1	1	31 2					11 1	
223	*Anagallis arvensis			1		1			1	11111	+				+	
623	Carex appressa						1	1				22	1		1 3	
1432	Geranium retrorsum								1	1 1	1				1+	1
1956	Leptospermum juniperinum									+ +2+			2	+	23	
2600	Poa labillardieri							1		54342	1	11			4 11	
1616	Helichrysum dendroideum					1		1		1113+					21	
1692	*Holcus lanatus					+	1	1		11112	2	122	+		22+3	1
1748	*Hypochoeris radicata								+	2 12					11+1	1
105	Acaena anserinifolia									2211	1				11	
770	*Chrysanthemoides monilifera									332	1				1	+
2179	Microlaena stipoides									1123					1211	
2381	Oxalis exilis									1++		1			+1	
2959	*Rubus procerus									1+ 1	1				1 1	
57	Acacia melanoxylon									321					1211	
1307	Eucalyptus ovata						1								41	
100	Acacia verticillata									2					222	
2777	Pteridium esculentum				+				1		5				1211	1
1775	Isolepis fluitans												+	2		
211	Amphibromus recurvatus											21	2	2		
1146	Eleocharis sphacelata													14		
3448	Triglochin procera											+		33	1	
3521	Villarsia reniformis												1	51		
3873	Myriophyllum simulans													44		
1779	Isolepis inundata												1	1	1	
2153	Melaleuca squarrosa												3	1	2	
1323	Eucalyptus viminalis														44	1
1317	Eucalyptus sideroxylon														4	4

TABLE 7: Significant vascular plant species in the Painkalac Creek floodplain study area, Airey's Inlet, Victoria, February 1990. Taxonomic nomenclature follows Forbes and Ross (1988) or Jessop and Toelken (1986).

SPECIES	COMMON NAME	VEGETATION COMMUNITY	SIGNIFICANCE RATING	REFERENCES *
Amphibromus archeri	Pointed Swamp Wallaby-grass	13.0	R	Beauglehole (1980)
Amphibromus recurvatus	Dark Swamp Wallaby-grass	13.0	R	Beauglehole (1980, 1983)
Apium annum	Annual Celery	2.0	R	Carr *et al.* (1989)
Apium prostratum 'form A'	Sea Celery	2.0	R	
Brachyscome graminea	Grass Daisy	2.0	R	Beauglehole (1980)
Bursaria spinosa var. *macrophylla*	Large-leaf Sweet Bursaria	14.0	R	Carr *et al.* (1989a)
Calocephalus lacteus	Milky Beauty-heads	5.0, 9.0	R	this study +
Carex fascicularis	Tassel Sedge	14.0	L	this study +
Centaurium spicatum	Spike Centaury	2.0, 4.0	R	this study +
Cyperus lucidus	Leafy Flat-sedge	14.0	L	this study +
Eragrostis parviflora	Weeping Love-grass	2.0	R	Beauglehole (1983); Carr *et al.* (1989)
Eucalyptus sideroxylon	Red Iron-bark	15.0	R	Beauglehole (1989)
Gahnia filum	Coast Saw-sedge	2.0	R	Carr *et al.* (1989a)
Geranium retrorsum	Grassland Crane's-bill	5.0, 8.0, 9.0	R	Beauglehole (1980)
Lawrencia spicata	Salt Lawrencia	2.0	R	Beauglehole (1980, 1983); Carr *et al.* (1989a)
Lepilaena cylindrocarpa	Long-fruit Water-mat	1.0, 2.0	R	Beauglehole (1980, 1983); Carr *et al.* (1987)
Lilaeopsis polyantha	Australian Lilaeopsis	12.0	R	this study +

* Note: Exhaustive references are not provided for all species.

+ This study - opinion of authors of this report.

TABLE 7 (Continued)

SPECIES	COMMON NAME	VEGETATION COMMUNITY	SIGNIFICANCE RATING	REFERENCES
Melaleuca lanceolata	Moonah	8.0	R	Beauglehole (1980)
Mimulus repens	Creeping Monkey-flower	2.0, 1.0, 3.0	R	Carr *et al.* (1989a)
Myriophyllum amphibium	Broad Milfoil	12.0	R	this study +
Pimelea serpyllifolia	Thyme Rice-flower	8.0	R	Beauglehole (1980)
Plantago debilis	Shade Plantain	14.0	R	Beauglehole (1980)
Pomaderris oraria sens. lat.	Coast Pomaderris	8.0	R	Beauglehole (1980)
Potamogeton pectinatus	Fennel Pondweed	1.0	R	Beauglehole (1983); Carr *et al.* (1989a)
Pratia platycalyx	Salt Pratia	2.0, 3.0	L	Carr *et al.* (1989a)
Puccinellia stricta sens. lat.	Australian Saltmarsh-grass	2.0	R	Carr *et al.* (1989a).
Ruppia polycarpa	Many-fruit Tassel	1.0	R	Carr *et al.* (1989a)
Sebaea albidiflora	White Sebaea	2.0		Beauglehole (1980), Carr *et al.* (1989a)
Veronica gracilis	Slender Speedwell	5.0, 9.0	?	Beauglehole (1980)
Villarsia reniformis	Running Marsh-flower	13.0	R	this study +
Viminaria juncea	Gold Spray	13.0	R	Beauglehole (1980)

* Note: Exhaustive references are not provided for all species.

+ This study - opinion of authors of this report.

TABLE 8: Summary of significance of vegetation communities recorded in the Painkalac Creek floodplain study area, Aireys Inlet, Victoria, December 1989.

VEGETATION COMMUNITY	PRE-EUROPEAN DISTRIBUTION IN REGION	CURRENT DISTRIBUTION LOCALLY	REGIONALLY	STATEWIDE	NUMBER AND RANKING OF SIGNIFICANT SPECIES	RELATIVE VULNERABILITY TO WEED INVASION	DEGREE OF DISTURBANCE AND/OR DEGRADATION IN STUDY AREA	RESERVATION STATUS IN REGION	BOTANIAL SIGNIFICANCE	REFERENCES *
1.0 Submerged Saline Herbfield	rare	rare	rare	uncommon	4 species of regional significance	low	low	unknown	regional	Carr *et al.* (1987)
2.0 Saltmarsh Complex	rare	rare	rare	uncommon; scattered along coast coast	11 regional 1 local	moderate	low	poor in region but moderate statewide	high regional	Carr *et al.* (1987) Yugovic (1985) Carr & Kinhill Planners (1979) Carr *et al.* (1989a) Frood & Calder (1987)
3.0 *Juncus kraussii* (Sea Rush) Herbfield	rare	rare	rare	uncommon	2 regional	low	low	unknown	regional	Yugovic (1985) Carr & McMahon (1988)
4.0 *Baumea juncea* (Bare Twig-rush) Herbfield	rare	rare	rare	rare, likely to be restricted	1 species of regional significance	low	low	none known elsewhere in region	regional	Carr & Beauglehole (1980) C. Meredith (pers. comm.)
5.0 *Poa poiformis* (Coast Tussock-grass) Grassland	apparently rare	rare	rare	rare except on Bass Strait islands	3 regional	moderate	low	some reserved in Port Campbell National Park	regional	Yugovic (1985), Carr *et al.* (1987) Carr *et al.* (1989a) Frood &Calder (1987),
6.0 *Typha* (Cumbungi) Herbfield	rare	rare	uncommon and assumed to be largely anthropogenic	uncommon in natural environments	——	low	low	unknown	local	Carr *et al.* (1989) Aston (1973)
7.0 *Phragmites australis* (Common Reed0 Grassland	uncommon	rare	restricted to largely estuarine situations	widespread but many examples assumed to be anthropogenic	——	low	low	unknown	local	Yugovic (1985), Carr *et al* (1989b) Aston (1973) Cropper & Calder (1987),
8.0 Coastal Dune Shrubland	uncommon	uncommon	restricted	common but existing examples much degraded	4 species of regional significance	high	moderate to high	most protected in coastal reserves but management negligible	regional	Frood & Calder (1987) Parsons *et al.* (1977)
9.0 *Poa labillardieri* (Common Tussock-grass) Grassland	restricted	rare	rare	rare	3 regional	moderate	low	unknown	state	Frood (1988, Frood & Calder (1987), Carr *et al.* (1989b)

* Note: Exhaustive references are not provided for all communities

TABLE 8 (Continued)

VEGETATION COMMUNITY	PRE-EUROPEAN DISTRIBUTION IN REGION	CURRENT DISTRIBUTION LOCALLY	REGIONALLY	STATEWIDE	NUMBER AND RANKING OF SIGNIFICANT SPECIES	RELATIVE VULNERABILITY TO WEED INVASION	DEGREE OF DISTURBANCE AND/OR DEGRADATION IN STUDY AREA	RESERVATION STATUS IN REGION	BOTANIAL SIGNIFICANCE	REFERENCES
10.0 *Pteridium esculentum* (Common Bracken) Herbfield	considered in present form to be somewhat anthropogenic, i.e. likely to have originally supported a significant woody component of trees and shrubs				----	moderate	moderate	N.A.*	local	Carr & Beauglehole (1980) Carr (1987)
11.0 *Eleocharis acuta* (Common Spike Rush) Herbfield	rare	rare	rare	common	—	low	low	unknown	regional	Yugovic (1985), Frood & Calder (1987), Carr *et al.* (1989),
12.0 *Melaleuca squarrosa* (Scented Paperbark) - *Leptospermum juniperinum* (Prickly Tea-tree) Shrubland	common	uncommon	uncommon	common	2 regional	low	low	moderate	regional	Frood & Calder (1987) Parsons *et al.* (1977)
13.0 *Eleocharis sphaceolata* (Tall Spike-rush)- *Myriophyllum simulans* (Water Milfoil)- *Villarsia reniformis* (Running Marsh-flower) Freshwater Herbfield	rare	only known example		probably rare	4 regional	low	low	unknown but likely to be	state	this study +
14.0 Riparian	heterogeneous grouping of communities that could not be delineated within scope of study		NA*	NA*	11 regional	high	moderate 2 local	NA*	local	----
15.0 *Eucalyptus sideroxylon* (Red Ironbark) Open Forest	common	common	restricted	data unavailable for comparative vegetation	1 regional	moderate	low	good	regional	Parsons *et al.* (1977) Vase *et al.* (1987)

* NA - Not applicable
\+ This study - unpublished data of authors.

Table 10. Mammals captured during 445 trap-nights October 23-27, 1989 at the Painkalac Creek study area, Aireys Inlet.

Transect 4 was only trapped for one night.

DATE	NO. TRAPS	OCT 23-24	OCT 24-25	OCT 25-26	OCT 26-27
Transect 1 Sedgeland & *Poa* grassland	20		1 *Rattus lutreolus* 1 *Mus musculus*		1 *Cisticola exilis* 2 *R. lutreolus*
Transect 2 Sedgeland & *Poa* grassland	20	1 *M. musculus*		1 *R. lutreolus*	
Transect 3 *Poa* grassland	25	1 *Mastacomys fuscus*	1 *M. fuscus*		
Transect 4 *Leptospermum* heathland, saltmarsh & heathy dune scrub	25	1 *R. lutreolus*	-	-	-
Transect 5 Remnant riparian woodland	20	5 *Rattus fuscipes* 2 *Antechinus stuartii*	4 *R. fuscipes*	6 *R. fuscipes* 1 *A. stuartii*	9 *R. fuscipes* 2 *A. stuartii*
Transect 6 Wattle scrub	20	1 *R. fuscipes*	4 *R. fuscipes* 1 *R. lutreolis*	4 *R. fuscipes* 1 *R. lutreolus*	5 *R. fuscipes* 2 *R. lutreolus*

Table 11. Serious or potentially serious weed species threatening indigenous vegetation and faunal habitats in the Painkalac Creek floodplain and wetlands study area, Aireys Inlet, Victoria. December 1989.
Source: Carr and Yugovic (1989) plus additional data (this study).

