CP36157/5/92-500

ENVIRONMENTAL PROTECTION AUTHORITY

File Number

CT6/C54/1 Vol 1

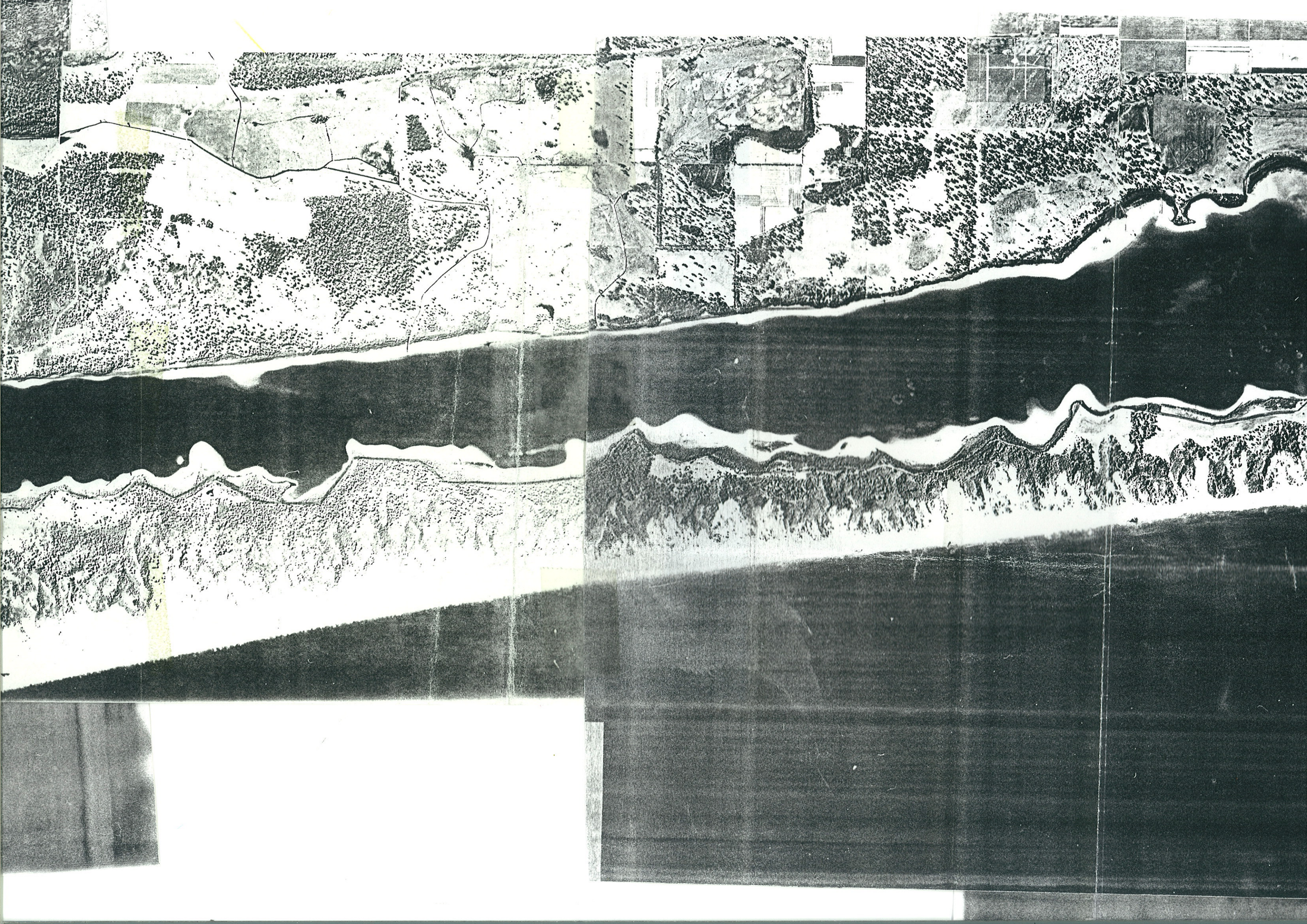
File Title

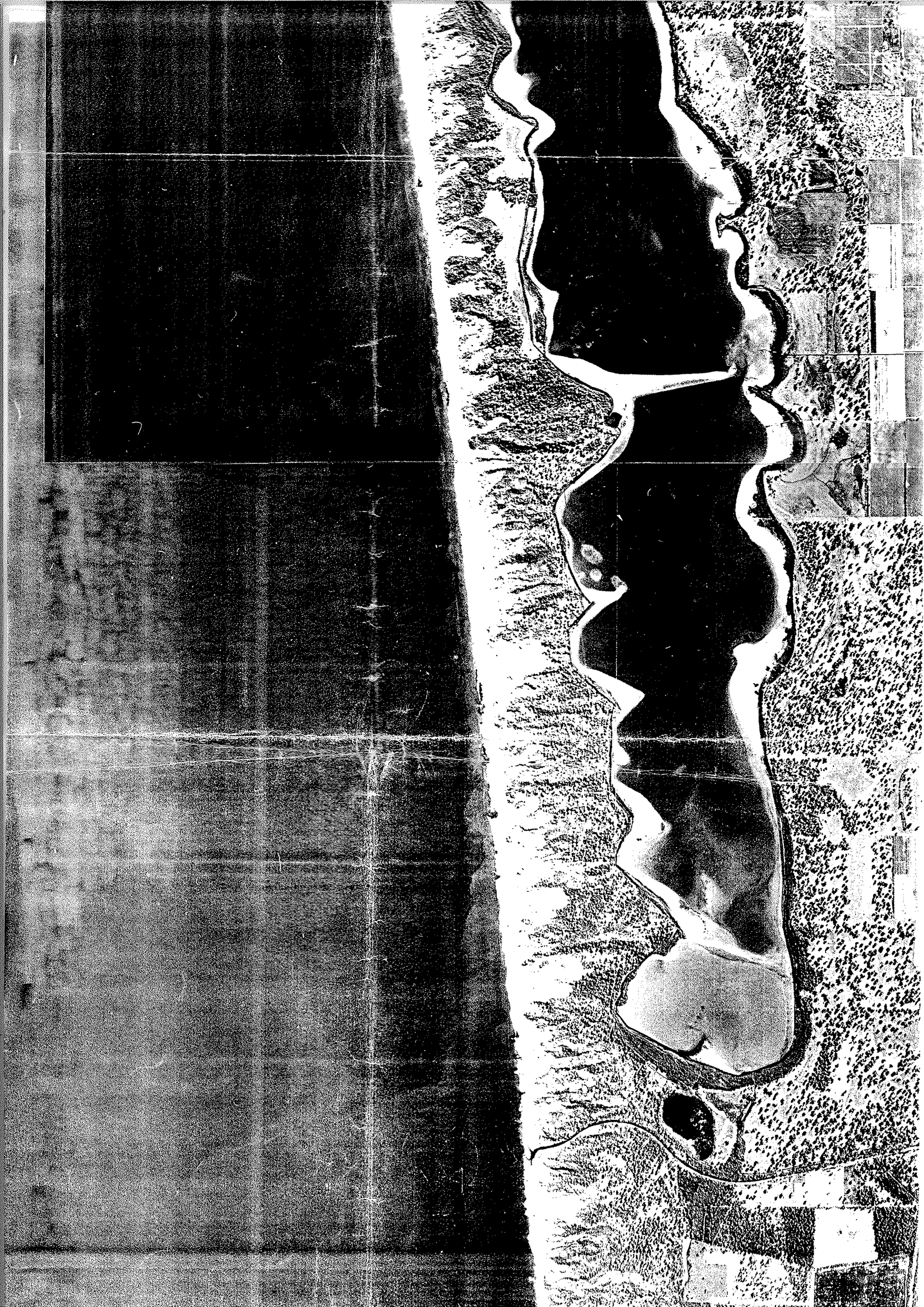
YALGORUP NATIONAL PARK - BIOLOGICAL DATA

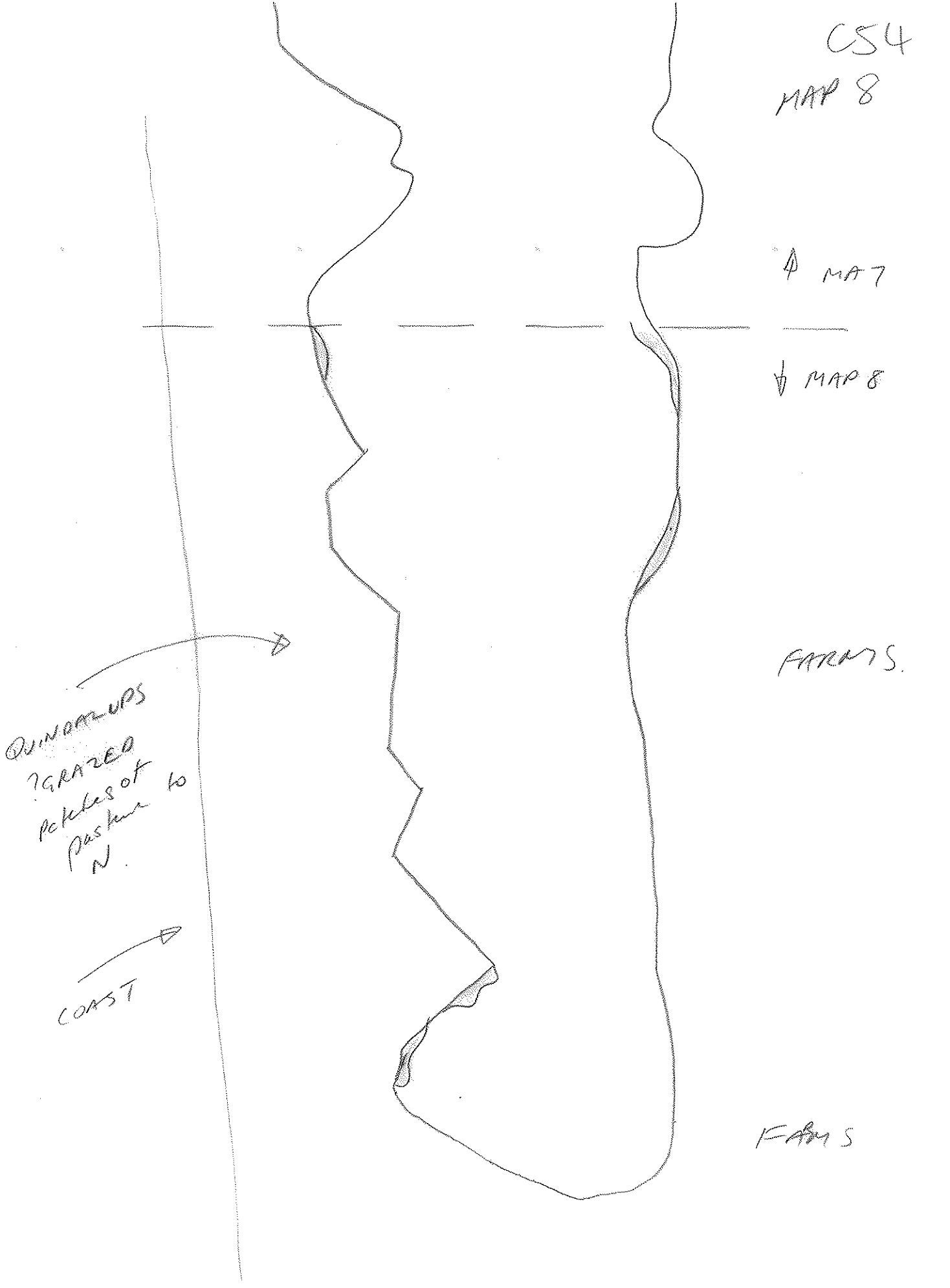
Volume created: 26/4/95

Relevant Files

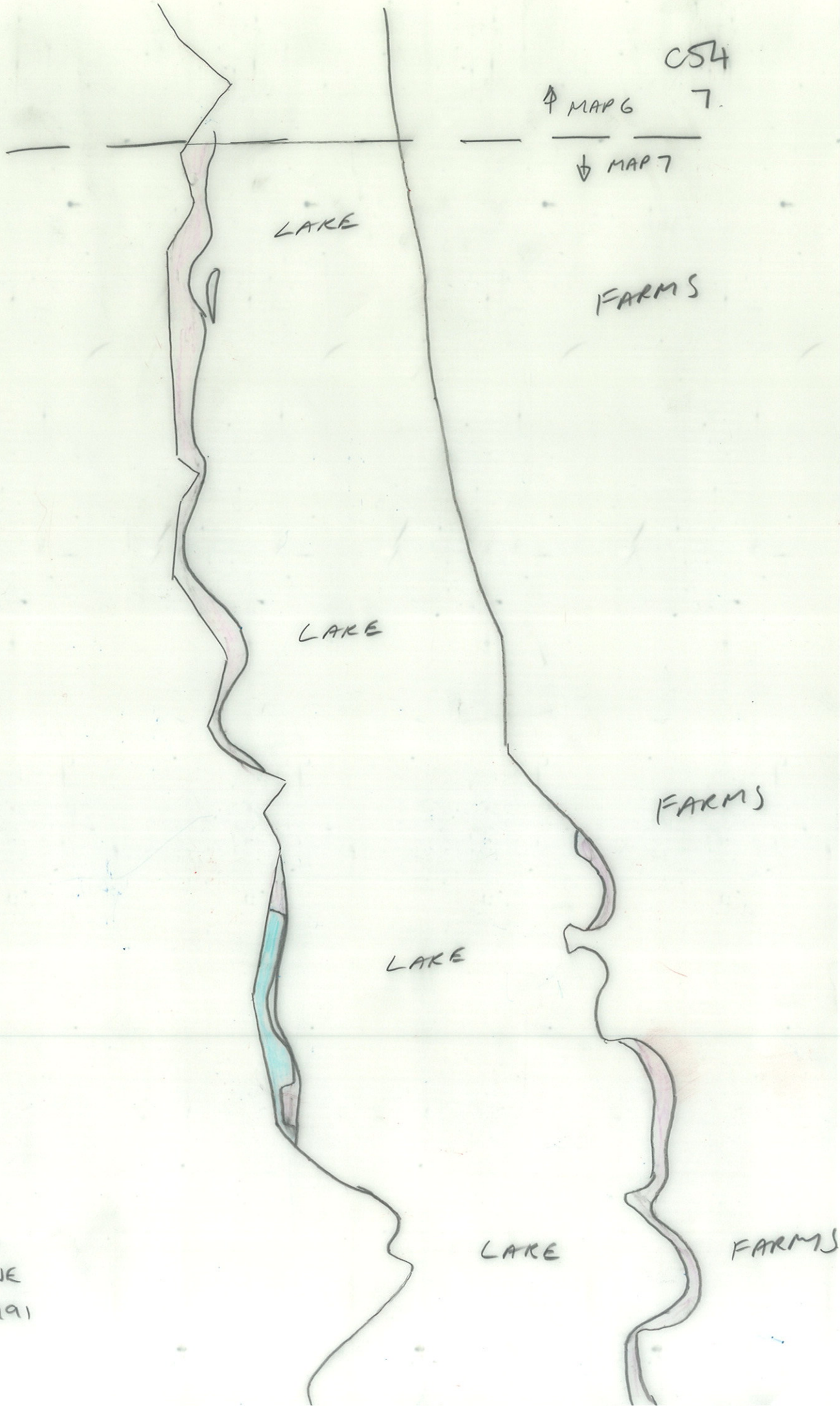
Folio	Date Referred	Officer	Initials	Folio	Date Referred	Officer	Initials







orthophoto
2031 W NE
Aug 1991



orthophoto
2031 IV NE
Aug 1991

C54
MAP 6.
MAP 5
LAKE
LAKE
2032 III SE

VEGETATION MAP 4

SCALE

0 500m 1

kilometre

1:25 000

N

LEGEND

- Urban Development
- The Strand
- Q4 and Q3 Age Quindalup Dunes
- Spearwood Dunes
- Q2 and Q1 Age Quindalup Dunes
- Yoongarillup Plain – Seasonally Damp to Wetland Areas
- Quindalup Beach Ridges
- Limestone Areas
- Cleared and Parkland Cleared
- Yoongarillup Plain – Peel Inlet Edge

PEEL

INLET

INDIAN

OCEAN

MANDURAH ESTUARY

Halls Head

MANDURAH

Channel Island

Creery Island

Outside Study Area

Outside Study Area

Outside Study Area

Urban

Urban

Urban

Urban

Spearwood Dune

Inlet edge

Swamp

Er/Ec (PC)

Ec(PC)

Eg(PC)

EgAf(PC)

Some Eg

Some Er+As

McJ

McJS

CMcSa

Not mapped in detail

COAST ROAD

OLD COAST ROAD

MANDURAH BYPASS

PINJARRA ROAD

MANDURAH TERRACE

ARTWORK PREPARED BY PROMOTIONS BRANCH, STATE PLANNING COMMISSION, WESTERN AUSTRALIA
JUNE 1988

VEGETATION MAP 3

SCALE

0 500m 1

kilometre

1:25000

N

LEGEND

- Urban Development
- The Strand
- Q4 and Q3 Age Quindalup Dunes
- Intergrades, Limestone to Spearwood Dunes
- Yoongarillup Plain – Seasonally Damp to Wetland Areas
- Yoongarillup Plain – Peel Inlet Edge
- Spearwood Dunes
- Limestone Areas
- Peppermint (Agonis flexuosa) Units
- Tuart (Eucalyptus gomphocephala) Units
- Cleared and Parkland Cleared
- Q2 and Q1 Age Quindalup Dunes and Swales Between Older (Q2 and Q1) Quindalup Dunes

INDIAN

OCEAN

PEEL

INLET

Strand remains outside blowout. Also some very disturbed vegetation.

This SO area tends to AM on crests

not orange.

Refuse Disposal Site

A. saligna regenerated

Water Tower

Urban

Spearwood Dune

Eg/Ec (PC)

Wannanup

Inlet edge

Pleasant Grove

Falcon

COAST

ROAD

OLD

3

VEGETATION MAP 2

SCALE

0 500m 1

kilometre

1:25 000

N

A

B

INDIAN OCEAN

HARVEY ESTUARY

Not mapped

Not mapped

Not mapped

Not mapped

Melros Urban

Florida (Ocean) Urban

Florida (Estuary)

Dawesville Urban

Park Ridge Urban

COAST ROAD

OLD COAST ROAD

WHITE HILLS ROAD

THOMAS ROAD

LEGEND

Urban Development

The Strand

Limestone Areas

Peppermint (Agonis flexuosa) Units

Tuart (Eucalyptus gomphocephala) Units

Spearwood Dunes

Cleared and Parkland Cleared

Yoongarillup Plain – Seasonally Damp to Wetland Areas

Q2 and Q1 Age Quindalup Dunes and Swales Between Older (Q2 and Q1) Quindalup Dunes

Q4 and Q3 Age Quindalup Dunes and Swales Between Younger (Q4 and Q3) Quindalup Dunes

Intergrades, Limestone to Spearwood Dunes and Intergrades, Limestone Types to Quindalup Dune Types

ARTWORK PREPARED BY PROMOTIONS BRANCH, STATE PLANNING COMMISSION, WESTERN AUSTRALIA
JUNE 1980

MAP 3

total	223.125	80.312
///	22.5	-
Q	169.375	-
L	29.5	25
✱	1.75	24.062
Y	—	31.25

MAP 4

total	533.75	1339.375	1172.188
///	155	-	-
Q	320.377	-	-
L	27.813	150.937	80.625
CO	12.125	35	1.25
sand	10	-	-
	8.438	14062/15	-
#	-	389.625	294.375
?E	-	83.438	-
lake	-	521.249	648.125
Y	-	144.189	132.188
ΔΔ	-	30.875	15.625

MAP 5

total	1506.875	1698.75 - 42.188 = 1656.562
lake	548.126	415.312
L	138.25	216.562
✱	567.204	219.626
///	-	-
Y	139.125	63.563
Y	84.187	76.813
CO	30ha	939.61 ~~823.75~~
ΔΔ		57.562
to a degree degraded		262.812 281.874
E		263.5

