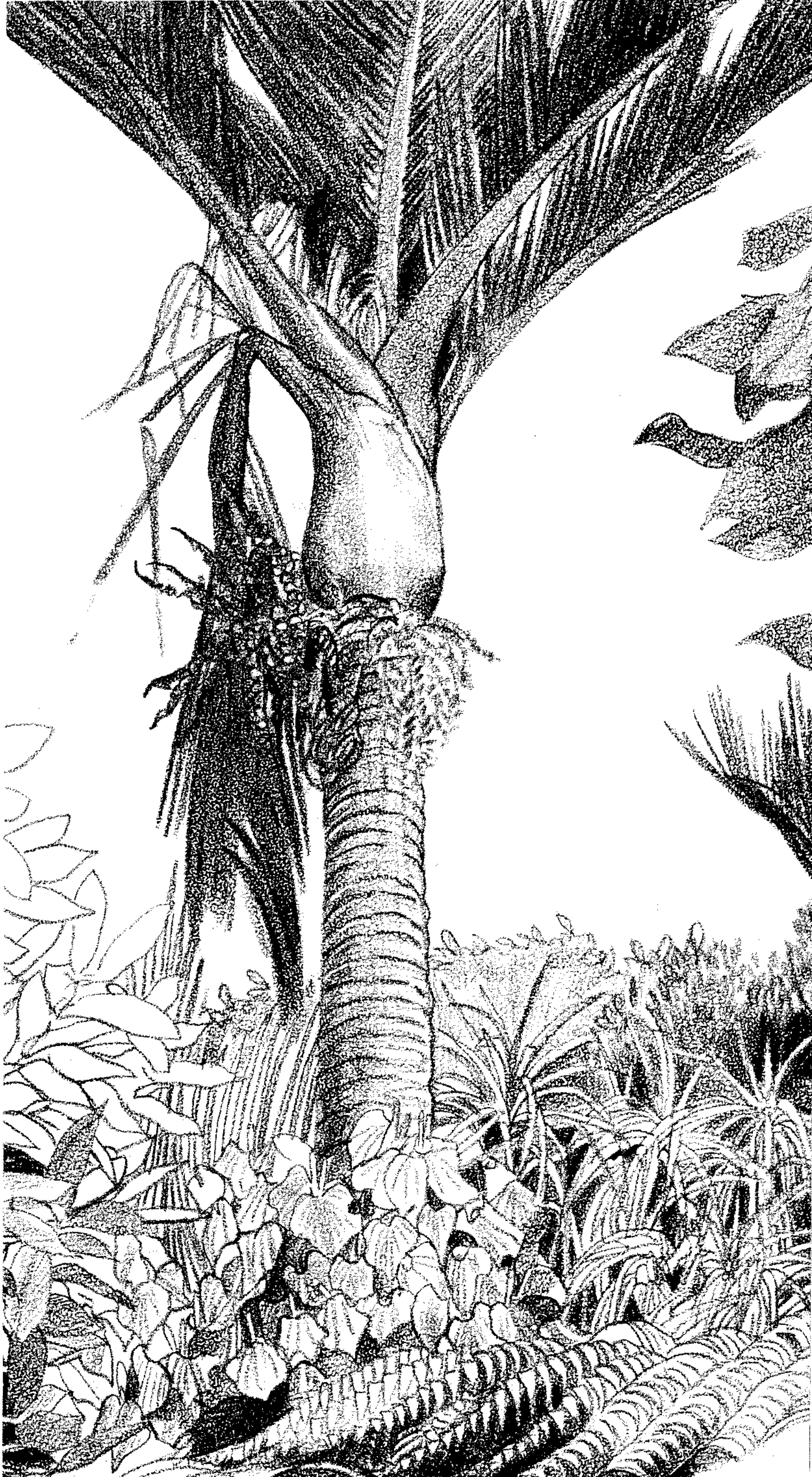
PAPAROA NATIONAL PARK
resource summary



PAPAROA NATIONAL PARK

Resource Summary

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CONSERVATION
TE PAPA ATAWHAI

Front Cover: Illustration by Chris Gaskin
nikau palm

FIG 1
LOCALITY MAP

FOREWORD

This publication has been produced to coincide with the release, for public comment, of the draft of the first Paparoa National Park Management Plan. Its main purpose is, therefore, to assist in the formulation of submissions by all interested persons or organisations.

As a consequence this Resource Summary contains no information of either a strategic planning or a policy nature. It merely attempts to gather together all known sources of information pertaining to Paparoa National Park and its environs, including Bullock Creek Farm. The information of the natural, historical and cultural values of the area has been summarised for the purposes of brevity, but the extensive bibliography allows further investigation of the finer details of such resource information if desired.

Knowledge of the area referred to as Paparoa National Park is growing all the time, thus, even though this Resource Summary is not actually released for public comment, the department welcomes any comments on its factual content.

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1 GEOLOGY

The Paparoa range came into being in the late Pliocene or early Pleistocene on the site of a former geosyncline that persisted from late Cretaceous until towards the close of the Oligocene.

Subsidence occurred as a result of normal faulting along a regionally active tectonic feature, the Paparoa tectonic zone (Laird 1968). This developing trough along the eastern margin of the park formed the depocentre for a great thickness of sand, mud and sediment, gravity flow deposits (Rapahoe group) until early Whaingaroan times. The increase in thickness of lower Tertiary deposits from the margin to the axis of the trough is striking and is reflected by a corresponding increase in Brunner coal rank. Subsidence continued, but at a slower pace until late London times (Nile group, including the Pancake Rocks).

Renewed tectonic activity, but this time along reverse faults, took place along the Paparoa tectonic zone in the Altonian, intensifying during the Waianan and causing deposition of a great thickness of sands and muds (Blue Bottom group).

These movements heralded the beginning of the Kaikoura Orogeny, with uplift along the site of the early Tertiary depocentre which finally became emergent as the Paparoa Range during late Pliocene or early Quaternary times (Laird 1988).

The rocks which make up the geology of the park display a wide range of ages.

Charleston metamorphic group

The rock of this group is the oldest, with an age of 665m years (Adams 1975). There are three outcrops of the group represented in the park. The Pecksniff Metasedimentary Gneiss occurring along the summit of the range, White Knight Granite Gneiss, a narrow zone between Pecksniff Metasedimentary Gneiss and two areas of Greenland group at the top of the range south of White Knight, and the Constant Gneiss outcropping on the coast at Needle Point.

Greenland Group

Sedimentary rocks make up the major base rocks in the park and the oldest of these is the Greenland group. Unfossiliferous, indurated 'greywackes and argillites' occur in the upper Punakaiki River area. Ages range from 304m to 446m years (Laird 1988). The Greenland group is in contact with the granite gneiss of the Charleston Metamorphic Group and there is a probable tectonic relationship.

Intrusive Granites (Karamea Batholith)

Meybille granite is restricted to a 3km long coastal strip at Meybille Bay. This granite is estimated to be from the middle Paleozoic period.

Intrusive undifferentiated granites also occur in Tindale Creek and a west-flowing tributary of the Punakaiki River. This outcrop is considered to be from the early Cretaceous period, 130m years ago.

Pororari Group

The Pororari group (Bowen 1964) rests on the Greenland group or granite basement. It is a non-marine sequence dominated by coarse clastic detritus. These sediments were deposited in grabens or fault-angle depressions initiated during mid-Cretaceous block-faulting. In the park the group is exposed in the headwaters of Bullock Creek and the Pororari River from where it takes its name (Laird 1988). There are four formations in the Pororari group the oldest being the Watson formation, which is restricted to the Pororari River and its tributories, but the younger Hawks Crag Breccia, Bovis and Bullock Creek formations occur in all major outcrop areas and on both flanks of the Paparoa Range.

This indicates that the original area of deposition extended over the site of the present Paparoa Range (Laird 1988).

Hawks Crag Breccia is the most widespread of the Pororari group formations. As well as outcrops in Tindale and Bullock Creeks there are numerous small areas such as those at the head of the Fox River, Fox River mouth and the Punakaiki River (Laird 1988).

The Cretaceous and Eocene Coal Measures

There are two separate coal measure formations now recognised: the Paparoa Coal Measures (late Cretaceous) and the Brunner Coal Measures (early Tertiary). Like the Pororari group, the Paparoa Coal Measures are inferred to have been deposited in restricted grabens or fault-angle depressions, whereas the younger Brunner Coal Measures were formed as a sheet-like body over much of the West Coast region (Laird 1988).

The Paparoa Coal Measures are restricted to a discontinuous belt along the eastern side of the park, outcropping in the headwaters of the Fox River, Bullock Creek, the Pororari River and the head of the Punakaiki River (Pike Coal Field). The only complete section through the Paparoa Coal Measures occurs in the escarpment at the head of the Punakaiki River.

The Brunner Coal Measures occur along the coast from Meybille Bay north, to the Tiropahi River and along the eastern side of the Barrytown syncline between Lawson Creek and Pororari River. It is also represented in the escarpment at the head of the Punakaiki River.

The coal is commonly confined to a single seam, often no more than two to three metres thick but varying up to ten metres in thickness. In the escarpment at the head of the Punakaiki River it is only a few metres thick (Laird 1988).

Following the deposition of the Paparoa Coal Measures there was a period of relative tectonic quiescence extending well into the Eocene during which a landscape of subdued relief developed. By early Eocene times most of the mapped area was reduced to a low-lying terrain close to sea level which was the site of extensive peat swamps (Brunner Coal Measures) (Laird 1988).

Rapahoe Group

Overlying the Brunner Coal Measures are the marine sediments of the Rapahoe group (Nathan 1974) which are made up of four formations. At the bottom is the Little Totara Sand which occurs only in the coastal cliffs near Limestone Creek, Meybille Bay and near the Tiropahi River. Further south it becomes progressively thinner, disappearing south of Meybille Bay (Laird 1988). These sands are thought to be a tidal sand-bar or beach.

The Island Sandstone outcrops on both sides of the Barrytown syncline. It consists of moderately well sorted, brown-grey, fine to very fine muddy calcareous sandstone. The more resistant well-cemented layers contain up to 60% calcium carbonate, whereas the intervening layers average only 20 to 25% calcium carbonate. The thickness of the formation is variable. In the Pororari River, on the eastern flank of the Barrytown syncline where the formation is thickest, it reaches 850m. It thins rapidly to the south-west, being 420m thick in the Punakaiki River section but no more than 20m thick in Lawson Creek. At Perpendicular Point it is 270m thick, but diminishes as it progresses north.

The Kaiata Formation occurs on the eastern limb of the Barrytown syncline between the Punakaiki and Pororari Rivers. The Kaiata Formation consists of moderately well sorted, micaceous and glauconitic, dark brown or grey calcareous sandy mudstone. Kaiata Formation and Island Sandstone are differentiated primarily on the bases of sand content and colour. Calcium carbonate content is up to 40% in the resistant layers and 5 to 15% in the intervening layers. It reaches 900m thick in the Pororari River, but only 70m thick at the Punakaiki (Laird 1988).

Both the Island and Kaiata formations originated in a shallow marine environment, the former inner to middle shelf and the latter, middle to outer shelf.

The last member of the group is the Fossil Creek Formation (Laird 1988), which occurs in the headwaters of Fossil and Dilemma Creeks and again in Henniker Creek, made up of pebbly mudstone with clasts up to 5cm. Thinner interbedded units include coarse sandstone and fine conglomerates with clasts up to 60cm. Thin beds of laminated sandstone and slump horizons occur in the lower half with well-bedded, fine to medium embedded sandstone showing parallel laminations and frequent grading in the upper half. The formation attains a thickness of 140m in Fossil Creek and it is suggested that it was deposited by sediment gravity flows in a subsiding basin (Laird 1988).

Nile Group

The Nile Group (Nathan 1974) contains two members. The first is the Tiropahi Limestone which outcrops in the north, but has not been recognised south of Hatters Bay. Its maximum thickness is 150m in the north, but it rapidly thins to the south. The Tiropahi limestone further south interdigitates with Potikohua limestone south of Fox River. Potikohua limestone outcrops on both limbs of the Barrytown syncline. This hard white flaggy, polyzoan limestone, locally sandy, is petrographically a polyzoan biosporite (Folk 1959). It is highly variable in thickness reaching a maximum of 600m south of the Pororari River on the east side of the syncline thinning rapidly to less than 18m in the headwaters of Lawson Creek. At Dolomite Point a horizon of phosphatic nodules and quartz granules up to 1cm in diameter divides the 44m thick limestone almost equally into a lower thicker-bedded non-platy limestone and an upper stylo-bedded platy limestone. The rapid weathering of the softer layers has formed the Pancake Rocks.