LATIN NAME	COMMON NAME	LIFE FORM	ORIGIN	INTROD	AVAIL	DISPERSAL	COMMUN'S INVADED
Paraserianthus lophantha	Cape Wattle	Ls	S.W. W. Aust.	D	Y	W,?B,H	8,14
Chrysanthemoides monilifera	Boneseed	Ls	S.Af.	D		B,I,H	8,9,10,14,15
Coprosma repens	Taupata	Ls	N.Z.	DE	Y	B,I	8
Cupressus macrocarpa	Monterey Cypress	T	Cal.	D	Y	W,H	14
Cytisus palmensis	Tree Lucerne	Ls	Canary Is.	D	Y	H	14,D
Erica lusitanica	Spanish Heath	S	Spain	D	Y	W,H,?A	9
Foeniculum vulgare	Fennel	P	Eur.,W.As.	D	Y	H,A	D
Genista linifolia	Flax-leaf Broom	S	Med.	D	Y	H	14,D
Gladiolus undulatus	Gladiolus	Gc	S.Af.	D	?	V, H	5,7
Leptospermum laevigatum	Coast Tea-tree	Ls	Vic.,N.S.W.,Tas.	D	Y	W,H	8,9,D
Lycium ferocissimum	African Box-thorn	Ls	Af.	D	Y	B,I	8, 14
Melaleuca armillaris	Giant Honey-Myrtle	Ls-T	Vic.,N.S.W.,Qld.Tas.	D	Y	W,H	LH
Melaleuca hypericifolia	Red Honey-Myrtle	Ls	N.S.W	D	Y	W,H,D	D
Melaleuca parvistaminea	Rough Paperbark	Ls	Vic.,N.S.W.		Y	W,H,D	6
Oxalis pes-caprae	Soursob	Gb	S.Af.	D		V,H,W	D
Pennisetum clandestinum	Kikuyu Grass	P	E.Af.	?	Y	A,V,W,H	8, 14, D
Phalaris aquatica	Toowoomba Canary-grass	P	Med.	?		A,?I,W,H	9, 11
Phalaris arundinacea	Reed Canary-grass	P	N.Hem.,S.Af.	D	Y	A,?I,W,H	9, 11
Pinus radiata	Monterey Pine	T	Cal.	D	Y	W,H	14
Polygala myrtifolia	Myrtle-leaf Milkwort	S	S.Af.	D	Y	W	8
Prunus cerasifera	Cherry-plum	T	Eur.	D	Y	B,I,H	9, 14
Prunus cf. spinosa	Plum	Ls	Eur.			B,I	9
Rosa rubiginosa	Sweet Briar	S	Eur.	D		B,I,H	14
Rubus procerus	Blackberry	Ls	Eur.	D		B,A,V	9, 10, 14
Rubus sp.	Blackberry	S	Eur.			B,I	14
Rumex sagittatus	Arrow Dock	C	S.Af.			W,D	11, 14, D
Stenotaphrum secundatum	Buffalo grass	P	E.Af.	D	?	V,?	8, D
Ulex europaeus	Furze or Gorse	Ls	Eur.	D		H,B	9, 14, D
Vinca major	Blue Periwinkle	P	Eur.			V,W	14, D
Watsonia versfeldii	Watsonia	Gc	S.Af.	D	Y	V	14, D
Cortaderia selloana	Pampas Grass	P	S.Am	D	Y	W	2, 7

Table 11. (cont'd.)

LIFE FORM		ORIGIN		INTRODUCTION		DISPERSAL	
A	Annual	Af.	Africa	D	deliberate	A	animal (incl. human) (external)
C	Climber	Am.	America			B	birds
Gb	Bulbous geophyte	Aust.	Australia			D	dumped garden rubbish (longer distances)
Gc	Cormous geophyte	As.	Asia			H	water
Gr	Rhizomatous geophyte	Cal.	California	AVAILABILITY		I	animal (internal)
Ls	Large shrub	Eur.	Europe	Y	available from commercial nurseries	V	vegetative
P	Perennial herb	Med.	Mediterranean			W	wind
S	Small to medium shrub	N.S.W.	New South Wales				
T	Tree	Qld.	Queensland				
		Tas.	Tasmania				
		Vic.	Victoria				
		W.A.	Western Australia				

SERIOUSNESS

N Considered a relatively minor threat at present
S Serious threat to one or more plant communities in study area
E Extremely serious threat to one or more plant communities in study area
P Potentially serious weed species in study area
1 Widespread, populations medium to large
2 Widespread, populations small
3 Limited distribution, medium to large populations
4 Limited distribution, small populations
5 Rare or localized, medium to large populations
6 Rare or localized, small populations
7 Visual significance only

COMMUNITIES INVADED

2: Saltmarsh Complex
5: Poa poiformis (Coast Tussock-grass) Grassland
6: Typha (Cumbungi) Herbfield
7: Phragmites australis (Common Reed) Grassland
8: Coastal Dune Shrubland
9: Poa labillardieri (Common Tussock-grass) Grassland
10: Pteridium esculentum (Common Bracken) Herbfield
11: Eleocharis acuta (Common Spike-rush) Herbfield
14: Riparian Complex
15: Eucalyptus sideroxylon (Red Ironbark) Open Forest
D: Disturbed site
LH: Unsampled *Leptospermum juniperinum* heath

TABLE 12. Summary of environmental, biological and landscape values and developmental constraints, Painkalac Creek floodplain study area, Aireys Inlet, Victoria, December 1989.

PROPOSED DEVELOPMENT	LOCATION (Refer Map 2)	PHYSICAL ENVIRONMENT	VEGETATION COMMUNITIES & SIGNIFICANCE	FAUNAL SIGNIFICANCE	LANDSCAPE VALUES AND ABORIGINAL SITES	EXISTING ENVIRONMENTAL PROBLEMS AND CONSTRAINTS	POTENTIAL EFFECTS OF PROPOSED DEVELOPMENT	
							DIRECT	INDIRECT
Residential development	Area C, Allen's Land	Alluvial floodplain and terraces; yellow and yellow-brown sodic soils	Community 11.0: regional significance but small disturbed remnants Community 14.0, local significance. (high local at NW end of property). Grazed pasture: no botanical significance	Regional significance in riparian complex at NW end of property (Koala habitat)	Moderate scenic quality High landscape sensitivity. Low visual capability. Landscape management objective - inevident alteration. Potential for Aboriginal sites close to creek or on terraces.	• Soil pugging • Poor drainage • Erosion of creek bank • Relatively high nutrient levels in groundwater and creek • Weed invasions	• Soil compaction • Effluent disposal problems • Siltation of creek • User pressure on riparian woodland at northern end of property • Increased weed invasions from garden plantings • Increased threat to native fauna from introduced dogs and cats. • Reduction in visual quality Intrusion into travel route viewshed	Pollution of creek and groundwater
Establishment of cricket oval and associated facilities	Area C, Allen's Land	As above	As above	—	As above	• Seasonally water-logged and occasional seasonal flooding • Soil pugging, compaction	• Soil compaction • Effluent disposal problems • Increased user-pressure on creek. • Erosion and siltation on creek. • Reduction in visual quality. • Intrusion into travel route viewshed.	Pollution of creek and ground water
Establishment of oval in Painkalac Creek Reserve	Area B	Alluvial flood plain; saline, grey gradational soils	Community 9.0: state significance Community 2.0: high regional significance Communities 3.0 and 11.0: regional significance Communities 7.0 and 10.0: local significance	Regional	High scenic quality High landscape sensitivity Low visual capability Potential for Aboriginal sites	• Creek siltation from fire access track • Moderate pollution levels in creek • Creek bank erosion • Seasonal waterlogging • Weed invasions • Fire control measures (e.g. slashing and access track) reduce faunal habitat and exacerbate weed invasions	• Increased siltation and soil compaction • Effluent disposal problems • Destruction of significant vegetation and faunal habitat • User-pressure on surrounding environment • Loss of high-quality landscape • Loss of 'naturalness' as visual quaility • Intrusion into travel route viewshed	• Pollution of creek and ground water • Disturbance to fauna, including birds

TABLE 12 (Continued)

PROPOSED DEVELOPMENT	LOCATION (Refer Map 2)	PHYSICAL ENVIRONMENT	VEGETATION COMMUNITIES & SIGNIFICANCE	FAUNAL SIGNIFICANCE	LANDSCAPE VALUES	EXISTING ENVIRONMENTAL PROBLEMS AND CONSTRAINTS	POTENTIAL EFFECTS OF PROPOSED DEVELOPMENT	
							DIRECT	INDIRECT
Establishment of oval south-west of Great Ocean Road (proposed pre-1986)	West of Area A, just outside study area	Estuarine flats; saline grey gradational soils	Communities 2.0 and 5.0, high regional significance Community 1.0, 3.0 and 8.0: regional significance Community 6.0: local significance	High regional	High scenic quality High landscape sensitivity Low visual capability Key visual landmark identifying Aireys Inlet Potential for Aboriginal sites	• Creek siltation • Low levels of pollution in creek • Weed invasions • Permanent water-logging • Frequent flooding	• Increased siltation and soil compaction • Effluent disposal problems • Destruction of significant vegetation and faunal habitat • User pressure on surrounding environment • Destruction of significant landscape • Significant intrusion into vista from lighthouse	As above
Development of fire-safety area adjoining Great Ocean Road	Area A	Estuarine flats and alluvialterraces; saline, grey gradational soils	Community 2.0: high regional significance significance. Communities 3.0 and 4.0: regional signifcance.	Local	High scenic quality High landscape sensitivity Low visual capability Key visual landmark identifying Aireys Inlet (Potential for Aboriginal sites)	• Weed invasions • User pressure on significant vegetation and faunal habitat.	• Increased weed invasions and user pressures. • Incremental intrusion into high quality landscape	
Public access BAC proposals (1983)	Areas A & B	Estuarine flats and alluvial terraces, saline, grey, gradational soils to yellow and yellow-brown sodic soils.	Community 9.0: state significance. Communities 2.0 and 5.0: high regional significance. Communities 1.0 to 4.0 and 11.0: regional significance. Communities 6.0, 7.0 and 10.0: local significance.	Local to high regional	High scenic quality High landscape sensitivity Low visual capability Potentaal for Aboriginal sites	• Creek siltation from fire access track. • Moderate pollution levels in creek. • Creek bank erosion. • Seasonal water logging • Weed invasion • Fire control measures (e.g. slashing and access track) reduce faunal habitat and exacerbate weed invasions.	• Increased erosion and siltation of creek. • Increased user pressures and disturbance of significant vegetation and faunal habitat. • Loss of vusual quality due to reduced 'naturalness' • Pavilion an inappropriate intrusion into grassland landscape	
Wetland proposal	Area B	As above	As above	As above	As above	As above	• Increased erosion and siltation of creek. • Destruction of significant vegetation communities and faunal habitat. • Floodgates may reduce visual quality.	

Appendix 1. Vascular plant species recorded at the Painkalac Creek wetlands and floodplain study area, Aireys Inlet, Victoria. December 1989.

Taxonomic nomenclature follows Forbes and Ross (1988)
* Denotes introduced species
W Denotes species recorded by M. White but not by us in the study area.

GYMNOSPERMS	
CUPRESSACEAE	
*Cupressus macrocarpa	Monterey Cypress
PINACEAE	
*Pinus radiata	Monterey Pine
FERNS AND FERN ALLIES	
ADIANTACEAE	
Adiantum aethiopicum	Common Maidenhair
BLECHNACEAE	
Blechnum minus	Soft Water-fern
Blechnum nudum	Fishbone Water-fern
DENNSTAEDTIACEAE	
Pteridium esculentum	Austral Bracken
SCHIZAEACEAE	
Schizaea asperula	Rough Comb-fern
MONOCOTYLEDONS	
CYPERACEAE	
Baumea juncea	Bare Twig-sedge
Baumea tetragona	Square Twig-sedge
Carex appressa	Tall Sedge
Carex fascicularis	Tassel Sedge
Carex inversa	Common Sedge
Carex pumila	Strand Sedge
*Cyperus eragrostis	Drain Flat-sedge
Cyperus exaltatus	Tall Flat-sedge
*Cyperus tenellus	Tiny Flat-sedge
Eleocharis acuta	Common Spike-sedge
Eleocharis sphacelata	Tall Spike-sedge
Gahnia filum	Chaffy Saw-sedge
Gahnia radula	Thatch Saw-sedge
Isolepis cernua	Nodding Club-sedge
Isolepis fluitans	Floating Club-sedge
Isolepis inundata	Swamp Club-sedge
W Isolepis marginata	Little Club-sedge
Isolepis nodosa	Knobby Club-sedge
W Isolepis platycarpa	Flat-fruit Club-sedge
Lepidosperma elatius	Tall Sword-sedge
Lepidosperma gladiatum	Coast Sword-sedge
Schoenus nitens	Shiny Bog-sedge