1436 930

map 6

total	503.125
Y	40
lake	463 125

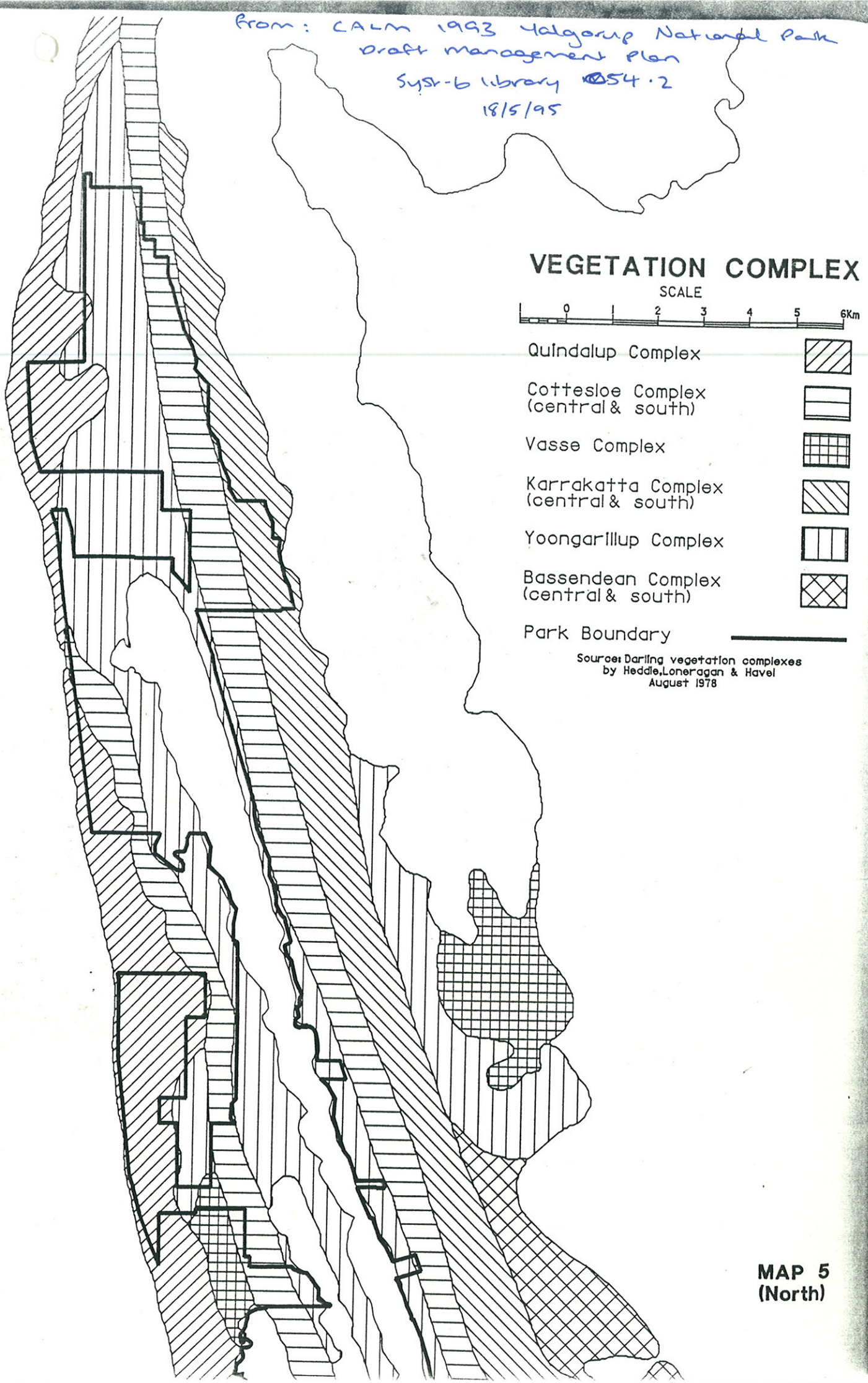
MAP 7

total	1001.25
lake	922.188
Y	68.812
CO	10.25

MAP 8

total	597.812
lake	591 562
Y	5.558

From: CALM 1993 Yalgorup National Park Draft Management Plan
Syst-6 library ✪54·2
18/5/95



MAP 5 (North)

VEGETATION COMPLEX

SCALE

0 2 3 4 5 6Km

Quindalup Complex

Cottesloe Complex (central & south)

Vasse Complex

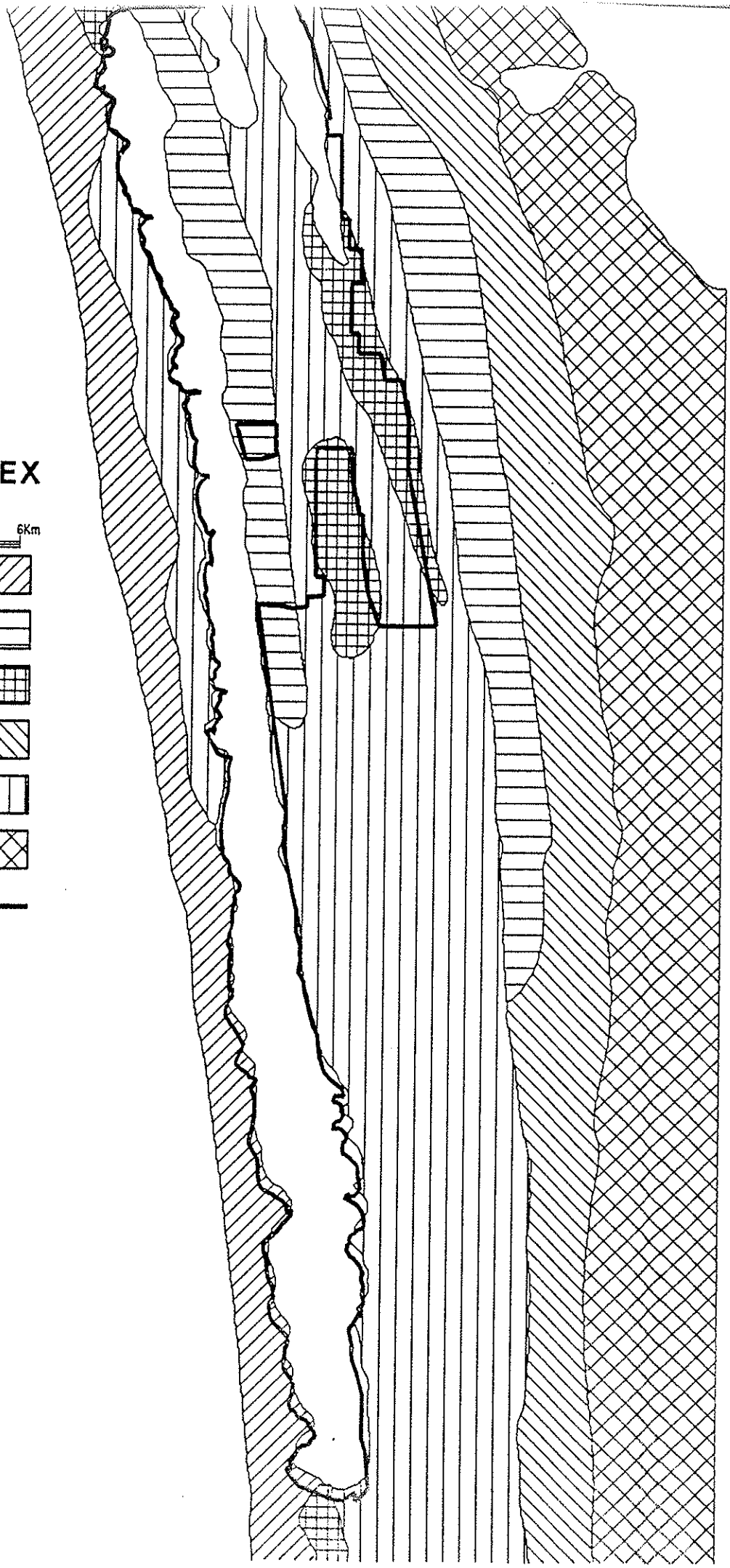
Karrakatta Complex (central & south)

Yoongarillup Complex

Bassendean Complex (central & south)

Park Boundary

Source: Darling vegetation complexes by Heddle, Loneragan & Havel August 1978



MAP 5 (South)

ENTERED ON GIS

Name: Environmental Scoping Document for the subdivision of Lots 2240, 2275, 2657, 3045 and 1536 Lake Clifton, City of Mandurah
Date: 05/05/2006
Capture Author: Thomas Leong / Ian Steward

Comments:
Polygon
Created to match documented study area with high level of accuracy

Accuracy Levels:

- High = Document contained visual and or described spatial references easily copied, resulting in little or no polygon boundary errors
- Acceptable = Document contained visual and or described spatial references with complex boundaries, resulting in minor boundary errors
- Low = Document contained little or no visual and or described spatial references, resulting in polygon boundary errors

Attributes
Report Info – Captured without problems
Custodial/Contact – Captured without problems
Content – Captured without problems

CONSERVATION COMMISSION OF WESTERN AUSTRALIA

SUMMARY SHEET

TITLE: CAPE BOUVARD INVESTMENTS – LAKE CLIFTON WEST PROPOSAL

FORWARDED BY: DIRECTOR NATURE CONSERVATION

ISSUES TO BE DISCUSSED: REQUEST FROM EPA SERVICES UNIT FOR ADVICE REGARDING SUBDIVISION PROPOSAL FOR CBI LAND ADJACENT TO LAKE CLIFTON / YALGORUP NATIONAL PARK

WHERE DOES THIS FIT IN WITH THE CONSERVATION COMMISSION'S STATUTORY RESPONSIBILITY (indicate section(s) of the CALM Act):

Conservation and Land Management Act 1984 Section 19 (1)(e)

BACKGROUND SUMMARY / IMPORTANT CONTENTIOUS ISSUE(S):

Background

Cape Bouvard Investments (CBI) Pty Ltd purchased the 790 hectare Lake Clifton West property in September 1995 for a reported $3.5 million. The site is surrounded entirely by Yalgorup National Park and at the time of purchase, had no gazetted access (Figure 1).

In December 1995 CBI and the Department were involved with discussions regarding possible land swaps that would result in the holding being added to Yalgorup National Park. No appropriate site for swapping was identified by the Department. CBI indicated its intent to proceed with plans to develop the site for rural/residential purposes.

CBI made a number of presentations to the National Parks and Nature Conservation Authority (NPNCA) between 1996 and 1998 regarding the development of this area of land, based upon a requirement for access through the National Park, and a proposal for a land swap between part of the CBI landholding and coastal portions of Yalgorup National Park. A summary of NPNCA considerations is attached as background information.

The NPNCA agreed to the development of access and land swap proposals for consideration, until July 1998 when the NPNCA decided against giving in principle approval for the proposed land exchange and recommended that the access proposal be considered as part of the formal assessment process for the proposed development.

Current Status

In June 2002, the Western Australian Planning Commission (WAPC) referred a 24 lot rural subdivision proposal by CBI to the EPA. The EPA set a Public Environmental Review (PER) level of assessment on the proposal, with an eight week public review period.

The EPA indicated to the WAPC and CBI, that its decision on level of assessment was not a straightforward one in that the subject site and its immediate surrounds were known to possess environmental values of very high significance, and that very strong justification would need to be provided in order for the proposal to be considered environmentally acceptable in its current form.

Shortly after setting the level of assessment, the EPA Services Unit indicated to CBI that there was scope to modify the proposal so that more intense development would be indicated for areas with less environmental sensitivity and areas of high environmental sensitivity would be indicated with no development. However it was also agreed that no negotiation could be entered into until a comprehensive analysis of the environmental values of the site had been provided.

On this basis, flora and fauna work was undertaken for the proponent by ATA Environmental and other consulting specialists such as M.J and A.R Bamford Consulting Ecologists. A draft environmental scoping document was provided to the EPA in October 2002. Since the drafting of this document the proposal has been substantially modified, and the scoping document has yet to be finalised.

In April 2003, the 24 lot rural proposal was modified to include two cluster nodes of development totalling 1200 lots adjacent to Lake Clifton and a coastal node located to the northwest of the site. The proposal has been modified again to the current concept put forward for consideration by the Conservation Commission.

The latest proposal is illustrated in Figure 2 and is based upon a northern access route and a 150 lot subdivision. The key points of the concept layout are:

- a coastal strip of development, approximately three kilometres in length, with an average 100m coastal setback;
- about 40 coastal lots of 0.5 – 2 ha in size and a residential node ('seaside style mini-community) of 100 lots sized between 1000 – 1500 m2; and
- an additional 8 non-coastal lots of up to 5ha interspersed with POS

A large proportion of the site (approximately 600 ha) adjacent to Lake Clifton and including other wetlands has no proposed development. It is noted that this design is predicated upon this area being "ceded" in return for northern access through Yalgorup National Park and an expansion of the development into Yalgorup National Park to the north and/or to the south towards Preston Beach (*i.e.* is a land swap proposal).

In order to progress the proposal, and to provide guidance to the proponent, the EPA Services Unit consider it important that the position of the Conservation Commission is sought in relation to the key issues of:

1) Conservation Commission interest in acquisition of the land for addition to Yalgorup National Park
2) Position of the Commission regarding land swaps of coastal portions of the National Park for lakeside areas of the Lake Clifton West property; and
3) Provision of northern access through Yalgorup National Park.

Discussion

The current proposal is similar to that considered by the NPNCA in 1998 in reference to the elements of land swaps and northern access alignments, although the lot configuration has altered. The issues discussed in 1998 regarding planning and environmental approval processes, in particular their timing and sequence remain valid.

One aspect that has changed since 1998 is that CBI have purchased additional private property to the south of the Lake Clifton West holding, which now provides gazetted access to the property from the south. While southern access is available CBI retain a preference for a northern access route to minimise travel time and distance from the Perth and Mandurah areas.

The consideration of access in the past was due to the only way to provide gazetted road access to the property was through the National Park. While there is a gazetted road along the western edge of Lake Clifton, there is an approximately 750m gap where there is no legal access. Part of consideration of the previous proposals was that there may be pressure to construct on the gazetted road within the National Park and this is located in an

environmentally inappropriate location. The previous proposal was based on studies carried out to provide a better alignment within the park and to meet up with the existing road reserve to the north.

Consideration of the matters relating to acquisition, land swaps and provision of access cannot be done in isolation from a consideration of the likely impacts of the overall proposal to develop the site for residential purposes. There are a number of impacts on the environmental values of Lake Clifton / Yalgorup National Park from the property being developed that have been identified and are of concern. Key environmental factors identified by the EPA Services Unit to be addressed as part of the PER include the potential impact on:

- flora and fauna, including Threatened Ecological Communities, Specially Protected flora and fauna, disturbance of waterbird habitat, and migratory species;
- wetlands - the impact on Lake Clifton (a Ramsar wetland), Boundary Lake, and an Unnamed Lake in terms of surface water quality, water balance, nutrients, thrombolites, wetland vegetation, fringing wetland vegetation and dryland buffers;
- karstic terrain, subterranean fauna and root mat communities;
- Yalgorup National Park, including impacts of the access corridor and interface values;
- coastal processes including the stability of the beach and integrity, function and environmental values of the dune system;
- erosion, fire risk, spread of weeds and feral animals; and
- Aboriginal heritage.

Additional issues of particular concern to the Department are long term management issues for the National Park resulting from the increased access to and through the Park (fire, weeds, unmanaged access etc) and a likely increase in demand for visitor services and facilities. There is also a potential requirement for the Department to modify existing management practices (particularly in reference to fire) to protect new property development.

It is also not clear what additional impacts will result from the requirement for infrastructure including water supply, sewerage, gas, power and telephone services, as well as ongoing access and maintenance activities for these services.

There are issues also relating to the planning and environmental processes currently underway. The land is zoned Rural under the City of Mandurah Town Planning Scheme No 3, and the Peel Region Scheme. Under the Peel Region Scheme, Rural zoned land is " - to provide for the sustainable use of land for agriculture, assist in the conservation and wise use of natural resources including water, flora, fauna and minerals, provide a distinctive rural landscape setting for the urban areas and accommodate carefully planned rural living developments." The current proposal appears to have been developed without reference back to the planning process and consequently may be incompatible with the zoning.

The following points are in specific reference to the advice sought by the EPA Services Unit from the Conservation Commission:

1) Acquisition of land for addition to the National park

While the addition of this area to the National park is desirable from a conservation and management perspective, and is consistent with the aims of the Management Plan, the likely cost of the property (assuming the 1995 purchase price of $3.5 million is a minimum) is beyond the funding available from within the Department. Pursuing acquisition of the property would require a specific funding allocation to be sought from Government.

2) Land swaps

The Yalgorup National Park Management Plan states: "Acquire by purchase or exchange when opportunities arise and funds are available, private property enclaves and properties adjoining the Park that have exceptional conservation or recreation values, management benefits, or that could protect areas with these values within the Park." Consideration of land swap proposals in reference to the CBI land is therefore consistent with the Management Plan.

The National Park areas adjacent to the CBI property are 'zoned' under the management plan as Special Preservation and Natural Environment. It is noted that the coastal portions of the Park to the north and south of the CBI property are 'zoned' special preservation. The objective of the Special Preservation zones is for access and use to be strictly controlled or prohibited altogether.

The 1998 proposals were based on a similar premise of accessing coastal areas of Yalgorup National Park for residential development in exchange for the western borders of Lake Clifton. Work undertaken by CBI at the time inferred that the environmental values of the lakeside private property were higher than that of the adjoining coastal portions of the National park.

The discussion during the NPNCA meeting indicated that many of the conservation values on the private property were not likely to be at threat of development due to existing environmental, planning and policy requirements. This includes proximity to the Ramsar listed Lake Clifton, impacts on waterbirds and possible hydrological impacts, presence of Declared Rare Flora and threatened ecological communities, and a lack of capability for development due to constraints resulting from both coastal and karstic terrain. This situation remains unchanged.

While the CBI land proposed for exchange may have higher conservation values in direct comparison with the coastal portions of the National Park, this does not take into account regional environmental considerations, management requirements for the National park, or public interest elements of such a proposal. It is likely that the development proposal outlined would significantly increase the level of management required, as well as constitute risks to the conservation values acquired. The extent to which a land swap proposal will meet the intent of the management plan will largely depend on the type of development proposed.

It is not possible to determine, based on the concept provided, that there are significant conservation or public interest benefits that would result from an exchange.

3 Access through Yalgorup National Park

The NPNCA previously expressed in principle support for northern or eastern access proposals. CBI has previously indicated that the development would not be viable unless the northern access route was approved, requiring excision from the National park and gazettal of a dedicated road.

As CBI has now purchased property to the south to provide gazetted access to the property, there is no immediate rationale for an access route to be excised from the National park to facilitate the site's development. Provision of northern access would also result in a 'through-route' increasing access to and pressures on the western portion of the National park and the western edge of Lake Clifton.

A determination on the access route needs to be based upon a definite proposal where the number of lots, likely number of residents, likely number of vehicle movements and road design could be assessed. There are also possible impacts on the National Park should a development option using southern access be pursued, in that the existing road to the south may require upgrading to allow for additional vehicle movements.

RECOMMENDATION(S):

That the Conservation Commission advise the EPA Services Unit that:

1) the advice is indicative only as it is understood that there is potential for the proposal to change and the Commission would consider any proposal on its merits.
2) while the property would make a valuable addition to the National Park the funds for acquisition are not available.

3) land swaps are permissible under the Yalgorup National Park Management Plan provided they "have exceptional conservation or recreation values, management benefits, or that could protect areas with these values within the Park." While there are nature conservation values on the CBI property, the increased management requirements and subsequent risks from development may negate the added conservation values and overall integrity of the National Park and so would not meet the intent of the Management Plan.

4) there are no apparent benefits to the National Park from allowing provision of access from the north.

DECISION(S):

Attachment One

SUMMARY OF NPNCA CONSIDERATIONS

NPNCA meeting 6 June 1996:
Following a presentation by CBI, the NPNCA endorsed a proposed process to determine preferred access to the Lake Clifton land. The process was based upon CBI and the Department determining a preferred route, based on the National Park, environmental and developer's criteria, liaison with other agencies and relevant site investigations.

NPNCA meeting 12 December 1997
The minutes of the meeting state:

> "...that the Authority write to CBI stating that the NPNCA has agreed in principle to the options of the northern access routes and the option of an access route across Lake Clifton and form the information to date the NPNCA views access across Lake Clifton as an environmentally viable alternative as it may have less impact on the Park. The NPNCA should also request further information on the northern access routes and the option of an access route across the lake once a detailed design has been completed by CBI."

The presentation to the NPNCA in December 1997 was followed with CBI doing additional infrastructure, planning and environmental studies including assessments of both the northern and eastern (across Lake Clifton) access routes. CBI then also developed a proposal for the possible exchange of land owned by CBI for part of the National Park.

In a letter from NPNCA dated 25/5/99 regarding the CBI proposal, the Authority indicated its position was that the access proposal within the National Park be considered as part of the formal process for the proposed land development. The NPNCA indicated that access across Lake Clifton should be considered along with all other options so that the Authority could be confident that the least environmentally impacting alternative was identified.

NPNCA meeting 3 April 1998
In March 1998 the NPNCA considered a proposal involving northern access and CBI land for National Park land swap proposals. The NPNCA decision was that is was not opposed to the concept of a land exchange but needed to consider the values of the areas involved in the proposed exchange and approvals and processes that needed to be followed.

NPNCA meeting 12 June 1998
The NPNCA agreed to a written request from CBI to provide a briefing to the NPNCA with representatives from Ministry for Planning, Water & Rivers Commission and Department of Environmental Protection. CBI indicated they were seeking an in principle approval for the realigned access and land exchange proposal. The NPNCA agreed to the briefing and to also invite the CEO from the Shire of Mandurah.

NPNCA meeting 10 July 1998
CBI made a presentation and the proposal was discussed at length, including issues relating to planning considerations, fire management, relative conservation values in the exchange proposal, conservation values along the proposed access route, regional values of Yalgorup National Park. The processes that the proposal had to go through and appropriate times for the NPNCA to give approval to elements of it was also subject to discussion.

In further considering land swap and northern access proposals, the NPNCA decided against giving approval for the proposed land exchange and that the access proposal be considered as part of the formal process for the proposed development.

Environmental Protection Authority Advice

The EPA recommended to CBI by letter dated 8 September 1998, that a proposal be submitted to the City of Mandurah to initiate an amendment to rezone CBIs Lake Clifton properties from Rural to Development Zone and to consider a new access road alignment and then the EPA would set a level of assessment on that proposal. The EPA indicated that if this was followed then the planning and environmental review processes could run side by side.

The EPA letter also indicated that they would not consider coastal development on the area of land for a proposed land swap unless the agreement of the NPNCA for the swap had been obtained.

ECOLOGICAL SYSTEMS BRANCH
(TERRESTRIAL SECTION)

Memorandum

ATTENTION: Juliet Cole
FROM: Bridget Hyder-Griffiths, Bronwen Keighery, John Dell
DATE: 21 November 2003
SUBJECT: Cape Bouvard Investments Lake Clifton subdivison Scoping Document
FILE NO.:

Terrestrial Ecosystems Branch have the following comments on the scoping document for the above proposal.