Blue Bottom Group

The Welsh Formation (Nathan 1974) outcrops in the middle of the Barrytown syncline and around the mouth of the Punakaiki River, and consists of calcareous muddy sandstone with a few decimeters of coarse greensand at its base. South of Dilemma Creek calcareous mudstone becomes increasingly abundant and comprises the formation between Bullock Creek and the Pororari River. South of the Pororari River calcareous, muddy, very fine sandstone is dominant with a maximum thickness of 600m. Laird (1988), recognised a new member of this group at Razorback Point where it forms a lens within the Welsh Formation. It is absent north of the Pororari River. At Razorback Point it is 50m thick and consists of a sandy limestone with coal pebbles up to 5cm in diameter.

The O'Keefe Formation (Nathan 1974) is found in the core of the syncline, where it sits uncomfortably on the Welsh Formation. It consists of blue-grey micaceous, non-calcareous, muddy, very fine sandstone. Pebbly mudstone of mass-flow origin occurs in the basal 20m in outcrops between Dilemma Creek and Welsh Creek, but is apparently absent in the south-west. The maximum thickness is 900m (Laird 1988).

When mountain building began the geosynclinal sediments at first provided a homogeneous plaster over the growing anticline. The consequent stream pattern became deeply engraved and was thus able to resist the deflecting influence of the lower rocks of variable hardness when they were eventually brought to the surface by erosion.

Upper Quaternary Deposits

The Upper Quaternary Deposits were formed during a series of alternating glacial and interglacial periods, and overlie older rocks with marked angular unconformity. Sand and gravel, forming three distinct coastal marine terraces ranging in altitude from 34 to 120m above sea level, was deposited during interglacial high stands of sea level. Equivalent river terraces were formed inland as rivers aggraded rapidly to these higher interglacial base levels. Continuing regional uplift resulted in sediments, deposited during each interglacial marine transgression, being raised high enough not to be submerged during the next transgression so that a complete set of terraces has been preserved (Laird 1988). The highest terraces, the Candelight Formation (Nathan 1975), consist of small terrace remnants in the headwaters of the Tiropahi and Fox Rivers made up of weathered granitic and gneissic river gravel up to 1,370m asl. The Whiskey Formation (Nathan 1975) is also present in the Tiropahi and Fox Rivers and is found up to 260m asl.

The Caledonian Formation (McPherson 1978) forms small high marine terraces along the coast between Canoe Creek and the Punakaiki River, and at Meybille Bay. It also forms river terraces in the headwaters of the Fox River. This formation is made up of fluvial river gravels in the headwaters of the Fox River while sand and fine gravel form the coastal marine terraces, 105 to 120m asl.

The Addison Formation (McPherson 1978) is comprised of the river terraces along the axis of the Barrytown syncline and marine terraces outside the park. Between the Punakaiki River and Dilemma Creek the gravel deposits are fluvial. The fine sand and gravel deposits of the Waites Formation (McPherson 1978) form terraces 34 to 36m asl at Razorback and Dolomite Points and along the coast at Truman Track. They also occur in the depressions along the axis of the Barrytown syncline. Although the Paparoa Range has been glaciated, no glacial deposits have been recognised in the park (Laird 1988).

Fossils and Sub-Fossils

All caves and 'tomo' of the park are potentially important repositories of fossil and sub-fossil material. Fossil bones and teeth have been observed in caves in the Bullock Creek area, and sub-fossil birds and reptiles have been recorded from several cave systems. Larger fossils are found in sandstone rocks.

Ananui (Metro or Nile River) Caves hold nationally significant bird bone deposits (Williams, 1980) and it is likely that other cave systems within the park may also become significant sub-fossil sites. Similarly the adjoining Tiropahi (Four Mile) area is known to contain nationally significant fossil Oligocene whale deposits.

Despite the relative abundance of known fossil sites and sub-fossil deposits, few have been well researched and documented. No sites are currently listed in the inventory of New Zealand fossil localities (Hayward and Ward 1989).

2 LANDFORMS

The park is known for its outstanding geological diversity - reflected by the intense variety of mountain, lowland and coastal landforms - combined with a spectacular, varied and accessible coastline.

The major geological structures affecting the geomorphology of the park are the Cape Foulwind fault, the Punakaiki anticline, the Barrytown syncline, the Paparoa Tectonic Zone and the Hawera Fault.

The Hawera fault has caused down-throw of 1,000m to the west near Hawera. The Tertiary rocks are folded into the north-east trending fault, forming the Punakaiki anticline and the Barrytown syncline (Laird 1988). The Barrytown syncline is almost entirely contained within the park.

Mountains

The mountains of the park were uplifted during Late Pliocene or early Quaternary times and, although this is recent in geological terms, the rocks of the highest mountain, Mt Lodge (1,447m), are recorded as being the oldest in New Zealand.

The metasedimentary gneiss along the crest of the range at this point shows evidence of glaciation where ice occupied cirques and planed off the hard rock surfaces. Further south sandstones and greywacke support a lower and more gentle profile.

The two dominant landforms in this area are Mt Bovis (1,252m) and the Lone Hand (947m). The Lone Hand consists of an outcrop of hard Hawks Crag Breccia which has weathered into a series of rounded domes.

Limestone Syncline

The coastal limestone syncline supports the most extensive unspoilt lowland karst landscape in New Zealand: comprising exposed karst plateaux with "jumbled" polygonal depressions (dolines), karren (minor solutionally sculpted limestone outcrops), sunken and blind valleys, broad low-lying basins with sea-planed tertiary karst landforms, subterranean waterways and extensive cave systems.

Rivers

Spectacular coastal and inland limestone canyons where westward-flowing rivers plunge through the limestone syncline are major features of the park. These rivers are the Fox, Porarari and Punakaiki which have their origins high in the Paparoa Range.

Other significant drainage affecting the landscape includes the Tiropahi River in the north, Cave Creek North, Bullock Creek and Cave Creek South which support major cave systems and karst aquifers. Many of the more minor streams and creeks are also significant components of the park's complex karst hydrology.

Rivers and streams disappear into dolines, tomo and cave entrances and may reappear kilometres away. In heavy rain the park's major waterways become raging torrents, small streams and creeks break their banks, and low-lying land and many of the park's caves are rapidly flooded.

Basin Features and Terraces

The park possesses a remarkable sequence of Quaternary marine terraces formed by interglacial high seas. Recent depositional landforms are also represented in the park including river terrace land, and low dissected hill country in the bed of the western limestone syncline.

Coastline

The entire coastline is a distinctive feature, with striking contrasts between the wild rocky splendour of its bluffs, steep plunging spurs, rocky headlands, offshore reefs and stacks and the intervening sandy beaches and coves. Above the shoreline the sea-front is dominated by the great cliff of the coastal escarpment that sweeps in smooth curves northward from Punakaiki.

The park's most well known coastal landform, Punakaiki Blowholes at Dolomite Point, was created by solutional (karstic) processes, weathering and the pounding actions of waves against a 'pancake' layered limestone headland. The tomo, passages and fissures thus formed give rise to spectacularly explosive columns of water which are forced upwards, at high tide, by surging westerly seas.

3 CLIMATE

The climate of the Punakaiki region is classified as mild and humid along the coast, and wet montaine along the spine of the Paparoa Range to the east. Moderating influences produce a coastal climate between Greymouth and Westport which is relatively warm and shows minimal annual variation. Mean daily temperatures range from a summer maximum of 18°C to a winter minimum of 10°C.

Rainfall exhibits a marked west to east gradient, with approximately 2500mm per annum on the coast increasing to 6500mm per annum along the Paparoa Range (West Coast Regional Council Data Archive). Rainfall is distributed throughout the year with slight autumn and spring maxima.

Temperatures are also influenced by the effects of katabatic drainage of cool air from mountain slopes. The floors of the larger river valleys, such as Henniker Creek, Pororari River and Bullock Creek, are cooled by katabatic winds and are closer in temperature to higher altitude montane areas. Conversely, milder temperatures occur in areas of a more flat and planed topography that are free of this effect. These variations in micro-climate have considerable effect on the vegetation of the park.

4 SOILS

The soils of the park are developed on a range of parent materials from acid granite through to limestone and have marine, glacial, and alluvial origins. Most of the soils in the region are classed as steepland soils, within which several distinct soil series can be recognised, primarily because of the wide variety of soil parent material. The coastal escarpments near the mouth of the Tiropahi have shallow soils derived from gneiss, while further south the coastal escarpment has been eroded to give mixed slope deposits of limestone and Tertiary sedimentary rocks with deeper soils.

Behind the frontal plateau lies the synclinal feature which contains a complex range of Tertiary sedimentary rocks and Pleistocene gravels. The Charleston-Tiropahi area is noted for its well preserved marine terraces. They were left intact after their formation by high sea levels during inter-glacial periods because of rapid tectonic uplift. The soil pattern within the syncline is relatively complex. The soils of the karst area in general have shallow profiles and are lacking in development of a number of zones.

The only flat land within the park is that of the pakihi on the older river terraces between Waggon Creek and the Tiropahi River. At its southern extremity this abuts an area of steepland soils developed on Pleistocene alluvium derived from the granite and gneiss of the Paparoa Range. The latter are well drained, bouldery soils up to 1 metre thick which lie on top of the Tertiary silty sandstone that is a common feature in the area (Laffan 1980).

Soil types include yellow brown earths, gley podzols, gley soils, podzols, recent and organic soils (N.F.A.C. 1979).

The soils of the park are an integral part of a remarkably diverse natural landscape and are representative of the soils found on the western side of the Paparoa Range (Laffan 1980). Only the soils of the river flats currently being farmed in Bullock Creek are excluded. However, soils associated with the inland gravels and coastal terraces (Waites Formation) and those of subalpine bog soils are particularly underrepresented within the park.

5 PLANTS

The vegetation pattern found in the park is a result of the varied geology, soils and topography. Climate, micro-climates and altitude also contribute to the diverse range of species found in the area.

Although none of the major vegetation types described by various botanists are unique, the occurence of so much variety within a relatively small area, combined with intact coastal to alpine sequences, gives a uniqueness to the park as a whole (Norton and Lord 1989).

The vegetation types have been divided into six major types based on the classification approach taken by Park and Bartle (1978). This approach recognises that the lithology and altitude play an important role in determining the observed vegetation pattern.

Coastal (10m asl)

While the coastal vegetation varies depending on lithology and local topography, exposure to salt-laden wind and waves is the dominant factor controlling species distribution. Salt tolerant vegetation occurs close to the wave limit on shallow soils overlying rock. This low turf is dominated by creeping plants such as Samolus repens, Selliera radicans, Leptinella dioica, Centella uniflora and Plantago triandra with larger herbs including Lobelia anceps, Apium prostratum and Craspedia uniflora scattered throughout. On turf further from the waves or in lenses of deeper soils, clumps of Poa cita, Cyperus ustulatus and Juncus species occur. As distance from the waves increases, these merge into a low dense shrubland of Coprosma propinqua, which in turn grades back into taller shrubland and forest. Both species of flax occur in these coastal shrublands with Phormium cookianum in the more exposed sites (eg bluffs) and Phormium tenax forming very dense stands in less exposed situations. Cabbage tree (Cordyline australis) and toitoi (Cortaderia richardii) are scattered through this taller vegetation as also is gorse (Ulex europaeus). With increasing distance from the coast trees and tall shrubs such as mahoe (Melicytus ramiflorus), kawakawa (Macropiper excelsum), Coprosma lucida, nikau (Rhopalostylis sapida), wheki (Dicksonia squarrosa), toro (Myrsine salicina) and kamahi (Weinmannia racemosa) become more common and provide a microclimate suitable for numerous other forest species. The whole sequence from coast to forest is well illustrated on mudstone at Te Miko where it occurs over a very short distance, perhaps less than 200m in places.

Similar vegetation occurs at Dolomite Point, although the flaxland has been extensively modified by fire. The native milkweed, Euphorbia glauca, is abundant, and the rare Carmichaelia arenaria is also present.

Many of the salt turf plants also occur on the rocky granite coastline north of Perpendicular Point. However, only a short distance separates wave affected areas from relatively sheltered sites here. Consequently salt turf plants and coastal shrubland are more intimately mixed. The tiny fern Hymenophyllum minimum is present on rocks at Meybille Bay as is the orchid Bulbophyllum pygmaeum, normally a forest ephiphyte. Other distinctive coastal plants along this coastline include Peperomia urvilleana, Blechnum banksii and Asplenium obtusatum, with the vegetation behind grading quickly back into a diverse shrubland dominated by flax, Hebe elliptica, mahoe, Griselinia lucida (growing terrestrially) and kiekie (Freycinetia baueriana). At Meybille Bay a large grove of nikau is present behind a sandy beach. No pingao (Desmoschoenus spiralis) is recorded in the park although the species is present on sand dunes in the Pororari River estuary.

Lowland Brunner Coal Measures (300m asl)

In the northeast corner of the park, where the road leaves the coast at Whitehorse Creek and climbs inland towards the Tiropahi River, a band of coal measures outcrops between the limestone escarpment and gneissic coastal cliffs. Open pakihi communities and stunted forest form a mosaic across this area, showing the influence of past fire history.