IRIDACEAE		
	*Gladiolus undulatus	Gladiolus
	*Romulea rosea	Common Onion-grass
	*Sisyrinchium iridifolium	Striped Rush-leaf
	*Watsonia versfeldii	Watsonia
JUNCACEAE		
	*Juncus articulatus	Jointed Rush
	Juncus bufonius	Toad Rush
	*Juncus bulbosus	Bulbous Rush
	Juncus holoschoenus	Joint-leaf Rush
	Juncus kraussii	Sea Rush
	Juncus pallidus	Pale Rush
	Juncus pauciflorus	Loose-flower Rush
	Juncus planifolius	Broad-leaf Rush
	Juncus procerus	Tall Rush
	*Juncus sp.	Rush
	Juncus subsecundus	Finger Rush
JUNCAGINACEAE		
	Triglochin procera	Water-ribbons
	Triglochin striata	Streaked Arrow-grass
LILIACEAE		
	*Asphodelus fistulosus	Onion Weed
	Dianella revoluta	Black-anther Flax-lily
	Dianella revoluta var. brevicaulis	Black-anther Flax-lily
	Dianella revoluta var. revoluta	Black-anther Flax-lily
	Dichopogon strictus	Chocolate-lily
ORCHIDACEAE		
	Caladenia dilatata	Green-comb Spider-orchid
	Dipodium punctatum	Hyacinth Orchid
W	Microtis unifolia	Common Onion-orchid
POACEAE		
	Agrostis avenacea	Common Blown-grass
W	Agrostis billardieri	Coast Blown-grass
	*Agrostis capillaris	Brown-top Bent
	*Aira caryophyllea	Silvery Hair-grass
	*Aira elegantissima	Hair-grass
	Amphibromus archeri	Pointed Swamp Wallaby-grass
	Amphibromus recurvatus	Dark Swamp Wallaby-grass
	*Amphibromus sp.	Swamp Wallaby-grass
	*Anthoxanthum odoratum	Sweet Vernal-grass
	*Avena strigosa	Bristle Oat
	*Briza minor	Lesser Quaking-grass
	*Bromus catharticus	Prairie Grass
	*Bromus diandrus	Great Brome
	*Bromus hordeaceus	Soft Brome
	Chionochloa pallida	Silvertop Wallaby-grass
	*Critesion marinum	Sea Barley-grass
	*Critesion murinum ssp. leporinum	Wall Barley-grass
	*Cynodon dactylon	Couch
	*Cynodon sp.	Couch
	*Dactylis glomerata	Cocksfoot
	Danthonia caespitosa	Common Wallaby-grass
	Danthonia geniculata	Kneed Wallaby-grass
W	Danthonia laevis	Smooth Wallaby-grass
	Danthonia racemosa	Branched Wallaby-grass

POACEAE (cont'd.)	
Danthonia semiannularis	Heath Wallaby-grass
Danthonia sp.	Wallaby-grass
Dichelachne crinita	Long-hair Plume-grass
Dichelachne micrantha	Short-hair Plume-grass
Distichlis distichophylla	Australian Salt-grass
Elymus scabrus	Common Wheat-grass
Eragrostis parviflora	Weeping Love-grass
*Eragrostis sp.	Love-grass
*Festuca arundinacea	Tall Fescue
*Holcus lanatus	Yorkshire Fog
*Lagurus ovatus	Hare's Tail
*Lolium perenne	Perennial Rye-grass
Microlaena stipoides	Weeping Grass
*Parapholis incurva	Coast Barb-grass
*Parapholis sp.	Barb-grass
*Paspalum dilatatum	Paspalum
*Paspalum distichum	Water Couch
*Pennisetum clandestinum	Kikuya
*Phalaris aquatica	Toowoomba Canary-grass
*Phalaris arundinacea	Reed Canary-grass
Phragmites australis	Common Reed
*Poa annua	Annual Meadow-grass
Poa labillardieri	Common Tussock-grass
Poa poiformis	Blue Tussock-grass
Poa sieberiana	Grey Tussock-grass
*Poa sp.	Tussock-grass
*Polypogon monspeliensis	Annual Beard-grass
Puccinellia stricta	Australian Saltmarsh-grass
Sporobolus virginicus	Salt Couch
*Stenotaphrum secundatum	Buffalo Grass
Stipa flavescens	Coast Spear-grass
Themeda triandra	Kangaroo Grass
*Vulpia bromoides	Squirrel-tail Fescue
POTAMOGETONACEAE	
Potamogeton ochreatus	Blunt Pondweed
Potamogeton pectinatus	Fennel Pondweed
Ruppia polycarpa	Many-fruit Tassel
TYPHACEAE	
♀♂Typha domingensis	Cumbungi
XANTHORRHOEACEAE	
Lomandra filiformis	Wattle Mat-lily
Lomandra filiformis ssp. coriacea	Wattle Mat-Lily
Lomandra filiformis ssp. filiformis	Wattle Mat-Lily
Lomandra longifolia	Spiny-headed Mat-lily
ZANNICHELLIACEAE	
Lepilaena cylindrocarpa	Long-fruited Water-mat
ZOSTERACEAE	
W Zostera ?muelleri	Dwarf Grass-wrack

DICOTYLEDONS

AIZOACEAE	
*Carpobrotus edulis	Hottentot
Carpobrotus rossii	Karkalla
Tetragonia implexicoma	Bower Spinach
APIACEAE	
Apium annuum	Annual Celery
Apium prostratum	Sea Celery
Centella cordifolia	Centella
*Foeniculum vulgare	Fennel
Lilaeopsis polyantha	Australian Lilaeopsis
Platysace lanceolata	Shrubby Platysace
APOCYNACEAE	
*Vinca major	Blue Periwinkle
ASTERACEAE	
*Arctotheca calendula	Cape Weed
*Aster subulatus	Aster-weed
Brachyscome graminea	Grass Daisy
Calocephalus lacteus	Milky Beauty-heads
*Chrysanthemoides monilifera	Boneseed
*Cirsium vulgare	Spear Thistle
*Conyza albida	Fleabane
*Conyza sp.	Fleabane
*Cotula coronopifolia	Water Buttons
Cotula reptans	Creeping Cotula
*Dittrichia graveolens	Stinkweed
Gnaphalium gymnocephalum	Creeping Cudweed
Gnaphalium involucratum sensu stricto	Cudweed
Gnaphalium sphaericum	Common Cudweed
Helichrysum dendroideum	Tree Everlasting
*Hypochoeris radicata	Cat's Ear
*Leontodon taraxacoides	Hairy Hawkbit
Olearia axillaris	Coast Daisy-Bush
*Picris echioides	Ox-tongue
Pseudognaphalium luteo-album	Jersey Cudweed
Senecio glomeratus	Annual Fireweed
W Senecio hispidulus	Rough Fireweed
Senecio minimus	Shrubby Fireweed
W Senecio quadridentatus	Cotton Fireweed
*Senecio sp.	Fireweed
Senecio tenuiflorus	Narrow Groundsel
*Sonchus asper	Rough Sow-thistle
*Sonchus oleraceus	Milk Thistle
*Sonchus sp.	Thistle
*Taraxacum Sect. Vulgaria	Garden Dandelion
*Vellereophyton dealbatum	White Cudweed
BRASSICACEAE	
*Hirschfeldia incana	Hoary Mustard
CALLITRICHACEAE	
*Callitriche sp.	Starwort
*Callitriche stagnalis	Water Starwort

CAMPANULACEAE	
Lobelia alata	Angled Lobelia
Pratia pedunculata	Matted Pratia
Pratia platycalyx	Salt Pratia
Wahlenbergia gracilis	Sprawling Bluebell
CARYOPHYLLACEAE	
*Cerastium glomeratum	Common Mouse-ear Chickweed
*Polycarpon tetraphyllum	Four-leaved Allseed
Spergularia media	Coast Sand-spurrey
Stellaria pungens	Prickly Starwort
CHENOPODIACEAE	
*Atriplex prostrata	Creeping Saltbush
Chenopodium glaucum	Glaucous Goosefoot
*Chenopodium murale	Sowbane
Rhagodia candolleana	Seaberry Saltbush
Sarcocornia quinqueflora	Beaded Glasswort
CLUSIACEAE	
Hypericum gramineum	Small St. John's Wort
CONVOLVULACEAE	
Dichondra repens	Kidney-weed
CRASSULACEAE	
W Crassula helmsii	Swamp Crassula
DILLENIACEAE	
Hibbertia sericea	Silky Guinea-flower
DROSERACEAE	
Drosera peltata ssp. auriculata	Tall Sundew
EPACRIDACEAE	
Leucopogon parviflorus	Coast Beard-heath
Lissanthe strigosa	Peach Heath
ERICACEAE	
*Erica lusitanica	Spanish Heath
FABACEAE	
*Cytisus palmensis	Tree Lucerne
*Genista linifolia	Genista
Glycine clandestina	Twining Glycine
*Lotus corniculatus	Bird's-foot Trefoil
*Lotus hispidus	Hair Bird's-foot Trefoil
*Lotus pedunculatus	Greater Bird's-foot Trefoil
*Medicago minima	Little Medic
*Medicago polymorpha	Burr Medic
*Melilotus indica	Sweet Melilotus
Pultenaea daphnoides	Large-leaf Bush-pea
*Trifolium angustifolium	Narrow-leaf Clover
*Trifolium dubium	Suckling Clover
*Trifolium glomeratum	Cluster Clover
*Trifolium repens	White Clover
*Ulex europaeus	Furze
*Vicia sativa	Common Vetch
*Vicia sativa ssp. sativa	Common Vetch
*Vicia tetrasperma	Slender Vetch
W Viminaria juncea	Golden Spray

GENTIANACEAE		
	*Centaurium erythraea	Common Centaury
	Centaurium spicatum	Spike Centaury
	*Centaurium tenuiflorum	Centaury
	*Cicendia quadrangularis	Square Cicendia
	Sebaea albidiflora	White Sebaea
GERANIACEAE		
	Geranium potentilloides	Cinquefoil
	Geranium retrorsum	Grassland Crane's-bill
W	Geranium solanderi	Austral Crane's-bill
	Pelargonium australe	Austral Stork's-bill
GOODENIACEAE		
	Goodenia geniculata	Bent Goodenia
	Goodenia ovata	Hop Goodenia
	Selliera radicans	Shiny Swamp-mat
HALORAGACEAE		
	Gonocarpus tetragynus	Common Raspwort
	Myriophyllum amphibium	Broad Milfoil
	Myriophyllum simulans	Amphibious Milfoil
	*Myriophyllum sp.	Milfoil
LAURACEAE		
	Cassytha melantha	Coarse Dodder-laurel
LINACEAE		
W	Linum marginale	Native Flax
LYTHRACEAE		
	Lythrum hyssopifolia	Small Loosestrife
MALVACEAE		
	Gynatrix pulchella	Hemp Bush
	Lawrencia spicata	Salt Lawrencia
MENYANTHACEAE		
	Villarsia reniformis	Running Marsh-flower
MIMOSACEAE		
	Acacia melanoxylon	Blackwood
	Acacia pycnantha	Golden Wattle
	Acacia sophorae	Coast Wattle
W	Acacia suaveolens	Sweet Wattle
	Acacia verniciflua	Varnish Wattle
	Acacia verticillata	Prickly Moses
	Acacia verticillata var. verticillata	Prickly Moses
	*Albizia lophantha	Cape Wattle
MYOPORACEAE		
	Myoporum insulare	Common Boobialla

MYRTACEAE	
Eucalyptus ovata	Swamp Gum
Eucalyptus sideroxylon	Red Ironbark
Eucalyptus viminalis	Manna Gum
Leptospermum juniperinum	Prickly Tea-tree
Leptospermum laevigatum	Coast Tea-tree
Melaleuca armillaris	Bracelet Paperbark
Melaleuca lanceolata	Moonah
Melaleuca parvistaminea	Rough Paperbark
Melaleuca squarrosa	Scented Paperbark
ONAGRACEAE	
Epilobium billardierianum ssp. billardieranum	Robust Willow-herb
Epilobium billardierianum ssp. cinereum	Variable Willow-herb
Epilobium hirtigerum	Hairy Willow-herb
OXALIDACEAE	
Oxalis exilis	Shady Wood-sorrel
*Oxalis pes-caprae	Soursob
*Oxalis sp.	Soursob
PITTOSPORACEAE	
Bursaria spinosa var. macrophylla	Sweet Bursaria
Bursaria spinosa var. spinosa	Sweet Bursaria
PLANTAGINACEAE	
*Plantago coronopus	Buck's-horn Plantain
Plantago debilis	Shade Plantain
*Plantago lanceolata	Ribwort
Plantago varia	Variable Plantain
POLYGALACEAE	
*Polygala myrtifolia	Myrtle-leaf Milkwort
POLYGONACEAE	
Muehlenbeckia adpressa	Climbing Lignum
*Polygonum aviculare	Prostrate Knotweed
Polygonum minus	Slender Knotweed
*Polygonum sp.	Knotweed
*Rumex acetosella spp. agg.	Sheep Sorrel
Rumex brownii	Slender Dock
*Rumex conglomeratus	Clustered Dock
*Rumex crispus	Curled Dock
*Rumex pulcher	Fiddle Dock
*Rumex sagittatus	Arrow Dock
PORTULACACEAE	
Montia australasica	White Purslane
PRIMULACEAE	
*Anagallis arvensis	Pimpernel
Samolus repens	Creeping Brookweed
RANUNCULACEAE	
Clematis aristata	Mountain Clematis
*Ranunculus repens	Creeping Buttercup
Ranunculus rivularis	Small River Buttercup
RHAMNACEAE	
Pomaderris aspera	Hazel Pomaderris
Pomaderris oraria	Coast Pomaderris