The following suggested additions;

Section 7 Summary of impacts and potential significance and impacts on:

- of clearing for housing, roads, building envelopes, fire breaks and resulting increased disturbance due to human habitation adjacent to bushland;
- the Quindalup dunes should be placed in a regional context;
- there is an incomplete knowledge of Yalgorup National Park and the relationship of the area within the proposal this needs to be determined;
- the Tuart health issue both on the site and adjacent to the site;
- loss of feeding and roosting habitat for Baudin's Cockatoo;
- conservation significant vertebrate species that have declined on the Swan Coastal Plain eg those listed in *Bush Forever* (Government WA 2000) especially birds and significant reptile species;
- frog breeding habitat in wetlands on the western side of Lake Clifton;
- of roads on fauna (see top of p2 of Trudgen advice);
- wilderness experience;
- ecological linkages.

8.1 Proposed further studies

- Conduct site investigations to identify flora and delineate vegetation associations (rather than type) and condition at a comparable scale to Trudgen 1991.
- Comparison of flora and vegetation with Yalgorup National Park;
- Tuart conservation issues on the Quindalup (particularly the significance of the mallee populations) and Spearwood soils;
- Address the 'wilderness' values Yalgorup National Park and the contribution the study area makes to this.
- All study's should be consistent with EPA Guidances 10, 51 and 56.
- Frog survey should be conducted in winter to determine signficant breeding areas;

- Assess area for conservation significant vertebrate species that have declined on the Swan Coastal Plain eg those listed in *Bush Forever* (Government WA 2000) especially birds and significant reptile species
- Assess CALM priority species and Threatened invertebrate species and
- Five fauna survey sites is not enough to sample all the habitats (apparent from recent site visit). It is recommended that the diversity of all the habitats are sampled (approximately 10). There should be replicated sample sites in each habitat. Adequate sample sites and sample periods are required to assess the diversity of the area (see How 1998 Journal Royal Society of WA 81:143-148.
- Consider the implications of the proposal on management of Yalgorup National Park and on the conservation values of the Park.

8.3 Hydrology

- Other vegetation particularly that dominated by Tuart.

Appendix 1 Environmental Factors

- This is not adequate and should place the area in the regional context.
- Not just threatened fauna should be considered.

This should be used in conjunction with the previous advice given by Conservation Branch.

DELL John

From: Kaye Godwin [kaye.godwin@ataenvironmental.com.au]
Sent: Wednesday, 13 November 2002 10:05
To: DELL John
Subject: Re: Preston Beach Road, Lake Clifton - Assessment 1440

Thanks John.

Have a great day!
K
----- Original Message -----
From: "DELL John" <john.dell@environ.wa.gov.au>
To: "'Kaye Godwin'" <kaye.godwin@ataenvironmental.com.au>
Cc: "DUFTY Nicholas" <nicholas.dufty@environ.wa.gov.au>; "HYDER-GRIFFITHS Bridget" <bridget.hyder.griffiths@environ.wa.gov.au>
Sent: Wednesday, 13 November 2002 9:42 am
Subject: RE: Preston Beach Road, Lake Clifton - Assessment 1440

> Hello Kaye
> This is in response to the email request you sent me on 6 November 2002 with
> an attached outline of the revised scope of works to be implemented in
> relation to vertebrate fauna for the proposed Preston Road, Lake Clifton
> subdivision.
>
> You asked me to review the attached scope and advise whether the scope was
> satisfactory in addressing the EPA's requirements in relation to this issue.
>
> I understand that you previously had discussions with Nicholas Dufty from
> the Planning Assessments Branch and he advised you to contact me directly
> regarding fauna issues for this project.
>
> The scope of works outlined in your attachment(section 8.2.2 Proposed
> Further Studies)if undertaken would be satisfactory in addressing the fauna
> issues in relation to this project.
>
> In assessing the fauna conservation significance of the site with respect to
> the local and regional context, including its role as a north south regional
> ecological linkage it is expected that species of conservation significance
> included in Bush Forever would be considered in addition to any Specially
> Protected (threatened) or Priority Fauna.
>
> Regards, John
>
> Disclaimer:
> This e-mail is confidential to the addressee and is the view of the writer, not necessarily that of the Department of Environmental Protection, which accepts no responsibility for the contents.
> If you are not the addressee, please notify the Department by return e-mail and delete the message from your system. You must not disclose or use this information in any way.
> No warranty is made that this material is free from computer viruses.
>

DELL John

From: Kaye Godwin [kaye.godwin@ataenvironmental.com.au]
Sent: Wednesday, 6 November 2002 12:27
To: John Dell
Subject: Preston Beach Road, Lake Clifton - Assessment 1440

Vertebrate Fauna Assessment (r...

Hi John

Further to our recent discussion please find attached an outline of the revised scope of works to be implemented in relation to vertebrate fauna for the proposed Preston Road, Lake Clifton subdivision.

Could you please review the attached scope and advise whether the scope is satisfactory to meet with the EPA's requirements in relation to this issue.

I look forward to receiving your response shortly. Should you have any queries or you require clarification please do not hesitate to contact me.

Regards
Kaye Godwin
Senior Environmental Scientist

ATA Environmental
Dilhorn House
2 Bulwer Street
PERTH WA 6000

Ph: (08) 9328 3488
Fax: (08) 9328 3588

8.2 Fauna

8.2.1 Background

A vertebrate fauna survey of the eastern portion of the Cape Bouvard Inveswtments (CBI) landholding and the proposed land exchange parcel in Yalgorup National Park was undertaken by ATA Environmental with assistance from John Dell in June 1998. The survey involved a systematic trapping program, bird surveys, active searching and opportunistic observations of all major habitats within the CBI landholding and the Yalgorup National Park study area.

Although the ATA Environmental fauna survey did not include the western portion of the CBI landholding, this area comprises similar fauna habitat (Quindalup Dunes interspersed with areas of limestone) to that assessed as part of the Yalgorup National Park study area. As a result, this information will provide baseline data of species expected to occur within the western portion of the CBI landholding. Habitat such as the Peppermint Woodlands of the Quindalup Dunes found in the CBI landholding, but not in the Yalgorup NP study area may yield additional species.

8.2.2 Proposed Further Studies

A vertebrate fauna survey will be undertaken of the property, particularly focussing on the areas of the property that were not investigated during the previous June 1998 survey. It is intended that some sites within habitats that were previously surveyed also be surveyed to record species more active in the warmer months.

The survey will include a review of the Museum and CALM databases to identify any species of significance that are known from the area.

The survey will comprise a trapping program involving pit fall, cage and Elliott traps as well as a systematic recording of bird species in all of the major habitats (ie. dominant vegetation types). It is expected that a minimum of 5 sites will be intensively surveyed with about 8-10 pit fall (with drift fences), 6-10 cage and 20-25 Elliott traps located at each. Active searching such as checking under rocks, leaf litter and logs, night spotlighting and recording of bat calls will also be undertaken.

The findings of the fauna survey will be compiled to produce a list of recorded species; a list of species predicted to occur; an assessment of the significance of any rare and endangered species; identification of species present that are vulnerable to disturbance or loss of habitat; and a comparison with available survey data from other locations in the area. The assessment will also include discussion on the conservation significance of the habitat and fauna assemblages, and the value of the site in terms of local and regional linkages.

The survey will be carried out over a standard 5-night period in late November or December 2002. This timing should be highly suitable for recording a range of reptiles and small mammals as well as a variety of birds.

It is intended the vertebrate fauna survey be carried out by Bamford Consulting Ecologists under direction from ATA Environmental.

CONSERVATION BRANCH

INTRA DEPARTMENTAL ADVICE
NB: For Internal Use Only

TO: Gary Whisson
SUBJECT: Yalgorup National Park
FROM: Malcolm Trudgen
DATE: 9/7/1998

Please could I be provided with a copy of your final advice. Thank you.

This proposal raises major issues relating to all national parks as well as issues relating to Yalgorup National Park.

1. The appropriateness of swaps of parts of national parks for other areas.

In this regard, it is arguable that if national parks are to have the proper respect that they deserve, then changes to their boundaries should only be made in the most exceptional circumstances of national interest. Otherwise, national parks will not be respected and will be viewed as mutable areas that can be successfully varied to suit the wants of private companies, the different levels of government and pressure groups that for their own purposes see an advantage in re-arranging the boundaries.

If national parks are to survive in the long term as effective areas for the conservation of the vegetation, flora, fauna and landscape then they must be viewed by the public, companies and government as areas that have this special status. Otherwise, respect for the conservation estate will be reduced and this will impact not only on boundary issues but on all issues relating to management, including provision of access, acceptability of different passive and active uses, provision of commercial facilities. For example, if it is acceptable to swap areas in a fashion that commercially advantages one group how do you argue against allowing another commercial group to have another area to provide a facility such as a resort that uses much less area but also has significant management difficulties.

2. To what degree should access to areas be allowed though national parks?

Roads have very significant environmental impacts that are much greater than simply the area of vegetation that is lost. The total impact has several components, including:

- the loss of the vegetation and its component flora;

- loss of the populations of animals present, these are not simply displaced they are largely destroyed;

- ongoing effects on the populations of fauna in the areas adjoining the road through road kill and changes to patterns of movement and access to food sources.

- loss of landscape value;

- loss of wilderness values through the presence of the road and the noise of the traffic on it;

- the introduction of weed species that can have very significant impacts on the vegetation and populations of flora and fauna;

- the introduction of diseases such as *Phytophthora* that can have major impacts on the vegetation and flora and fauna populations; and

- increases in the frequency of bushfires due to arson and accidentally (or negligently) from causes such as careless disposal of cigarette buts.

Obviously, the provision of roads through national parks is a very significant environmental impost that should only be allowed where there is an overpowering argument for it. For example, such as where a new park would prevent access between existing communities in a situation where no other reasonable alternative access was available.

In the particular case involved at Yalgorup National Park, some of these impacts would be particularly severe. The area between the lakes and the coast is protected to some degree from new invasion by weeds by the lakes, a new road would take away this protection. The area between the lakes and the coast has special value on the Swan Coastal Plain south of Perth as probably the most significant area of remaining wilderness or near wilderness value. Construction of a road through the area would severely degrade this value. The area also has some protection from wildfires due to the lakes and this would be significantly reduced by the proposed road.

If the access sought by Cape Bouvard Investments is allowed, then it is hard to envisage how other road proposals with a high environmental impact put forward by either commercial groups or local interest groups (such as fishermen seeking access to beaches) could be refused.

3. The conservation significance of Yalgorup National Park.

Yalgorup National Park is a relatively small national park, yet it is the largest national park on the Swan Coastal Plain between Perth and Bunbury.

If we were starting with an untouched environment on the Swan Coastal Plain and planning national parks, then Yalgorup would surely have been included because of

the lakes, the variety of vegetation, the value for flora and fauna and the the subtle but rich variation in landscape values and the special feature of the beaches. These qualities would have been undoubtedly included in a much larger national park than currently exists. However, the reality is that we are dealing with a fragmented landscape that is under increasing development pressure. In this circumstance, what should we be aiming for? The following are the principles that should be applied:

- the boundary to area ratio of Yalgorup should be defended vigorously, to reduce environmental impacts and to maintain manageability;

- developments that increase the pressures on the park and bring them into immediate contact with the park boundaries should be encouraged to be moved to more appropriate locations;

every opportunity should be taken to add areas to the park, provided this does not involve the acceptance of increased pressure on the park.

4. Knowledge of the Quindalup Vegetation Complex south of the Swan River.

The state of knowlege of variation in the Quindalup Vegetation Complex south of the Swan River is is fairly basic. Studies on this vegetation complex north of the Swan River have shown substantial variation in floristic composition that in places have fairly abrupt boundaries. The information that is available south of the Swan River indicates that there is likely to be variation in this area as well. Before the current proposal could be adequately assessed, a floristic study similar to that carried out for the area north of the Swan River should be carried out.

5. Definition of Environmental values of Yalgorup national Park.

Only the part of Yalgorup National Park north from the area of the proposed development has been mapped in detail for its vegetation, and other values are not well known (flora, fauna, definition of landscape) for all of the park. The values for fauna particularly are likely to be quite high. Values for landscape, while not dramatic, are very significant in the context of the degree of clearing of the Swan Coastal Plain south of the Swan River and the signifcant range of landscapes present (lakes, ocean/beach, dunes of various types) in the park.

6. The increasing pressures on Yalgorup National Park.

Yalgorup National Park lies in an area that is going to experience a very significant increase in population levels. This will partly be the result of increasing appreciation of the values of the area and partly due to likely increases in industrial development and other economic activities. This increase in population will lead to increased direct pressures on the park and increased management difficulties. The park already has fragmented boundaries and the increase in pressures from

general population rises would be exacerbated by the location of significant numbers of people in a new township immediately adjacent to the park.

CAPE BOUVARD INVESTMENTS PTY LTD

John
I have put some
adds on this. Yours from.
Bronwen

Sys 6
Bird
File Kalan

ENVIRONMENTAL SCOPING DOCUMENT FOR THE SUBDIVISION OF LOTS 2240, 2275, 2657, 3045 AND 1536 LAKE CLIFTON, CITY OF MANDURAH

SCANNED

VERSION 1

OCTOBER 2002

REPORT NO: 2002/138

CRN 184622

NO. 934 D002
03/10/2002 16:50

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An internal quality review process has been applied to each project task undertaken by us. Each document is carefully reviewed by core members of the consultancy team and signed off at Director level prior to issue to the client. Draft documents are submitted to the client for comment and acceptance prior to final production.

Document No: 98056_scoping_002_sm_V1

Report No: 2002/138

Checked by: Signed:

Name: Sarah Maxwell Date:

Approved by: Signed:

Name: Paul van der Moezel Date:

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1. PURPOSE OF DOCUMENT

The purpose of this document is to assist the EPA/DEP in scoping the necessary work required to ensure that all possible significant issues are properly considered during the Public Environmental Review (PER) period.

2. IDENTIFICATION OF PROPONENT

The proponent for the proposed rural development of Lots 2240, 2275, 2657, 3045 and 1536 Lake Clifton, City of Mandurah and Shire of Waroona is Cape Bouvard Investment Pty Ltd.

3. SUMMARY DESCRIPTION OF PROJECT

Cape Bouvard Investments proposes to subdivide its landholding located adjacent to Lake Clifton in the City of Mandurah and Shire of Waroona.

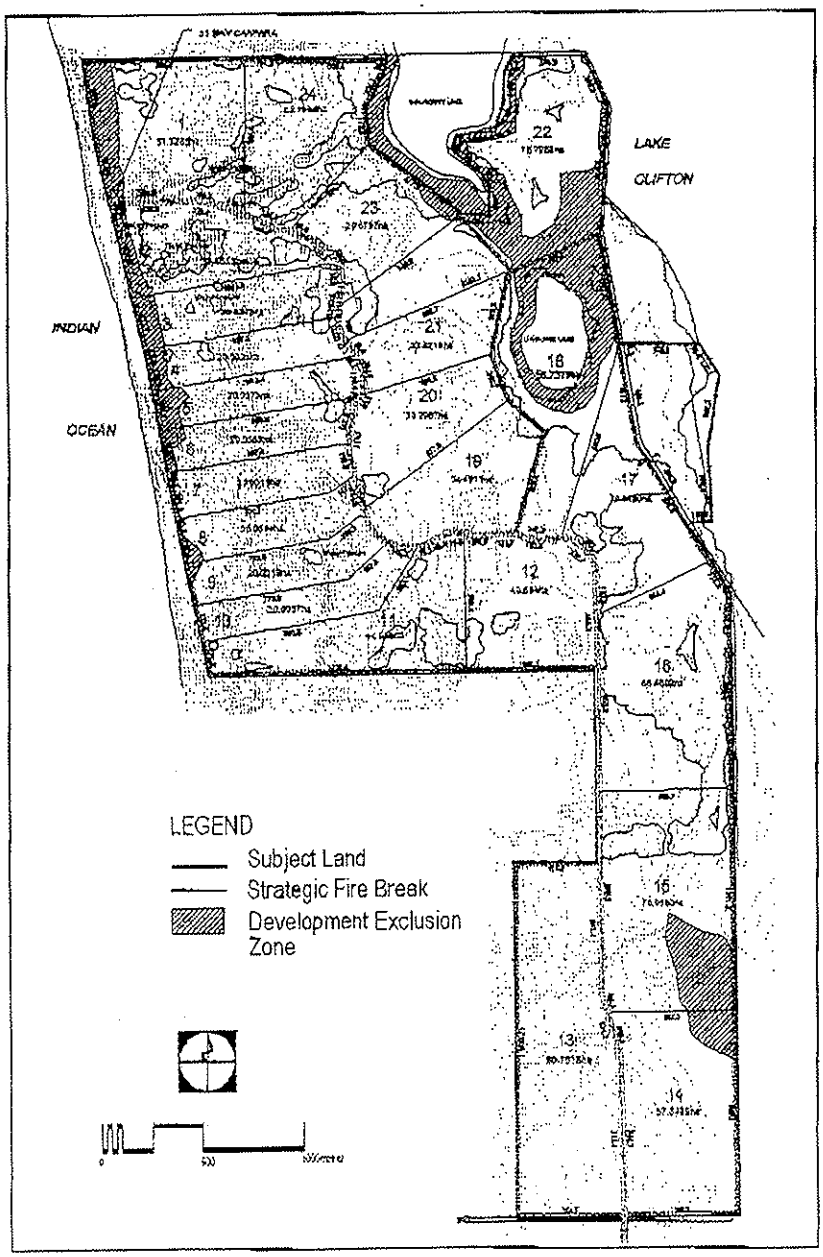

Figure 1:

Cape Bouvard Landholding Lake Clifton - Subdivision Design

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The proposed subdivision of the CBI property will result in the creation of 24 rural landholdings ranging in size from 20ha to 80ha, as shown in Figure 1.

The coastal portion of the landholding is proposed to be subdivided into nine 20ha lots, a 32ha incorporating existing water features and a 51ha lot located adjacent to Yalgorup National Park. Four larger lots (57 to 72ha) are proposed on the eastern portion of the landholding and are setback up to [redacted] from Lake Clifton. The central region of the landholding adjacent to Boundary Lake and Unnamed Lake is proposed to be subdivided into lots ranging from 22ha to 42ha.

A 'Development Exclusion Zone' is proposed along the coastal foreshore area and at the periphery of Boundary Lake and Unnamed Lake.

4. ALTERNATIVE OPTIONS CONSIDERED

Alternative options of the development of the CBI landholding have been investigated and have included the proposed sensitive development of the eastern portion of the landholding only comprising a cluster design with larger rural lots located adjacent to the wetland systems.

An Outline Development Plan (ODP) was prepared for the proposed development in 1998 and outlined the development design as follows:

- Development design incorporating wetland buffers, coastal setbacks, protection of Quindalup Dune landform and concentration of development in swales.
- Development to physically impact 15% of landholding, with remainder (85%) to be managed for conservation.
- Subdivision density determined by EPA criteria (Guidance Statement No. 28) to maintain a zero water balance and minimal nutrient outputs.
- Installation of fully reticulated sewer and water supply.
- Emphasis on sustainable development including energy efficient design.

In addition, a land exchange proposal was investigated by CBI which would result in the western portion of the landholding being exchanged for an equivalent area of land in Yalgorup National Park.

The City of Mandurah did not allow the ODP to be advertised and the proposed development was not progressed further.

5. BASIS FOR JUSTIFYING PROPOSAL AND SELECTING PREFERRED OPTION

The preferred option proposes to maintain development within the CBI landholding in accordance with current planning and environmental guidelines. In particular, the proposed subdivision of the land into rural lots ranging in size from 20ha to 80ha is in accordance with the current land use zoning for the site. In keeping with the previous development options considered by CBI the current proposal aims to protect the environmentally sensitive values of the site and surrounding area.

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6. REGIONAL SETTING OF PROPOSAL

The landholding encompasses 975.2ha and is bounded by the bushland and lakeland environs of Yalgorup National Park to the north, south and east and the coast to the west. The study area is situated in the City of Mandurah and is currently zoned 'Rural' under the Town Planning Scheme No. 1.

The study area comprises the varying landforms and vegetation of the Quindalup and Spearwood Dune Systems. Closest to the coast, the Quindalup Dunes include the primary and secondary dunes rising to 25m and extending 1-2km inland. These dunes are made up of a complex pattern of parabolic dunes of rapidly draining calcareous Safety Bay Sand. The coastal foreshore area, generally up to 100m inland, is relatively fragile and susceptible to erosion from wind and wave action. The vegetation of the Quindalup Dunes is characterised by mainly salt-tolerant heaths and closed scrubs.

Further inland the Quindalup Dunes give way to the interdunal flats and the gently undulating ridges of the Spearwood Dunes which extend to the western edge of Lake Clifton and the smaller wetlands of Boundary and Unnamed Lake. The Spearwood Dune System is made up of siliceous sands overlying Tamala Limestone. Vegetative cover is characterised by open forests of Jarrah, Marri and Tuart over Banksia species, Peppermint and Sheoak. The vegetation of the Spearwood Dune System are broadly categorised into the Cottesloe and Yoongarillup Vegetation Complexes, depending on the characteristic mix of tree species. The Yoongarillup Complex is located closer to Lake Clifton.

Areas of lagoonal deposits, known as Vasse Estuarine deposits, are located around the lake shore. These flats comprise highly saline soils subject to periodic inundation, and are important in supporting the ecology of the lake and shoreline.

The hydrology of the study area is dominated by underground water. There are no creek or other surface drainage systems, for the ground is permeable and conducive to infiltration rather than surface runoff. Three wetlands are located adjacent to the study area which are expressions of the water table with Lake Clifton and Boundary Lake permanently inundated. The smallest wetland, Unnamed Lake, is seasonally inundated and is identified as a 'Sumpland' type wetland rather than a Lake.