A 'stunted' forest community occurs in areas undisturbed by fire and is highly variable in both floristics and structure. Canopy height varies from 5-20m, and is predominantly comprised of an upper, usually emergent tier of rimu (Dacrydium cupressinum) and hard beech (Nothofagus truncata), and a lower tier of mountain beech (Nothofagus solandri) together with yellow-silver pine (Lepidothamus intermedius), pink pine (Halocarpus biformis), kaikawaka (Libocedrus bidwillii), toro and southern rata (Metrosideros umbellata). While rimu, hard beech and mountain beech are the most abundant canopy trees, there can be considerable variation in canopy composition due to factors such as aspect and drainage.

The shrub tier is comprised of a diverse range of plants including Dracophyllum townsonii and D.longifolium, Archeria traversii, Quintinia acutifolia and Coprosma foetidissima as well as most of the canopy species. Yellow-silver pine and the two Dracophyllum species are particularly conspicuous. The forest floor vegetation is variable, but Gahnia species are conspicuous. To the southwest of Tiropahi River bridge, the dominant forest floor species are Gahnia xanthocarpa, Dicksonia lanata and Sticherus cunninghamii, with Phormium cookianum, Gahnia xanthocarpa and Blechnum 'blackspot' locally abundant.

In areas that have been subjected to fire (mainly of European origin), a range of floristically poor pakihi communities (sensu Mew 1983) are present. If these are left undisturbed, there is a clear succession back to forest via tall manuka (Leptospermum scoparium) shrubland (see Williams et al. 1987).

Pakihi vegetation communities occur between the Tiropahi River and Waggon Creek. In this latter area, the underlying geology is fluvial outwash gravels rather than coal measures. In places these pakihis show no obvious evidence of former forest cover, although areas with charred tree stumps are also present. The pakihi vegetation here is dominated by tangle fern, wire rush and Baumea teretifolia. Epacris pauciflora and manuka are the dominant shrubs and there are some conspicuous herbaceous species (eg Celmisia aff. alpina and Drosera species), but generally the pakihis are floristically poor. This vegetation type has strong floristic and structural affinities to the natural pakihis of South Westland.

Lowland Tertiary Rocks (Except Coal Measures)

Extensive areas of lowland forest occur within the park covering about half of the total park area. The communities present are complex, with marked variations in composition depending on topography and lithology. For ease of description, six main landform related forest types are recognised: coastal limestone escarpment and talus slopes; dissected karst plateau; syncline bed; inland limestone escarpment; recent river terraces; and fluvial terraces. It should be emphasised that this is a very simplified classification of a complex of forest communities. Small areas of riverbed and fertile wetland are also present in these lowland areas.

Coastal Limestone Escarpment and Talus Slope Forest

A distinctive feature of the park is the belt of non-beech forest present along the coastal escarpment and talus slopes, and extending up the main rivers. The mild, humid, frost free environment favours the growth of many plants with restricted, generally coastal, distributions (eg nikau, Phymatosorus scandens, Anarthropteris lanceolata, kawakawa and Collospermum hastatum).

The only true coastal forest in the park occurs at Truman track, and to a lesser extent at Dolomite Point. At Truman track the forest consists of scattered northern rata (Metrosideros robusta), rimu and kahikatea (Dacrycarpus dacrydioides) emergent over a diverse canopy and subcanopy of mahoe, pigeonwood (Hedycarya arborea), ribbonwood (Hoheria sexstylosa), pate (Schefflera digitata), kamahi, nikau, hinau (Elaeocarpus dentatus), various Coprosma species and fuchsia (Fuchsia excorticata). Tree ferns are abundant in the gullies.

The forest floor vegetation is dense, with extensive carpets of bryophytes and a diverse array of fern species. Epiphytic species are also abundant. The coastal edge of this community has been affected by fire, but excellent regeneration of rimu is occurring.

At Dolomite Point, a degraded form of this community is present (modified by fire and stock), but lacks the emergent podocarps and northern rata. Nikau are, however, abundant.

On the steep talus slopes under the limestone escarpments, both along the coastal face and up the major valleys (especially Fox, Bullock and Pororari), the forest is characterised by a very variable canopy (both in height and composition) of nikau, tree ferns (especially black mamaku, Cyathea medullaris), pigeonwood, mahoe, kamahi and hinau with nikau and black mamaku often dominant. Above this are scattered large northern rata and rimu, with occasional miro (Prumnopitys ferruginea). Rimu and miro are mainly present on the more gentle slopes, while northern rata is the only emergent tree on the steeper slopes below escarpments. The forest understorey is often nearly impenetrable with dense thickets of supplejack (Ripogonum scandens) and kiekie. Epiphytes, especially bryophytes, are abundant. Vascular epiphytes include two species of Phymatosorus, Anarthropteris lanceolata, and several Hymenophyllum species. Asplenium bulbiferum is one of the more common forest floor plants, and litter accounts for a high percentage of forest floor cover.

This community is one of the most distinctive in the park, and is ecologically very dynamic. Mass movements of debris off the escarpments appear to occur regularly and are continually disturbing the forest. After such a disturbance, various indigenous and naturalised species, especially sedges, quickly establish and are soon replaced by dense thickets of wineberry (Aristotelia serrata), mahoe, tutu (Coriaria arborea) and other small trees. Other forest plants establish amongst these, and presumably if enough time elapses without disturbance, northern rata is also able to establish. The very low density of northern rata in these forests indicates the frequency of disturbance.

Dissected Karst Plateau Forest

The dissected karst plateau between the coastal escarpment and the syncline basin supports a large area of forest. This is a mixture of beech and podocarps and topographic diversity results in rapid changes in the forest composition over short distances. Some of the more unusual plant communities in the park are associated with 'tomos' and 'dolines' which are common on the karst plateau. Many species otherwise restricted to warmer sites occur here, presumably due to a constant flow of warmer air from the cave systems (Park and Bartle, 1978).

For example, Brachyglottis hectorii was noted around tomos between Bullock Creek and the Pororari River and otherwise only occurs on slopes above river gorges. However, an inverted vegetation pattern appears to occur in large dolines (eg north of the Fox River), presumably because of cold air ponding.

Beech is apparently absent from the forests immediately above the coastal escarpments between the Pororari River and the Fox River, although this needs further investigation. These forests are variable in structure and composition with rimu and northern rata occuring as emergents, and hinau, kamahi, miro, matai (Prumopitys taxifolia), Quintinia, putaputaweta (Carpodetus serratus) and pigeonwood important in the canopy. Nikau is often present in gully heads. Further east from the escarpment edge there is a complex mixture of forest types with beech species becoming plentiful. Hard beech is usually dominant on ridges, while silver beech (Nothofagus menziesii) and red beech (Nothofagus fusca) together with rimu, tend to dominate on the more gentle sloping country. Park and Bartle (1978) record a large area of pure red beech/silver beech forest in a basin to the west of Cave Stream. Kamahi is common in the subcanopy, while several species occur in the lower shrub layers. The forest floor vegetation shows considerable variation depending on topography.

Syncline Bed Forest

The Barrytown syncline is a striking geological feature dominating the park. The low-lying surface of the syncline is characterised by a range of podocarp-beech forest types. Variation in the composition of these forests relates primarily to drainage and, to a lesser extent, fertility. The floristics and structure of these forests recall both the dense terrace rimu forests of South Westland and the terrace podocarp-beech forests of North Westland.

Typically, forest in the syncline bed consists of a canopy of rimu and hard beech up to 30m in height, with kamahi, Quintinia and miro forming a tall subcanopy. Silver beech is locally important. Quintinia is also abundant in the understorey, where it occurs in association with Myrsine divaricata, Dracophyllum species, Coprosma species, lancewood (Pseudopanax crassifolius), toro and mountain toatoa (Phyllocladus alpinus). Tree ferns, especially wheki, are present throughout. Important forest floor plants include Blechnum discolor, B. 'blackspot' (mainly on slopes), B. procerum, Sticherus cunninghamii, Dianella nigra and Gahnia species. Bryophytes are abundant on the forest floor.

With poorer drainage, other conifers (especially yellow-silver pine, silver pine (Lepidothamnus colensoi), Hall's totara (Podocarpus hallii) and kaikawaka), southern rata and mountain beech become more common. The canopy is lower (often 10 to 15m or less), and the forest interior more open. Manuka and Dracophyllum species become important in the understorey, and Gahnia species also increase in abundance. On better drained sites, especially ridges and knolls, hard beech increasingly dominates and kiekie can be locally abundant.

At the base of the inland limestone escarpment, massive slumps have locally increased the fertility of the syncline forest soils. Here kahikatea 55m in height and red beech 2.5m in diameter indicate that these forests, although small in area, must be amongst the most majestic in the park.

Inland Limestone Escarpment Forest

The forest vegetation on the inland limestone escarpment is similar to that of the coastal escarpment, with scattered rimu and northern rata over a diverse canopy of broadleaved trees, nikau and tree ferns. Beech is largely absent from these forests, and while many of the 'coastal' species reappear (eg nikau, black mamaku, Griselinia lucida, Collospermum hastatum, rangiora Brachyglottis repanda and kawakawa), the forest lacks coastal luxuriance. The reappearance of 'coastal' species in this area is due to both the milder climate (especially lack of frost) and more fertile soils.

River Terrace Forests

On recent river terraces, forests are generally dominated by beech, with only a scattering of podocarps. Silver beech is usually the dominant species, although red beech is also occasionally present. Distinctive understorey shrubs include pepperwood (Pseudowintera colorata) and Pseudopanax anomalus. Uncinia species, Blechnum discolor and Microlaena avenacea dominate the forest floor vegetation. Rimu occurs on higher (older) terraces, and similarities with the forests of the syncline bed become stronger. This transition almost certainly reflects a change in soil fertility and nutrient status (cf Smith and Lee 1984).

Fluvial Terrace Forests

On terrace surfaces of Pleistocene aged fluvial deposits, probably of glacial origin, near Fox River and Waggon Creek, areas of low forest similar to those present on low altitude coal measures occur. Rimu is generally emergent over a mixed canopy of mountain beech, pink pine, silver pine, yellow-silver pine and southern rata. Mountain toatoa and manuka are also conspicuous, while Gahnia species are common on the forest floor.

These forests and their associated pakihis (described above under Lowland Brunner Coal Measures) have been modified by fire and logging to varying degrees (Park and Bartle, 1978; Stengs, 1985). On more dissected surfaces, taller rimu-beech forests are present, with hard beech dominant on the ridges and red and silver beech more abundant in gullies. These latter forests are floristically and structurally similar to the forests of the syncline bed.

Riverbed Vegetation

A small flora is present in the larger riverbeds in the park. This is not as extensive as in eastern South Island riverbeds, but still contains some plants unique to these sites. The larger riverbeds are generally open, but where flooding has not occurred recently, small mats of Raoulia tenuicaulis occur, providing sites for other plants to establish. Some native grasses are present (eg Rytidosperma gracile), but adventive species are conspicuous. In small creeks with hard tertiary beds (limestone or mudstone, eg Doubtful Creek and Waggon Creek) creeping herbs (eg Ranunculus reflexus, Pratia angulata, Nertera depressa and Hydrocotyle heteromeria) are scattered through abundant bryophyte growth. Frequently flooded river banks also have a distinctive flora including the large tussock Chionochloa conspicua, native broom (Carmichaelia grandiflora), tutu, several herbs (eg Anaphalis species, Helichrysum bellidioides and Myosotis laxa) and ferns (eg Blechnum species and Phymatosorus diversifolius).

Fertile Wetland

The largest example of fertile wetland in the park occurs in Bullock Creek where a large rock fall has blocked the valley. A wetland dominated by Carex species and flax (Phormium tenax) occurs behind this. However, formerly abundant kahikatea forest has been removed, so that increased sedimentation from upstream farming continues to modify this area. Fertile wetlands, and associated kahikatea forest, occur around the fringe of Bullock Creek farm. A small area of high quality flax - Carex wetland is also present just south of Razorback Point, with Coprosma tenuifolia and cabbage trees scattered throughout. This is probably the 'best' fertile wetland in the park (in terms of general condition), although only half the wetland complex is actually within the park boundaries.

Vegetation of Steep Hill Country Inland of the Limestone Syncline (150-900m asl)

The vegetation of this area is poorly known and is undoubtedly much more complex than existing information suggests.

At least four distinct lithologies are present (greywacke, granite, gneiss and breccia) and presumably have a major influence on vegetation pattern. Park and Bartle (1978) observe that the forests of the upper Punakaiki River and Tindale Creek are 'entirely beech', while those of the Pororari River, Bullock Creek, Fox River and Tiropahi River are composed of podocarp-broadleaf forest, and relate this to differences in lithology. However, beech forests occur more widely than these authors suggest. In both the Pororari and Bullock Creek catchments, the forests are dominated by beech, with scattered emergent rimu at lower altitudes. Both hard and red beech are present, with silver beech becoming more important with increasing altitude. The forests further north also appear to contain a significant beech component, although detailed information is lacking. Other important species include kamahi, miro and southern rata.