ROSACEAE		
	Acaena agnipila	Hairy Sheep's Burr
	Acaena anserinifolia	Bidgee-widgee
W	Acaena echinata	Sheep's Burr
	Acaena ovina	Australian Sheep's Burr
	*Prunus cerasifera	Cherry-plum
	*Rosa rubiginosa	Sweet Briar
	Rubus parvifolius	Small-leaf Bramble
	*Rubus procerus	Blackberry
	*Rubus sp.	Blackberry
RUBIACEAE		
	Coprosma quadrifida	Prickly Coprosma
	*Coprosma repens	Taupata
	Opercularia varia	Variable Stinkweed
SALICACEAE		
	*Salix babylonica	Weeping Willow
SCROPHULARIACEAE		
	Gratiola peruviana	Brooklime
	Mimulus repens	Creeping Monkey-flower
	Veronica gracilis	Slender Speedwell
SOLANACEAE		
	*Lycium ferocissimum	African Box-thorn
	*Physalis alkekengi	Alkekengi
	Solanum laciniatum	Large Kangaroo Apple
	*Solanum nigrum	Black Nightshade
THYMELAEACEAE		
	Pimelea serpyllifolia	Thyme Rice-flower
VIOLACEAE		
	*Viola odorata	Fragrant Violet

Appendix 2. Vascular plant species and their frequency of occurrence in quadrats sampled in the Painkalac Creek floodplain study area, Aireys Inlet, Victoria, December 1989

	NAME	QUADRATS	FREQ
57	Acacia melanoxylon	7	20.0%
88	Acacia sophorae	2	5.7%
99	Acacia verniciflua	2	5.7%
4213	Acacia verticillata var. ovoidea	1	2.9%
4213	Acacia verticillata var. verticillata	6	17.1%
104	Acaena agnipila	2	5.7%
105	Acaena anserinifolia	7	20.0%
107	Acaena ovina	2	5.7%
8004	Acaena agnipila x anserinifolia	1	2.9%
129	Adiantum aethiopicum	2	5.7%
151	Agrostis avenacea	12	34.3%
164	*Aira caryophyllea	1	2.9%
166	*Aira elegantissima	1	2.9%
169	*Albizia lophantha	1	2.9%
208	Amphibromus archeri	1	2.9%
211	Amphibromus recurvatus	4	11.4%
8046	Amphibromus sp.	1	2.9%
223	*Anagallis arvensis	10	28.6%
236	*Anthoxanthum odoratum	5	14.3%
244	Apium annuum	1	2.9%
247	Apium prostratum sp. A	8	22.9%
8063	Apium prostratum sp. B	4	11.4%
297	*Aster subulatus	10	28.6%
329	*Atriplex prostrata	9	25.7%
377	Baumea juncea	2	5.7%
381	Baumea tetragona	2	5.7%
407	Blechnum minus	1	2.9%
408	Blechnum nudum	1	2.9%
460	Brachyscome graminea	1	2.9%
496	*Briza minor	7	20.0%
498	*Bromus catharticus	1	2.9%
500	*Bromus diandrus	5	14.3%
501	*Bromus hordeaceus	4	11.4%
4298	Bursaria spinosa var. spinosa	1	2.9%
532	Caladenia dilatata	1	2.9%
574	*Callitriche stagnalis	2	5.7%
583	Calocephalus lacteus	4	11.4%
623	Carex appressa	7	20.0%
638	Carex fascicularis	1	2.9%
642	Carex inversa	1	2.9%
657	Carpobrotus rossii	1	2.9%
672	Cassytha melantha	2	5.7%
702	*Centaurium erythraea	1	2.9%
704	Centaurium spicatum	5	14.3%
705	*Centaurium tenuiflorum	8	22.9%
706	Centella cordifolia	1	2.9%
719	*Cerastium glomeratum	1	2.9%
973	Chionochloa pallida	2	5.7%
770	*Chrysanthemoides monilifera	6	17.1%
782	*Cirsium vulgare	4	11.4%
788	Clematis aristata	3	8.6%
810	*Conyza albida	1	2.9%
8253	*Conyza sp.	2	5.7%

	NAME	QUADRATS	FREQ
822	Coprosma quadrifida	1	2.9%
848	*Cotula coronopifolia	10	28.6%
850	Cotula reptans	2	5.7%
1702	*Critesion marinum	5	14.3%
1701	*Critesion murinum ssp. leporinum	1	2.9%
888	*Cupressus macrocarpus	1	2.9%
907	*Cynodon dactylon	2	5.7%
919	Cyperus exaltatus	1	2.9%
936	Cyperus tenellus	1	2.9%
948	*Dactylis glomerata	3	8.6%
961	Danthonia caespitosa	3	8.6%
965	Danthonia geniculata	2	5.7%
977	Danthonia racemosa	2	5.7%
979	Danthonia semiannularis	1	2.9%
8313	Danthonia sp.	1	2.9%
4412	Dianella revoluta var. brevicaulis	3	8.6%
4413	Dianella revoluta var. revoluta	2	5.7%
1034	Dichelachne micrantha	1	2.9%
1036	Dichondra repens	7	20.0%
1068	Dipodium punctatum	1	2.9%
1076	Distichlis distichophylla	18	51.4%
1102	Drosera peltata ssp. auriculata	1	2.9%
1139	Eleocharis acuta	6	17.1%
1146	Eleocharis sphacelata	2	5.7%
146	Elymus scabrus	1	2.9%
4444	Epilobium billardierianum ssp. billardiera	12	34.3%
4445	Epilobium billardierianum ssp. cinereum	5	14.3%
1179	Epilobium hirtigerum	3	8.6%
1185	Eragrostis brownii	1	2.9%
1193	Eragrostis parviflora	1	2.9%
1210	*Erica lusitanica	1	2.9%
1307	Eucalyptus ovata	3	8.6%
1317	Eucalyptus sideroxylon	2	5.7%
1323	Eucalyptus viminalis	3	8.6%
1356	*Festuca arundinacea	1	2.9%
1389	Gahnia filum	5	14.3%
1394	Gahnia radula	1	2.9%
1431	Geranium potentilloides	2	5.7%
1432	Geranium retrorsum	7	20.0%
1438	*Gladiolus undulatus	1	2.9%
1455	Glycine clandestina	1	2.9%
1465	Gnaphalium involucratum sensu stricto	1	2.9%
1466	Gnaphalium japonicum	1	2.9%
1471	Gnaphalium sphaericum	1	2.9%
1489	Gonocarpus tetragynus	2	5.7%
1497	Goodenia geniculata	1	2.9%
1507	Goodenia ovata	2	5.7%
1524	Gratiola peruviana	1	2.9%
1557	Gynatrix pulchella	4	11.4%
1616	Helichrysum dendroideum	9	25.7%
1692	*Holcus lanatus	18	51.4%
1741	Hypericum gramineum	1	2.9%
1748	*Hypochoeris radicata	9	25.7%
1772	Isolepis cernua	9	25.7%
1775	Isolepis fluitans	2	5.7%
1779	Isolepis inundata	3	8.6%
1782	Isolepis nodosa	15	42.9%

	NAME	QUADRATS	FREQ
1806	*Juncus articulatus	2	5.7%
1810	Juncus bufonius	1	2.9%
1811	*Juncus bulbosus	1	2.9%
1821	Juncus holoschoenus	1	2.9%
1826	Juncus kraussii	17	48.6%
1830	Juncus pallidus	6	17.1%
1831	Juncus pauciflorus	2	5.7%
1833	Juncus planifolius	1	2.9%
1835	Juncus procerus	3	8.6%
8601	Juncus spp.	4	11.4%
1843	Juncus subsecundus	2	5.7%
1864	*Lagurus ovatus	1	2.9%
1888	Lawrencia spicata	1	2.9%
1895	*Leontodon taraxacoides	8	22.9%
1919	Lepidosperma elatius	1	2.9%
1922	Lepidosperma gladiatum	1	2.9%
1934	Lepilaena cylindrocarpa	1	2.9%
1956	Leptospermum juniperinum	8	22.9%
1957	*Leptospermum laevigatum	3	8.6%
1987	Leucopogon parviflorus	5	14.3%
2005	Lilaeopsis polyantha	1	2.9%
2024	Lobelia alata	3	8.6%
2036	*Lolium perenne	2	5.7%
2042	Lomandra filiformis	1	2.9%
4709	Lomandra filiformis ssp. coriacea	1	2.9%
4710	Lomandra filiformis ssp. filiformis	1	2.9%
2046	Lomandra longifolia	2	5.7%
2058	*Lotus corniculatus	2	5.7%
2060	*Lotus hispidus	21	60.0%
2061	*Lotus pedunculatus	4	11.4%
2078	*Lycium ferocissimum	1	2.9%
2092	Lythrum hyssopifolia	7	20.0%
2140	*Medicago polymorpha	4	11.4%
2145	Melaleuca armillaris	1	2.9%
2150	Melaleuca lanceolata	2	5.7%
2154	Melaleuca parvistaminea	1	2.9%
2153	Melaleuca squarrosa	3	8.6%
2161	*Melilotus indica	4	11.4%
2179	Microlaena stipoides	8	22.9%
2197	Mimulus repens	5	14.3%
2221	Montia australasica	4	11.4%
2225	Muehlenbeckia adpressa	2	5.7%
2239	Myoporum insulare	6	17.1%
2251	Myriophyllum amphibium	1	2.9%
3873	Myriophyllum simulans	3	8.6%
2301	Olearia axillaris	1	2.9%
2344	Opercularia varia	1	2.9%
2381	Oxalis exilis	6	17.1%
8835	Oxalis sp.	1	2.9%
2418	*Parapholis incurva	8	22.9%
2430	*Paspalum dilatatum	1	2.9%
2442	Pelargonium australe	3	8.6%
2476	*Phalaris aquatica	2	5.7%
2477	*Phalaris arundinacea	2	5.7%
2497	Phragmites australis	5	14.3%
2511	*Picris echioides	2	5.7%
2530	Pimelea serpyllifolia	1	2.9%

	NAME	QUADRATS	FREQ
2553	*Plantago coronopus	13	37.1%
2555	Plantago debilis	1	2.9%
2561	*Plantago lanceolata	9	25.7%
2566	Plantago varia	1	2.9%
2573	Platysace lanceolata	1	2.9%
2600	Poa labillardieri	12	34.3%
2605	Poa poiformis	11	31.4%
2608	Poa sieberiana	3	8.6%
8909	Poa sp.	1	2.9%
2622	*Polycarpon tetraphyllum	1	2.9%
2624	*Polygala myrtifolia	1	2.9%
2631	Polygonum minus	1	2.9%
8916	Polygonum sp.	1	2.9%
2640	*Polypogon monspeliensis	15	42.9%
2650	Pomaderris aspera	3	8.6%
2691	Potamogeton pectinatus	1	2.9%
2730	Pratia pedunculata	2	5.7%
2731	Pratia platycalyx	3	8.6%
2758	*Prunus cerasifera	2	5.7%
2762	Pseudognaphalium luteo-album	1	2.9%
2777	Pteridium esculentum	8	22.9%
2834	Puccinellia stricta	5	14.3%
2844	Pultenaea daphnoides	1	2.9%
2906	*Ranunculus repens	1	2.9%
2907	Ranunculus rivularis	1	2.9%
2927	Rhagodia candolleana	1	2.9%
2942	*Romulea rosea	3	8.6%
2950	*Rosa rubiginosa	1	2.9%
2956	Rubus parvifolius	3	8.6%
2959	*Rubus procerus	6	17.1%
8998	*Rubus sp.	1	2.9%
2966	*Rumex acetosella spp. agg.	2	5.7%
2968	Rumex brownii	3	8.6%
2969	*Rumex conglomeratus	3	8.6%
2970	*Rumex crispus	7	20.0%
2975	*Rumex sagittatus	2	5.7%
2979	Ruppia polycarpa	2	5.7%
3001	Samolus repens	15	42.9%
3012	Sarcocornia quinqueflora	8	22.9%
3051	Schoenus nitens	3	8.6%
3091	Sebaea albidiflora	3	8.6%
3100	Selliera radicans	10	28.6%
3107	Senecio glomeratus	8	22.9%
3119	Senecio minimus	5	14.3%
9058	Senecio spp.	4	11.4%
3129	Senecio tenuiflorus	1	2.9%
3163	*Sisyrinchium iridifolium	1	2.9%
3179	Solanum laciniatum	1	2.9%
3183	*Solanum nigrum	1	2.9%
3203	*Sonchus asper	12	34.3%
3204	*Sonchus oleraceus	16	45.7%
9077	Sonchus cf hydropiper	6	17.1%
3218	Spergularia media	2	5.7%
3255	Stellaria pungens	2	5.7%
3276	Stipa flavescens	1	2.9%
3343	Tetragonia implexicoma	1	2.9%
3427	*Trifolium dubium	1	2.9%

	NAME	QUADRATS	FREQ
3429	*Trifolium glomeratum	1	2.9%
3451	*Trifolium ornithopodioides	1	2.9%
3435	*Trifolium repens	5	14.3%
3448	Triglochin procera s.l. nrw. lv'd., floating	4	11.4%
3448	Triglochin procera s.l. brd. lv'd., emergent	4	11.4%
3449	Triglochin striata	7	20.0%
3468	Typha domingensis	1	2.9%
3491	*Vellereophyton dealbatum	1	2.9%
3506	Veronica gracilis	2	5.7%
3518	*Vicia sativa	4	11.4%
5054	*Vicia sativa ssp. sativa	7	20.0%
3519	*Vicia tetrasperma	5	14.3%
3521	Villarsia reniformis	3	8.6%
3524	*Vinca major	1	2.9%
3531	*Viola odorata	1	2.9%
3544	*Vulpia bromoides	4	11.4%
3558	Wahlenbergia gracilis	1	2.9%

Appendix 3. Quadrat data from vegetation sampled in and adjacent to the Painkalac Creek and Wetlands study area, Aireys Inlet, Victoria. December 1989.