7. SUMMARY OF POTENTIAL ENVIRONMENTAL IMPACTS, THEIR SIGNIFICANCE AND POSSIBLE MANAGEMENT RESPONSES

The following environmental issues are considered relevant to the proposed development of the Cape Bouvard landholding:

- potential impact of clearing, housing, and access, fire breaks, increase disturbance
- Potential loss of flora and vegetation of conservation significance and associated impacts on fauna habitat. For example, previous investigations have determined that the study area supports:
  - FCT 26a which is listed as a Threatened Ecological Community at a State level (CALM, 2001).
  - FCT 25 and 29b which are classified as under-reserved and as susceptible or critically endangered in terms of their conservation status, respectively.
  - Two small populations of the Declared Rare mallee, *Eucalyptus argutifolia*.

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- Populations of the Priority 3 flora species, *Hibbertia spicata* ssp. *leptotheca* on limestone ridges.
- Populations of the Priority 4 flora species, *Hakea* sp. Yalgorup on limestone.
- Populations of the Priority 3 flora species, *Stylidium maritimum* were recorded in the adjacent National Park.
- Loss of habitat suitable for the Short-billed Black Cockatoo (Carnaby's Cockatoo), a Schedule 1 species.
- Potential impacts on Yalgorup National Park, including impacts on corridor and interface values.
- Potential impacts on Lake Clifton – surface and water quality, wetland vegetation, and thrombolites.
- Potential impact on karstic terrain, associated threatened rootmat communities and stygofauna.
- Potential impacts on the stability of the beach and the integrity, function and environmental values of the dune system.
- Potential impact on Aboriginal heritage.

The following potential management measures are proposed to minimise the potential impacts listed above. The measures will be reviewed as further environmental investigations of the study area are undertaken.

- Protection of Declared Rare Flora populations (*Eucalyptus argutifolia*) and TECs from clearing in the subdivision design.
- Provisions to minimise clearing of native vegetation (including significant fauna habitat and populations of Priority Flora) wherever possible through the implementation of restrictive covenants, provisions on the Scheme and/or subdivision conditions.
- Provision of appropriate setbacks from wetland areas and the coastal foreshore to development, including the designation of buffers to be addressed in the proposed subdivision.
- Identification of Aboriginal heritage site within the study area to be addressed in accordance with the Aboriginal Heritage Act.
- Management Strategies will be prepared to prevent impacts associated with fire, wastewater, vegetation clearing and weeds.

8. PROPOSED STUDIES AND INVESTIGATIONS

8.1 Vegetation and Flora

8.1.1 Background

Detailed flora and vegetation investigations of the eastern portion of the Cape Bouvard landholding were undertaken by Weston in 1998 and Trudgen in 1991 as part of surveys of the coastal region of the City of Mandurah. To date, no detailed flora and vegetation surveys of the western portion of the landholding have been completed.

Weston's investigations of the eastern portion of the landholding involved desktop and field surveys in late February and mid June 1998 to produce the following reports:

- *Vegetation Survey of the Eastern Part of Lake Clifton West (Location 4185 and parts of Locations 2240, 2275, 2657, 3045, 4981 and 5182),*

- *Potential Rare Flora in the Proposed White Hill Road to Lake Clifton West Access Road Route Corridor,*
- *Floristic Community Types in the Proposed White Hill Road to Lake Clifton West Access Road Route Corridor, and*
- *Comparisons of Vegetation, Flora and Rare Flora of Proposed Exchange Areas in Lake Clifton West and Yalgorup National Park.*

Although Declared Rare and Priority Flora searches were carried out by Weston (1998), no field work was undertaken during late winter, spring or early summer, when most rare flora species are expected to be flowering.

A flora and vegetation survey will be undertaken to expand the 1998 studies to the unmapped western portion of the landholding. The study will identify and map the vegetation types (diversity) and distribution of vegetation (including vegetation associations and floristic community types), list native and introduced flora including any Declared Rare, Priority and other significant flora recorded in the study area.

8.1.2 Proposed Further Studies

The following study methods are proposed for the western region of the landholding:

- Review of existing reports and species lists relevant to the surrounding area.
- Review of Department of Conservation and Land Management Declared Rare and Priority Flora databases.
- Conduct site investigations to identify flora and delineate vegetation ~~types~~ and condition.
- Identify and delineate Floristic Community Types in the study area and assess representation of these on the Threatened Ecological Community database.
- Compare the vegetation complexes, vegetation associations and floristic community types of the entire landholding with distributions in nearby reserves using available data.

The recommended timing of the site investigation is October to optimise the identification of ephemeral and annual species, particularly significant flora.

8.2 Fauna

8.2.1 Background

A vertebrate fauna survey of the eastern portion of the Cape Bouvard landholding and the proposed land exchange parcel in Yalgorup National Park was undertaken by ATA Environmental in June 1998. The survey involved a systematic trapping program, bird surveys, active searching and opportunistic observations of all major habitats within the CBI landholding and the Yalgorup National Park study area.

Although the ATA Environmental fauna survey did not include the western portion of the CBI landholding, this area comprises similar fauna habitat (Quindalup Dunes interspersed with areas of limestone) to that assessed as part of the Yalgorup National Park study area. As a result, this information will provide baseline data of species expected to occur within the western portion of the CBI landholding. Habitat such as the Peppermint Woodlands of

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the Quindalup Dunes found in the CBI landholding, but not in the Yalgorup NP study area will be assessed as part of further investigations and may yield additional species.

8.2.2 Proposed Further Studies

A vertebrate fauna survey will be undertaken of the property, particularly focussing on the areas of the property that were not investigated during the previous June 1998 survey. It is intended that some sites within habitats that were previously surveyed also be surveyed to record species more active in the warmer months.

The survey will include a review of the Museum and CALM databases to identify any species of significance that are known from the area.

The survey will comprise a trapping program involving pit fall, cage and Elliott traps as well as a systematic recording of bird species in all of the major habitats (ie. dominant vegetation types). It is expected that a minimum of 5 sites will be intensively surveyed with about 8-10 pit fall (with drift fences), 6-10 cage and 20-25 Elliott traps located at each. Active searching such as checking under rocks, leaf litter and logs, night spotlighting and recording of bat calls will also be undertaken.

The findings of the fauna survey will be compiled to produce a list of recorded species; a list of species predicted to occur; an assessment of the significance of any rare and endangered species; identification of species present that are vulnerable to disturbance or loss of habitat; and a comparison with available survey data from other locations in the area.

The survey will be carried out over a standard 5-night period in late November or December 2002. This timing should be highly suitable for recording a range of reptiles and small mammals as well as a variety of birds.

It is intended the vertebrate fauna survey be carried out by ATA Environmental with assistance from Bamford Consulting Ecologists.

8.3 Hydrology

The nature of the Lake Clifton environment requires that any development in the Lake Clifton catchment has minimum adverse impact on the lake. The EPA (1998) identifies the following key factors as relevant in protecting the lake:

- Water balance – new developments are to be managed to maintain the existing water balance.
- Nutrient loads – new developments are to be managed so that phosphorus and nitrogen export to the lake are negligible.
- Regionally significant wetlands - new developments are to managed so that direct impacts of humans and stock so not cause physical damage to the thrombolites, wetland vegetation, fringing wetland vegetation and dryland buffer around Lake Clifton.

Ultramafics Pty Ltd was engaged in 1997 to investigate the environmental hydrology of the study area including a review of the infiltration and movement of groundwater across the

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area, seepage discharge, as well as upon lake and groundwater interactions. The investigation provided background and baseline data (with hydrological interpretation) to determine the implications of the then proposed cluster and part rural lot development of the land.

The following additional investigations were recommended by Ultramafics (1997) and are considered relevant to the proposed rural development of the landholding:

- Monitor the water levels in the monitor bores each month to determine the seasonal water-table fluctuations.
- Monitor the lake water levels to observe the peak and seasonal changes.
- Assess the capacity of the fringing vegetation to accept and assimilate nutrient loads carried in the groundwater percolating in from the property.
- Assess the capacity of the soils – Safety Bay Sand and Tamala Limestone – to strip nutrients (including orthophosphate, nitrate and ammonium) from infiltrating wastewaters (whether from water treatment facilities or other sources).
- Confirm hydrochemical data on nutrients by collection and analysis of a new set of shallow groundwater samples from some of the monitor bores.
- Investigate the potential and capacity for groundwater abstraction in the study area to ensure no deleterious effects from over-pumping.

o Investigate Transect locations x

8.4 Karstic Terrain, Stygofauna and Root Mat Communities

8.4.1 Background

Karstic terrain is often host to subterranean fauna including terrestrial (troglobites) and aquatic (stygofauna) species. Small solution cavities allow the movement of groundwaters and subterranean fauna through the limestone rock. These fauna are highly specialised to living in cave conditions and are considered 'rare' by the scientific community because of their restricted habitat. They are very sensitive to changes in atmospheric conditions of the cavity, fluctuations in water levels (particularly lowering) and the quality of the groundwater flowing through. In addition, the fauna are affected by disturbance to surface vegetation as certain tree roots and root mats are known to be important permanent food source for stygofauna.

ATA Environmental conducted site investigations in June 1998 to assess the potential for karst development on the eastern portion of the CBI landholding. The study determined that some areas, particularly in the more rugged and higher relief terrain comprised solution cavities indicative of karst development. No caves were located at the site, however their presence was not discounted, and was considered highly likely. Further supporting evidence was found in the hydrology study (Ultramafics, 1997) where during the installation of a monitoring bore (west of Boundary Lake) a significant open discontinuity, possibly a solution cavity was detected.

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8.4.2 Proposed Further Studies

A geotechnical appraisal and assessment of risk (including a drilling program) would need to be undertaken to further assess karstic terrain on the site.

The geotechnical appraisal of the site would involve a field reconnaissance and drilling at select locations using an Electric Friction Cone penetrometer (EFCP) and Air Core boreholes. These investigations will determine the presence of features associated with karstic terrain. If karst terrain is identified at the site an assessment of risk will be undertaken as there major implications for land use potential and development. Management procedures will be identified to reduce the risks associated with karst features such as avoiding potentially dangerous land uses and reducing impacts associated with the concentration of surface water runoff and changes to groundwater levels.

8.6 Coastal Processes

8.6.1 Background

A Foreshore Management Strategy for the CBI landholding was prepared by ATA Environmental in 1998. The Strategy identified appropriate measures for the long-term management of public use and access, landscape protection, stabilisation and rehabilitation requirements in the foreshore area.

8.6.2 Proposed Further Studies

Further investigations are required to determine the appropriate setbacks to development taking into account the general requirement for a minimum setback of 100m with provision for increase where there is evidence of natural coastal recession (WAPC, 1999). According to the Coastal and Lakelands Planning Strategy (WAPC, 1999) most of the shoreline in the study area has been experiencing erosion (1955-1982). A review of the coastal process and long-term trend of shoreline movement will confirm these findings and assist in identifying appropriate setbacks to development.

8.7 Aboriginal Heritage

8.7.1 Background

A review of the Aboriginal Sites Register was conducted in 1998 and revealed 17 sites within the general area. Six sites are located in close proximity to the study area and are of varying archaeological importance comprising artefact scatters of fossiliferous chert flakes and quartz chips.

8.7.2 Proposed Further Studies

Site specific archaeological and ethnographic investigations are proposed to be undertaken to ensure all relevant Aboriginal interest groups are consulted to identify sites and implement appropriate management measures where necessary.

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9. ENVIRONMENTAL FACTORS RELEVANT TO THIS PROPOSAL

Please refer to Appendix 1 for the environmental factors relevant to this proposal.

10. APPLICABLE LEGISLATION

Legislation relevant to the subdivision of the CBI landholding includes:

- Environmental Protection and Biodiversity Conservation Act, 1999
- Environmental Protection Act, 1986
- Soil and Land Conservation Act, 1945
- Wildlife Conservation Act, 1950
- Aboriginal Heritage Act, 1980
- Peel Region Scheme, 1999
- City of Mandurah Town Planning Scheme.

11. COMMUNITY AND OTHER STAKEHOLDER CONSULTATION PROGRAM

During the development of an Outline Development Plan in 1998, Cape Bouvard Investments sought community feedback for the original development proposal through public advertising and five public meetings.

In addition, this period of consultation involved close liaison, including on-site meetings with relevant government agencies including the Department of Planning and Infrastructure (formerly Ministry for Planning), CALM, Department of Environmental Protection, Water and Rivers Commission, Water Corporation, and the City of Mandurah. Furthermore, CBI held briefings with the then Minister for Planning and the then Minister for the Environment, WA Planning Commission, National Parks and Nature Conservation Authority, Mr Arthur Marshall MLA and Mr John Bradshaw MLA.

The revised development proposal involving the subdivision of the landholding into rural lots is significantly different to the ODP. As a result, CBI proposes to initiate consultation with representatives of all relevant agencies identified above and commence a period of community consultation to obtain community comments and suggestions.

In addition, CBI proposes to undertake consultation with appropriate Aboriginal groups to determine if there are any sites of significance within the project area.

12. PROJECT AND ASSESSMENT SCHEDULE

The proposed development of the Cape Bouvard landholding at Lake Clifton has been actively pursued since 1998. Extensive research has been undertaken in the areas of environment, hydrology, flora and vegetation, fauna and sustainable planning for the previous development proposals for the property. Studies completed prior to submission of this Scoping document which address part or all of the property are listed as follows:

- Development construction and access road options (Gutteridge Haskins and Davey, 1998)

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- Environmental assessment (ATA Environmental, 1998)
- Various flora and vegetation surveys (Weston, 1998)
- Fauna surveys (Bamford Consulting Ecologists and ATA Environmental, 1998)
- Environmental hydrology (Ultramafics, 1998)
- Karstic appraisal (ATA Environmental, 1998)
- Desktop Aboriginal heritage assessment (ATA Environmental, 1998)
- Coastal management (ATA Environmental, 1998)
- Planning reports (including statutory planning reports) (The Planning Group; Jones Coulter Young, 1998)
- Community vision and conceptual community development plan (Creating Communities, 1998)

At present, the future timing for project implementation is largely dependent on environmental and planning approval processes, both at the state and local level. Subject to all issues being resolved, it is CBI's intention to commence subdivision of the property in [redacted].

Where necessary, all additional survey work identified in Section 8 will be undertaken at an appropriate time of year.

13. PEER REVIEW

Peer review is not considered necessary as the use of expert consultants followed by the document being reviewed by the relevant government agencies would appear to adequately ensure that the information provided is correct.

14. STUDY TEAM

The project will be managed by Mr Gary Godfrey of Cape Bouvard Investments. The preparation of the PER will be undertaken by a suitably qualified consultant in accordance with the scoping brief to be provided by the DEP.

Previous investigations have involved the following team of consultants:

Environmental:	ATA Environmental
Planning:	The Planning Group, Jones Coulter Young and Roberts Day Group
Hydrological:	Ultramafics
Engineering:	Gutteridge Haskins and Davey
Flora and Vegetation:	Mr Arthur Weston and ATA Environmental
Fauna:	Mr John Dell and ATA Environmental
Community Design:	Creating Communities

15. REFERENCES

Alan Tingay & Associates. (1998) Foreshore Management Strategy / Aboriginal Heritage Study

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Alan Tingay & Associates. (1998) Karstic Terrain Appraisal, Lake Clifton Land Exchange Proposal.

Alan Tingay & Associates. (1998) Vertebrate Fauna Assessment Proposed Land Exchange Areas in Lake Clifton West and Yalgorup National Park.

Trudgen, M.E. (1991) A Flora and Vegetation Survey of the Coast of the City of Mandurah. Prepared for the Department of Planning and Urban Development.

Western Australian Planning Commission (1999) Coastal and Lakelands Planning Strategy (Dawesville – Binningup).

Weston, A. (1998) Comparisons of Vegetation, Flora and Rare Flora of Proposed Exchange Areas in Lake Clifton West and Yalgorup National Park.

Weston, A. (1998) Floristic Community Types in the Proposed White Hill Road to Lake Clifton West Access Road Route Corridor.

Weston, A. (1998) Potential Rare Flora in the Proposed White Hill Road to Lake Clifton West Access Road Route Corridor.

Weston, A. (1998) Vegetation Survey of the Eastern Part of Lake Clifton West (Location 4185 and parts of Locations 2240, 2275, 2657, 3045, 4981 and 5182.

Ultramafics. (1998) Environmental Hydrology – Cape Bouvard Landholding Lake Clifton.

NO. 934 D01

APPENDIX 1

ENVIRONMENTAL FACTORS

NO. 934 D018

APPENDIX 1 – ENVIRONMENTAL FACTORS

Environmental Factor	Environmental Objective	Potential Impact	Additional Investigations	Potential Management
Flora and Vegetation	To ensure that the proposed rural development is compatible with maintaining and enhancing the biological integrity of the surrounding environmental and minimising vegetation loss and degradation.	Clearance of vegetation for the construction of building envelopes, access roads and to meet FESA and LGA requirements for fire management.	Undertake additional flora and vegetation survey.	Clearly delineate building envelopes and limits of clearing. Cleared native vegetation from the site to be used to assist with rehabilitation, where required.
Significant Flora	To protect Declared Rare and Priority Flora consistent with the provisions of the Wildlife Conservation Act, 1950.	Potential direct and indirect impacts on stands of *Eucalyptus argutifolia* (DRF), *Hibbertia spicata* ssp. *leptotheca* (P3), *Hakea* sp. Yalgorup (P4) and *Stylidium maritimum* (P3).	Undertake additional flora and vegetation survey of the study area to delineate populations of DRF and Priority Flora. RHD significant flora	Delineate populations of significant flora and manage in accordance with recommendations of CALM.
Significant Vegetation	Not to have an negative impact on the survival of any endangered Threatened Ecological Communities.	Potential direct and indirect impacts on FCT 26a.	Undertake a flora and vegetation survey to delineate Threatened Ecological Communities.	Delineate stands of TECs and manage in accordance with recommendations of CALM.
Vertebrate Fauna	To have no negative impacts on fauna known to occur in the area.	Potential clearance of vertebrate fauna habitat.	Undertake a vertebrate fauna survey of the property, particularly focussing on the areas of not investigated during the previous June 1998 survey. Previously surveyed habitats will also be surveyed to record species more active in the warmer months.	Clearing to be undertaken in a progressive manner to ensure corridors are maintained for mobile fauna.
Threatened Fauna	To protect Specially Protected (Threatened) Fauna consistent with the provisions of the Wildlife Conservation Act, 1950.	Potential clearing of Threatened Fauna (ie Carnaby's Cockatoo) habitat.	Vertebrate fauna survey to be undertaken to identify species of Threatened Fauna in the study area.	Clearing to be undertaken in a progressive manner to ensure corridors are maintained to mobile fauna. Relocation of Threatened species (ie Bandicoots) to be considered.

Not adequate!!
Upland area in regional perspective!!
should be much more than just threatened fauna!

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NO. 934 0019

Environmental Factor	Environmental Objective	Potential Impact	Additional Investigations	Potential Management
Wetlands	Protect the environmental values and maintain or enhance the key ecological functions of the wetlands.	Potential changes to water levels and water quality of Lake Clifton, Boundary Lake and Unnamed Lake. Potential physical impacts on wetlands as a result of increased pressure.	Undertake a detailed hydrological study of the area including additional groundwater modelling to be undertaken – refer to Section 8.3.	Development to be setback from wetlands. Measures to maintain zero water balance to be considered include selective groundwater extraction. Restriction of native vegetation clearing to designated areas.
Groundwater	Maintain or improve the quality of the groundwater to ensure that existing and potential uses, including ecosystem maintenance are protected.	Potential changes to water balance and nutrient loading as a result of development.	Undertake a detailed hydrological study of the area including additional groundwater modelling to be undertaken – refer to Section 8.3.	Implementation of Water sensitive design. Controls on landuse and fertiliser application.
Karstic Terrain	Minimise the potential impact on caves and other karst landforms in the area	Portions of site comprise solution cavities indicative of karst development. Potential changes in water levels and quality might impact on stygofauna. Potential safety risks associated with development of karstic terrain.	Geotechnical appraisal (including a drilling program) and risk assessment to be undertaken to delineate areas of karst terrain.	Restrict development in high risk areas. Development Karst Management Plan.
Stygofauna and Rootmat Communities	Minimise the potential impact on stygofauna and rootmat communities associated with karstic terrain.	Indicative areas of karst development may support subterranean fauna and rootmat communities. Potential changes in water levels and quality might impact on stygofauna.	Geotechnical appraisal (including a drilling program) and risk assessment to be undertaken to delineate areas of karst terrain and potential stygofauna and rootmat communities.	Investigate development options in areas identified as supporting stygofauna and rootmat communities.
Coastal Processes	Maintain the stability of the beach and the integrity, function and environmental values of the dune system.	Development adjacent to the coast will increase pressure on this area. Coastal processes to be addressed when determining appropriate setbacks to development.	Further investigations to be undertaken to determine appropriate setbacks to development.	Prepare a Foreshore Management Plan to address increased human use of the coastal area.
Aboriginal Heritage	To ensure that there is no unauthorised disturbance to Aboriginal Heritage sites associated with the proposed rural development	Six sites have been recorded in close proximity to the study area. Development may impact Aboriginal sites which may be present at the site.	Site specific archaeological and ethnographic investigations are proposed to be undertaken to identify sites and consult Aboriginal interest groups.	Management of any identified sites of significance to Aboriginal people to be in accordance with the requirements of the Aboriginal Heritage Act.

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COMPARISONS OF VEGETATION, FLORA AND RARE FLORA OF PROPOSED EXCHANGE AREAS IN LAKE CLIFTON WEST AND YALGORUP NATIONAL PARK

CITY OF MANDURAH

CONFIDENTIAL

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SUMMARY

This report describes and compares vegetation types and floras and the results of rare flora surveys of parts of two properties south of White Hill Road and west of Lake Clifton. It is proposed that one part, which is privately owned, be exchanged for the other part, which is in a national park.