Paparoa coal measures and sandstones are present in the head of the Punakaiki and Pororari Rivers and support a stunted forest. This low canopied forest is dominated by a variety of species including mountain beech, pink pine, yellow-silver pine, mountain toatoa, kaikawaka, kamahi, Quintinia, pokaka (Elaeocarpus hookerianus), broadleaf (Griselinia littoralis) and Dracophyllum traversii. Clear affinities exist with low altitude Brunner coal measure forests.

Subalpine (900-1100m asl)

The timberline along the Paparoa Range is at about 1100m asl, with variations depending on topography and lithology. This is considerably lower than along the main divide where timberlines are as high at 1300 to 1400m asl. Throughout most of the park, silver beech forms dense monospecific stands close to the timberline, with areas of subalpine scrub also present. The exact relationship between these two vegetation types is uncertain, although subalpine scrub is often present above the silver beech forest. The silver beech canopy is of varied height (5 to 25m), with a sparse subcanopy and shrub tier (mainly Archeria traversii and Coprosma species). Dracophyllum traversii is usually the only other species present in the canopy. Uncinia astonii is as abundant on the forest floor as bryophytes and Hymenophyllum species are as epiphytes.

The subalpine scrub communities comprise a range of species; the most important being Dracophyllum traversii, D. longifolium, Olearia colensoi, Archeria traversii, Pseudopanax linearis, pink pine, mountain flax (Phormium cookianum) and Coprosma species. Astelia nervosa and Blechnum 'mountain' are abundant beneath the scrub cover. Small areas of stunted shrubland with subalpine and alpine affinities are also present within the silver beech forest, as at the head of Bullock Creek for example.

These communities occur where a very shallow soil overlies bedrock and usually consist of a mosaic of cushion plants (eg Donatia novae-zelandiae and Chionochloa australis) and stunted shrubs, especially manuka, pink pine and silver beech.

Alpine (1100m asl)

Although the area above timberline occupies only a small proportion of the park, it contains a great diversity of herbaceous species and a number of the more spectacular and 'charismatic' plants. The alpine zone within the park crosses areas of greywacke, coal measure and gneiss, with granitic peaks occurring to the north of the park. Gneiss is by far the most common alpine lithology and the vegetation types occurring on it are the most typical alpine associations of the park. Coal measures, although providing interesting floristic associations, underlie only a small alpine area of the park. (As the alpine area underlain by greywacke has not been examined, it is not described here although it could harbour species not yet recorded in the park).

The physiognomically dominant alpine plants are various species of Chionochloa (snow tussock), with the shrubs Olearia colensoi and Dracophyllum uniflorum becoming increasingly abundant towards the timberline. The two main vegetation types are tussock grassland and herbfield, with scattered alpine shrubs and cushion bog dominated by carpet grass (Chionochloa australis). Drainage is the most important factor controlling the distribution of these vegetation types, with differences in substrate influencing floristic composition.

Well-drained Paparoa Coal Measures and Related Sandstones

Chionochloa grassland with scattered Dracophyllum uniflorum forms an uneven cover across the slopes with many small areas of talus (up to 2 x 3m) on slightly steeper sites. The dominant tussock is Chionochloa juncea with occasional C. falvescens. Carpet grass forms extensive mats in places with Carpha alpina and Oreobolus impar of importance in the turf. Dracophyllum uniflorum, the dominant shrub, is never more than 1m tall. Celmisia dallii is the most abundant large herb with only scattered plants of the larger Celmisia semicordata. Celmisia species, Epilobium species, Raoulia grandiflora and several grasses are common on the small areas of talus. Due to a small number of abundant species, this vegetation initially appears to be floristically poor. However, there are a relatively large number of uncommon species, some of which are much more common in alpine grassland on other substrates (eg Celmisia armstrongii, Poa colensoi).

Poorly-drained Paparoa Coal Measures and Related Sandstones

Here the vegetation is a mixture of grassland and sparse shrubland, interspersed with numerous small cushion bogs. Patches of shrubs are generally more common on the better drained slopes and comprise a diverse mixture of species with dwarfed silver beech, leatherwood (Olearia colensoi), pink pine and manuka the most common (see subalpine section). Grassland dominates more level areas with cushion bog on the most poorly drained sites. Chionochloa juncea is the dominant tussock, and carpet grass forms patches accompanied by abundant Carpha alpina, and scattered Schoenus pauciflorus. The cushion bog is predominantly Donatia novae-zelandiae and Phyllachne colensoi with Carpha alpina, Empodisma minus and Oreobolus species throughout. These areas support a relatively rich herbaceous flora. Microlaena thomsonii, a small grass previously only recorded from the Denniston Plateau and southern New Zealand, also occurs here.

Both coal measure vegetation types described here resemble vegetation types on the Denniston and Stockton Plateaux in their general appearance and dominant species, which is to be expected due to the similarity in substrate. However, the area of coal measure vegetation in Paparoa National Park (and adjacent Pike River) has not been modified by fire or mining and therefore is an especially important example of natural alpine/subalpine coal measure vegetation.

Well-drained Gneiss

Chionochloa pallens forms a moderately dense grassland with occasional shrubs of Olearia colensoi and Dracophyllum uniflorum. This is interspersed with patches of lower herbaceous vegetation, predominantly mats of carpet grass, Celmisia discolor and Leucogenes grandiceps, and scattered single plants of the larger Celmisia semicordata. Several other Celmisia species and abundant small herbs occur throughout. Where boulder fields intrude into the grassland, stands of denser tussock interspersed with shrubs (eg Podocarpus nivalis) occur. Astelia nervosa and Astelia skottsbergii often form dense patches in the alpine grassland, especially on these more bouldery sites. Melicytus alpinus and a number of herbaceous species are scattered across the boulder field itself.

A relatively rich herbaceous flora, including Euphrasia petriei, Ranunculus insignis, two Grammitis species and several species of Hymenophyllum and indigenous grasses, occurs on rocky bluffs especially when these are south-facing. Schoenus pauciflorus is also conspicuous on these sites. The restriction of some species to these and other inaccessible sites reflects the impact of goat browsing in the alpine zone.

Poorly-drained Gneiss

On gentle slopes, or where underlying bedrock prevents water from draining away, areas of low cushion bog interspersed with mats of carpet grass occur. On semi-flush sites or where there is some degree of drainage, carpet grass dominates and forms a dense turf in which only a small number of herbaceous species are at all abundant (eg Carpha alpina, Oreobolus impar and Astelia linearis). On more poorly drained areas, where small pools of open water are evident, a cushion bog dominated by Donatia novae-zelandiae occurs. Celmisia dallii, Draceophyllum uniflorum and Chionochloa flavescens are infrequent but conspicuous across these bogs and mats of Celmisia discolor occur on adjacent areas of slightly better drainage. A number of other herbaceous species (eg Gentiana gracilifolia, Celmisia alpina, Raoulia grandiflora and Oreobolus impar) are frequent, but relatively inconspicuous. Occasional small tarns occur in these cushion bogs and, at least in the areas investigated, have been colonised by the introduced Juncus articulatus.

Introduced Plants

Weed species which have the capability of seriously changing the natural plant communities in the park are:-

Gorse (Ulex europaeus)
Germany ivy (Senecio mikanioides)
Broom (Cytisus scoparius)
Wandering willy (Tradescantia fluminensis)
Ragwort (Senecio jacobaea)
Jointed rush (Juncus articulatus)
Cotoneaster lactea
Marram grass (Ammophila arenaria)

Gorse is common in coastal communities and is present in most of the large riverbeds as far inland as the east side of the syncline, along road edges and tracks and in disturbed sites.

German ivy is present near the Pororari River bridge and along the coast adjoining the Punakaiki Camping Ground. This weed appears to be spreading and requires attention before it becomes widespread. The plant reproduces vegetatively.

Broom has been reported in the park, but the area was not identified (Kelly 1989.)

Wandering willy is an escapee from gardens and is present in areas adjoining the village. It also reproduces vegetatively, and represents a serious threat, as it is able to grow in low light conditions under the canopy, suppressing native seedlings and regeneration.

Ragwort is present in the Bullock Creek farm area and open riverbeds throughout the park. Small infestations have been controlled by hand-pulling and sheep grazing has kept the Bullock Creek ragwort in check. Flooding and wind dispersal play an important role in the re-infestation and spread of seed.

A weed that is being spread by birds in limestone areas adjoining the village at Pororari is Cotoneaster lactea.

The jointed rush Juncus articulatus is found in many of the small tarns on poorly drained sites on the alpine gneiss. It has the potential to choke these small tarns.

Marram grass occurs along beach areas adjoining the park. It has the potential to suppress and replace native sand binders. Recent erosion has reduced the native pingao to two sites, at Pororari and Hatters Beach along the coast adjoining the park. As an aggressive species marram has the potential to take over all available sandy sites.

Other weeds which are highly visible but not considered a serious threat include:-

Hydrangea spp.
Banana passionfruit (Passiflora mollissima)
Montbretia (Crocosmia x crocosmiiflora)
Burdock (Arctium lappa)
Blackberry (Rubus fruticosa)

These plants usually occur near old settlements or along road edges, except for Burdock which is found in the isolated areas of Fox River.

Other adventive plants such as clovers and grasses are present, but are impossible to eradicate or control.

6 ANIMALS

Westland Black Petrel (Procellaria westlandica)

Petrels as a group visit land only to breed. The Westland black petrel is unusual as it is a winter breeder and the largest of all burrow-nesting seabirds (Bartle 1983).

Both sexes are similar in plumage and colouring, but the females are smaller and lighter. Plumage is sooty black above and below. The large bill is bi-coloured, with the strongly developed dark grey hook (maxillary and mandibular ungues), contrasting sharply with the cream-coloured nostrils, latericorn and ramicorn. The irises are dark brown and the legs, feet and claws black.

Fledglings are virtually identical to adults, but the parts of the bill which are cream in adults are white in juveniles. Adults do not normally call in flight, but on the colony they make a wide variety of harsh calls and cackles (Warham 1988). Birds arriving at the colony at dusk trigger off a chorus of noise from birds on the ground and in burrows which carries on late into the night. Eventually, quiet, except for the occasional cackle or growl, lasts until just before dawn when the crescendo starts again and continues until all the departing birds have left. The colony then lapses into near silence for the rest of the day.

Birds returning to the colony each evening in calm conditions fly with slow, lazy, regular wing beats. Their wings appear then to be wide and floppy, but in windy conditions the birds take on typical petrel flight, soaring, scudding and wheeling in smooth, fluid motion with a sleek, narrow wing configuration. During windy conditions the birds usually fly high over land, soaring and wheeling. However, the occasional bird will fly very low downwind at incredible speed and have been observed flying below six-metre high powerlines (Champness, pers. comm. 1989).

The morning exodus from the colony is much more definite as the birds fly directly out to sea, 15 to 70m above the ground, losing altitude all the way and rarely flapping their wings. Often when they fly low overhead a 'whoosh' can be heard.

The population size is estimated to be 20,000 ± 5,000 birds (Bartle 1987 pers comm). This figure is for the entire population of Westland black petrels and includes many sub-adults and non-breeders. The number of birds breeding in any one year varies, but is often much less than 30% of this total, an average of 2,000 pairs each year (Bartle 1983).

Various estimates of the size of the population range from the 3,000 to 6,000 birds observed by Jackson (1958), to 900 occupied burrows (Best and Owen 1974), to 2,000 breeding pairs (Bartle 1988). Recent regular evening counts of incoming birds would support Bartle (Champness, pers. comm. 1989).

The colony lies west of SH6, extending south west from the Punakaiki River as far south as Lawson Creek (Bartle 1988). Soft tertiary silt-stones have been elevated to form low coastal hills. These hills were an island during interglacial periods when the sea level was much higher than the present.

The burrows are spread over an area of approximately $10km^2$ in extent, concentrated in sub-colonies with the largest concentration in the catchment of Scotchman's Creek (Bartle 1988).

Other concentrations occur (in order of abundance), in the catchments of Lyddy's Creek; on the sides of the two major spurs adjoining a side creek of the Punakaiki River; spurs and ridges above Lawson Creek; spurs and ridges above Hibernia Creek; and other sites along the main Razorback ridge. These small patches of breeding birds around the fringes of the main breeding colonies are considered an important indicator of the health of the breeding (Onley 1980).

The burrows are not evenly dispersed over the nesting habitat, but are clumped in small groups of 2 to 30, or in large concentrations of over 100. Usually the burrows are situated below ridges or on the sides of ridges with access to suitable take-off sites such as clear slip faces, cliff edges or old leaning trees. Claw marks on take-off trees and mudstone faces are sure signs of areas used by petrels. Another indication is the presence of large, white fluid droppings on the forest floor. When the colony is occupied, the areas where large concentrations are present have a distinct petrel odour.

The breeding season is much longer than that of other petrels with the exception of albatrosses (Bartle 1988).