* Denotes introduced species.
Taxonomic nomenclature follows Forbes and Ross 1988).

QUADRAT D19021 19 SPECIES 144 5'48" 38 28' 5" December 1989 0.5 m 10' GRID P19

247	1	Apium prostratum	297	+	*Aster subulatus
329	1	*Atriplex prostrata	848	+	*Cotula coronopifolia
1076	1	Distichlis distichophylla	1772	+	Isolepis cernua
1826	5	Juncus kraussii	2161	+	*Melilotus indica
2197	1	Mimulus repens	2418	1	*Parapholis incurva
2497	1	Phragmites australis	2640	+	*Polypogon monspeliensis
2834	1	Puccinellia stricta	3001	2	Samolus repens
3012	2	Sarcocornia quinqueflora	3100	1	Selliera radicans
3218	+	Spergularia media	3449	2	Triglochin striata
8063	1	Apium sp.			

QUADRAT D19022 27 SPECIES 144 5'46" 38 28' 5" December 1989 0.5 m 10' GRID P19

151	2	Agrostis avenacea	244	+	Apium annuum
247	2	Apium prostratum	297	1	*Aster subulatus
329	+	*Atriplex prostrata	460	1	Brachyscome graminea
704	1	Centaurium spicatum	705	1	*Centaurium tenuiflorum
1076	3	Distichlis distichophylla	1389	2	Gahnia filum
1782	1	Isolepis nodosa	1826	2	Juncus kraussii
2060	1	*Lotus hispidus	2161	+	*Melilotus indica
2553	3	*Plantago coronopus	2605	2	Poa poiformis
2640	1	*Polypogon monspeliensis	2731	1	Pratia platycalyx
2834	1	Puccinellia stricta	3001	3	Samolus repens
3012	+	Sarcocornia quinqueflora	3091	+	Sebaea albidiflora
3100	1	Selliera radicans	3107	+	Senecio glomeratus
3203	+	*Sonchus asper	3204	+	*Sonchus oleraceus
8063	+	Apium sp.			

QUADRAT D19023 6 SPECIES 144 5'44" 38 28' 6" December 1989 0.5 m 10' GRID P19

1772	+	Isolepis cernua	1826	+	Juncus kraussii
2640	+	*Polypogon monspeliensis	3001	3	Samolus repens
3012	4	Sarcocornia quinqueflora	3100	1	Selliera radicans

QUADRAT D19024 4 SPECIES 144 5'41" 38 28' 3" December 1989 0 m 10' GRID P19

1076	1	Distichlis distichophylla	2197	+	Mimulus repens
2979	5	Ruppia polycarpa	3449	2	Triglochin striata

QUADRAT D19025 26 SPECIES 144^ 5'38" 38^28' 2" December 1989 0.75 m 10' GRID P19

151	+	Agrostis avenacea	223	1	*Anagallis arvensis
496	1	*Briza minor	583	2	Calocephalus lacteus
704	1	Centaurium spicatum	705	1	*Centaurium tenuiflorum
965	1	Danthonia geniculata	979	1	Danthonia semiannularis
1036	1	Dichondra repens	1076	2	Distichlis distichophylla
1389	1	Gahnia filum	1782	2	Isolepis nodosa
1826	2	Juncus kraussii	1888	+	Lawrencia spicata
1987	1	Leucopogon parviflorus	2239	+	Myoporum insulare
2553	2	*Plantago coronopus	2561	+	*Plantago lanceolata
2942	1	*Romulea rosea	3001	1	Samolus repens
3051	+	Schoenus nitens	3100	1	Selliera radicans
3427	1	*Trifolium dubium	3506	1	Veronica gracilis
4445	1	Epilobium billardierianum ssp. cine	9058	1	Senecio sp.

QUADRAT D19026 19 SPECIES 144^ 5'46" 38^28' 2" December 1989 1.0 m 10' GRID P19

151	1	Agrostis avenacea	247	1	Apium prostratum
297	1	*Aster subulatus	377	5	Baumea juncea
705	+	*Centaurium tenuiflorum	1076	3	Distichlis distichophylla
1389	1	Gahnia filum	1782	+	Isolepis nodosa
1826	1	Juncus kraussii	2553	1	*Plantago coronopus
2605	2	Poa poiformis	2640	1	*Polypogon monspeliensis
3001	1	Samolus repens	3100	1	Selliera radicans
3107	1	Senecio glomeratus	3203	+	*Sonchus asper
3204	+	*Sonchus oleraceus	4445	1	Epilobium billardierianum ssp. ciner
9077	1	Sonchus hydrophylla			

QUADRAT D19027 28 SPECIES 144^ 5'43" 38^27'39" December 1989 5 m 10' GRID P19

297	1	*Aster subulatus	496	1	*Briza minor
848	+	*Cotula coronopifolia	1076	1	Distichlis distichophylla
1139	5	Eleocharis acuta	1179	+	Epilobium hirtigerum
1692	1	*Holcus lanatus	1772	+	Isolepis cernua
1826	1	Juncus kraussii	1830	1	Juncus pallidus
1895	1	*Leontodon taraxacoides	2024	1	Lobelia alata
2060	1	*Lotus hispidus	2061	1	*Lotus pedunculatus
2092	1	Lythrum hyssopifolia	2418	1	*Parapholis incurva
2430	+	*Paspalum dilatatum	2477	1	*Phalaris arundinacea
2511	1	*Picris echioides	2553	1	*Plantago coronopus
2605	1	Poa poiformis	2640	1	*Polypogon monspeliensis
2970	1	*Rumex crispus	3204	+	*Sonchus oleraceus
3449	+	Triglochin striata	3544	1	*Vulpia bromoides
4444	1	Epilobium billardierianum ssp. bill	9077	1	Sonchus hydrophylla

QUADRAT D19028 48 SPECIES 144^ 5'42" 38^27'35" December 1989 6 m 10' GRID P19

57	1	Acacia melanoxylon	99	1	Acacia verniciflua
105	1	Acaena anserinifolia	223	+	*Anagallis arvensis
500	1	*Bromus diandrus	501	1	*Bromus hordeaceus
623	1	Carex appressa	642	1	Carex inversa
672	2	Cassytha melantha	702	+	*Centaurium erythraea
770	1	*Chrysanthemoides monilifera	782	1	*Cirsium vulgare
888	1	*Cupressus macrocarpus	936	1	Cyperus tenellus
948	1	*Dactylis glomerata	1139	1	Eleocharis acuta
1317	4	Eucalyptus sideroxylon	1432	1	Geranium retrorsum
1557	1	Gynatrix pulchella	1692	2	*Holcus lanatus
1748	1	*Hypochoeris radicata	1772	1	Isolepis cernua
1782	1	Isolepis nodosa	1830	1	Juncus pallidus
1895	1	*Leontodon taraxacoides	1956	2	Leptospermum juniperinum
2024	1	Lobelia alata	2061	1	*Lotus pedunculatus
2179	1	Microlaena stipoides	2239	+	Myoporum insulare
2381	+	Oxalis exilis	2561	1	*Plantago lanceolata
2600	4	Poa labillardieri	2650	1	Pomaderris aspera
2758	1	*Prunus cerasifera	2777	1	Pteridium esculentum
2959	1	*Rubus procerus	2968	1	Rumex brownii
2969	1	*Rumex conglomeratus	3119	+	Senecio minimus
3179	1	Solanum laciniatum	3203	1	*Sonchus asper
3204	1	*Sonchus oleraceus	3435	1	*Trifolium repens
3519	1	*Vicia tetrasperma	4413	1	Dianella revoluta var. revoluta
5054	1	*Vicia sativa ssp. sativa	8601	1	Juncus sp. aff. pallidus

QUADRAT D19029 22 SPECIES 144^ 5'45" 38^27'39" December 1989 5 m 10' GRID P19

223	1	*Anagallis arvensis	297	+	*Aster subulatus
1076	1	Distichlis distichophylla	1139	+	Eleocharis acuta
1616	1	Helichrysum dendroideum	1692	1	*Holcus lanatus
1772	1	Isolepis cernua	1782	+	Isolepis nodosa
1826	1	Juncus kraussii	1956	+	Leptospermum juniperinum
2060	1	*Lotus hispidus	2092	1	Lythrum hyssopifolia
2600	5	Poa labillardieri	2640	1	*Polypogon monspeliensis
3107	+	Senecio glomeratus	3119	1	Senecio minimus
3518	+	*Vicia sativa	4444	2	Epilobium billardierianum ssp. billa
4445	2	Epilobium billardierianum ssp. cine	8601	+	Juncus sp. aff. procerus
9058	+	Senecio glomeratus x minimus	9077	+	Sonchus hydrophylla

QUADRAT D19030 27 SPECIES 144^ 5'47" 38^27'36" December 1989 3 m 10' GRID P19

297	+	*Aster subulatus	329	2	*Atriplex prostrata
623	1	Carex appressa	1307	1	Eucalyptus ovata
1438	+	*Gladiolus undulatus	1557	1	Gynatrix pulchella
1616	1	Helichrysum dendroideum	1692	1	*Holcus lanatus
1782	1	Isolepis nodosa	1826	1	Juncus kraussii
1895	+	*Leontodon taraxacoides	2060	1	*Lotus hispidus
2061	1	*Lotus pedunculatus	2497	5	Phragmites australis
2561	1	*Plantago lanceolata	2600	1	Poa labillardieri
2966	+	*Rumex acetosella spp. agg.	2969	1	*Rumex conglomeratus
2970	1	*Rumex crispus	3001	2	Samolus repens
3119	1	Senecio minimus	3203	1	*Sonchus asper
3204	+	*Sonchus oleraceus	3519	2	*Vicia tetrasperma
4444	1	Epilobium billardierianum ssp. bill	5054	1	*Vicia sativa ssp. sativa
9058	1	Senecio sp.			