The proposed exchange areas are the eastern part of Lake Clifton West and a part of Yalgorup National Park immediately north of the western part of Lake Clifton West. The former proposed exchange area is approximately 500 ha, and the latter is approximately 225 ha.

The Lake Clifton West proposed exchange area is mainly between stable Quindalup dunes and the western shore of Lake Clifton, although its western side has some Quindalup landform. An enclave of tuart and peppermint forest in the eastern part of the area is not part of the exchange area.

The Yalgorup National Park proposed exchange area is mainly stable Quindalup dune landform between coastal mobile dunes and the proposed route for an access road from White Hill Road to Lake Clifton West. The property also has relatively small representations of mobile dune and blowout landforms and small enclaves of limestone.

Vegetation
Beard's 1:250 000 scale 1979 vegetation map (Beard 1979) shows the Yalgorup National Park proposed exchange area as all Coastal Heath and Thicket while the Lake Clifton West proposed exchange area has Coastal Heath and Thicket formation, Tuart Woodland (e_4Mi) association and formation and Paperbark (*Melaleuca rhaphiophylla* and *M. cuticularis*) association, though only small amounts of Paperbark and Coastal Heath and Thicket. The *Melaleuca acerosa* Heath on Limestone (m_4Zc) shown nearest the study areas is north of Lake Clifton, but this association/formation is the best-represented one in the Lake Clifton West proposed exchange area.

The 1:250 000 scale vegetation map by Heddle *et al.* (1980). has three vegetation complexes in the study areas, but they are not coincident with Beard's plant formations or associations. These three vegetation complexes are Quindalup Coastal Dune Complex (55), Cottesloe Complex – Central and South (52) and Yoongarillup Complex (56). Complexes 55 and 52 are in the Yalgorup National Park proposed exchange area, and Complexes 52 and 56 are in the Lake Clifton West proposed exchange area.

The 1:20 000 scale maps by Weston, based upon Trudgen (1991) and additional field work, show 13 vegetation units in the Yalgorup National Park proposed exchange area and 34 units in the Lake Clifton West proposed exchange area, plus complexes. But one of the 13 units is in a conservation zone outside the Yalgorup National Park proposed exchange area.

Each legend on Weston's Map 1 and Map 2 groups the vegetation by landform and vegetation complexes that follow Trudgen (1991) and Wells and Hesp (1989). There are five groupings for each map, but the sets of groups differ from each other. All of the Map 2, Yalgorup National Park proposed exchange area, groupings are Quindalup, and most of the Map 1, Lake Clifton West proposed exchange area, groupings are Spearwood and Vasse (or Yoongarillup).

The first Map 2 group, Strand/Foredunes, is in a proposed protection/conservation zone and three other Map 2 groups, Younger Dunes and Swales and Blowouts, Limestone and Shallow Sand over Limestone, and Peppermint mainly on or near Qb landform, would also be protected and would be largely or totally excluded from development.

Floristic Community Type 29b, *Acacia* shrublands on taller Quindalup dunes, is the principal, possibly the only, described Floristic Community Type in the Yalgorup National Park proposed exchange area, but Type 27 may apply to the *Dryandra sesilis* scrub on limestone enclaves.

The Lake Clifton West proposed exchange area has Floristic Community Type 26a, *Melaleuca huegelii – M. acerosa* shrublands of limestone ridges, Type 25, Southern *Eucalyptus gomphocephala – Agonis flexuosa* woodlands, and , probably, Type 27, Species poor mallees and shrublands on limestone.

The original Gibson *et al.* (1994) southern Swan coastal plain study sampling of seasonal wetlands did not adequately represent their great heterogeneity. Also, because the study was mostly limited to public lands, it undersampled Quindalup dunes, where there are few reserves and little other public land (Keighery 1997). Consequently, floristic community types may not have been defined for some of the seasonal wetland and Quindalup dune vegetation.

Significance of Vegetation Types
Three of the Floristic Community Types in the study areas, Types 25, 26a and 29b, are classified as under-reserved and as susceptible or critically endangered. All three are proposed for inclusion on the Threatened Ecological Community Database (English and Blyth 1997).

The *Eucalyptus argutifolia* communities in the Lake Clifton West proposed exchange area are also significant, especially the largest one, which is similar to Type 26a, if not included in it.

Floristic Community Type 29b, provisionally recorded mainly in the Yalgorup National Park proposed exchange area, and Type 25, provisionally recorded only in the Lake Clifton West proposed exchange area, are classified as poorly reserved and susceptible (Gibson *et al.* 1994).

Floristic Community Type 26a, of the Lake Clifton West proposed exchange area, is considered to be poorly reserved and critically endangered (Weston and Gibson 1997).

Condition of Vegetation
The condition of vegetation in the Yalgorup National Park proposed exchange area is generally good to very or better, but swales range from very good to, more commonly, degraded due to infestation of weeds, primarily *Trachyandra divaricata* (false onion weed). Most swales have a mixture of herbaceous plants, often sedges, and *Acacia rostellifera* shrubs under 50 cm tall, which are regenerating after having been killed back by frost (O'Brien pers. comm.). Killed *Acacia* and other natives have, however, apparently been replaced in the bottoms of many swales by dense growths of *Trachyandra divaricata*.

Weeds are much more widespread and abundant in the Lake Clifton West proposed exchange area. *Trachyandra divaricata* is particularly abundant west and south of Boundary Lake and on sand on the western side of the study area, often with weedy grasses and other herbaceous weeds. It is common in patches on limestone, but other, smaller weed species are more widespread but less conspicuous there. Map 1 shows a few areas as C and AfC, which are almost devoid of native plants (except for clumps of peppermint in the latter).

Flora
One hundred and thirty-two (132) taxa (species, subspecies and varieties) of vascular plants were recorded during the study, of which 17 were not listed by Trudgen (1991). The number could be increased significantly by botanising in spring at times when most of the herbaceous plants are in flower.

One hundred and eight (108) taxa were found in the Lake Clifton West proposed exchange area and 71 were found in the Yalgorup National Park proposed exchange area. Twenty-four (24) are established aliens, 20 of which were found in the Lake Clifton West proposed exchange area and 10 in the Yalgorup National Park proposed exchange area.

Significant Flora
The seven significant species and subspecies recorded during the study, their conservation codes and the proposed exchange areas in which they were recorded are:

Acacia truncata (Yalgorup form)	--	*YNP*	*LCW*
Astroloma microcalyx	--	*YNP*	
Eucalyptus argutifolia	DRF, T		*LCW*
Hakea sp. Yalgorup	Priority 4	*YNP*	*LCW*
Hibbertia spicata subsp. *leptotheca*	Priority 3		*LCW*
Leptomeria ellytes	--		*LCW*
Stylidium maritimum	Priority 3	*YNP*	

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COMPARISONS OF VEGETATION, FLORA AND RARE FLORA OF PROPOSED EXCHANGE AREAS IN LAKE CLIFTON WEST AND YALGORUP NATIONAL PARK

CITY OF MANDURAH

1.0 INTRODUCTION

This report describes and compares vegetation types and floras and the results of rare flora surveys of parts of two properties south of White Hill Road and west of Lake Clifton. It is proposed that the part of one property, which is privately owned, be exchanged for part of the other property, which is Yalgorup National Park.

1.1 LOCATION

The proposed exchange areas are the eastern part of the Lake Clifton West property and a part of Yalgorup National Park that lies immediately north of the western part of Lake Clifton West. The former proposed exchange area is approximately 500 ha, and the latter is approximately 225.

The Lake Clifton West proposed exchange area is mainly between stable Quindalup dunes and the western shore of Lake Clifton, although its western side has some Quindalup landform. An enclave of tuart and peppermint forest in the eastern part of the area is not part of the exchange area, but it is included within the study area.

The Yalgorup National Park proposed exchange area is mainly stable Quindalup dune landform between coastal mobile dunes and the proposed route for an access road from White Hill Road to Lake Clifton West. The property also has relatively small representations of mobile dune and blowout landforms and small enclaves of limestone (see Section 3.5 for more detail on landforms and geomorphic elements).

The proposed exchange areas are shown in Maps 1 and 2 of this report, along with some relatively small adjoining areas which, while not part of the proposed exchange, are included in the study areas (see Section 3.1.3, Trudgen and Weston Vegetation Units).

1.2 OBJECTIVES

The objectives of this study are to:

- describe, briefly, the vegetation of the two proposed exchange areas and to compare the areas in terms of the kinds and diversity of their vegetation,
- list the flora of the two proposed exchange areas and to compare the areas in terms of the richness of their floras, and
- describe the results of searches for Declared Rare and Priority Flora and other significant plants and vegetation types in the two proposed exchange areas.

2.0 METHODS

The study was undertaken in the following series of overlapping and interrelated stages:

- preparation for field work, including consultations, the gathering and collation of available information and interpretation of aerial photography,
- field work to record and collect flora, determine parameters and distributions of vegetation units and search for significant flora,
- follow-up work, including identification and herbarium confirmations of plants recorded and collected during field work,
- comparison and integration of previously available information with the results of the field work, and
- report preparation.

2.1 PREPARATION

Preparation for field work entailed provisional description, listing and mapping of vegetation of the study areas, finding existing flora lists for the general area and preparing a table of significant flora to be searched for during field work. Methods and representative sites for field work were chosen during this preparation stage.

Major sources used for information on vegetation, flora and rare flora were Trudgen (1991, 1997). Other sources are listed in the following three sections and in three reports prepared prior to June field work (Weston 1998a,1998b, 1998c).

2.1.1 Vegetation

Provisional description, listing, mapping and understanding of vegetation of the study areas were based primarily upon aerial photography and various publications, reports and maps.

Pairs of colour contact prints from three sets of aerial photography were examined stereoscopically under magnification. Two of the sets were 1:20 000 scale Metro Regional Area aerial photography flown, in one case, in January 1997 and, in the other, in January 1998. The third set was 1:10 000 scale aerial photography flown for Cape Bouvard Investments in May 1998 by Kevron Aerial Surveys.

Reports, publications and maps used in provisional description, listing, mapping and understanding of vegetation of the study areas include Beard (1979, 1981), Heddle *et al.* (1980), Fox *et al.* (1980), Churchward and McArthur (1980), Wells (1989), Weston and Gibson (1997), Trudgen (1991), Gibson *et al.* (1994), Keighery (1997) and Department of Environmental Protection (1996).

Trudgen's system of vegetation classification and a slight modification of it were chosen as the bases for this study. This was done primarily because Trudgen's system is the one which was used previously for large scale mapping of vegetation in both study areas (Trudgen 1991) and because it gives much greater detail in both description and mapping than any other treatment of vegetation of the area.

Background and more details about systems of vegetation classification and description in the Yalgorup National Park area, including the two study areas, are given in Weston (1998c). In particular, the Weston report compares Trudgen's system and the Floristic Community Type system of Gibson *et al.* (1994).

2.1.2 Flora

Two principal lists of flora covering at least parts of the study areas, Fox *et al.* (1980) and Trudgen (1991), were used to get an appreciation of the types and range of plants which might be found in the study areas. Although none of the species lists for the permanent CLIF, ELLIS, NPRES, PRES, WHILL and YALG plots used in the Gibson study (Gibson *et al.* 1994) is for any site in the study areas, several of the plots were nearby. Consequently, a large proportion of the species on the lists can be expected to occur in the study areas.

2.1.3 Significant Flora

The first phase of the significant flora part of the study was preparation of a table of Declared Rare Flora, Priority Flora and other significant flora with distributions that may include the general area. This table was prepared from the CALM printouts in Appendix 1 of the report by Trudgen (1997), from confirmation of these printouts from the December 1997 update of the CALM annual rare flora database and from the other sources described in Appendix A of this report. This table, Appendix A's Table A1, lists 22 species and subspecies, along with conservation codes, distributions, localities, growth forms, habitats and flowering times.

The second phase of the project, determining which species listed in Table A1 might occur in the project area, was done by comparing information in Table A1 (and in supplementary sources), particularly about habitats, with vegetation and map information referred to in Section 2.1.1.

2.1.4 Significant Vegetation

The two publications that provide information about conservation and reservation status of vegetation types in the general area, Gibson *et al.* (1994) and English and Blyth (1997), do so for floristic community types. Codes for conservation and reservation status provided by Gibson *et al.* (1994) of floristic community types in the Yalgorup National Park area are listed in Appendix C's Table C1. The floristic community types proposed by English and Blyth (1997) for inclusion on the Threatened Ecological Community (TEC) Database are also indicated in the table.

2.2 FIELD WORK

The field work component of the study was carried out during two periods: 26-27 February 1998 and 14-16 June 1998. The Lake Clifton West proposed exchange area was studied during both periods, the Yalgorup National Park proposed exchange area during the June period. Methods and results of the first field work are described in Weston (1998a).

Vegetation and flora were recorded at series of representative sites and transects in both proposed exchange areas, and provisional vegetation descriptions and map boundaries were confirmed and revised. Recording of vegetation was concentrated in areas not mapped by Trudgen.

Most plants were identified in the field, with help from species lists collected during the preparation stage and descriptions in Marchant *et al.* (1987), Hussey *et al.* (1997) and other floras. Voucher specimens of plants not readily identifiable in the field were collected and pressed.

2.3 AFTER FIELD WORK

Pressed plant specimens were dried and fumigated in the Western Australian Herbarium in South Perth, then identified by comparing them with specimens in Herbarium collections, checking them against keys and descriptions in floras and taxonomic works and consulting other botanists.

The provisional vegetation boundaries and descriptions were refined and finalised.

3.0 RESULTS

This section compares the two proposed exchange areas in terms of vegetation types, significance and condition in each and numbers of plant species, particularly significant species. It also compares the two areas in terms of their types and numbers of geomorphic elements, as shown by Wells and Hesp (1989).

3.1 VEGETATION

The vegetation of the two proposed exchange areas is compared below in reference to maps by Beard, Heddle, Trudgen and Weston and in terms of representation of Floristic Community Types. Condition of the vegetation in the two areas is also compared.

3.1.1 Beard's Plant Formations and Associations

According to Beard's 1:250 000 scale 1979 vegetation map (Beard 1979), one vegetation unit is represented in the Yalgorup National Park proposed exchange area, and three are represented in the other proposed exchange area.

Beard's map shows two plant formations and two plant associations in the study areas and another association/formation nearby. The ones in the study areas are Coastal Heath and Thicket formation, Tuart Woodland (e_4Mi) association and formation and Paperbark (*Melaleuca rhaphiophylla* and *M. cuticularis*) association. The Yalgorup National Park proposed exchange area is all Coastal Heath and Thicket, while the Lake Clifton West proposed exchange area has all the formations and associations, though only small amounts of Paperbark and Coastal Heath and Thicket.

The *Melaleuca acerosa* Heath on Limestone (m_4Zc) shown nearest the study areas is north of Lake Clifton, but this association/formation is the best-represented one in the Lake Clifton West proposed exchange area.

3.1.2 Heddle's Vegetation Complexes

According to the 1:250 000 scale vegetation map by Heddle *et al.* (1980) there are two vegetation complexes in each of the two proposed exchange areas.

The map by Heddle *et al.* has three vegetation complexes in the study areas, but they are not coincident with Beard's plant formations or associations. These three vegetation complexes are Quindalup Coastal Dune Complex (55), Cottesloe Complex – Central and South (52) and Yoongarillup Complex (56). Complexes 55 and 52 are in the Yalgorup National Park proposed exchange area, and Complexes 52 and 56 are in the Lake Clifton West proposed exchange area.

3.1.3 Trudgen and Weston Vegetation Units

Maps 1 and 2 show vegetation units of the study areas based upon Trudgen (1991), but with a modified system of symbols. Map 1, of the Lake Clifton West proposed exchange area, has many changes and additions from Trudgen's map, while Map 2, of the Yalgorup National Park proposed exchange area, has few changes and no additions. Some of the symbols used on Map 1 and Map 2 for vegetation units have been modified for the sake of rationalisation and consistency.

The symbols used on Maps 1 and 2 and Trudgen's counterparts for them are listed in Table C. The species to which the symbols refer are dominants in the associations the symbols represent. Each symbol and the species it represents are listed on the maps and in Table C5. Definitions and descriptions of most of the mapped units are given in Trudgen (1991) and Weston (1998a) and are summarised in Table C4. Few of the vegetation units on one map are the same as vegetation units on the other.

The 1:25 000 scale map by Trudgen (1991) shows 13 vegetation units in the Yalgorup National Park proposed exchange area and 27 in the Lake Clifton West proposed exchange area. Trudgen did not, however, map the vegetation of most of the Lake Clifton West proposed exchange area limestone, which covers much more than half of the Lake Clifton West proposed exchange area. Where Trudgen has mapped vegetation for large areas of limestone, the vegetation units are numerous and diverse.

The 1:20 000 scale map by Weston (1998a) and Map 1 in this report show 34 Trudgen type units in the Lake Clifton West proposed exchange area, plus complexes. Map 2, of the Yalgorup National Park proposed exchange area, shows 13 vegetation units. However, one, Unit Sh, is in a conservation zone outside the Yalgorup National Park proposed exchange area, and one of Trudgen's units, Unit Al, has been absorbed into its neighbour, Unit LT (which equals Weston Unit LmSg). This leaves a total of 12 vegetation units in the Yalgorup National Park proposed exchange area.

The few isolated tuart trees in the Yalgorup area, some of which were probably planted, did not cover large enough areas to be considered vegetation units. They were not mapped by either Trudgen or Weston.

Each legend on Map 1 and Map 2 groups the vegetation by landform and vegetation complexes that follow Trudgen (1991) and Wells and Hesp (1989). There are five groupings for each map, but the sets of groups differ from each other. All of the Map 2, Yalgorup National Park proposed exchange area, groupings are Quindalup, and most of the Map 1, Lake Clifton West proposed exchange area, groupings are Spearwood and Vasse (or Yoongarillup).

The first Map 2 group, Strand/Foredunes, is in a proposed protection/conservation zone and three other Map 2 groups - Younger Dunes and Swales and Blowouts, Limestone and Shallow Sand over Limestone, and Peppermint mainly on or near Qb landform - would also be protected and would be largely or totally excluded from development.

3.1.4 Gibson Floristic Community Types

Floristic community types (FCTs) have not been mapped for the Yalgorup National Park area, or anywhere else nearby, but there are 22 FCT quadrats in the Yalgorup National Park area (Gibson *et al.* 1994; Keighery 1997). They cover nine floristic community types (13, 17, 18, 21a, 26a, 26b, 27, 29a and 29b), all of which are listed in Weston (1998c) and Table C1 of Appendix C to this report. Two other FCTs believed to be represented in the Yalgorup National Park area, Types 19 and 25, are also listed in Table C1. The north-south distributions of these eleven FCTs and information about their habitats are given in Table C2.

Trudgen's units are not directly comparable to FCTs, but these units and groups of them are believed to be sufficiently comparable to them for the purposes of this study. However, the inferred identifications of which FCTs are represented in the study areas should be regarded as provisional.

Trudgen vegetation units and their inferred floristic community type counterparts are listed in Table C3. They are also listed in Weston (1998c) and discussed there.

Floristic Community Type 29b, *Acacia* shrublands on taller Quindalup dunes, is the principal, possibly the only, described Floristic Community Type in the Yalgorup National Park proposed exchange area, but Type 27 may apply to the *Dryandra sessilis* scrub on limestone enclaves there.

The Lake Clifton West proposed exchange area has Floristic Community Type 26a, *Melaleuca huegelii – M. acerosa* shrublands of limestone ridges, Type 25, Southern *Eucalyptus gomphocephala – Agonis flexuosa* woodlands, and, probably, Type 27, Species poor mallees and shrublands on limestone.

The original Gibson *et al.* (1994) southern Swan coastal plain study sampling of seasonal wetlands did not adequately represent their great heterogeneity. Also, because the study was mostly limited to public lands, it undersampled Quindalup dunes, where there are few reserves and little other public land (Keighery 1997). Consequently, floristic community types may not have been defined for some of the seasonal wetland and Quindalup dune vegetation.

3.1.5 Condition of Vegetation

The condition of vegetation in the Yalgorup National Park proposed exchange area is generally good to very good or better, but swales range from very good to, more commonly, degraded, due to infestation of weeds, primarily *Trachyandra divaricata* (false onion weed). Most swales have a mixture of herbaceous plants, often sedges, and *Acacia rostellifera* shrubs under 50 cm tall, which are regenerating after having been killed back by frost (O'Brien pers. comm.). Killed *Acacia* and other natives have, however, apparently been replaced in the bottoms of many swales by dense growths of *Trachyandra divaricata*.

Weeds are much more widespread and abundant in the Lake Clifton West proposed exchange area. *Trachyandra divaricata* is particularly abundant west and south of Boundary Lake and on sand on the western side of the study area, often with weedy grasses, *Arctotheca calendula* (cape

weed) and other herbaceous weeds. The *Trachyandra* is common in patches on limestone, but other, smaller weed species are more widespread, though less conspicuous, there. Map 1 shows a few areas as C and AfC, which are almost devoid of native plants (except for clumps of peppermint in the latter).

3.2 FLORA

One hundred and thirty-two (132) taxa (species, subspecies and varieties) of vascular plants were recorded during the study, of which 17 were not listed by Trudgen (1991). All are listed in Appendix B, in which the symbol 'N' indicates which were not listed in Trudgen's table. The number recorded, 132, could be increased significantly by botanising in spring at times when most of the herbaceous plants are in flower.

One hundred and eight (108) taxa were found in the Lake Clifton West proposed exchange area and 71 were found in the Yalgorup National Park proposed exchange area. Twenty-four (24) are established aliens, 20 of which were found in the Lake Clifton West proposed exchange area and 10 in the Yalgorup National Park proposed exchange area.