Birds congregate in rafts just offshore before flying inland at dusk. The majority of birds returning do so in a 40 minute period, just after the end of civil twilight. Up to 6,000 birds have been counted in one evening (April 1989). An average of 2000 birds fly up Scotchman's Creek each evening between April and July (Champness, pers. comm. 1989).

In late March/early April, the birds return to the colony to claim old burrows and clean them out in preparation for nesting. Burrows are usually dug into soft soils under roots of trees in the forest. Many large concentrations of burrows are in areas devoid of ground cover where the activity of the birds has removed all small plants, but other areas are in dense stands of kie-kie, shrubs, ferns and rata vine (Metrosiderous diffusa). The majority of burrow entrances face downhill, presumably to stop rainwater and debris from draining into the nesting chamber (Best and Owen 1976).

Established breeding males occupy their burrows as many nights as possible to re-establish ownership, and during this time there is a lot of competition for burrows with much fighting between males with burrows and those without. Throughout this period females rarely stay more than 24 hours (Bartle 1988).

A single egg is laid during a short three week period from early May until early June (Baker and Coleman 1977). Incubation is shared by both members of the pair, taking separate shifts. Hatching starts mid-July after an estimated 51 to 68 days incubation (Baker and Coleman 1977). Chicks are fed by both parents, one of the pair staying at the burrow for sometimes as long as the first six weeks of its life. Most fledglings leave the colony in November (Bartle 1983).

The adults do not breed every year; one or two successful years may be followed by a break of one or two years when the birds visit the colony without breeding. Non-breeders, failed breeders and burrow-holding pre-breeders make up a large percentage of the population in the colony (Bartle 1983).

Westland black petrels are essentially birds of continental shelf waters and are not known to be regular ocean wanderers. During December and March the birds appear to be absent from New Zealand waters - their whereabouts are still a mystery during this period (Bartle 1983). During the breeding period the birds range over the continental shelf waters between Cape Egmont and Foveaux Strait (in the west) and between East Cape and Banks Peninsula (in the east).

Large scale commercial fishing off the West Coast of the South Island did not begin until 1966, when large trawlers first started to regularly fish the area. During the next decade this trawl fishery slowly expanded, eventually peaking sharply in 1977 when around 120,000 tonnes of fish were taken with 200km of the Westland black petrel breeding ground. There is evidence to suggest that the portion of petrels which regularly feed on fish waste has increased greatly since 1956.

Today, fish waste makes up the greater part of the Westland black petrels' diet during breeding. Pelagic squid are still important food items and birds have often been seen at sea by night, feeding on planktonic crustacea (Bartle 1983).

Predation does occur in the colony from introduced predators such as dogs, cats and birds. Other predators are present in the colony such as rats, mustelids and wekas, although there is no evidence to show these have an effect on the population. The population is most vulnerable in October and November when the young fledglings are preparing to leave the colony. During this period, cats may take young birds. Cats very rarely kill adult birds, as it is believed that they are ferocious enough to defend themselves. Dogs have the potential to kill both adult and fledglings. In June 1989, for example, three birds were taken by dogs (Champness, pers. comm. 1989).

Birds

The range of habitat types within the park is extraordinarily broad encompassing warm, humid coastal forest through diverse lowland and terrace podocarp-beech forests to extensive montane beech-hardwood forests. Consequently, densities and diversities of bird species are very rich. Variations in species representation and abundance appear to be directly related to variations in forest type. The population densities of birds in the forests on the karst and limestone talus slopes landforms at the southern end of the limestone syncline are the highest recorded for the South Island (Park and Bartle 1978). A detailed list of birds recorded for the western Paparoa area is included as an appendix.

The various forest types form a continuum with the warmer lowland forests playing a vital role in maintaining populations of wintering birds from the adjacent high country.

Apart from the country north of the Buller River, the Paparoa Range is the only area where great spotted kiwi (Apteryx hastii) are known to exist in relatively high numbers (Morse 1981). The bird is widespread in the park, can be expected in all catchments and occurs from sea level to the tops of the range at 1200 metres or more (Jolly & Roderick 1983). While the kiwi may be widespread in the park, it is not evenly distributed and in particular, there seem to be relatively few birds in the low country.

The Paparoa population is regarded as one of the two most important, in terms of density and extent (Jolly and Roderick 1983), because the species displays a patchy distribution possibly indicating that it is in decline.

The blue duck (Hymenolaimus malacorhynchos) is a nationally threatened species, making the population that is believed to exist in the park one of potentially great significance.

Cave Animals

The study of New Zealand's cave fauna is in its infancy although work to date suggests that South Island caves have more species in greater abundance than North Island caves. Several cave species in the park are unique (endemic) and the fauna forms the southern-most assemblage of the Nelson-Westland populations. The Paparoa caves comprise the Punakaiki-Nile-Inangahua cave area which has a fauna distinct from, but related to, that present in two other cave areas spaced northwards along the western coastal strip (with small inland outliers) viz. Oparara-Seddonville and Westhaven-Patarau-Heaphy-Collingwood-Bainham. Each of these three cave systems is a centre for a largely unique faunal assemblage, unlike the surface biota which shows a gradual change in species composition that follows the climatic gradient.

Caves provide an unusually stable environment in which specialised invertebrate fauna have evolved. No light reaches the interior of caves, there are no frosts, minimal wind, humidity changes are usually slight and the temperature is remarkably constant. The periodic flooding of some caves provides the major form of natural variation, an event to which several species have adapted.

Cave animals are generally divided into three groups: 'trogloxenes', which are normal surface animals found in caves purely by accident, often around entrances and washed in by flood waters; 'troglophiles', meaning cave-loving animals such as cave wetas and New Zealand glow worms, which are regularly found in caves, but can also be found in dark, damp places; and 'troglobytes', which are the true cave animals found only in caves, often with adaptions such as extra long antennae, loss of pigments or eyes. The best example known from the park is the eyeless, flightless, unpigmented ground beetle Erebotrechus infernus found deep inside many of the caves (type locality, Fox River caves).

Other invertebrates unique to the Paparoa caves are a new species of millipede (Tongodesmus), a new species of weta (Gymnoplectron), the harvestman Hendea coatesi and the beetle Duvaliominius walkeri.

Although no aquatic crustacean species are known to be unique to the caves, they are one of the few places where the as yet undescribed isopod Phreotoclicus sp. is abundant. The Amphipoda, Ostracoda and Harpacticoida are also represented. Three species of water snail have been identified from cave gravels.

Food chains are based on detritus brought into the caves by streams or through tomo. Bacteria and fungi play a key role, but biomass is low and food scarce. Cave animals have responded with low metabolic rates, larger and fewer eggs and specialised habitat requirements. Numbers of both species and individuals are usually very low. The most scientifically interesting species are those troglobytes at the top of the food chain in the deeper and moister parts of the caves. They are also the ones most vulnerable to changes to their environment and food chains; such as trampling of cave sediments, changes to natural flooding, siltation of cave streams and uncontrolled collection of specimens when individual numbers are low.

The cave systems of the park are likely to reveal other invertebrates as there is a range of likely habitats ranging from dry-hot and warm-humid systems high on cliff faces to cool wet systems, flood systems and permanent phreatic water systems.

Other Native Wildlife

Native fish species are well represented in the park (McDowell, Graynoth and Eldon, 1977) including uncommon species such as the short-jawed and giant kokopu. Brown trout may exclude the latter from streams suitable for both species (McDowell, 1978). The stretches of land-locked rivers in the karst area are regarded as scientifically important for their fish populations.

A skink has been recorded from the alpine tussock and two widely distributed gecko species are present in the forests, but little is known about lizard distribution and further species undoubtedly remain to be recorded.

Over twenty-five species of land snails have been recorded from the park. Of these the largest and most spectacular are Rhytida patula from the limestones of the mid-Pororari gorge, and Powelliphanta rossiana gagei, a small alpine snail from the tussock/greywacke country at the head of the Punakaiki River. Regular and systematic studies of various habitats will undoubtedly identify many more species, especially in the calcium-rich areas of the karst.

Emberson (1988) listed 16 species of carabid beetle from the Paparoa National Park. Of these, three occur only in the Bullock Creek cave system, Fox River cave, Cave Creek North and Armaggedon cave.

Two rare species of beetles, Onysius anomalus and Ophryops dispor, were collected from the Pororari River with the latter being winter-active (Early pers. comm. 1989). Collections and studies are continuing which will no doubt lead to a better understanding and knowledge of the species and their habitats in the park.

The Strepsiptera is a strange group of parasitic insects of uncertain affinities, usually assigned to its own order but sometimes considered a bizarre sub-group of beetles. Specimens of a new species in the family Halictophagidae, previously unknown in New Zealand, were captured at Bullock Creek. Its host is the leaf-hopper Novothymbris vagans.

Recent research indicates that there is a rich parasitic wasp fauna both in numbers and species. Within the several families that comprise the superfamily Proctotrupoidea, collecting has shown that species diversity is far greater than in pure Nothofagus forests in Canterbury, Fiordland and Lewis Pass, or in other areas of mixed podocarp-hardwood forests at Waipoua, Mt Egmont National Park or Westland National Park (Early, pers. comm. 1989). It is believed by specialists that this area is one of the richest in New Zealand. Over 57 species of parasitic wasps have been recorded so far.

The parasitic wasp Archaeoteleia novaezealandiae preys on the eggs of cave wetas (Gymaopleleia spp). Although this wasp is not rare it is not often found because of its secretive nature. A population exists around the Ananui cave system and probably elsewhere in the park where wetas breed. It is a relict member of New Zealand's fauna and has survived with little modification since the Jurassic period, over 120m years ago, thus making it a contemporary of the Tuatara. Its nearest relatives are found in Chile.

The diverse range of habitats is matched by a wide range of insect fauna. Butterflies, moths, cicadas, weevils, flies and glow worms make up the complex insect fauna of the park. Interesting associations recorded include: the stinging nettle Urtica ferox and the red admiral butterfly Brassaris gonerilla; cicada nymphs and parasitic fungi; and flying insects as food for the New Zealand glow worm present in caves and the bush.

Introduced Animals

Feral goats (Capra hircus) are widely distributed throughout the park and adjacent lands from coastal forests to the alpine tops. Population densities vary according to habitat preference and are considered to be moderate overall with pockets of higher density. The higher goat densities are found in the coastal forests, upper catchments of the Punakaiki and Pororari Rivers and on the alpine tops.

Goats pose a significant threat to the natural values of the park. At high densities, their browsing of herbaceous and woody species modifies vegetation structure through the local extinction of highly preferred species, the destruction of wildlife habitat and a reduction in the ability of vegetation to protect the soil. In a limestone area with high rainfall, soil loss may be severe. Additionally, the removal of thick understorey enhances the habitat for possums and opens the forest to greater wind damage.

The areas where the worst impact has occurred are in the warm forests on coastal and inland limestones, and the alpine zone. Many palatable plant species are almost absent except for those growing in inaccessible sites.

Possums (Trichosurus vulpecula) are also widely distributed throughout the park and are present in all forest types and on the alpine tops. Observations have shown the highest populations to be in the mid to upper catchments of the main rivers, the coastal forests and forests bordering pasture. Possums are causing serious damage to the forests of the park, especially the warm coastal forest where the northern rata, a canopy tree, is dying off because of possum browsing. Many other species of plants are being damaged by possums; such damage impacts indirectly on native birds, and may also affect important scenic values. They are also recognised as a vector of bovine tuberculosis.

The dispersal and eruptive phases of red deer (Cervus elaphus) colonisation in the western Paparoas were both later and less damaging than in other areas of the West Coast. Deer are now present in low numbers throughout the park although they are rarely seen in the coastal areas. They particularly avoid the karst areas because of the broken nature of the terrain.

Chamois (Rupicapra rupicapra) occur within the park but densities are very low. They appear to be confined to high altitude forest and mountain tops.

Domestic and wild cats are present, particularly adjacent to human settlement and pose a serious threat to the native bird populations of the park. Nesting little blue penguin, sooty shearwater and kiwi are particularly vulnerable to predation. Westland black petrel chicks and fledglings are at risk around November and December. The full effect of predation by cats is very hard to assess, but they are efficient hunters which should be eliminated from the park.

Wild dogs also have the potential to destroy ground birds such as kiwi, weka, penguins and Westland black petrels. There have been several occasions where wild dogs have had to be shot to protect the ground birds.

Stoats are present within the park, but little is known of their distribution, density or impact on indigenous wildlife by predation.

Cattle and sheep graze pasture and shrublands adjacent to the park and are not always well contained by fences. Unmustered wild sheep have been noted in several mid-catchment areas of the park, but are confined to the river terraces. Cattle entering the petrel colony could have serious implications because of the trampling of burrows.

The black rat (Rattus rattus) is known to be present in the vicinity of the petrel colony and is probably widely distributed. The Norway rat (Rattus norvegicus) is present and is often recorded by possum trappers. Both species have adverse effects, consuming seeds and birds eggs.