QUADRAT D19031 11 SPECIES 144^ 5'53" 38^27'38" December 1989 4 m 10' GRID P19

105	1	Acaena anserinifolia	223	+	*Anagallis arvensis
770	1	*Chrysanthemoides monilifera	788	1	Clematis aristata
1432	1	Geranium retrorsum	1692	2	*Holcus lanatus
2060	1	*Lotus hispidus	2600	1	Poa labillardieri
2777	5	Pteridium esculentum	2959	1	*Rubus procerus
3204	+	*Sonchus oleraceus			

QUADRAT D19032 29 SPECIES 144^ 5'51" 38^27'37" December 1989 4 m 10' GRID P19

104	1	Acaena agnipila	105	2	Acaena anserinifolia
223	1	*Anagallis arvensis	236	1	*Anthoxanthum odoratum
501	1	*Bromus hordeaceus	770	3	*Chrysanthemoides monilifera
977	+	Danthonia racemosa	1036	1	Dichondra repens
1432	1	Geranium retrorsum	1616	1	Helichrysum dendroideum
1692	1	*Holcus lanatus	1748	2	*Hypochoeris radicata
1895	1	*Leontodon taraxacoides	2060	2	*Lotus hispidus
2061	1	*Lotus pedunculatus	2179	1	Microlaena stipoides
2381	1	Oxalis exilis	2561	3	*Plantago lanceolata
2600	4	Poa labillardieri	2959	1	*Rubus procerus
2966	1	*Rumex acetosella spp. agg.	2968	+	Rumex brownii
3204	1	*Sonchus oleraceus	3435	1	*Trifolium repens
3506	1	Veronica gracilis	3519	1	*Vicia tetrasperma
3544	+	*Vulpia bromoides	5054	1	*Vicia sativa ssp. sativa
8004	1	Acaena agnipila x anserinifolia			

QUADRAT D19033 28 SPECIES 144^ 5'46" 38^27'44" December 1989 2 m 10' GRID P19

151	1	Agrostis avenacea	247	1	Apium prostratum
297	1	*Aster subulatus	329	+	*Atriplex prostrata
583	+	Calocephalus lacteus	704	+	Centaurium spicatum
848	1	*Cotula coronopifolia	1076	1	Distichlis distichophylla
1702	+	*Critesion marinum	1772	1	Isolepis cernua
1810	+	Juncus bufonius	1826	1	Juncus kraussii
2060	1	*Lotus hispidus	2092	1	Lythrum hyssopifolia
2197	1	Mimulus repens	2418	1	*Parapholis incurva
2553	1	*Plantago coronopus	2640	1	*Polypogon monspeliensis
2834	1	Puccinellia stricta	3001	3	Samolus repens
3012	3	Sarcocornia quinqueflora	3051	+	Schoenus nitens
3100	1	Selliera radicans	3107	1	Senecio glomeratus
3203	1	*Sonchus asper	3449	1	Triglochin striata
4444	1	Epilobium billardierianum ssp. bill	9077	+	Sonchus hydrophylla

QUADRAT D19034 31 SPECIES 144^ 5'48" 38^27'43" December 1989 2 m 10' GRID P19

247	+	Apium prostratum	297	1	*Aster subulatus
329	+	*Atriplex prostrata	496	+	*Briza minor
704	1	Centaurium spicatum	848	+	*Cotula coronopifolia
1076	2	Distichlis distichophylla	1139	1	Eleocharis acuta
1193	1	Eragrostis parviflora	1702	1	*Critesion marinum
1772	1	Isolepis cernua	1826	2	Juncus kraussii
1830	1	Juncus pallidus	2036	+	*Lolium perenne
2060	1	*Lotus hispidus	2418	+	*Parapholis incurva
2511	1	*Picris echioides	2553	3	*Plantago coronopus
2605	1	Poa poiformis	2640	1	*Polypogon monspeliensis
2731	1	Pratia platycalyx	2834	1	Puccinellia stricta
2970	1	*Rumex crispus	3001	1	Samolus repens
3012	3	Sarcocornia quinqueflora	3091	1	Sebaea albidiflora
3203	+	*Sonchus asper	3218	1	Spergularia media
3451	+	*Trifolium ornithopodioides	4444	+	Epilobium billardierianum ssp. billa
9077	+	Sonchus hydrophylla			

QUADRAT D19035 19 SPECIES 144^ 5'47" 38^27'47" December 1989 2 m 10' GRID P19

151	1	Agrostis avenacea	247	1	Apium prostratum
297	1	*Aster subulatus	329	1	*Atriplex prostrata
848	1	*Cotula coronopifolia	1076	1	Distichlis distichophylla
1772	1	Isolepis cernua	1782	+	Isolepis nodosa
1826	5	Juncus kraussii	2140	+	*Medicago polymorpha
2197	+	Mimulus repens	2553	1	*Plantago coronopus
2605	+	Poa poiformis	2640	+	*Polypogon monspeliensis
3001	2	Samolus repens	3012	+	Sarcocornia quinqueflora
3100	+	Selliera radicans	4444	1	Epilobium billardierianum ssp. billa
8063	1	Apium sp.			

QUADRAT D19036 6 SPECIES 144^ 5'45" 38^27'47" December 1989 1.5 m 10' GRID P19

848	1	*Cotula coronopifolia	1826	1	Juncus kraussii
2497	5	Phragmites australis	2640	+	*Polypogon monspeliensis
3001	1	Samolus repens	4444	+	Epilobium billardierianum ssp. billa

QUADRAT D19037 30 SPECIES 144^ 5'40" 38^27'53" December 1989 1 m 10' GRID P19

151	1	Agrostis avenacea	247	1	Apium prostratum
297	2	*Aster subulatus	377	1	Baumea juncea
704	1	Centaurium spicatum	848	1	*Cotula coronopifolia
1036	+	Dichondra repens	1076	1	Distichlis distichophylla
1782	4	Isolepis nodosa	1826	3	Juncus kraussii
1830	1	Juncus pallidus	2060	2	*Lotus hispidus
2092	1	Lythrum hyssopifolia	2145	+	Melaleuca armillaris
2418	2	*Parapholis incurva	2553	1	*Plantago coronopus
2605	2	Poa poiformis	2640	1	*Polypogon monspeliensis
2731	1	Pratia platycalyx	2762	1	Pseudognaphalium luteo-album
3001	1	Samolus repens	3051	1	Schoenus nitens
3100	1	Selliera radicans	3107	1	Senecio glomeratus
3119	+	Senecio minimus	3204	1	*Sonchus oleraceus
4444	1	Epilobium billardierianum ssp. billa	4445	+	Epilobium billardierianum ssp. ciner
8063	1	Apium sp.	9077	+	Sonchus hydrophylla

QUADRAT D19038 37 SPECIES 144^ 5'59" 38^27'46" December 1989 2 ■ 10' GRID P19

57	3	Acacia melanoxylon	104	1	Acaena agnipila
105	2	Acaena anserinifolia	223	1	*Anagallis arvensis
500	+	*Bromus diandrus	501	1	*Bromus hordeaceus
705	1	*Centaurium tenuiflorum	770	3	*Chrysanthemoides monilifera
977	1	Danthonia racemosa	1076	+	Distichlis distichophylla
1210	1	*Erica lusitanica	1557	1	Gynatrix pulchella
1616	1	Helichrysum dendroideum	1692	1	*Holcus lanatus
1702	+	*Critesion marinum	1782	1	Isolepis nodosa
1830	1	Juncus pallidus	1956	+	Leptospermum juniperinum
1987	1	Leucopogon parviflorus	2046	1	Lomandra longifolia
2058	+	*Lotus corniculatus	2060	1	*Lotus hispidus
2179	1	Microlaena stipoides	2239	1	Myoporum insulare
2381	+	Oxalis exilis	2418	+	*Parapholis incurva
2497	1	Phragmites australis	2561	1	*Plantago lanceolata
2600	3	Poa labillardieri	2758	+	*Prunus cerasifera 'Nigra'
2942	+	*Romulea rosea	2959	+	*Rubus procerus
2970	+	*Rumex crispus	3203	+	*Sonchus asper
3204	+	*Sonchus oleraceus	3518	+	*Vicia sativa
4213	3	Acacia verticillata var. vert.			

QUADRAT D19039 36 SPECIES 144^ 5'46" 38^27'57" December 1989 2 ■ 10' GRID P19

57	2	Acacia melanoxylon	88	1	Acacia sophorae
105	1	Acaena anserinifolia	107	1	Acaena ovina
223	1	*Anagallis arvensis	236	1	*Anthoxanthum odoratum
496	1	*Briza minor	770	2	*Chrysanthemoides monilifera
850	1	Cotula reptans	961	1	Danthonia caespitosa
1036	1	Dichondra repens	1076	+	Distichlis distichophylla
1616	3	Helichrysum dendroideum	1692	1	*Holcus lanatus
1748	1	*Hypochoeris radicata	1895	1	*Leontodon taraxacoides
1956	2	Leptospermum juniperinum	1957	1	Leptospermum laevigatum
1987	1	Leucopogon parviflorus	2060	1	*Lotus hispidus
2140	1	*Medicago polymorpha	2179	2	Microlaena stipoides
2239	+	Myoporum insulare	2381	f	Oxalis exilis
2442	1	Pelargonium australe	2476	1	*Phalaris aquatica
2573	2	Platysace lanceolata	2600	4	Poa labillardieri
3107	1	Senecio glomeratus	3203	+	*Sonchus asper
3204	+	*Sonchus oleraceus	3518	1	*Vicia sativa
3519	+	*Vicia tetrasperma	3544	+	*Vulpia bromoides
4213	2	Acacia verticillata var. vert.	8835	1	Oxalis sp.

QUADRAT D19040 36 SPECIES 144^ 5'47" 38^27'58" December 1989 2 m 10' GRID P19

57	1	Acacia melanoxylon	105	1	Acaena anserinifolia
107	1	Acaena ovina	223	1	*Anagallis arvensis
496	3	*Briza minor	501	1	*Bromus hordeaceus
583	+	Calocephalus lacteus	705	+	*Centaurium tenuiflorum
1036	1	Dichondra repens	1076	1	Distichlis distichophylla
1185	1	Eragrostis brownii	1432	1	Geranium retrorsum
1616	+	Helichrysum dendroideum	1692	2	*Holcus lanatus
1702	1	*Critesion marinum	1748	2	*Hypochoeris radicata
1895	2	*Leontodon taraxacoides	1956	+	Leptospermum juniperinum
1957	+	Leptospermum laevigatum	1987	1	Leucopogon parviflorus
2060	2	*Lotus hispidus	2140	2	*Medicago polymorpha
2179	3	Microlaena stipoides	2442	1	Pelargonium australe
2477	1	*Phalaris arundinacea	2553	+	*Plantago coronopus
2561	2	*Plantago lanceolata	2600	2	Poa labillardieri
2942	1	*Romulea rosea	2959	1	*Rubus procerus
3107	1	Senecio glomeratus	3163	+	*Sisyrinchium iridifolium
3203	2	*Sonchus asper	3204	1	*Sonchus oleraceus
3518	1	*Vicia sativa	3519	1	*Vicia tetrasperma

QUADRAT D19041 17 SPECIES 144^ 5'44" 38^27'56" December 1989 1.5 m 10' GRID P19

151	1	Agrostis avenacea	583	5	Calocephalus lacteus
705	1	*Centaurium tenuiflorum	850	1	Cotula reptans
961	1	Danthonia caespitosa	1076	1	Distichlis distichophylla
1782	1	Isolepis nodosa	1826	1	Juncus kraussii
2060	1	*Lotus hispidus	2553	1	*Plantago coronopus
2605	2	Poa poiformis	2730	1	Pratia pedunculata
3001	2	Samolus repens	3012	+	Sarcocornia quinqueflora
3091	1	Sebaea albidiflora	3100	1	Selliera radicans
8313	1	Danthonia ?elatius			

QUADRAT D19042 35 SPECIES 144^ 5'37" 38^28'10" December 1989 7 m 10' GRID P19

88	1	Acacia sophorae	146	1	Elymus scabrus
223	1	*Anagallis arvensis	500	1	*Bromus diandrus
657	1	Carpobrotus rossii	705	+	*Centaurium tenuiflorum
948	1	*Dactylis glomerata	1036	1	Dichondra repens
1432	1	Geranium retrorsum	1748	+	*Hypochoeris radicata
1782	2	Isolepis nodosa	1864	2	*Lagurus ovatus
1922	2	Lepidosperma gladiatum	1957	2	*Leptospermum laevigatum
1987	2	Leucopogon parviflorus	2150	2	Melaleuca lanceolata
2161	1	*Melilotus indica	2225	1	Muehlenbeckia adpressa
2239	2	Myoporum insulare	2301	1	Olearia axillaris
2530	1	Pimelea serpyllifolia	2561	1	*Plantago lanceolata
2605	2	Poa poiformis	2622	1	*Polycarpon tetraphyllum
2624	1	*Polygala myrtifolia	2777	1	Pteridium esculentum
2927	1	Rhagodia candolleana	3203	1	*Sonchus asper
3204	1	*Sonchus oleraceus	3255	1	Stellaria pungens
3276	2	Stipa flavescens	3343	1	Tetragonia implexicoma
4412	+	Dianella revoluta var. brevicaulis	4413	+	Dianella revoluta var. revoluta
5054	1	*Vicia sativa ssp. sativa			

QUADRAT D19043 17 SPECIES 144^ 5'25" 38^28' 5" December 1989 3 m 10' GRID P19 .