There are several reasons why more taxa were recorded in the Lake Clifton West proposed exchange area than in the Yalgorup National Park proposed exchange area. These reasons include the following:

- The Lake Clifton West proposed exchange area was botanised in both February and June, but the Yalgorup National Park proposed exchange area was botanised only in June, when some of the plants recorded in February were no longer identifiable.

- Trudgen (1991) found high species richness in limestone heaths and tuart-banksia vegetation, both of which are in the Lake Clifton West proposed exchange area and neither of which are in the Yalgorup National Park proposed exchange area. He found low species richness in dense stands of *Dryandra sessilis*, the only limestone vegetation in the Yalgorup National Park proposed exchange area, and of *Acacia rostellifera*, a principal vegetation dominant in the Yalgorup National Park proposed exchange area.

- The range of vegetation types in the Lake Clifton West proposed exchange area is much greater than in the Yalgorup National Park proposed exchange area.

- The size of the Yalgorup National Park proposed exchange area is much smaller than the size of the Lake Clifton West proposed exchange area.

3.3 SIGNIFICANT FLORA

3.3.1 Introduction

Seven significant species and subspecies were recorded during the study. They and their conservation codes and the proposed exchange areas in which they were recorded are listed in the table on the next page.

Five of the species and subspecies - *Acacia truncata* (Yalgorup form), *Eucalyptus argutifolia, Hibbertia spicata* subsp. *leptotheca, Hakea* sp. Yalgorup and *Leptomeria ellytes* - were in the Lake Clifton West proposed exchange area and four - *Acacia truncata* (Yalgorup form), *Stylidium*

maritimum, Hakea sp. Yalgorup and *Astroloma microcalyx* - were in the Yalgorup National Park proposed exchange area.

Three of the species, the *Leptomeria*, the *Astroloma* and the *Acacia,* do not have conservation codes, but Trudgen considered the first two to be of particular interest because the first was very poorly collected and the second had not previously been recorded south of the Fremantle area. Both have since been collected in various locations between Perth and Bunbury. The *Leptomeria* was uncommon in low areas near Boundary Lake in the Lake Clifton West proposed exchange area, and the *Astroloma* was found on several stable dune crests in the Yalgorup National Park proposed exchange area.

Acacia truncata (Yalgorup form) is a narrow-phylloded, often tall shrub apparently restricted to the Yalgorup area (Marchant *et al.* 1987). It is occasional to common in both proposed exchange areas.

Significant Flora Recorded in the Proposed Exchange Areas

TAXON	*CONSERVATION CODE*	*YALGORUP NATIONAL PARK PROPOSED EXCHANGE AREA*	*LAKE CLIFTON WEST PROPOSED EXCHANGE AREA*
Acacia truncata (Yalgorup form)	--	*YNP*	*LCW*
Astroloma microcalyx	--	*YNP*	
Eucalyptus argutifolia	DRF, T		*LCW*
Hakea sp. Yalgorup	Priority 4	*YNP*	*LCW*
Hibbertia spicata subsp. *leptotheca*	Priority 3		*LCW*
Leptomeria ellytes	--		*LCW*
Stylidium maritimum	Priority 3	*YNP*	

3.3.2 Declared Rare and Priority Flora

Eucalyptus argutifolia is a Declared Rare Flora mallee which, prior to this study, was believed to be restricted to shallow soils over limestone (Powell 1990) in a narrow coastal strip between Wanneroo and Hill River (Kennington and James 1997). Two small populations of the mallee were found in the Lake Clifton West proposed exchange area in its largest, central limestone outcrop in February, and a much larger population was found in its southernmost limestone outcrop in June. This third, largest population is estimated to have more than 100 mallees which occur in at least ten discrete groups. Kennington and James (1997) estimate that there is a total of 2000 discrete *Eucalyptus argutifolia* mallees north of Perth. The locations of the three Lake Clifton West proposed exchange area populations are shown on Map 1.

Hibbertia spicata subsp. *leptotheca* is a Priority 3 small shrub which was found on limestone in the southern part of the Lake Clifton West proposed exchange area, mainly under *Melaleuca huegelii* and mallees.

Stylidium maritimum is a Priority 3 trigger plant with tufts of long leaves which were conspicuous at the time of the June rare flora survey because they were dark red. Eight plants were found on the crests of dunes near the centre of the Yalgorup National Park proposed exchange area, and Trudgen (1991) and Paust (Fox *et al.* 1980) found other populations on stabilised dunes,

particularly dune crests and upper slopes in AtMa vegetation. The species is in depressions in limestone outcrops and on stable dunes between Cervantes (or Lancelin) and Yalgorup (Lowrie, Coates and Kenneally 1998).

Hakea sp. Yalgorup is a Priority 4 limestone species which was rare in the Yalgorup National Park proposed exchange area and common in the Lake Clifton West proposed exchange area. It was abundant with *Dryandra sessilis* on limestone just east of the Yalgorup National Park proposed exchange area. *Hakea* sp. Yalgorup is a dense shrub generally around 1 m tall with narrow leaves similar to those of *Hakea anadenia* ms and the narrow-leafed form of *Hakea undulata*. It was first recorded by Paust in limestone heath (Fox *et al.* 1980) and is known only from the Yalgorup National Park area.

Trudgen (1997) previously recorded plants of *Astroloma* sp. Yalgorup (P2), *Conostylis pauciflora* subsp. *pauciflora* (P4), *Eryngium pinnatifidum* subsp. *palustre* ms (P2) and *Platysace ramosissima* (P3) in the general vicinity of the Yalgorup National Park proposed exchange area, but I saw no sign of any of them or likely habitat for most of them in the study areas.

3.4 SIGNIFICANT VEGETATION

Three of the Floristic Community Types in the study areas, Types 25, 26a and 29b, are classified as under-reserved and as susceptible or critically endangered. All three are proposed for inclusion on the Threatened Ecological Community Database (English and Blyth 1997).

The *Eucalyptus argutifolia* communities in the Lake Clifton West proposed exchange area are also significant, especially the largest one, which is similar to Type 26a, if not included in it.

Floristic Community Type 29b, provisionally recorded mainly in the Yalgorup National Park proposed exchange area, and Type 25, provisionally recorded only in the Lake Clifton West proposed exchange area, are classified as poorly reserved and susceptible (Gibson *et al.* 1994).

Floristic Community Type 26a, of the Lake Clifton West proposed exchange area, is considered to be poorly reserved and critically endangered (Weston and Gibson 1997).

3.5 LANDFORMS / GEOMORPHIC ELEMENTS

On their 1:50 000 scale land resources map, Wells and Hesp (1989) show distributions of landforms and soils in the two proposed exchange areas. Eight units are in the Lake Clifton West proposed exchange area, and six are in the Yalgorup National Park proposed exchange area.

The eight map units in the Lake Clifton West proposed exchange area are Qd, Qp2,, S1a, S2a, S2b, S4b, V4 and V5, but the representations of Units Qd and V5 are very small.

The six map units in the Yalgorup National Park proposed exchange area are Qb, Qd, Qf1, Qp1, Qp2, and S1a, but the representations of Units Qp2 and S1a are very small.

4.0 ACKNOWLEDGEMENTS

The assistance of Mike Hislop, Greg Keighery, Brendan Lepschi, Terena Lally, Malcolm Trudgen, Paul Wilson and other Western Australian Herbarium staff, consulting and visiting botanists in helping to identify specimens is gratefully appreciated. Access to the Western Australian Herbarium collections was essential for carrying out the project and is greatly appreciated. Information and other assistance provided by Des O'Brien and his family are also greatly appreciated.

5.0 REFERENCES

Beard, J.S. (1979). *The Vegetation of the Pinjarra Area, Vegetation Survey of Western Australia 1:250,000 Series*. Vegmap Publications, Applecross.

Beard, J.S. (1981). *Sheet 7, Swan, Vegetation Survey of Western Australia 1:1,000,000 Series*. University of Western Australia Press, Nedlands.

Churchward, H.M. and McArthur, W.M. (1980). Pinjarra Sheet. Landforms and Soils of the Darling System, Western Australia. in: *Atlas of Natural Resources Darling System, Western Australia*. Western Australian Department of Conservation and Environment, Perth.

Department of Environmental Protection. (1996). System 6 and part of System 1 update programme – plot and area records and analysis (unpublished: cf. B.J. Keighery).

English, V. and Blyth, J. (1997). *Identifying and Conserving Threatened Ecological Communities (TECs) in the South West Botanical Province*. ANCA National Reserves System Cooperative Program: Project Number N702. Department of Conservation and Land Management, Wanneroo.

Gibson, N., Keighery, B.J., Keighery, G.J., Burbidge, A.H. and Lyons, M.N. (1994). *A Floristic Survey of the Southern Swan Coastal Plain*. Unpublished Report for the Australian Heritage Commission prepared by Department of Conservation and Land Management and the Conservation Council of Western Australia (Inc.), Perth.

Heddle, E.M., Loneragan, O.W. and Havel, J.J. (1980). Pinjarra Sheet Vegetation Complexes of the Darling System, Western Australia. in: *Atlas of Natural Resources Darling System, Western Australia*. Western Australian Department of Conservation and Environment, Perth.

Hussey, B.M.J., Keighery, G.J., Cousens, R.D., Dodd, J. and Lloyd, S.G. (1997). *Western Weeds: A Guide to the Weeds of Western Australia*. The Plant Protection Society of Western Australia, Victoria Park.

Kennington, W.J. and James, S.H. (1997). Contrasting patterns of clonality in two closely related mallee species from Western Australia, *Eucalyptus argutifolia* and *E. obtusiflora* (Myrtaceae). *Aust, J. Bot.* **45**: 679-689.

Lowrie, A., Coates, D.J. and Kenneally, K.F. (1998). A taxonomic review of the *Stylidium caricifolium* complex (Stylidiaceae), from south-west Western Australia. *Nuytsia* **12**(1): 43-58.

Keighery, B.J. (1997). *Floristic Community Types in the Area of the System 6/1 Update.* Unpublished report, Department of Environmental Protection, Perth.

Marchant, N.G., Wheeler, J.R., Rye, B.L., Bennett, E.M., Lander, N.S. and Macfarlane, T.D. (1987). *Flora of the Perth Region*. Western Australian Department of Agriculture, Perth.

Powell, R. (1990). *Leaf and Branch.* Department of Conservation and Land Management, Perth.

Rye, B.L (1997). A synopsis of the annual species of Cyperaceae from central and southern Western Australia. *Nuytsia* **11**(3): 383-423.

Semeniuk, C.A. (1987). Wetlands of the Darling System – consanguineous wetlands and their distribution in the Darling System, south Western Australia. *J. Roy. Soc. of West. Aust.* **70**: 69-87.

Trudgen, M. (1991). *A Flora and Vegetation Survey of the Coast of the City of Mandurah*. Department of Planning and Urban Development, Perth.

Trudgen, M. (1997). The occurrence and potential occurrence of rare and priority flora on access options to the Cape Bouvard Investments block near Boundary Lake. Unpublished report prepared for Cape Bouvard Investments.

Wells, M.R. (1989). *Land Capability Study of the Shires of Mandurah and Murray*. Department of Agriculture Land Resources Series No. 2.

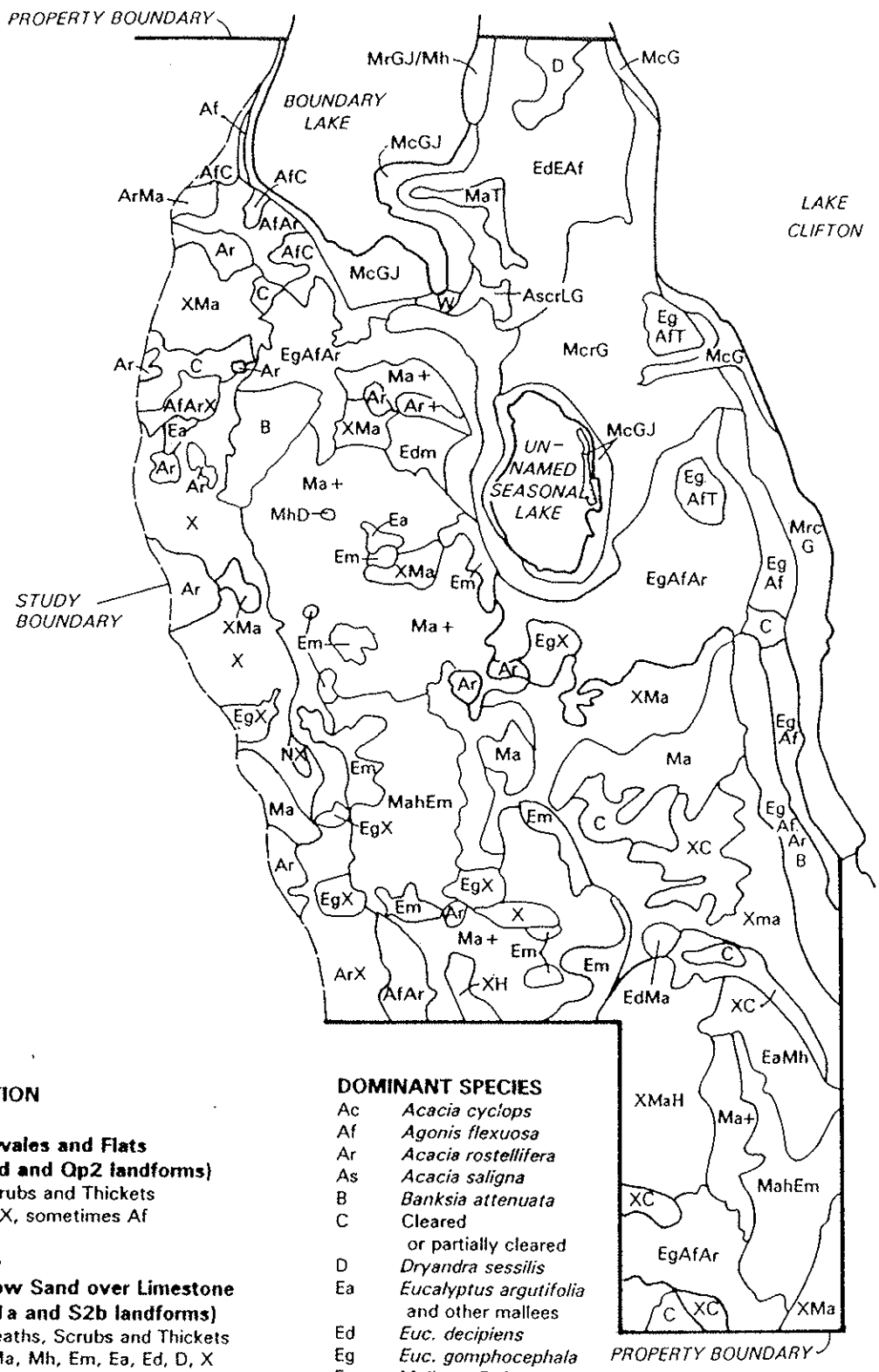
Wells, M.R. and Hesp, P.A. (1989). *Land Resources of the Mandurah – Murray Region, Western Australia.* 1:50 000 scale map in: Wells (1989).

Weston, A.S. (1998a). *Vegetation survey of eastern part of Lake Clifton West (Locations 4185 and parts of Locations 2240, 2275, 2657, 3045, 4981 and 5182), City of Mandurah.* Unpublished report prepared for Cape Bouvard Investments Pty Ltd, Perth.

Weston, A.S. (1998b). *Potential Rare Flora in the Proposed White Hill Road to Lake Clifton West Access Road Route Corridor, City of Mandurah.* Unpublished report prepared for Cape Bouvard Investments Pty Ltd, Perth.

Weston, A.S. (1998c). *Floristic Community Types in the Proposed White Hill Road to Lake Clifton West Access Road Route Corridor, City of Mandurah.* Unpublished report prepared for Cape Bouvard Investments Pty Ltd, Perth.

Weston, A.S. and Gibson, N. (1997). *Report on the Limestone Vegetation of Wabling Hill Area, Reserves 39411 and 39412 and the Ridges Extension to Yanchep National Park.* Unpublished report to Department of Conservation and Land Management, Woodvale.



LEGEND

VEGETATION

Dunes, Swales and Flats
(mainly Qd and Qp2 landforms)
Heaths, Scrubs and Thickets
of Ar, Ma, X, sometimes Af

Limestone
and Shallow Sand over Limestone
(mainly S1a and S2b landforms)
Mallees, Heaths, Scrubs and Thickets
mainly of Ma, Mh, Em, Ea, Ed, D, X

Tuart and Peppermint
(mainly S4b and S2a landforms)
Thickets, Woodlands and Forests
of Eg, Af, Ar, X, T, B, Ed

Wetlands
(mainly V4 landform)
Forests, Woodlands and Sedgelands
of Mc, Mr, J, G, L, *Baumea juncea*

Cleared and Partially Cleared
(mainly Qp2 and Qd landforms)
Herblands of grasses *Trachyandra divaricata*, *Arctotheca calendula*

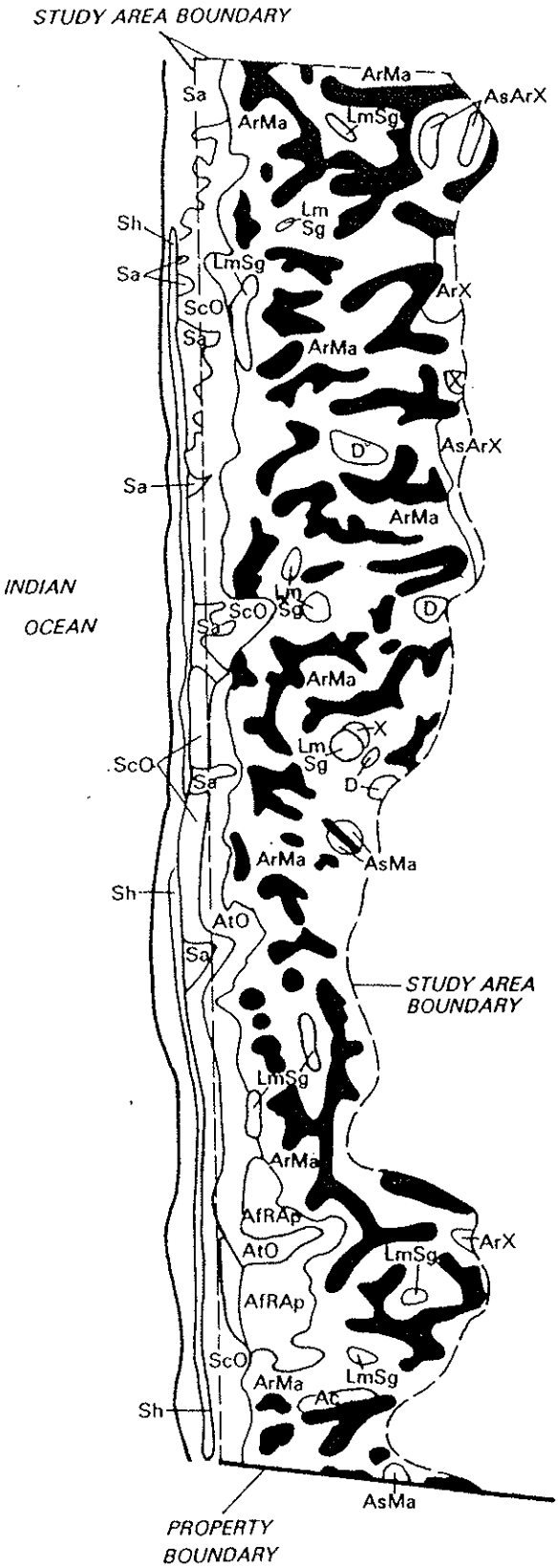
DOMINANT SPECIES

Ac	*Acacia cyclops*
Af	*Agonis flexuosa*
Ar	*Acacia rostellifera*
As	*Acacia saligna*
B	*Banksia attenuata*
C	Cleared or partially cleared
D	*Dryandra sessilis*
Ea	*Eucalyptus argutifolia* and other mallees
Ed	*Euc. decipiens*
Eg	*Euc. gomphocephala*
Em	Mallees: *E. foecunda* &/or *E. petrensis*
G	*Gahnia trifida*
J	*Juncus kraussii*
L	*Lepidosperma ? longitudinale*
Ma	*Melaleuca acerosa*
Ma +	*M. acerosa* mixed
Mc	*Mel. cuticularis*
Mh	*Mel. huegelii*
Mr	*Mel. rhaphiophylla*
N	*Nuytsia floribunda*
T	*Templetonia retusa*
W	Wetland herbaceous plants
X	*Xanthorrhoea preissii*

VEGETATION OF LAKE CLIFTON WEST STUDY AREA

June 1998 A S Weston [Tel 08 9458 9738]

MAP 1



LEGEND

N

VEGETATION

Strand/Foredunes (partly Qf1 landforms)
Bare sand and Sh, *Cakile maritima* and other herbaceous plants

Younger Dunes and Swales and Blowouts (mainly Qf1 and Qb landforms)
Heaths & Scrubs with O prominent

Dunes, Swales and Flats (Qp1 landforms)
Heaths, Scrubs and Herblands of Ar, At, Ma, X, and Lm

Vegetation Unit AtMa

Limestone and Shallow Sand over Lime stone (Qd landform)
Heaths, Scrubs and Thickets mainly of Ma, D, and X

Peppermint (mainly on or near Qb landform)
Thickets of Af, with shrubs & vines

DOMINANT SPECIES

Ac	*Acacia cochlearis*
Af	*Agonis flexuosa*
Ap	*Acanthocarpus preissii*
Ar	*Acacia rostellifera*
As	*Acacia saligna*
At	*Acacia truncata*
D	*Dryandra sessilis*
Lm	*Lomandra maritima*
Ma	*Melaleuca acerosa*
O	*Olearia axillaris*
R	*Rhagodia baccata*
Sa	Bare, mobile sand
Sc	*Scaevola crassifolia*
Sg	*Schoenus grandiflorus*
Sh	*Spinifex hirsutus*
X	*Xanthorrhoea preissii*

0 — 1 km

SCALE 1:20 000

VEGETATION OF YALGORUP NATIONAL PARK STUDY AREA

Modified from Trudgen (1991)

June 1998 A S Weston (Tel 08 9458 9738)

MAP 2

APPENDICES

APPENDIX A	**Rare Flora with Distributions which may include the Yalgorup Area**
APPENDIX B	**Species Lists**
APPENDIX C	**Vegetation Types in the Yalgorup Study Areas (tables)**

APPENDIX A

Rare Flora with Distributions which may include the Yalgorup Area

(compiled April 1998)

Table A1 lists 22 species of rare flora recorded in the general vicinity of Yalgorup National Park, along with information about their conservation codes, distributions, localities where they have been recorded, growth forms, habitats and flowering times. The information about distributions, localities, growth forms, habitats and flowering times is not always comprehensive. For instance, the localities are often selections and do not include all of the localities given for a listed species in the CALM printouts, which are also often only selections. Information about growth form and habitat is at least indicative and should be useful in assessing how likely rare flora is to occur at particular locations in study areas.