7 MAORI CULTURAL SIGNIFICANCE

The Paparoa area has a high cultural value to Maori and especially the people of the Katiwaewae hapu of Ngai Tahu. The area is described in the legends of the tupuna (ancestors) as a source of both spiritual and physical resources.

The main Paparoa massif is the heartland of Papatuanuku personified in this area. Creeks and waterways hold spiritual significance and water is respected by the Maori as a substance of indisputable quality never to be defiled.

There is a long history of use of the area's plant resources, which provide food, herbs and medicines, fibres for weaving and timber for special purpose building. Forest birds and kai moana have also traditionally been taken.

8 HISTORY

The Paparoa National Park and the adjacent area has a lengthy history of Maori occupation, gold rushes, timber milling and farming.

Present evidence indicates that the Maori had explored and settled the West Coast some 1,000 years ago.

From field evidence and ethnographic accounts, fishing, fish drying, shellfishing, sealing and moa-hunting took place in and adjacent to the park. The beaches were a source of flint and jade, and the coast was the pathway between Mawhera and Kawatiri. No permanent settlements were recorded by the early European explorers: the nearest settlement recorded by Brunner was Kararoa, 20km south of Punakaiki.

During the period 1810-1830 sealers are known to have frequented the area, concentrating on the seal colonies at Cape Foulwind.

European coastal travellers were infrequent up to the discovery of gold around Hokitika in late 1864. A gold rush to Charleston occurred in August 1866 followed by rushes to terraces at Fox River in October. In December and January further gold discoveries were made in the Punakaiki-Barrytown area. As finds were made to the north and south the miners passed back and forth. The greatest obstacles on the coastal track were the cliffs and headlands between Fox River and the Punakaiki River and many miners died by falls or drowning. To enable these hazards to be avoided the Nelson Provincial Council constructed the Inland Pack Track in January-February 1867.

A number of townships sprang up to service the mining activity, with Brighton (Fox River) probably being the most famous. There were also two Canoe Creek settlements - Barrytown and Curtis Town (probably in the vicinity of the present day Punakaiki village) - as well as stores/hotels at regular intervals, including along the pack track. The main sources of interest for the goldminers were the series of marine terraces adjacent to the coast. Most were gold bearing, though the payable ground was usually very erratic in nature.

Following the rushes a small goldmining population remained reworking some of the terraces and black-sanding the beaches, with a few remaining right until the Great Depression. The condition of the Inland Pack Track deteriorated until in 1873 it was described as "a slough of gaping holes and unfordable mud". Agitation for a replacement track finally succeeded in 1885 when a new coastal route was constructed. A fully formed roadway connecting the Barrytown Flats and Brighton was not completed until the early 1930s.

This coastal road enabled visitors to travel easily to the Pancake Rocks at Dolomite Point, and when a major upgrade and sealing of the road was completed in 1979, a through route between Westport and Greymouth was established for the average motorist.

Small scale farming and grazing commenced after the gold rushes. The first clearances at Bullock Creek Farm, now an enclave within the park, began between 1874 and 1881.

A proposal for a large-scale timber industry based on the West Coast beech forests in 1974 led to the formation of the Beech Forest Action Committee, which became the Native Forest Action Council (NFAC, now the Maruia Society) who pressed for places of special value to be reserved. The clamour for protective measures, especially for the lowland forests on the karst, increased with a 1978 proposal by Park (DSIR) and Bartle (National Museum) for an ecological area based on the Pororari River valley.

In 1976 Federated Mountain Clubs had identified the northern part of the Paparoa Ranges as a potential wilderness area, and in 1979 NFAC proposed a 130,000 hectare national park, including this and land to the north and east. This eventually led to the National Parks and Reserves Authority identifying the western Paparoa Range as a prospective national park. Meanwhile, the joint proposal by the DSIR and the National museum succeeded in having a core area of great ecological significance - the forests of the lowland karst syncline - gazetted as the Pororari Ecological Area in 1979.

The initial proposal for a large park incorporating the wilderness area was rejected, but after seven rounds of public submissions, and help from other environment groups including the Royal Forest and Bird Protection Society, the present park of 30,327 hectares was gazetted on 23rd November 1987.

9 RECREATIONAL USE AND VISITOR PROFILE

A general picture can be built up about the activities which take place in the park and the visitors that carry them out. However, definitive information based on studies done in the park is limited. There is a lack of comprehensive long term data about visitors, but local managers' knowledge provides a good background.

Recreation Activities

Activities which occur in the park at present include sightseeing, picnicking, camping, walking, tramping, climbing, caving, fishing, hunting, underground rafting, water recreation and bird watching.

Coast Zone Activities:

The main activities in the coast zone of the park itself, where the majority of visitors go, are sightseeing, picnicking and walking. These are concentrated around Dolomite Point, the Visitor Centre, Truman Track and the Punakaiki and Pororari River mouths. The coast zone also supports fishing and swimming and has limited opportunities for whitebaiting.

Karst Zone Activities:

Walking, tramping and canoeing up the river gorges, and tramping along the Inland Pack Track are popular in the karst zone. Caving is also a major activity, undertaken by members of caving clubs, school and youth groups.

Mountain Zone Activities:

The backcountry has fewer visitors than the other zones, mainly trampers and hunters.

Adjacent Activities:

The Croesus Track, just south of the park, and Bucklands Peak Track to the north, are popular tramping tracks with huts providing overnight accommodation. The high mountainous country to the north and the rugged country to the east provide opportunities for remote tramping, hunting and climbing.

Recreational Visitors

A 1983 study (Stephens and Wells 1983) found that visitors to the area tend to fall into three main categories:

- Tour bus travellers stopping briefly at Dolomite Point, overnighting at Greymouth or Westport (30%);

- Independent travellers passing through the area as part of a trip that includes all of the West Coast (50%);

- Independent travellers, based in Greymouth or Westport making day trips to the area (15%).

The balance of visitors stay within the park, mainly at Punakaiki Campground.

More recently, a 1988 student study (Wilson pers. comm.) found that there was a decline in the number of tour bus tourists, family groups and Australians, and an increase in the number of campervan travellers, cyclists, North Americans, West Germans and other Europeans.

It is estimated that most visitors use the coastal zone, while a smaller number visit the karst zone and very few visit the mountain zone.

Visitor Numbers

In 1987/88 there were 265,000 international and 473,000 domestic visitors to the West Coast, a total of 738,000. A 1986 visitor survey of the West Coast (Sandrey 1987) found that 41% of those surveyed had visited Punakaiki and that another 16% intended to visit. On this basis it may be suggested that 300,000 people visit or pass through Punakaiki each year.

Figures recorded at Dolomite Point and the visitor centre help to substantiate these estimates. In January 1989, a survey found that between 500 and 800 people visited Dolomite Point each day. Only about half of these went into the visitor centre where there was an electronic counter at the door. This counter recorded 52,739 people in 1983/84 and 103,196 in 1987/88. If it is assumed that at least twice this number of visitors use the Dolomite Point walk, then more than 206,000 people visited the area. Although a difference of nearly 100,000 seems large it does give some indication of the intensity of visitor use.

Figures recorded for the Punakaiki Campground show that 3,345 people stayed there in 1984/85. This increased to 6,416 (2,723 international, 3,693 domestic) in 1987/88 and 7,584 (3,092 international, 4,492 domestic) in 1988/89.

10 ADJOINING LAND USE

Punakaiki village, although small, is the focal point for accommodation, information, tearooms and souvenirs. The potential for new development in the village is great and it is desirable that growth is sensitively planned if it is not to detract from the park experience.

Bullock Creek Farm, administered by the department, in the centre of the karst zone is not part of the park although it is surrounded by it. It is traversed by the Inland Pack Track and many people camp on the farm by the river as it is the halfway point on the track.

In a number of ways the farm has the potential to impact adversely on Paparoa National Park. It is currently let for farming on a two year lease and it is crucial that the management of the farms is undertaken in as harmonious a way as possible with that for the park. Grazing of the park fringes can seriously affect botanical values particularly the sensitive wetland vegetation types in Bullock Creek. The complex karst hydrology is also vulnerable to impacts from insensitive practices affecting drainage and run-off from farmland. Bullock Creek Road is itself a significant adjoining land use. It is maintained by the Buller District Council and, whilst servicing the farm, is also important for general access into the heart of the park.

The control and use of land in the coastal area outside the park boundaries is of great relevance to the integrity of the park. Most of the coastal strip is either freehold land farmed to various degrees, or unformed legal road: little of the park bounds the foreshore. Therefore, the utilisation of adjacent land and its impact on landscape values, visitors' visual appreciation, access and noxious plant and animal control is beyond the direct control of the department.

A similar situation exists regarding the maintenance of State Highway 6, under the auspices of Transit New Zealand, and the provision along it of utilities such as powerlines. The highway is generally the visitor's first point of contact with the park, and is frequently the predominant viewpoint from which the visitor experiences the park.

Directly outside the park there are a number of mining operations amd licence applications for gold, coal, limestone and ilmenite. A number of these could develop into large scale operations. Open-cast mining for ilmenite is being investigated for the whole of the Barrytown Flats, and large operations may eventuate north of the park in the Charleston Historic Goldfields.

Exotic forestry and timber extraction occurs north of the park on land managed by Timberlands in the Tiropahi and Waitakere catchments.

To the east the land is conservation area, including the proposed Paparoa Wilderness Area to the north-east of the park, currently under investigation by the department.

11 LANDSCAPES

Introduction

Paparoa National Park contains very distinctive landscape types. Together, and in their relatively natural condition, these landscapes create an overall landscape of very high quality, and scenery of unique and outstanding value. This great visual diversity within such a small area, especially in the lowland and coastal parts, is rare even in New Zealand.

The park may be divided into three main character types which will be referred to as landscape units (see Fig 2). Each has its own set of physical and natural features, and these have largely been described in the preceeding sections of this plan. These features collectively make up the characteristic visual experience of each unit.

Not only is each character type of high scenic and ecological quality but the visual boundaries between the different character types are very clear. Each landscape unit is clearly defined both in terms of its ecological and geomorphological qualities as well as in its visual qualities. The result is a clearly perceptible pattern of landscape types which combine |o form an area of unique scenic value.

The Paparoa National Park Management Plan takes account of, and makes provision for, the different management requirements of each of these landscape units, while acknowledging that many management proposals can be applied to the park as a whole.

Taken together the coast and karst are unique in New Zealand. These landscapes are distinctly coastal and lowland in character. Scenically, the area is distinct from other coastal and lowland areas because of the largely unmodified natural features as those and the diverse range of visual experiences that the area contains. While other coastal-lowland areas are protected within the national park system (Abel Tasman and Westland National Parks), no other area displays the same unique sets of features as those that characterise the park and which contribute to its outstanding scenic quality.

The karst landscape around Punakaiki is the only extensive area of lowland karst left in New Zealand with an almost undisturbed forest cover (Williams 1982a). Thus, in addition to its visual qualities, this unit is of great scientific importance.

The Coast

The coastal unit is bounded in the east by the top of the coastal scarp and extends across the coastal plain to the sea.

Conceptually this coast landscape unit extends beyond the shoreline to the horizon or a distance of approximately 15km off shore. At present the national park "stops" at various cadastral boundaries above mean high water mark, but for practical management purposes it is desirable that an holistic approach is adopted which contemplates implications beyond this arbitrary delineation. Such an approach, whilst accepting certain limitations on management of national park land, would be a genuine recognition of both the ecological realities and the visual experience of the landscape.

Whether experienced from the road or from the sea's edge, the coastal edge has a wild and dramatic character which changes constantly with the changing weather conditions. The coastline, because of its physical nature, is one of high energy impact. It is spectacular for its visual contrasts - high vertical headlands alternate with steeply grading beaches, and high inland cliffs alternate with deeply cut river gorges. Always the vegetation accentuates the landform and is luxuriant, whether it is a dense covering of coastal shrubs or flax, or dense rich forest. The sub-tropical forest is dominated by plants of northern origins normally associated with warmer regions, and contains the southernmost palms in the world.

The Karst

Biotic and geological factors predominate in the karst landscape unit. It lies east of the coastal scarp and stretches west to the foot of the mountains.

Paparoa provides one of the two best examples of lowland karst in New Zealand (the other is at Waitomo in the King Country). However, only the karst areas of Paparoa possess their natural vegetation in a predominantly unmodified state.

In particular, the Paparoa area has examples of steep sided river gorges, disappearing and reappearing streams, caves exhibiting the many different characteristics that may be found in karst regions, enclosed and collapsed dolines, a polje, and areas of karren. No other rain forest-covered karst is known from similar latitude: only a few small patches in British Columbia could be compared. The Paparoa karst is more similar to the forested mountain plateau karsts of Papua New Guinea (Williams, 1982a).

The unit exhibits a hydrological feature of significant interest where a major river system is superimposed on a typical dendritic drainage system.