329	1	*Atriplex prostrata	623	1	Carex appressa
1076	1	Distichlis distichophylla	1179	2	Epilobium hirtigerum
1356	1	*Festuca arundinacea	1692	1	*Holcus lanatus
1782	1	Isolepis nodosa	1826	1	Juncus kraussii
1843	2	Juncus subsecundus	2092	1	Lythrum hyssopifolia
2154	1	Melaleuca parvistaminea	2605	1	Poa poiformis
2640	1	*Polypogon monspeliensis	2970	1	*Rumex crispus
3001	1	Samolus repens	3468	5	Typha domingensis
4444	2	Epilobium billardierianum ssp. bill			

QUADRAT D19044 21 SPECIES 144^ 5'27" 38^28' 6" December 1989 2 m 10' GRID P19

247	1	Apium prostratum	329	1	*Atriplex prostrata
848	+	*Cotula coronopifolia	1076	1	Distichlis distichophylla
1179	+	Epilobium hirtigerum	1389	1	Gahnia filum
1772	1	Isolepis cernua	1826	2	Juncus kraussii
2060	+	*Lotus hispidus	2418	1	*Parapholis incurva
2553	1	*Plantago coronopus	2605	+	Poa poiformis
2640	1	*Polypogon monspeliensis	2834	1	Puccinellia stricta
3001	4	Samolus repens	3012	4	Sarcocornia quinqueflora
3100	1	Selliera radicans	3203	1	*Sonchus asper
3204	1	*Sonchus oleraceus	3449	2	Triglochin striata
4444	+	Epilobium billardierianum ssp. bill			

QUADRAT D19045 23 SPECIES 144^ 5'38" 38^28' 8" December 1989 1 m 10' GRID P19

223	1	*Anagallis arvensis	705	1	*Centaurium tenuiflorum
810	1	*Conyza albida	1076	1	Distichlis distichophylla
1389	1	Gahnia filum	1616	1	Helichrysum dendroideum
1692	+	*Holcus lanatus	1782	1	Isolepis nodosa
1826	2	Juncus kraussii	2060	2	*Lotus hispidus
2150	2	Melaleuca lanceolata	2161	+	*Melilotus indica
2225	+	Muehlenbeckia adpressa	2239	1	Myoporum insulare
2418	+	*Parapholis incurva	2553	2	*Plantago coronopus
2605	5	Poa poiformis	2640	+	*Polypogon monspeliensis
2777	+	Pteridium esculentum	3001	1	Samolus repens
4444	1	Epilobium billardierianum ssp. billa	4445	1	Epilobium billardierianum ssp. ciner
5054	1	*Vicia sativa ssp. sativa			

QUADRAT D19046 40 SPECIES 144^ 5'42" 38^26'45" December 1989 9 m 10' GRID P19

99	3	Acacia verniciflua	151	+	Agrostis avenacea
164	1	*Aira caryophyllea	166	1	*Aira elegantissima
236	1	*Anthoxanthum odoratum	496	1	*Briza minor
532	+	Caladenia dilatata	672	1	Cassytha melantha
770	+	*Chrysanthemoides monilifera	965	1	Danthonia geniculata
973	1	Chionochloa pallida	1034	1	Dichelachne micrantha
1068	1	Dipodium punctatum	1102	1	Drosera peltata ssp. auriculata
1317	4	Eucalyptus sideroxylon	1323	1	Eucalyptus viminalis
1394	1	Gahnia radula	1432	1	Geranium retrorsum
1466	1	Gnaphalium japonicum	1489	1	Gonocarpus tetragynus
1497	1	Goodenia geniculata	1692	1	*Holcus lanatus
1741	1	Hypericum gramineum	1748	1	*Hypochoeris radicata
1843	+	Juncus subsecundus	2042	1	Lomandra filiformis
2060	+	*Lotus hispidus	2344	+	Opercularia varia
2566	1	Plantago varia	2608	1	Poa sieberiana
2777	1	Pteridium esculentum	2844	1	Pultenaea daphnoides
3129	+	Senecio tenuiflorus	3255	+	Stellaria pungens
3429	1	*Trifolium glomeratum	3544	1	*Vulpia bromoides
4213	5	Acacia verticillata var. vert.	4412	+	Dianella revoluta var. brevicaulis
4709	1	Lomandra filiformis ssp. coriacea	4710	1	Lomandra filiformis ssp. filiformis

QUADRAT D19047 27 SPECIES 144^ 5'45" 38^26'48" December 1989 6 m 10' GRID P19

151	1	Agrostis avenacea	208	1	Amphibromus archeri
211	2	Amphibromus recurvatus	381	2	Baumea tetragona
623	1	Carex appressa	706	1	Centella cordifolia
961	+	Danthonia caespitosa	1524	1	Gratiola peruviana
1692	+	*Holcus lanatus	1775	+	Isolepis fluitans
1779	1	Isolepis inundata	1811	1	*Juncus bulbosus
1821	1	Juncus holoschoenus	1831	2	Juncus pauciflorus
1833	1	Juncus planifolius	1835	3	Juncus procerus
1956	2	Leptospermum juniperinum	2005	1	Lilaeopsis polyantha
2060	1	*Lotus hispidus	2153	3	Melaleuca squarrosa
2221	1	Montia australasica	2251	2	Myriophyllum amphibium
3449	2	Triglochin striata	3491	+	*Vellereophyton dealbatum
3521	1	Villarsia reniformis	3873	3	Myriophyllum simulans
8601	1	Juncus pauciflorus x pallidus			

QUADRAT D19048 12 SPECIES 144^ 5'44" 38^26'49" December 1989 6 m 10' GRID P19

151	+	Agrostis avenacea	211	2	Amphibromus recurvatus
381	+	Baumea tetragona	1146	1	Eleocharis sphacelata
1779	1	Isolepis inundata	1956	+	Leptospermum juniperinum
2153	1	Melaleuca squarrosa	2221	1	Montia australasica
3448	3	Triglochin procera	3521	5	Villarsia reniformis
3873	4	Myriophyllum simulans	8046	2	Amphibromus sp.

QUADRAT D19049 5 SPECIES 144^ 5'43" 38^26'51" December 1989 6 m 10' GRID P19

1146	4	Eleocharis sphacelata	1775	2	Isolepis fluitans
3448	3	Triglochin procera	3521	1	Villarsia reniformis
3873	4	Myriophyllum simulans			

QUADRAT D19050 29 SPECIES 144^ 5'40" 38^26'48" December 1989 7 ■ 10' GRID P19

57	2	Acacia melanoxylon	105	1	Acaena anserinifolia
169	1	*Albizia lophantha	236	2	*Anthoxanthum odoratum
782	+	*Cirsium vulgare	973	1	Chionochloa pallida
1307	4	Eucalyptus ovata	1432	+	Geranium retrorsum
1489	1	Gonocarpus tetragynus	1507	1	Goodenia ovata
1692	2	*Holcus lanatus	1748	1	*Hypochoeris radicata
1830	1	Juncus pallidus	1919	1	Lepidosperma elatius
1956	3	Leptospermum juniperinum	2060	1	*Lotus hispidus
2153	2	Melaleuca squarrosa	2179	2	Microlaena stipoides
2381	1	Oxalis exilis	2561	1	*Plantago lanceolata
2608	1	Poa sieberiana	2650	1	Pomaderris aspera
2777	2	Pteridium esculentum	2956	1	Rubus parvifolius
3204	+	*Sonchus oleraceus	3435	+	*Trifolium repens
4213	2	Acacia verticillata var. vert	4412	1	Dianella revoluta var. brevicaulis
5054	+	*Vicia sativa ssp. sativa			

QUADRAT D19051 55 SPECIES 144^ 5'25" 38^27' 0" December 1989 6 ■ 10' GRID P19

57	1	Acacia melanoxylon	129	1	Adiantum aethiopicum
151	1	Agrostis avenacea	329	+	*Atriplex prostrata
407	+	Blechnum minus	408	1	Blechnum nudum
500	+	*Bromus diandrus	574	1	*Callitriche stagnalis
623	3	Carex appressa	638	3	Carex fascicularis
719	+	*Cerastium glomeratum	782	+	*Cirsium vulgare
788	1	Clematis aristata	822	2	Coprosma quadrifida
919	1	Cyperus exaltatus	1307	1	Eucalyptus ovata
1323	4	Eucalyptus viminalis	1431	1	Geranium potentilloides
1455	+	Glycine clandestina	1465	+	Gnaphalium involucratum sensu strict
1507	1	Goodenia ovata	1557	3	Gynatrix pulchella
1616	2	Helichrysum dendroideum	1692	+	*Holcus lanatus
1748	+	*Hypochoeris radicata	1779	1	Isolepis inundata
1806	1	*Juncus articulatus	1831	1	Juncus pauciflorus
2024	+	Lobelia alata	2046	1	Lomandra longifolia
2179	1	Microlaena stipoides	2497	1	Phragmites australis
2555	+	Plantago debilis	2600	1	Poa labillardieri
2631	2	Polygonum minus	2650	2	Pomaderris aspera
2777	1	Pteridium esculentum	2907	+	Ranunculus rivularis
2950	+	*Rosa rubiginosa	2956	1	Rubus parvifolius
2968	+	Rumex brownii	2969	+	*Rumex conglomeratus
3107	+	Senecio glomeratus	3119	+	Senecio minimus
3203	+	*Sonchus asper	3204	+	*Sonchus oleraceus
3448	1	Triglochin procera	3524	2	*Vinca major
3531	+	*Viola odorata	3558	+	Wahlenbergia gracilis
4213	2	Acacia verticillata var. vert	5054	+	*Vicia sativa ssp. sativa
8253	+	*Conyza sp.	8909	1	Poa sp.
9058	1	Senecio sp.			

QUADRAT D19052 34 SPECIES 144^ 5'30" 38^27' 1" December 1989 8 m 10' GRID P19

57	1	Acacia melanoxylon	129	+	Adiantum aethiopicum
236	1	*Anthoxanthum odoratum	498	1	*Bromus catharticus
500	2	*Bromus diandrus	782	2	*Cirsium vulgare
788	+	Clematis aristata	948	1	*Dactylis glomerata
1036	1	Dichondra repens	1323	4	Eucalyptus viminalis
1431	1	Geranium potentilloides	1616	1	Helichrysum dendroideum
1692	3	*Holcus lanatus	1701	+	*Critesion murinum ssp. leporinum
1748	1	*Hypochoeris radicata	2036	1	*Lolium perenne
2060	1	*Lotus hispidus	2078	1	*Lycium ferocissimum
2179	1	Microlaena stipoides	2442	1	Pelargonium australe
2561	1	*Plantago lanceolata	2600	1	Poa labillardieri
2608	+	Poa sieberiana	2777	1	Pteridium esculentum
2956	1	Rubus parvifolius	2959	1	*Rubus procerus
2975	1	*Rumex sagittatus	3183	2	*Solanum nigrum
3204	1	*Sonchus oleraceus	3435	1	*Trifolium repens
4213	2	Acacia verticillata var. vert	4298	1	Bursaria spinosa var. spinosa
8253	1	*Conyza sp.	8998	1	*Rubus sp.

QUADRAT D19053 25 SPECIES 144^ 6' 1" 38^27'41" December 1989 7 m 10' GRID P19

211	2	Amphibromus recurvatus	496	+	*Briza minor
574	2	*Callitriche stagnalis	623	2	Carex appressa
848	1	*Cotula coronopifolia	907	1	*Cynodon dactylon
1139	5	Eleocharis acuta	1471	+	Gnaphalium sphaericum
1692	2	*Holcus lanatus	1782	1	Isolepis nodosa
1806	2	*Juncus articulatus	1835	1	Juncus procerus
1895	1	*Leontodon taraxacoides	2060	1	*Lotus hispidus
2092	1	Lythrum hyssopifolia	2221	2	Montia australasica
2476	1	*Phalaris aquatica	2553	1	*Plantago coronopus
2600	1	Poa labillardieri	2640	+	*Polypogon monspeliensis
2730	2	Pratia pedunculata	2970	1	*Rumex crispus
3435	1	*Trifolium repens	3448	+	Triglochin procera
8916	+	Polygonum sp.			

QUADRAT D19054 23 SPECIES 144^ 5'52" 38^27'30" December 1989 7 m 10' GRID P19

151	1	Agrostis avenacea	211	1	Amphibromus recurvatus
623	2	Carex appressa	848	1	*Cotula coronopifolia
907	1	*Cynodon dactylon	1139	4	Eleocharis acuta
1692	2	*Holcus lanatus	1702	1	*Critesion marinum
1782	2	Isolepis nodosa	1835	1	Juncus procerus
1895	1	*Leontodon taraxacoides	2058	1	*Lotus corniculatus
2060	1	*Lotus hispidus	2092	1	Lythrum hyssopifolia
2140	1	*Medicago polymorpha	2221	2	Montia australasica
2381	1	Oxalis exilis	2600	1	Poa labillardieri
2906	1	*Ranunculus repens	2970	1	*Rumex crispus
2975	1	*Rumex sagittatus	4444	1	Epilobium billardierianum ssp. billa
8601	1	Juncus sp.			