The table lists three R species (gazetted Declared Rare Flora), one P1 species (Priority One), four P2 species and subspecies (Priority Two), eight P3 species and subspecies (Priority Three), five P4 species and subspecies (Priority Four) and one apparently rare species which is known from only one population but has not been assigned a conservation code by CALM. All three of the R species are also V species (Threat: Vulnerable), two of them are V (ESP: Vulnerable), and one of them is E* (ESP: Endangered) (presumably 'Threat' is for 'Scientific Ranking Panel for Western Australia's Threatened Flora and Fauna' and 'ESP' is for the Commonwealth 'Endangered Species Protection Act'). A copy of CALM's definitions of the R and P conservation codes follows the table.

Table A1 contains all 18 of the rare flora listed in the CALM Declared Rare and Priority List appended to Trudgen (1997) plus four additional taxa (species and subspecies) recorded in or near Yalgorup National Park. The four additional taxa are *Diurus micrantha*, *Eryngium pinnatifidum* subsp. *palustre*, *Eucalyptus argutifolia* and *Rorippa* sp. Yalgorup. The *Diuris* is listed in the 1994 CALM Declared Rare and Priority Flora List as including Yalgorup in its distribution; the *Eryngium* was found in Route Options 1a and 2 by Trudgen in October 1997, the *Eucalyptus* was found by me west of Lake Clifton in February 1998, then south of there in June 1998. The *Rorippa* was found somewhere in the Yalgorup area by G Keighery, possibly in 1997.

The CALM list in Trudgen is an October 1997 printout from a database which was updated in October 1996. The date on the most recent update printout is December 1997. Consequently, I have brought the CALM printout in Trudgen up to date by checking it against the current, December 1997 CALM list and by searching the current database for Yalgorup, Clifton, Mandurah and Waroona.

Table A1 was compiled from CALM printouts and database referred to above, examination of herbarium specimens and their labels in the Western Australian Herbarium, consultations with other botanists, observations made during my field work and information in Marchant *et al.* (1987), Hoffman and Brown (1995), Hopper *et al.* (1987), Trudgen (1997, Rye (1997) and other references listed in the report to which this is Appendix A.

Notes on Table's **X Column** – X: *Lasiopetalum membranaceum* recorded at 32^41'-42', 115^37'-38', *Platysace ramosissima* at 32^45.5', 115^37.5 (CALM's Summary of Threatened Flora Data); T: Found by M Trudgen in Route Option 2 in October 1997 (the *Conostylis* plants were identified as hybrids between *C. p.* subsp. *p.* and *C. candicans* subsp. *calcicola*).

Table A1 Rare Flora with Distributions which may include the Yalgorup Area (April 1998)

Species / Family	Cons. Codes	Distribution and Localities	Growth Form; Habitats	X	Flowers
Aristida ramosa POAC	P1	Near Waroona, Serpentine, Gingin, eastern states	Tufted grass; Marri woodland on brown sandy clay	-	Jun,Nov
Astroloma sp. Yalgorup (MET #?) EPAC	P2	Yalgorup (>300 m WNW of Duck Pond, W of Lake Clifton)	Shrub; Limestone, (no specimen in WA Herbarium)	T	?
Blennospora sp. Ruabon (BJK & NG 20) ASTE	P3	Yalgorup, Austin Bay NR, Ruabon, Kooljerrenup NR, Busselton, L Muckinburra	Small annual; Under *Melaleuca* spp; seasonally wet grey clay; on flats &, perhaps, between dunes	-	Oct-Nov
Conostylis pauciflora subsp. *euryrhipis* HAEM	P3	Yanchep, Lancelin, Seabird, (Yalgorup?)	Stoloniferous herb; In heath on coastal stable dunes	-	Jul
Conostylis pauciflora subsp. *pauciflora* HAEM	P4	Yarloop, Dawesville, Yalgorup NP	Stoloniferous herb; Eucalypt, peppermint, banksia woodlands on deep grey sand on lower and middle slopes of stabilised dunes	T	(Jun-) Aug-Oct
Diuris micrantha ORCH	R V,E*	Yalgorup, Medina, Yarloop, Yunderup, Manjimup, Bowelling	Dwarf Bee Orchid; Sandy clayey soil, shallowly winter-wet short dense *Lepidosperma* sedgeland	-	Aug-Sep
Diuris purdiei ORCH	R V,V	Perth-Waroona; E of Harvey Estuary	A donkey orchid; Seasonally wet semi-swamp on sand over clay, usually in burnt *Regelia* and *Pericalymma* shrublands	-	Sep-Nov
Eryngium pinnatifidum subsp. *palustre* ms APIA	P2	Gingin-Serpentine, Kenwick, Bullsbrook	Herb; *Melaleuca* shrublands on winter-wet sandy-clay flats; (MET: swales in Quindalup dunes)	T	Oct-Nov
Eucalyptus argutifolia MYRT	R V,V	W of Lake Clifton, Jurien, Yanchep, Lancelin, Seabird	Yanchep Mallee; Limestone	-	Mar-Apr
Eucalyptus rudis subsp. *cratyantha* MYRT	P4	Mandurah-Yallingup, Eagle Bay, Meelup, Busselton	Tree similar to typical Flooded Gum but buds and nuts larger; same habitats as Flooded Gum	-	Jun-Sep?
Hakea sp. Yalgorup (BK & NG 897) MYRT	P4	W of Lake Clifton, Yalgorup	Shrub w. leaves narrower than *H. undulata*; Limestone heath	T	Aug-Oct
Haloragis aculeolata HALO	P2	Yalgorup N.P., Yanchep (Toolbrunup, Cannington)	Herb; Shelley sand or brown clay over limestone, with tuart, flooded gum, *Acacia, Melaleuca* shrubs and/or *Gahnia trifida*	-	Dec-Apr
Hibbertia silvestris DILL	P4	Dwellingup-Pemberton, Waroona, Collie, Barlee Brook, Glenoran, Dickson	Low, often dense and rounded, shrub; Generally on laterite	-	Aug-Mar
Hibbertia spicata subsp. *leptotheca* DILL	P3	Yalgorup-Lancelin, Burns Beach, Yanchep	Mound or semi-prostrate small shrub; Mainly limestone heath	-	Sep-Nov (Jul-Dec)
Jacksonia sericea FABA	P3	Wanneroo-Pinjarra, Perth Mandurah, Neerabup NP	Low, usually prostrate shrub; Sandy soil in woodlands, usually low in the landscape	-	Nov-Feb
Lasiopetalum membranaceum STER	P2	Yanchep-Ludlow, Yalgorup, Capel	Small shrub w. cordate leaves; Sand, mainly over limestone and in tuart woodland	X	Sep-Dec
Lepidium pseudotasmanicum BRAS	P4	Wongan Hills – Esperance, mainly in and near Porongurup R; Lake Clifton, Yanchep, eastern states	Herb to 50 cm tall; Various habitats, including tuart forest on sand over limestone	-	Oct-Jun
Myriophyllum echinatum HALO	P3	Austin Bay NR, Waroona, Harvey, Tutunup, Ruabon	Small herb, disk large, yellow, rays sm, white; Clay on winter-wet flats	-	Oct-Nov
Platysace ramosissima APIA	P3	Yalgorup, W of Duck Pond, Boonanarring, Gingin	Perennial herb with ribbed or angular stems; Heath on Spearwood sand or limestone	X	Oct-Nov
Rorippa sp. Yalgorup (GJK 14,455) BRAS	-- rare	Yalgorup (only one population known)	Short annual; Undisturbed, long unburnt deep moss at bases of tuart trees on brown sandy clay	-	Sep?
Schoenus sp. Waroona (GJ Keighery 12235) CYPE	P3	Waroona, Kenwick, Harvey, Austin Bay	Annual < 3 cm; Clay or sandy-clay winter-wet flats	-	Oct
Stylidium maritimum STYL	P3	Yalgorup – Lancelin	Tufted, linear-leaved triggerplant; Sand dunes and depressions in limestone	T	Sep-Dec

THE DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT

DECLARED RARE AND PRIORITY FLORA LIST

for Western Australia

KJ Atkins 3 December, 1997

CONSERVATION CODES

R: Declared Rare Flora - Extant Taxa

Taxa which have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection, and have been gazetted as such.

X: Declared Rare Flora - Presumed Extinct Taxa

Taxa which have not been collected, or otherwise verified, over the past 50 years despite thorough searching, or of which all known wild populations have been destroyed more recently, and have been gazetted as such.

1: Priority One - Poorly known Taxa

Taxa which are known from one or a few (generally <5) populations which are under threat, either due to small population size, or being on lands under immediate threat, e.g. road verges, urban areas, farmland, active mineral leases, etc., or the plants are under threat, e.g. from disease, grazing by feral animals, etc. May include taxa with threatened populations on protected lands. Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey.

2: Priority Two - Poorly Known Taxa

Taxa which are known from one or a few (generally <5) populations, at least some of which are not believed to be under immediate threat (i.e. not currently endangered). Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey.

3: Priority Three - Poorly Known Taxa

Taxa which are known from several populations, and the taxa are not believed to be under immediate threat (i.e. not currently endangered), either due to the number of known populations (generally >5), or known populations being large, and either widespread or protected. Such taxa are under consideration for declaration as 'rare flora' but are in need of further survey.

4: Priority Four - Rare Taxa

Taxa which are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors. These taxa require monitoring every 5-10 years.

Note, the need for further survey of poorly known taxa is prioritised into the three categories depending on the perceived urgency for determining the conservation status of those taxa, as indicated by the apparent degree of threat to the taxa based on the current information.

APPENDIX B

Species Lists

(compiled June 1998)

Table B1 lists 132 taxa (species, subspecies and varieties) of vascular plants recorded in the Lake Clifton West and Yalgorup National Park proposed exchange areas during field work on 26-27 February 1998 and 14-16 June 1998. Neither period is a good time for collecting herbaceous plants, and the list is far short of complete.

As the table was compiled from the CALM database program Max, which was last updated in May 1998, the taxonomy, spelling and authorities of taxa listed should be up to date. Some of the taxon names in the table have superceded the names used by Trudgen.

Seventeen (17) of the taxa listed in Table B1were not listed by Trudgen (1991), although he did refer to some of them in the text of his report. A few of the 17 were listed by Fox *et al.* (1980).

Table B1 indicates which species were found during the field work only on limestone and shallow soil over limestone (L) or in wetlands (W) or mainly in tuart and peppermint woodlands (T).

One hundred and eight (108) taxa were found in the Lake Clifton West proposed exchange area and 71 were found in the Yalgorup National Park proposed exchange area. Twenty-four (24) are established aliens, 20 of which were found in the Lake Clifton West proposed exchange area and 10 in the Yalgorup National Park proposed exchange area.

Seven significant species and subspecies were recorded during the study. They and their conservation codes and the proposed exchange areas in which they were recorded are:

TAXON	*CONSERVATION CODE*	*YALGORUP NATIONAL PARK PROPOSED EXCHANGE AREA*	*LAKE CLIFTON WEST PROPOSED EXCHANGE AREA*
Acacia truncata (Yalgorup form)	--	*YNP*	*LCW*
Astroloma microcalyx	--	*YNP*	
Eucalyptus argutifolia	DRF, T		*LCW*
Hakea sp. Yalgorup	Priority 4	*YNP*	*LCW*
Hibbertia spicata subsp. *leptotheca*	Priority 3		*LCW*
Leptomeria ellytes	--		*LCW*
Stylidium maritimum	Priority 3	*YNP*	

Table B1 Vascular Plants Recorded in the Proposed Exchange Areas West of Lake Clifton

LEGEND

* Established aliens, mainly weeds

MET Listed by Trudgen (1991) under the same name or

D Different name or

N New record – not listed by Trudgen

LCW Lake Clifton West property

YNP Yalgorup National Park property

Recorded during 1998 surveys

X Habitats various or not only limestone, wetlands or tuart-peppermint woodlands

L Recorded only on limestone

T Recorded only or mainly in tuart-peppermint woodlands

W Recorded only in wetlands

CON Conservation Code

R Declared Rare Flora, Threatened

P3 Priority 3

P4 Priority 4

TAXON NAME	MET	LCW	YNP	CON
Family: Apiaceae (281)				
Apium prostratum Vent.		W		
Centella asiatica (L.)Urb.		W		
Hydrocotyle tetragonocarpa Bunge			X	
Trachymene coerulea Graham		X	X	
Family: Apocynaceae (304)				
Alyxia buxifolia R.Br.			X	
Family: Araceae (035)				
* Zantedeschia aethiopica (L.)Spreng.		X		
Family: Asclepiadaceae (305)				
* Gomphocarpus fruticosus (L.)W.T.Aiton	N	X		
Family: Asphodelaceae (054G)				
* Trachyandra divaricata (Jacq.)Kunth		X	X	
Family: Asteraceae (345)				
* Arctotheca calendula (L.)Levyns		X		
* Aster subulatus Michx.	N	W		
* Dittrichia graveolens (L.)Greuter		X		
* Hypochaeris glabra L.		X	X	
Lagenifera huegelii Benth.			X	
Olearia axillaris (DC.)Benth.			X	
Olearia rudis (Benth.)Benth.		L		
Senecio lautus Willd.			X	
* Sonchus oleraceus L.		X		

TAXON NAME	MET	LCW	YNP	CON
Family: Brassicaceae (138)				
* Brassica ? tournefortii Gouan		X	X	
Family: Casuarinaceae (070)				
Allocasuarina fraseriana (Miq.)L.A.S.Johnson		X		
Allocasuarina humilis (Otto & F.Dietr.)L.A.S.Johnson		X		
Family: Chenopodiaceae (105)				
* Chenopodium macrospermum Hook.f..	N	W		
Rhagodia baccata (Labill.)Moq. subsp. baccata	D		X	
Sarcocornia quinqueflora (Ung.-Sternb.)A.J.Scott		W		
Suaeda australis (R.Br.)Moq.	N	W		
Family: Convolvulaceae (307)				
Wilsonia backhousei Hook.f.		W		
Family: Cuscutaceae (307A)				
* Cuscuta epithymum (L.)L.			X	
Family: Cyperaceae (032)				
Baumea juncea (R.Br.)Palla		W	W	
Gahnia trifida Labill.		W		
Isolepis nodosa (Rottb.)R.Br.		W	?	
Lepidosperma gladiatum Labill.		X	X	
Lepidosperma ? longitudinale Labill.		W		
Lepidosperma ? pubisquameum Steud.	D	X	X	
Family: Dasypogonaceae (054C)				
Acanthocarpus preissii Lehm.		X	X	
Lomandra maritima T.S.Choo		X	X	
Family: Dilleniaceae (226)				
Hibbertia cuneiformis (Labill.)Sm.		X	X	
Hibbertia hypericoides (DC.)Benth.		X		
Hibbertia racemosa (Endl.)Gilg		X	X	
Hibbertia spicata F.Muell. subsp. leptotheca	N	L		P3
Family: Droseraceae (143)				
Drosera erythrorhiza Lindl. subsp. erythrorhiza	D		X	
Family: Epacridaceae (288)				
Acrotriche cordata (Labill.)R.Br.			X	
Astroloma microcalyx Sond.			X	
Leucopogon parviflorus (Andrews)Lindl.		X		

TAXON NAME	MET	LCW	YNP	CON
Leucopogon racemulosus DC.		L		
Leucopogon sp.	N		X	
Family: Euphorbiaceae (185)				
Adriana quadripartita (Labill.)Muell.Arg.		X	X	
* Euphorbia peplus L.		X		
* Euphorbia terracina L.	N	X		
Phyllanthus calycinus Labill.		X	X	
Family: Geraniaceae (167)				
* Erodium cicutarium (L.)L'Her.		X	X	
* Geranium molle L.		X	X	
Family: Goodeniaceae (341)				
Scaevola crassifolia Labill.			X	
Family: Juncaceae (052)				
Juncus kraussii Hochst. subsp. australiensis (Buchenau)Snogerup		W		
Family: Lamiaceae (313)				
Hemiandra glabra Benth.	D	X		
* Mentha pulegium L.	N	X		
Family: Lauraceae (131)				
Cassytha ? racemosa Nees		X		
Family: Lobeliaceae (340)				
Lobelia alata Labill.		W		
Family: Loganiaceae (302)				
Logania vaginalis (Labill.)F.Muell.		X		
Family: Loranthaceae (097)				
Nuytsia floribunda (Labill.)Fenzl		X	X	
Family: Malvaceae (221)				
Alyogyne huegelii (Endl.)Fryxell			X	
Lawrencia spicata Hook.	N	W		
Family: Mimosaceae (163)				
Acacia cochlearis (Labill.)H.L.Wendl.		X	X	
Acacia cyclops G.Don		X		
Acacia pulchella R.Br. var. glaberrima Meisn.			X	
Acacia pulchella R.Br. var. ? pulchella		X		
Acacia rostellifera Benth.		X	X	

TAXON NAME	MET	LCW	YNP	CON
Acacia saligna (Labill.)H.L.Wendl.		X	X	
Acacia truncata (Burm.f.)Hoffmanns.		X	X	
Family: Myoporaceae (326)				
Eremophila glabra (R.Br.)Ostenf.		X	X	
Myoporum insulare R.Br.		X	X	
Family: Myrtaceae (273)				
Agonis flexuosa (Willd.)Sweet		X	X	
Eucalyptus argutifolia P.M.Grayling & Brooker	N	L		R
Eucalyptus decipiens Endl. subsp. ?		X		
Eucalyptus foecunda Schauer		X	X	
Eucalyptus gomphocephala DC.		X	X	
Eucalyptus marginata Sm. subsp. marginata	D	X		
Eucalyptus petrensis Brooker & Hopper	N	L		
Melaleuca acerosa Schauer		X	X	
Melaleuca cuticularis Labill.		W		
Melaleuca huegelii Endl.		L	L	
Melaleuca rhaphiophylla Schauer		W		
Family: Orchidaceae (066)				
Pterostylis aff. pyramidalis Lindl.	N		X	
Family: Orobanchaceae (320)				
* Orobanche minor Sm.		X	X	
Family: Oxalidaceae (168)				
* Oxalis pes-caprae L.		X		
Family: Papilionaceae (165)				
Daviesia decurrens Meisn.			X	
Gompholobium tomentosum Labill.		X	X	
Hardenbergia comptoniana (Andrews)Benth.		X	X	
Jacksonia furcellata (Bonpl.)DC.		X		
Kennedia carinata (Benth.)Domin	N		X	
Templetonia retusa (Vent.)R.Br.		X	X	
* Trifolium sp.	N		X	
Family: Phormiaceae (054E)				
Dianella revoluta R.Br. var. divaricata (R.Br.)R.J.F.Hend.		X	X	
Family: Poaceae (031)				
* Ammophila arenaria (L.)Link			X	
Sporobolus virginicus (L.)Kunth		W		

TAXON NAME	MET	LCW	YNP	CON
Family: Primulaceae (293)				
* Anagallis arvensis L.		X	X	
Samolus junceus R.Br.		W		
Family: Proteaceae (090)				
Banksia attenuata R.Br.		T		
Banksia grandis Willd.		T		
Banksia littoralis R.Br.		X		
Dryandra lindleyana Meisn. var. lindleyana	D	X	X	
Dryandra sessilis (Knight)Domin var. cygnorum (Gand.)A.S.George	D	X	X	
Grevillea preissii Meisn.	D	X	X	
Hakea lissocarpha R.Br.		X		
Hakea prostrata R.Br.		X	X	
Hakea ruscifolia Labill.		L		
Hakea trifurcata (Sm.)R.Br.		X		
Hakea sp. Yalgorup (B. Keighery and N. Gibson 897)	N	L	L	P4
Hakea varia R.Br.		X		
Family: Ranunculaceae (119)				
Clematis linearifolia Steud.	D	X	X	
Clematis pubescens Endl.		T		
Family: Restionaceae (039)				
Desmocladus flexuosus (R.Br.)L.A.S.Johnson & B.G.Briggs ms	D	X	X	
Family: Rhamnaceae (215)				
Cryptandra mutila Reissek		X	X	
Spyridium globulosum (Labill.)Benth.		X	X	
Trymalium ledifolium Fenzl		X	X	
Family: Rutaceae (175)				
Diplolaena dampieri Desf.	D		X	
Family: Santalaceae (092)				
Exocarpos sparteus R.Br.		X		
Leptomeria cllytes Lepschi	D	L		
Santalum acuminatum (R.Br.)A.DC.		X	X	
Family: Sapindaceae (207)				
Dodonaea aptera Miq.	N	L		
Family: Scrophulariaceae (316)				
* Bartsia trixago L.	D	X		

TAXON NAME	MET	LCW	YNP	CON
Family: Solanaceae (315)				
Anthocercis littorea Labill.		X	X	
* Solanum linnaeanum Hepper & P.-M.L.Jaeger	D	X		
* Solanum nigrum L.		X		
Solanum symonii H.Eichler		X		
Family: Sterculiaceae (223)				
Thomasia cognata Steud.		X		
Thomasia triphylla (Labill.)Gay		L		
Family: Stylidiaceae (343)				
Stylidium maritimum Lowrie,Coates & Kenneally			X	P3
Family: Thymelaeaceae (263)				
Pimelea argentea R.Br.		X		
Pimelea ferruginea Labill.			X	
Family: Urticaceae (088)				
Parietaria debilis G.Forst.			X	
Family: Xanthorrhoeaceae (054D)				
Xanthorrhoea preissii Endl.		X	X	
Family: Zamiaceae (016A)				
Macrozamia riedlei (Gaudich.)C.A.Gardner	N	T		
Family: Zygophyllaceae (173)				
Zygophyllum fruticulosum DC.			X	

APPENDIX C

Vegetation Types in the Yalgorup Study Areas

(compiled June 1998)

Appendix C has five tables listing and comparing Trudgen, Weston and Gibson vegetation types and the map symbols used for them. These tables, and notes on some of them, are:

C1 Floristic Community Types which are definitely or probably in the Yalgorup National Park Area and their Conservation and Reservation Status

Floristic community types (FCTs) have not been mapped for the Yalgorup National Park area or anywhere else nearby, but there are 22 FCT quadrats in the Yalgorup National Park area (Gibson *et al.* 1994; Keighery 1997). They cover the nine floristic community types (13, 17, 18, 21a, 26a, 26b, 27, 29a and 29b) listed in this table. Two other FCTs believed to be represented in the Yalgorup National Park area, Types 19 and 25, are also listed in Table C1.