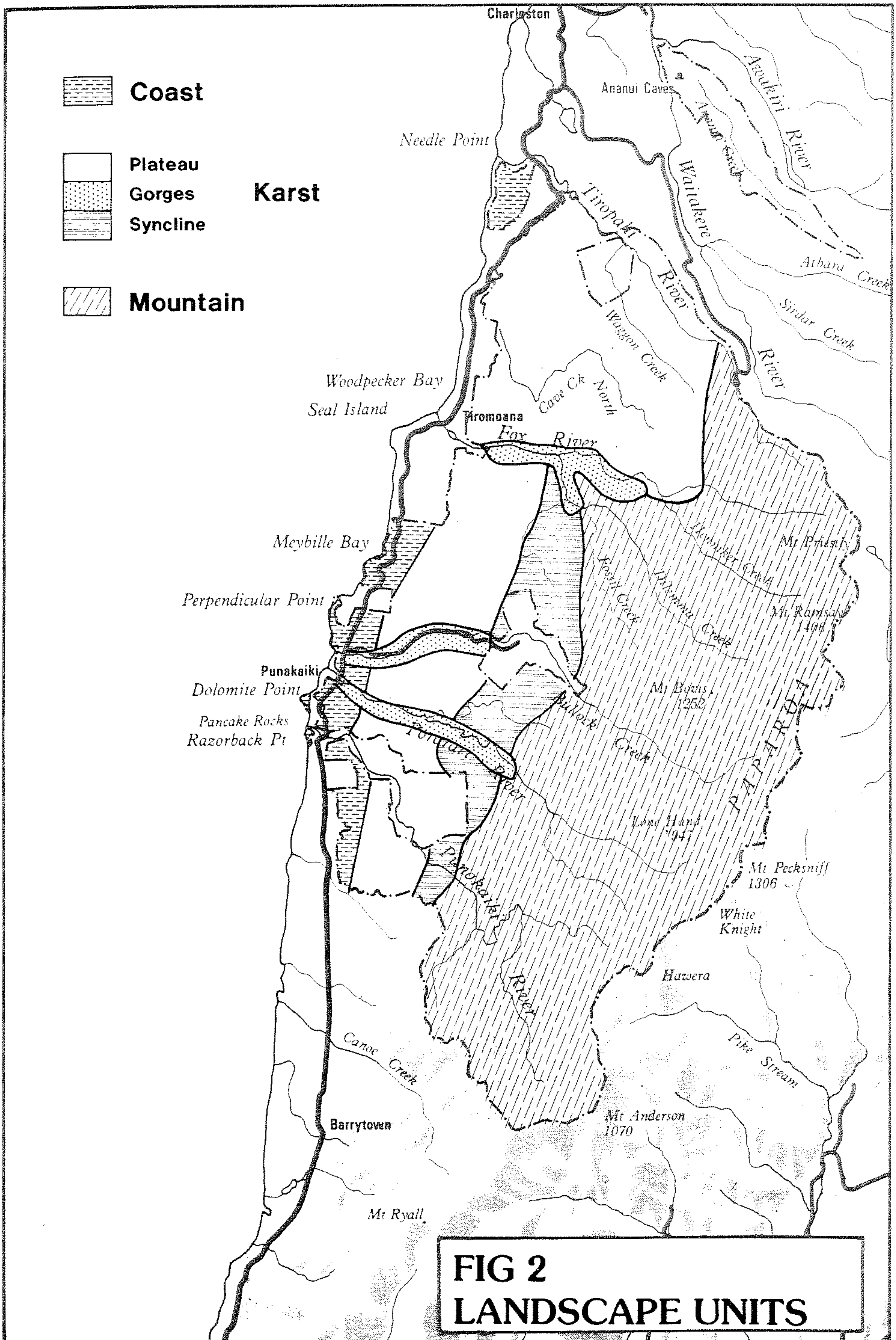

FIG 2
LANDSCAPE UNITS

The diversity within this unit allows for the description of a number of sub-units.

The River Gorges

In contrast to the coastal edge with its vast stretches of untamed sea, the river gorges are enclosed tracts, confined by high, forest-crowned, limestone cliffs. The gorges, deep cut and narrow, are dominated by the towering limestone out of which they are carved - the white cliffs standing out against the bright green forest. The valley flats have a variety of forest types because of localised climatic conditions. The rivers with their pools and rapids are an attraction in themselves.

The Limestone Plateau

The limestone plateau forms the western margin of the inland syncline but is distinguished from the syncline by its higher and less regular terrain. It forms the dramatic and visually dominant backdrop to the river gorges and to the coastal landscape unit. The details of landform and vegetation are visually interesting and offer a wide range of unusual experiences - caves (some with concretionary formations), dolines and sink-holes, waterfalls, mesas, moss enriched stream beds and inverted vegetational sequences.

The Syncline

The syncline similarly features some of the details of the plateau. However, the limestone of the syncline is in parts overtopped with more easily eroded mudstone, siltstone and granitic gravels of glacial and marine origins. It is distinguishable from the more rugged western limestone edge by its more gentle and regular terrain.

Visual distance within the syncline is largely confined by the dense forest vegetation. It is this which is important to and accentuates the feeling of wilderness experienced within this area.

Mountains

By contrast, the ancient and rugged Paparoa Ranges form a distinctive and natural eastern boundary to the park, and from their ice-carved tops the syncline, the deep river gorges, and the vast ocean beyond can be appreciated from a different perspective.

The montane unit, with its acid geology, supports alpine forests dominated by mountain beech. Dracophyllum spp and Dacrydium spp are also noticeable components in the shrublands and forests below the alpine grasslands. Northern rata, nikau, kiekie and kahikatea are visibly absent at these elevations.

APPENDIX

BIRDS OF PAPAROA NATIONAL PARK, BULLOCK CREEK FARM AND ENVIRONS

The following list has been compiled from several sources - NFAC (1979), Only (1980) and Morse (1981).

Native Species

Forest birds

bellbird (Anthornis m. melanura)
tui (Prosthemadera n. novaeseelandiae)
New Zealand pigeon (Hemiphaga n. novaeseelandiae)
grey warbler (Gerygone igata)
South Island fantail (Rhipidura f. fuliginosa)
yellow-breasted tit (Petroica m. macrocephala)
South Island robin (P. a. australis)
silvereye (Zosterops lateralis)
brown creeper (Finschia novaeseelandiae)
South Island rifleman (Acanthisitta c. chloris)
yellow-crowned parakeet (Cyanoramphus a. auriceps)
South Island kaka (Nestor m. meridionalis)
New Zealand kingfisher (Halcyon sancta)
morepork (Ninox n. novaeseelandiae)
shining cuckoo (Chalcites l. lucidus)
long-tailed cuckoo (Eudynamis taitensis)
New Zealand falcon (Falco novaeseelandiae)
great spotted kiwi (Apteryx haasti)
western weka (Gallirallus a. australis)
blue duck (Hymenolaimus malacorhynchos)

Alpine species

kea (Nestor notabilis)

Open country species

Australasian harrier (Circus approximans gouldi)
New Zealand pipit (Anthus n. novaeseelandiae)
welcome swallow (Hirundo tahitica neoxena)

Westland species

South Island fernbird (Bowdleria p. punctata)
pukeko (Porphyrio p. melanotus)
Australian bittern (Botaurus stellaris poiciloptilus)
white-faced heron (Ardea novaehollandiae)
white heron (Egretta alba modesta)
cattle egret (Bubulcus ibis coromandus)
little egret (Egretta garzetta immaculata)

royal spoonbill (Platalea leucorodia regia)
pied stilt (Himantopus h. leucocephalus)
spur-winged plover (Lobibyx novaehollandiae)
little shag (Phalacrocorax melanoleucos brevirostris)
black shag (P. carbo novaehollandiae)
paradise shelduck (Tadorna variegata)
grey duck (Anas s. superciliosa)
New Zealand shoveller (A. rhynchotis variegata)

Coastal and sea species that breed locally

Westland black petrel (Procellaria westlandica)
sooty shearwater (Puffinus griseus)
caspian tern (Hydroprogne caspia)
white-fronted tern (Sterna striata)
southern black-backed gull (Larus dominicanus)
red-billed gull (L. novaehollandiae scopulinus)
black-billed gull (L. bulleri)
South Island pied oyster catcher (Haematopus ostralegus finschi)
variable oystercatcher (H. unicolor)
banded dotterel (Charadrius bicinctus)
blue shag (Stictocarbo punctatus steadi)

Exotic Species

Californian quail (Lophortyx californica brunnescens)
skylark (Alauda arvensis)
hedge sparrow (Prunella modularis occidentalis)
song thrush (Turdus philomelos)
blackbird (T. m. merula)
yellow hammer (Emberiza citrinella sylvestris)
chaffinch (Fringilla coelebs)
greenfinch (Carduelis c. chloris)
goldfinch (C. c. britannica)
redpoll (Acanthis flammea)
house sparrow (Passer d. domesticus)
starling (Sturnus v. vulgaris)
little owl (Athene noctua)
rock pigeon (Columba livia)
Canada goose (Branta canadensis)
black swan (Cygnus atratus)
mallard (Anas p. platyrhynchos)

REFERENCES AND BIBLIOGRAPHY

Adams C J D	1975	Discovery of Precambrian rocks in New Zealand: age relations of the Greenland Group and Constant Gneiss, West Coast, SI. Earth and Planetary Science Letters 28(1): 98-104
Aitken N A & Gay R D	1975	State Highway 6 Reconstruction Rochfort Creek to Bullock Creek Interdepartmental Landscape Report MOWD and Lands and Survey
Anderson A	1983	When All the Moa Ovens Grew Cold. Otago Heritage Books, Dunedin
Anderson H J	19 1	Densities of Tertiary Rocks, West Coast, South Island. NZ Journal of Geology and Geophysics Vol. 24 pp 545-553
Anon	1985	The Little Red Cavers Book NZ Speleological Society
Ansley B	1987a	Range of Conflict in Paparoa National Park, NZ Listener September 12-18 1987 pp 16-19
	1987b	Cousteau's Coup de grace, NZ Listener March 21 1987 pp 14-16
Atkinson B	1970	Fox River Cave, NZ Speleological Bulletin Vol. 4 No. 73 March 1970
Baker A J & Coleman J D	1977	The Breeding Cycle of the Westland Black Petrels (Procellaria westlandica) Department of Zoology, University of Canterbury. Notornis 24 pp 211-231
Bartle J A	1974	Seabirds of eastern Cook Strait, New Zealand, in Autumn. Notornis 21: 135-166
	1977	Preliminary Assessment and Identification of National Park or Reserve Qualities in the Western Paparoa Range (First Report)

Bartle	1983	Report on Research on Westland black petrels 1969-1983 with an outline of future objectives and a brief summary of management problems. National Museum, Wellington
	1988	Justification of National Priority for Purchase of Pt. Sec. 18, BLK I, Punakaiki SD, for Protection of Westland Black Petrels Nesting Thereon Unpublished Report to DOC
	1989	Fieldwork on Westland black petrels. Extract from Director's report to Council, National Museum, Wellington
Bathgate J	1986	Outdoor Interpretation Panels (Draft). NZ Forest Service, Hokitika
Best H A & Harrison M	1976	An Assessment of Proposed Biological Reserves in the West Coast Beech Project Area with Respect to the Avifauna of the Region. Unpublished report, NZ Wildlife Service, Department of Internal Affairs, Wellington
Best H A & Owen K L	1976	Distribution of Breeding Sites of the Westland Black Petrel. NZ Wildlife Service, Department of Internal Affairs, Wellington
Bowen F E	1964	Sheet 15 - Buller. Geological Map of New Zealand 1:250,000, DSIR, Wellington
Brailsford B	1981	The Tattooed Land. Reed Ltd, Wellington
	1984	Greenstone Trails. Reed Ltd, Wellington
Brewster B	1987	Te Moa. The Life and Death of New Zealand's Unique Bird. Nikau Press

Bryon et al	1976	Report on Skidder Logging of Podocarp Beech Forest on Limestone and Related Management Aspects, Charleston State Forest, West Coast Beech Project. Experimental Utilisation and Management Unit Report No. 04, NZFS, Reefton
Cahn P & R	1988	NZ National Parks
Champness G R	1987	In Paparoa National Park. Heritage of the Parks of the People pp 211-214 David Thom, Auckland
Clark et al	1981	Preliminary design brief for proposed information centre and public toilets at Punakaiki. Ed. Champness, Clark, Findlay, Jacobsen and McGowan, Department of Lands and Survey, Wellington
Cornell J B	1979	Sharing Nature with Children. Ed. George Beinhorn. Ananda Publications, Earth Sky, Nevada City CD 95959
Darby G	1987	A Short Walk in the Paparoas. The Canterbury Mountaineer p 30
Davey A G	1987	Cave Area Management - A Select Bibliography (Draft) Canberra ACT, Australia
Day S	1988	Field Trip Report: Punakaiki and Environs. Otago University Science Students Association, Otago University
Dennis A	1981	The Paparoas Guide. Native Forest Action Council, Nelson
Dennis A & Potton C	1987	Paparoa National Park Booklet, Department of Conservation, Hokitika
	1987	Images from a Limestone Landscape. Craig Potton, Wellington