QUADRAT D19055 5 SPECIES 144^ 5'35" 38^28' 1" December 1989 0 m 10' GRID P19

1934	2	Lepilaena cylindrocarpa	2197	1	Mimulus repens
2691	2	Potamogeton pectinatus	2979	3	Ruppia polycarpa
3449	1	Triglochin striata			

Species recorded outside quadrats in the Painkalac Creek and Wetlands study area.

W denotes species recorded by M. White in the study area.

52 SPECIES 10' GRID P19

78	+	Acacia pycnantha	92	+	W Acacia suaveolens
106	+	W Acaena echinata	152	+	W Agrostis billardieri
153	+	*Agrostis capillaris	255	+	*Arctotheca calendula
655	+	*Carpobrotus edulis	744	+	W Chenopodium glaucum
746	+	*Chenopodium murale	777	+	*Cicendia quadrangularis
823	+	*Coprosma repens	862	+	W Crassula helmsii
918	+	*Cyperus eragrostis	946	+	*Cytisus palmensis
967	+	W Danthonia laevis	1033	+	Dichelachne crinita
1038	+	Dichopogon strictus	1077	+	*Dittrichia graveolens
1370	+	*Foeniculum vulgare	1421	+	*Genista linifolia
1434	+	W Geranium solanderi	1677	+	Hibbertia sericea
1690	+	*Hirschfeldia incana	1780	+	W Isolepis marginata
1783	+	W Isolepis platycarpa	2017	+	W Linum marginale
2021	+	Lissanthe strigosa	2138	+	*Medicago minima
2189	+	W Microtis unifolia	2387	+	*Oxalis pes-caprae
2431	+	*Paspalum distichum	2451	+	*Pennisetum clandestinum
2539	+	*Pinus radiata	2580	+	*Poa annua
2626	+	*Polygonum aviculare	2665	+	Pomaderris oraria
2690	+	Potamogeton ochreatus	2758	+	*Prunus cerasifera
2974	+	*Rumex pulcher	2989	+	*Salix babylonica
3111	+	W Senecio hispidulus	3124	+	W Senecio quadridentatus
3230	+	Sporobolus virginicus	3260	+	*Stenotaphrum secundatum
3336	+	*Taraxacum Sect. Vulgaria	3387	+	Themeda triandra
3423	+	*Trifolium angustifolium	3471	+	*Ulex europaeus
3523	+	W Viminaria juncea	3565	+	Watsonia versfeldii
3608	+	W Zostera ?muelleri	4296	+	Bursaria spinosa var. macrophylla

Appendix 4. Concentration of the major inorganic ions and total alkalinity as $CaCo_3$ in Painkalac Creek, February, May and August 1978. (Source: Yule 1978).

Inorganic ions and alkalinity (mg/litre)	SITE 1 DUCK POND				SITE 2 ABOVE DAM				SITE 3 200m BELOW DAM				SITE 4 1.2km BELOW DAM				SITE 5 BRIDGE			
	Feb.	May 16	May 30	Aug.	Feb.	May 16	May 30	Aug.	Feb.	May 16	May 30	Aug.	Feb.	May 16	May 30	Aug.	Feb.	May 16	May 30	Aug.
Total alkalinity as $CaCO_3$	-	23	18	19	41	6	19	21	58	20	20	23	57	20	23	24	48	19	18	23
Chloride as Cl^-	-	160	110	95	153	170	100	91	193	170	100	109	243	170	120	101	227	170	110	105
Sulphate as SO_4^-	-	3.1	10	10	<1	11	9.4	10	<1	10	8	11	9.6	15	15	12	12	16	13	14
Calcium as Ca^{++}	-	11	9	5.8	12	11	9	5.9	15.6	12	10	7.5	14	12	11	6.8	12	12	9	7
Magnesium as Mg^{++}	-	16	12	8.3	14.4	17	12	8.7	18	18	12	11	21	18	15	10	20	18	13	10
Sodium as Na^+	-	-	48	48	84.5	70	48	48	98	70	48	57	136	78	56	56	130	78	56	57
Potassium as K^+	-	2.4	2	8.6	3.3	2.2	2	2	4	2.4	2.4	2.7	5	2.6	2.6	2.1	4.6	2.9	2.4	2.2

- - no record

APPENDIX 5. Bird species recorded in different habitats (excluding wetlands) between Boundary Road and Beach Road, Aireys Inlet in November 1975 by A.I.D.A. Note that some bird species require more than one habitat type but this is not taken into account here.

Common Name	Scientific Name
Birds requiring hollow limbs & trunks	
Yellow-tailed Black Cockatoo	*Calyptorhynchus funereus*
Sulphur-crested Cockatoo	*Cacatua leadbeateri*
Galah	*Cacatua roseicapilla*
Crimson Rosella	*Platycercus elegans*
Blue-winged Parrot	*Neophema bourkii*
Musk Lorikeet	*Glossopsitta concinna*
Little Lorikeet	*Glossopsitta pusilla*
Purple-crowned Lorikeet	*Clossopsitta porphyrocephala*
Swift Parrot	*Lathamus discolor*
Grey Shrike-thrush	*Colluricincla harmonica*
Tree Martin	*Cecropos nigricans*
Laughing Kookaburra	*Dacelo gigas*
Sacred Kingfisher	*Halcyon sancta*
Birds requiring tall timber for feeding, nesting	
White-naped Honeyeater	*Melithreptus lunatus*
Brown-headed Honeyeater	*Melithreptus brevirostris*
Crescent Honeyeater	*Phylidonyris pyrrhoptera*
Yellow-faced Honeyeater	*Lichenostomus chrysops*
White-eared Honeyeater	*Lichenostomus leucotis*
Silvereye	*Zosterops lateralis*
Eastern Spinebill	*Acanthorhynchus tenuirostris*
White-plumed Honeyeater	*Lichenostomus penicillatus*
Red Wattlebird	*Anthochaera carunculata*
Little Wattlebird	*Anthochaera chrysoptera*
Jacky Winter	*Microeca leucophaea*
Satin Flycatcher	*Myiagra cyanoleuca*
Pallid Cuckoo	*Cuculus pallidus*
Fan-tailed Cuckoo	*Cuculus pyrrohophanus*
Horsfield Bronze-cuckoo	*Chrysococcyx basalis*
Shining Bronze-cuckoo	*Chrysococcyx lucidus*
Grey Currawong	*Strepera versicolor*
Pied Currawong	*Strepera graculina*
White-faced Heron	*Ardea novaehollandiae*
Pacific Heron	*Ardea pacifica*
Golden Whistler	*Pachycephala pectoralis*
Rufous Whistler	*Pachycephala rufiventris*
Olive Whistler	*Pachycephala olivacea*
Forest Raven	*Corvus tasmanicus*

Common Name	Scientific Name
Australian Magpie Lark	*Grallina cyanoleuca*
Australian Magpie	*Gymnorhina tibicen*
Dusky Woodswallow	*Artamus cyanopterus*
White-throated Gerigone	*Gerygone olivacea*
Scarlet Robin	*Petroica multicolor*
Buff-rumped Thornbill	*Acanthiza reguloides*
Yellow Thornbill	*Acanthiza nana*
Striated Thornbill	*Acanthiza lineata*
Olive-backed Oriole	*Oriolus sagittatus*
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*
Spotted Pardalote	*Pardalotus punctatus*
Varied Sitella	*Daphoenositta chrysoptera*
Weebill	*Smicrornis brevirostris*
Brown Goshawk	*Accipiter fasciatus*
Grey Goshawk	*Accipiter novaehollandiae*
Australian Kestrel	*Falco cenchroides*
Collared Sparrowhawk	*Accipiter cirrhocephalus*
Black-shouldered Kite	*Elanus notatus*
Peregrine Falcon	*Falco peregrinus*
Whistling Kite	*Haliastur sphenurus*
Wedge-tailed Eagle	*Aquila audax*
Australian Hobby	*Falco longipennis* Brown
Brown Falcon	*Falco berrigora*

Birds requiring bushes and shrubs for shelter, nesting and food

White-browed Scrubwren	*Sericornis frontalis*
Superb Fairy-wren	*Malurus cyaneus*
Chestnut-rumped Hylacola	*Sericornis pyrrhopygius*
Brown Thornbill	*Acanthiza pusilla*
Rufous Fantail	*Rhipidura rufifrons*
Grey Fantail	*Rhipidura fuliginosa*
Eastern Yellow Robin	*Eopsaltria australis*
Pink Robin	*Petroica rodinogaster*
Red-browed Firetail	*Emblema temporalis*
White's Thrush	*Zoothera dauma*
Painted Button-quail	*Turnix varia*
Spotted Quail-thrush	*Cinclosoma punctatum*
Willie Wagtail	*Rhipidura leucophrys*
Rufous Bristlebird	*Dasyopnis broadbenti*
Satin Bowerbird	*Ptilonorhynchus violaceus*
New Holland Honeyeater	*Phylidonyris novaehollandiae*

Birds requiring open pasture for feeding

Masked Lapwing	*Vanellus miles*
Australian Shelduck	*Tadorna tadornoides*
Cattle Egret	*Ardeola Ibis*

Appendix 6. Bird species recorded on Painkalac Creek wetlands by P. Reilly and Claire Roberts (pers. comm.).

Common Name	Scientific Name
Hoary-headed Grebe	*Poliocephelas poliocephelas*
Australasian Grebe	*Tachybaptus novaehollandiae*
Australian Pelican	*Pelicanus conspicillatus*
Little Pied Cormorant	*Phalacrocorax melanoleucos*
Great Cormorant	*Phalacrocorax carbo*
Little Black Cormorant	*Phalacrocorax sulcirostris*
Pacific Heron	*Ardea pacifica*
White-faced Heron	*Ardea novaehollandiae*
Cattle Egret	*Ardeola ibis*
Great Egret	*Egretta alba*
Rufous Night Heron	*Nycticorax caledonicus*
Little Bittern	*Ixobrychus minutus*
Australasian Bittern	*Botaurus poiciloptilus*
Glossy Ibis	*Plegadis falcinella*
Sacred Ibis	*Threskiornis aethiopicus*
Straw-necked Ibis	*Threskiornis spinicollis*
Royal Spoonbill	*Plataelea regia*
Yellow-billed Spoonbill	*Platalea flavipes*
Black Swan	*Cygnus atratus*
Pacific Black Duck	*Anas superciliosa*
Grey Teal	*Anas gibberlfrons*
Chestnut Teal	*Anas castanea*
Wood Duck	*Chenonetta jubata*
Musk Duck	*Biziura lobata*
Marsh Harrier	*Circus approximans*
Buff-banded Rail	*Rallus philippensis*
Lewins Rail	*Rallus pectoralis*
Baillon's Crake	*Porzana pusilla*
Black-tailed Native-hen	*Gallinula ventralis*
Dusky Moorhen	*Gallinula tenebrosa*
Black-winged Stilt	*Haemantopus haemantopus*
Greenshank	*Tringa nebularia*
Lathams Snipe	*Gallinago hardwickll*
Sharp-tailed Sandpiper	*Calidris acuminata*
Red-necked Stint	*Calidris ruficollis*
Curlew Sandpiper	*Calidris ferruginea*
Silver Gull	*Larus novaehollandiae*
Pacific Gull	*Larus pacificus*
Caspian Tern	*Hydropogne caspia*
Blue-winged Parrot	*Neophema chrysostoma*
Clamorous Reed-warbler	*Acrocephalus stentoreus*
Little Grassbird	*Megalurus gramineus*
Golden-headed Cisticola	*Cisticola exilis*
Southern Emu-wren	*Stipiturus malachurus*
White-fronted Chat	*Epithianura albifrons*

Common Name	Scientific Name
White-winged Triller	*Lalage sueurii*
Welcome Swallow	*Hirundo neoxena*
White-throated Needletail	*Hirundapus caudacutus*
Flame Robin	*Petroica phoenicea*
Singing Bushlark	*Mirafra javanica*

Appendix 7. List of mammals that could occur in the Painkalac Creek study area, Aireys Inlet, Victoria.

COMMON NAME	SCIENTIFIC NAME
Echidna	*Tachyglossus aculeatus*
White-footed Dunnart	*Sminthopsis leucopis*
Swamp Antechinus	*Antechinus minimus*
Southern Brown Bandicoot	*Isoodon obselus*
Sugar Glider	*Petaurus breviceps*
Feathertail Glider	*Acrobates pygmaeus*