Department of Conservation	1989	General Policy and Guidelines for Cave and Karst Management in Areas Managed by the Department of Conservation (Draft). Ed. Ian R Millar and Kevan A Wilde, Department of Conservation, Wellington
	1990a	Bullock Creek Farm Draft Management Plan. Department of Conservation, West Coast Conservancy, Hokitika
	1990b	Paparoa National Park - Resource Summary. Department of Conservation, West Coast Conservancy, Hokitika
Department of Lands & Survey	1978	The Punakaiki - Paparoa Region An Investigation for the National Parks and Reserves Authority, Wellington
	1979	The Punakaiki - Paparoa Region - Resource Report. An Analysis of Submissions, Department of Lands & Survey, Hokitika
	1981	Scenic Reserves of North Westland Biological Survey of Reserves Series No. 7, Department of Lands & Survey, Wellington
	1983	Proposed Punakaiki National Park, Department of Lands & Survey Report to National Parks and Reserves Authority National Park Series No. 23, Department of Lands & Survey, Wellington
	1984	Submissions on Proposed Punakaiki National Park. National Park Series No. 30, Department of Lands & Survey, Wellington
	1986	Bullock Creek Study. Department of Lands & Survey, Nelson
	1982	Punakaiki National Park Investigation (Call for written suggestions), Lands & Survey, Wellington

	1982	<u>Nile River Caves Scenic Reserve</u> Draft Management Plan, Lands & Survey, Nelson
D.S.I.R.	1987	<u>Guide to the Pancake Rocks, Punakaiki, New Zealand</u>. Geological Survey, D.S.I.R., Wellington
Edmonds J	1984	<u>Proposed Punakaiki National Park Working Party Reports</u>. Unpublished Report to National Parks & Reserves Authority, Punakaiki Subcommittee
Emberson R M	1975	<u>Bullock Creek Caves</u>. NZ Speleological Bulletin 5 (92): pp 345-346
	1977	<u>Metro Cave, Charleston</u>. NZ Speleological Bulletin 6 (130) pp 263-264
	1984	<u>Cave Creek Cave, Punakaiki</u>. NZ Speleological Bulletin 7 (130): pp 263-264
	1988	<u>Carabidae of Paparoa National Park in the collection of the Entomology Department, Lincoln University</u>. Unpublished report to Department of Conservation, Lincoln University
Falla R A	1946	<u>An Undescribed Form of Black Petrel</u>. Records of Canterbury Museum 5: 111-113
Folk R L	1959	<u>Practical Petrographic Classification of Limestones.</u> Bulletin of the American Association of Petroleum Geologists 43: 1-38
Gallas F E	1985	<u>Land Search & Rescue</u> (3rd Edition) FMC, Wellington
Hand G & Jones K	1982	<u>Vegetation Management on Archaeological Sites</u> NZ Historic Places Trust, Wellington
Hayward B	1984	<u>Extending Facilities at the Punakaiki Campground</u>. Department of Lands & Survey, Hokitika

Hayward B W & Ward B 1989 Inventory of New Zealand Fossil Localities of International, National and Regional Importance (Second Edition). Unpublished Report 89/1. Geological Society of New Zealand

Holdway R N 1986 Preliminary Report on the Subfossil Remains in Babylon Cave, Fox River, Punakaiki. Department of Zoology, Canterbury University

Imber M 1976 Comparison of Prey of the Black Procellaria Petrels of New Zealand. NZ Journal of Marine and Freshwater Research 10(1): 119-130

Jackson R 1958 The Westland Petrel. Notornis 7 230-233

Jennings J N 1985 Cave and Karst Terminology. ASF Newsletter 83 (1979)

Jolly J N & Roderick C D 1983 A Kiwi Survey of the Punakaiki District of the Paparoa Range. NZ Wildlife Service 1981 Technical Report No. 2, Wellington

Kelly G C 1989 Punakaiki (North of Pororari River) Draft. Pre-printed from: Scenic Reserves of Nelson Land District. Botany Division, D.S.I.R., Wellington

Kermode L O 1979 Assessment of New Zealand Tourist Caves. Cave Management in Australia III. Proc. Third Conference on Cave Tourism and Management, Mt Gambier

1966 Speleology in New Zealand. Speleological Bulletin Vol. 3 No. 60 December 1966

Laird M G 1968 The Paparoa Tectonic Zone. NZ Journal of Geology and Geophysics 11 (2): 435-54

1972 Sedimentology of the Greenland Group in the Paparoa Range, West Coast, South Island. NZ Geol. 15 (3) 372-393

	1973	<u>Comment on the Proposal to Open the 'Metro' Cave (near Charleston, West Coast) as a Tourist Attraction</u>. Unpublished, NZ Geological Survey Report (prepared for the Commissioner of Crown Lands, Nelson)
	1988	<u>Sheet S37 - Punakaiki</u>. Geological Map of New Zealand 1:63,360. NZ Geological Survey, DSIR, Lower Hutt
Lincoln College	1976	<u>Punakaiki Camp Study.</u> (Study No. 20) Landscape Architecture Section, Horticultural Department, Lincoln College
Laffan M D	1980	<u>Soils of Charleston - Punakaiki Region, South Island, New Zealand</u> NZ Soil Survey Report 47
Luckens J B	1984	<u>Moa Gizzard Stones in the South Island of New Zealand</u>. A Collection of Field Notes with some Observations. Cyclostyled
Millar I & Rautjoki H	1985	<u>Karst Caves and Caving - Buller Karst Resource</u> 1984/85 NZ Forest Service, Nelson
McCaskill W	1975	<u>Scenic Reserves of Nelson</u>. Department of Lands & Survey, Nelson
	1975	<u>Scenic Reserves of Westland</u>. Department of Lands & Survey, Wellington
McCulloch B	1984	<u>No Moa</u>. Canterbury Museum, Christchurch
McDowell R	1978	<u>New Zealand Freshwater Fishes - A Guide and Natural History</u>. Heinemann, Auckland
McDowell R, Graynoth E & Eldon G A	1977	<u>The Occurence and distribution of fishes in streams draining the beech forests of the West Coast and Southland, SI, New Zealand</u>. Journal of the Royal Society of NZ (7): 405-425

McPherson R I 1978 Geology of Quaternary ilmenite-bearing coastal deposits at Westport. New Zealand Geological Survey Bulletin (n.s.) 87

Molloy L F 1979 Outdoor Recreation on the West Coast - A Conservation Plan. Federated Mountain Clubs of NZ, Wellington

1982 "Will Punakaiki become the Eleventh National Park?" Forest and Bird 14 (4): 15-19

Morse P M 1981 Wildlife Values and Wildlife Conservation of Buller, North Westland. Fauna Survey Unit Report No. 29, NZ Wildlife Service. Department of Internal Affairs, Wellington

National Parks & Reserves Authority 1985 Proposed Punakaiki National Park. Report by the National Parks and Reserves Authority to the Minister of Lands, NPRA, Wellington

Native Forests Action Council 1977 "The future of West Coasts forests" - A Submission. Native Forests Action Council, Nelson

1979 Paparoa National Park. Native Forests Action Council, Nelson

Nathan S 1974 Stratigraphic nomenclature for the Cretaceous-Lower Quanternary rocks of Buller and North Westland, West Coast, SI, New Zealand. New Zealand Journal of Geology and Geophysics 17(2): 423-445

1975 Sheets S23 and S30 - Foulwind and Charleston (1st ed). Geological Map of New Zealand 1:63,360, NZ Geological Survey, DSIR, Lower Hutt

1978a Sheets S31 and pt S32 - Buller-Lyall. Geological Map of New Zealand 1:63,360, NZ Geological Survey, DSIR, Lower Hutt

	1978b	Sheet S44 - Greymouth. (1st ed). Geological Map of New Zealand 1:63,360, NZ Geological Survey, DSIR, Lower Hutt
New Zealand Geological Survey	1911	Greymouth Subdivision, North Westland. Chapter 5, New Zealand Geological Survey Bulletin No. 13, D.S.I.R, Lower Hutt
NZ Speleological Society	1985	New Zealand Karst Index. NZ Speleological Society, Waitomo
NZ Forest Service	1982	North Westland Regional Management Plan. NZ Forest Service, Wellington
	1981	Buller Regional Management Plan (Draft). NZ Forest Service, Wellington
Norris R	1978	Late Cenozoic Geology of the West Coast Shelf between Karamea and Waiho River, South Island, NZ. NZ Oceanographic Institute Memoir 81, Department of Scientific and Industrial Research, Wellington
Norton D A & Lord J M	1989	A Preliminary Account of the Vegetation of Paparoa National Park. Unpublished Report, University of Canterbury
Onley D J	1980	Bird Counts in Lowland Forests in the Western Paparoas. Notornis 27 (4): pp 335-362
Park G N & Bartle J A	1978	An evaluation of the lowland forests of the West Paparoa Ecological District with a proposal for a representative reserve in the Porarari. Botany Division, DSIR Nelson and National Museum of NZ
Penniket J G	1953	Notes on some Birds of the Western Paparoas, Westland. Notornis 6, Pages 177-175
Pugsley C W	1983	Literature review of the New Zealand glow-worm Arachnocampa luminosa (Diptera: Keroplatidae) and related cave-dwelling Diptera. NZ Entomologist 7 (4)

	1984	Ecology of the New Zealand Glow-worm, Arachnocampa luminosa (Diptera: Keroplatidae) in the Glowworm Cave, Waitomo. Journal of the Royal Society of New Zealand Vol. 14, No. 4 pp 387 - 407
Ringer M	1981	Your Part in Cave Conservation - Town and Country Planning Act 1977. New Zealand Speleological Bulletin 6 (117):pp 385-389
Rodgers T	1970	Xanadu Cave. New Zealand Speleological Bulletin 4 (73) March 1970
Sandrey R	1987	West Coast Visitor Survey. Unpublished Report to the West Coast Tourism Council, Lincoln College
Slee T A	1985	Punakaiki: Interpreting a Coastal Landscape. Dissertation: Diploma in Parks and Recreation, Lincoln College.
Smith R & Schilder S	1986	Punakaiki National Park Proposal: Economic Issues. Diploma in Parks and Recreation Management III: Economics of Parks and Recreation, Lincoln College
Spooner J	1985	Water Supply for the Punakaiki Area. Buller County Council, Westport
Stengs H	1985	Ecological Areas in the Punakaiki Ecological District. NZ Forest Service, Hokitika
Stephens R J & Wells C	1983	The Regional Economic and Social Impact of a Punakaiki National Park. Department of Economics, Victoria University
Sumner T	1984	Buller Walks. Nikau Press, Westport
Taylor J O	1979	Parks Presentation and Graphic Communication. Bulletin 28, Department of Horticulture, Landscape and Parks, Lincoln College

Telfer T C, Sincock J L, Byrd G V & Reed J R	1987	Attraction of Hawaiian Seabirds to Lights, Conservation Efforts and Effects of Moon Phase. Wildlife Soc. Bulletin Vol. 15 No. 3: pp 406-413, 1987
Tilden F	1977	Interpreting Our Heritage (Third Edition). University of North Carolina Press
Townsend J I	1973	Metro Cave. New Zealand Speleological Bulletin (87), September 1973
Warham J	1988	Vocalisations of Procellaria petrels. Notornis 33 pp 169-183
Wilde K A	1981	Caves - The Cave and Karst Resource of New Zealand. Unpublished dissertation, Dip. Parks and Recreation, Lincoln College
	1985	A Historical Review of Cave and Karst Management in New Zealand. Cave Management in Australia: Proceedings of Sixth Australasian Conference on Cave Tourism and Management, Waitomo
	1987	Preservation and Management of New Zealand's Caves and Karst. Newsletter No. 75, Geological Society of New Zealand
Wilde K A & Williams P W	1988	Environmental Monitoring of Karst and Caves. Report to Environmental Monitoring Symposium, University of Otago, Dunedin
Wilkinson S	1971	Bullock Creek 1969. NZ Speleological Bulletin No. 78: 520-523
Williams G R & Given D R	1981	The Red Data Book of New Zealand. Nature Conservation Council, Wellington
Williams P W (Ed)	1980	Metro Cave, Survey of Scientific and Scenic Resources. University of Auckland

Williams P W 1979 Potential impact on the Metro (Nile River) Cave system of logging in the catchments of the Ananui Creek. Report to Director General of Forests.

1982a Submission - Punakaiki National Park Investigation. Department of Geography, University of Auckland, Auckland

1982b Speleotherm Dates, Quaternary Terraces and Uplift Rates in New Zealand. Department of Geography, University of Auckland, Auckland

1987 The Significance of Karst in New Zealand. NZ Geographer October 1987, Auckland

Wilson G 1969 Some avian remains, South Island NZ. NZ Speleological Bulletin No. 69: 251-254

Wood M R 1983 "Cave Wilderness - The Reconciliation of Conservation and Use". Dissertation, Diploma in Parks and Recreation, Lincoln College