Gibson *et al.* (1994) considered Types 21a, 26b and 27 to be well reserved and at low conservation risk, Types 25 and 29b to be poorly reserved and susceptible and Type 19 to be unreserved and endangered. Type 26a, listed by Gibson *et al.* as unreserved and susceptible, now has a proposed conservation status of critically endangered (Weston and Gibson 1997). Gibson *et al.* regarded Type 27 as largely restricted to the Yalgorup area, but it is now known also to be well-represented in the Yanchep area (Weston and Gibson 1997). Floristic community types 19, 25, 26a and 29b are proposed by English and Blyth (1997) for inclusion on the Threatened Ecological Community Database (Rank No. 9, 99, 72 and 101, respectively).

C2 Distributions and Habitats of Floristic Community Types which are or may be in the Yalgorup National Park Area

The north-south distributions of the eleven FCTs and information about their habitats are given in Table C2. Gibson *et al.* describe floristic community type 19 as one restricted to the Becher Point area between Rockingham and Mandurah, but, according to English and Dutton (pers. comms.), it probably also occurs in the Preston Beach area, several kilometres south of the Yalgorup National Park proposed exchange area. It is also listed in Table C1.

C3 Floristic Community Types, Comparable Trudgen and Weston Vegetation Units and Geomorphic Elements in the Proposed Exchange Areas

C4 Trudgen and Weston Vegetation Units of Lake Clifton West and Yalgorup National Park Proposed Exchange Areas

Table C1
Floristic Community Types which are definitely or probably in the Yalgorup National Park Area and their Conservation and Reservation Status

(based upon information in Gibson *et al.* 1994 and Keighery 1997)

Key

Column 1: Codes of Floristic Community Type

Column 2: General descriptions of Floristic Community Types
Descriptions are taken mainly from Keighery (1997, Table 1).

Column 3: Threatened Ecological Communities (from English and Blyth 1997)
C – Critically Endangered, Priority 1 and Y; V – Vulnerable, Priority 3 and Y;
Y - proposed for inclusion on the Threatened Ecological Community database

Column 4: Reservation Status (from Gibson *et al.* 1994)
P – Poorly reserved, U – Unreserved, W – Well reserved
The reservation status of community type 26a is now probably 'poorly reserved', rather than 'unreserved'.

Column 5: Conservation Status (from Gibson *et al.* 1994)
C – Critically endangered, E – Endangered, L – Low risk, S – Susceptible, V – Vulnerable.
Weston and Gibson (1997) recommended that the conservation status of community type 26a be changed from S (susceptible) to C (critically endangered).

Column 6: Floristic Community Types recorded by Gibson *et al.* (1994) as being in or near the Yalgorup National Park Area

Supergroup 2 – Seasonal Wetlands

13	Deeper wetlands on heavy soils		W	L	X
17	*Melaleuca rhaphiophylla – Gahnia trifida* seasonal wetlands		W	L	X
18	Shrublands on calcareous silts	V	P	V	X
19	Sedgelands (19a) & Woodlands over sedgelands (19b) in Holocene dune swales between linear dune features	C	U	E	
21a	Central *Banksia attenuata – Eucalyptus marginata* woodlands		W	L	X

Supergroup 4 – Uplands centred on Spearwood and Quindalup Dunes

Spearwood Dunes					
25	Southern *Eucalyptus gomphocephala–Agonis flexuosa* woodlands	Y	P	S	
26a	*Melaleuca huegelii – M. acerosa* shrublands of limestone ridges	Y	U/P	S/C	X
26b	Woodlands and mallees on limestone		W	L	X
27	Species poor mallees and shrublands on limestone		W	L	X
Quindalup Dunes					
19	see Supergroup 2				
29a	Coastal shrublands on shallow sands	Y	P	S	X
29b	*Acacia* shrublands on taller dunes	Y	P	S	X

Table C2
Distributions and Habitats of Floristic Community Types which are or may be in the Yalgorup National Park Area

(based upon information in Gibson *et al.* 1994 and English and Dutton pers. comms.)

Key

Column 1: Floristic Community Type codes

Column 2: Distributions and Habitats

Supergroup 2 – Seasonal Wetlands

13	Mainly between Serpentine and Busselton; deeper wetlands on heavy soils, primarily Bassendean and Pinjarra Plain
17	Rockingham to west of Busselton; mainly swales in Quindalup and Spearwood dunes
18	Southern Yalgorup National Park near Ellis Road; a calcareous silt flat, dampland (sensu Semeniuk 1987)
19	Becher Point area between Rockingham and Mandurah and, probably, near Preston Beach in the Yalgorup area; linear swales between linear Holocene dunes near the coast
21a	Mainly between Perth and Capel; Bassendean, Spearwood and alluvial soils

Supergroup 4 – Uplands centred on Spearwood and Quindalup Dunes

Spearwood Dunes	
25	Woodmans Point to south of Capel; the southern tuart woodland and forest
26a	North of Perth and the Yalgorup area; skeletal soil on slopes and tops of limestone ridges
26b	North of Perth and the Yalgorup area; deeper soil on lower slopes and in pockets on limestone ridges
27	Yalgorup and Yanchep areas; mostly Yoongarillup limestone ridges
Quindalup Dunes	
29a	Seabird to Garden Island, with variants at Trigg and Yalgorup; shallow sands over limestone close to the coast
29b	Seabird to Yalgorup; larger dunes, varying dominants include *Acacia rostellifera, Acacia lasiocarpa* and *Melaleuca acerosa*

Table C3
Floristic Community Types, Comparable Trudgen and Weston Vegetation Units and Geomorphic Elements in the Proposed Exchange Areas

(based mainly upon analysis of Weston 1998a, Trudgen 1991 and Gibson *et al.* 1994)

Key

Column 1: Codes of Floristic Community Types
Column 2: Codes and Groups of Comparable Trudgen Vegetation Units
See Trudgen (1991) for definitions of the codes and descriptions of the units.
Column 3: Symbols of Weston's Vegetation Units
Column 4: Dominant species (from Trudgen 1991)
Column 5: Geomorphic Elements (from Wells and Hesp 1989 and Weston 1998a)

Supergroup 2 – Seasonal Wetlands

21a	Ba_2	B	*Banksia attenuata* with *Melaleuca acerosa* and *Acacia pulchella*; scattered tuart	Spearwood S2b

Supergroup 4 – Uplands centred on Spearwood and Quindalup Dunes

Spearwood Dunes				
25	EAA/ EAL]	EgAfAr	Tuart and peppermint (Unit EAA/EAL is not described by Trudgen)	Spearwood S2b/ Quindalup Qp2
26a	Part DS	MhD, Mah	*Dryandra sessilis*, *Melaleuca huegelii, M. acerosa, Templetonia retusa, Grevillea preissii*	Spearwood S1a
27	MG_2, AT, DsAt [part		*Acacia truncata, Melaleuca acerosa, Grevillea preissii, Hakea trifurcata*	Spearwood S2b
Quindalup Dunes				
29b	AM, AsM	AtMa,	Dune crests and slopes: *Acacia saligna, A. truncata, A. rostellifera, Melaleuca acerosa*	Quindalup Qp1
29b	Ar_2, Xp, ArXp, AsAr Xp?	ArMa, ArX, LmSg	Dune swales and lower slopes: *Acacia rostellifera, Xanthorrhoea preissii, Melaleuca acerosa, Lomandra maritima* (ArXp and AsArXp are not described by Trudgen)	Quindalup Qp1

Table C4

Trudgen and Weston Vegetation Units of Lake Clifton West and Yalgorup National Park Proposed Exchange Areas

Keys to the species codes used in Columns 2 and 3 are in Maps 1 and 2.

The vegetation descriptions in Column 3 are taken from Trudgen (1991). Some of the Trudgen units are not refered to in Trudgen(1991) other than on the Vegetation Map.

TRUDGEN	WESTON (dominants)	VEGETATION UNITS (principal species and structure; definitions mainly from Trudgen 1991)	LCW T	LCW W	YNP T	YNP W
Strand/Foredunes						
Sh	Sh	Sh Open Grassland to Grassland			X	X
Younger Dunes, Swales and Blowouts(Q4 and Q3)						
AtO	AtO	AtO Closed Heath			X	X
SO	ScO	ScO Low Open Heath to Closed Heath to Open Scrub			X	X
Dunes, Swales and Flats (Q2 and Q1)						
	mainly dune crests and upper slopes					
AM	AtMa	AtMa, Pimelea ferruginea, Lysinema ciliatum, Acrotriche cordata Low Shrubland to Low Open Heath over Lm Open Herbland to Herbland	X	--	X	X
AsArXp	AsArX	(not defined by Trudgen) Probably is As Low Open Woodland to Low Woodland over ArX Shrubland			X	X
AMT		(not defined by Trudgen)	X	--		
AsM	AsMa	As Open Scrub over ArMa Open Heath to Closed Heath			X	X
	mainly swales (and lower slopes)					
Ac	Ac	Ac Low Shrubland to Low Heath to Open Heath			X	X
Al	LmSg	(not defined by Trudgen) merged with LmSg			X	-
Ar		= Ar2 (not defined by Trudgen)	X		X	
Ar2	ArMa	Ar Low open Heath to Open Heath over Ma	X	X		
ArXp	ArX	(not defined by Trudgen)	X	X	X	X
LT	LmSg	LmSg Open Herbland to Herbland			X	X
XAM	XatMa ?	XatMa (not defined by Trudgen) ??			X	X
Xp	X	X Shrubland to Open Heath	X	X	X	X
Spearwood Dunes						
Ba2	B	B Woodlands to Forests, with Tuart (Eg) emergent	X	X		
Limestone Areas						
	Ar+	Ar plus X and other shrubs; margin of limestone		X		
Ds	D	D Open Heath to Closed Heath to Open Scrub to Closed Scrub	X	X	X	X
	Ea			X		
	EaMh			X		
	Edm			X		
	Em			X		
	EdMa			x		
DsN	NX	N Low Open Woodland over D Open Scrub	X	X		
	Ma			X		

	Ma+	Ma plus a varying range of species, mainly shrubs		X		
	MahEm	MaMhEm		X		
	MaT			X		
	MaX			X		
MG1		MaGp Low Open Heath to Closed Heath	X	--		
	MhD	Mh,Dodonea aptera		X		
TA		Thomasia tiphylla,At LowClosed Heath	X	--		
	XMa			x		
	XMah	XMaMh		X		
Peppermint Units						
Af	Af	Af Low Closed Forest to Closed Forest	X	X		
AfArXp	AfArX	Af Woodlands, ArX Scrubs	X	X		
AfRa	AfRAp	Af Low Open Forest over Spyridium globulosum, Diplolaena dampieri High Open Shrubland over RAp Low Shrubland to Low Open Heath			X	X
EdAf		(not defined by Trudgen) treat as EdALO	X			
EdALO	EdEgAf	Ed Woodlands over Af Forests over Lv, Ma, Tr Shrublands	X	X		
Tuart Units						
EAA	EgAfAr	Eg Woodlands to Forests over Af Woodlands to Forests over Ar Scrubs	X	X		
EALO	EgAfT	Eg Forests over Af Forests over Ar Scrubs X Shrublands over LvOr Shrublands	X	X		
EX2	EgX	Eg Open to Closed Forest over Opercularia hispidula, X Low Open Shrubland (Trudgen does not define EX2)	X	X		
EAr	With AfAr	Eg Woodland over Ar High Shrubland to Closed Scrub	X			
Wetlands - Yoongarillup Plain – Seasonally damp to wetland areas						
	AscrLG	AsAcArLG		X		
J	With McGJ	J Open Tussock Sedgeland to Tussock Sedgeland (not by Trudgen)	X	--		
McB	With McG	Mc Closed Scrub to Low Forest over B Open Sedgeland to Sedgeland	X	--		
McG	McG	Mc Low Woodland to Low Closed Forest over G Open Tussock Sedgeland to Tussock Sedgeland	X	X		
	McGJ			X		
McJ	With McGJ	Mc Low Woodland to Low Forest over JG Open Tussock Sedgeland to Tussock Sedgeland	X			
MrG	MrG	Mr Low Woodland to Low Closed Forest over G Open Tussock Sedgeland to Tussock Sedgeland	X			
	MrGJ			X		
MrMcG	MrcG,McrG	Mrc, Mcr Low Woodlands to Low Closed Forests over G Open Tussock Sedgeland to Tussock Sedgeland	X	X		
W		(not defined by Trudgen)	X			
	W			X		
Cleared and Partly Cleared						
Af(PC)	AfC	Cleared, with Af (mainly weedy)	X	X		
C	C	Cleared (weedy)	X	X		
	XC					

PROFORMA FOR REQUEST FOR TECHNICAL ADVICE

Title of Proposal/Issue:	**Rural Subdivision, Lake Clifton – Fauna Report**
Advising Division:	Policy & Coordination (John Dell)
Briefing Officer and Branch:	Nicholas DUFTY – Planning Assessments Branch
Date of Request:	**23 January 2003**
Date Advice Required:	**5 February 2002**

1. Background Information (to be provided by Division seeking advice)

- On 7 June 2002 the WAPC referred a 24 lot rural subdivision proposal, located on a large strategic landholding between Yalgorup National Park and the coast, to the EPA. On 4 July 2002 the EPA set a Public Environmental Review (8wks) level of assessment on the proposal;
- It was agreed shortly after setting this level of assessment that there was scope to modify the proposal so that more intense development would be indicated for areas with less environmental sensitivity and areas of high environmental sensitivity would be indicated with no development. However, it was also agreed that no negotiation could be entered into until a comprehensive analysis of the environmental values of the site had been provided.
- On this basis, an update and completion of flora and fauna work was undertaken for the proponent by ATA Environmental and other consulting specialists such as M.J. & A.R. Bamford CONSULTING ECOLOGISTS. The attached report is the fauna component of this work.
- It is hoped that the information in these reports will facilitate negotiations with the proponent for a more environmentally sensitive proposal.

2. Summary of Requesting Division's Assessment of the Proposal/Issue and Requested Advice

- Attached is the fauna report done by Bamford Consulting;
- Advice is requested on the following matters:
  - Is the fauna work comprehensive enough to enable the environmental impacts on the fauna from developing the site to be assessed? If not, what another fauna work is required?
  - Does the report enable a rational and scientific determination of where and what development can occur on the property without significantly impacting on the regional fauna values and the values of the surrounding Yalgorup National Park? If not, what another fauna work is required?

Regards

Nicholas

DUFTY Nicholas

From: DELL John
Sent: Wednesday, 13 November 2002 9:43
To: 'Kaye Godwin'
Cc: DUFTY Nicholas; HYDER-GRIFFITHS Bridget
Subject: RE: Preston Beach Road, Lake Clifton - Assessment 1440

Hello Kaye
This is in response to the email request you sent me on 6 November 2002 with an attached outline of the revised scope of works to be implemented in relation to vertebrate fauna for the proposed Preston Road, Lake Clifton subdivision.

You asked me to review the attached scope and advise whether the scope was satisfactory in addressing the EPA's requirements in relation to this issue.

I understand that you previously had discussions with Nicholas Dufty from the Planning Assessments Branch and he advised you to contact me directly regarding fauna issues for this project.

The scope of works outlined in your attachment (section 8.2.2 Proposed Further Studies) if undertaken would be satisfactory in addressing the fauna issues in relation to this project.

In assessing the fauna conservation significance of the site with respect to the local and regional context, including its role as a north south regional ecological linkage it is expected that species of conservation significance included in Bush Forever would be considered in addition to any Specially Protected (threatened) or Priority Fauna.

Regards, John

FAUNA VALUES OF CAPE BOUVARD INVESTMENTS PTY LTD LAND, YALGORUP

Prepared for: ATA Environmental,
2 Bulwer St,
Perth, WA, 6000.

Prepared by: M.J. & A.R. Bamford
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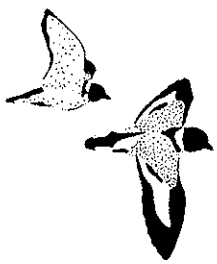

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INTRODUCTION

This fauna survey was conducted at the request of ATA Environmental for Cape Bouvard Investments Pty Ltd (CBI). The survey site was land owned by CBI between Lake Clifton to the east and the Indian Ocean to the west, with other private property and Yalgorup National Park to the north and south. The survey was commissioned to assess the values of the property for fauna as part of an Environmental Impact Assessment being carried out on a proposal to sub-divide the property.

A previous survey was undertaken in June 1998 by ATA Environmental with assistance from John Dell (Alan Tingay and Assoc. 1998). This survey gathered baseline data using systematic trapping for amphibians, reptiles and small mammals, bird surveys, active searching and opportunistic observations on the eastern portion of the CBI landholding and a coastal area of the adjacent Yalgorup National Park. The aims of the 2002 study were to repeat the 1998 survey at a different time of the year, to take advantage of seasonal variation in the abundance of many fauna species, and to investigate areas not covered previously.

The objectives of the two surveys can be summarised as follows:

- Produce a fauna list, containing both species recorded during the field surveys and species predicted to occur in the project area on the basis of known patterns of distribution and habitats present on the site;
- Identify species of conservation significance that are or may be present. These may be species listed under wildlife conservation acts or species that are unusual in a regional context;
- Identify significant or sensitive habitats and locations on the site and;
- Make management recommendations to minimise impacts upon fauna.

METHODS

Site Description

Four main habitat types have been identified on the property, and the following descriptions are based on those from the June 1998 survey (Alan Tingay and Assoc. 1998)

1. Quindalup Dunes

This habitat type dominates the western portion of the landholding, and consists of both primary and older dunes. Associated with the primary dunes are closed heaths dominated by *Olearia axillaris* and *Scaevola crassifolia*. Older dunes are dominated by *Acacia* species mixed with *Melaleuca acerosa* and other typical heath species.

2. Limestone areas

This habitat type dominates the CBI landholding, and is characterised by variable soil depth and vegetation types. Distinct limestone outcrops support *Dryandra sessilis*, while flat, low-lying limestone with a thin covering of soil supports a low heath of *Melaleuca acerosa* and *Grevillea thelemanniana*. Areas with more relief (ridges and

valleys) support *Melaleuca huegelii* or *Acacia truncata* heaths. Such heaths occurred on parts of the southern area of the property that were not surveyed in 1998. There are also areas with a low closed forest of *Eucalyptus decipiens* where there is a thin layer of sandy soil.

3. Tuart Woodland

The main area dominated by Tuart *Eucalyptus gomphocephala* is that alongside Boundary Lake and Linda's Lagoon, and in a thin strip next to Lake Clifton. A woodland of Peppermint *Agonis flexuosa* occurs beneath the open woodland of Tuart. Tuart/Peppermint woodland also occupies much of the southern area of the property that was not included in the 1998 survey.

4. Wetland areas (Yoongarillup Plain)

The wetland areas support low woodlands of *Melaleuca rhaphiophylla* and *Melaleuca cuticularis* with an understorey of sedges such as *Gahnia trifida* and *Baumea juncea*.

Field Survey Programme

Field-work on the CBI landholding took place from 16th to 22nd December 2002. Field personnel were: Dr M.J. Bamford, Mr P. Smith, Mr R.A. Davis, Mr B. Metcalf and Miss J. Wilcox. Work carried out in the field included:

- Systematic trapping for amphibians, reptiles and mammals;
- Censusing for birds in conjunction with systematic trapping;
- Spotlighting for nocturnal reptiles, birds and mammals;
- The use of a harp-trap and an ultra-sonic detector for bats;
- Searching for reptiles;
- The keeping of opportunistic records at all times.

Methods employed for these components of the field project are described in the following sections.

Systematic Trapping for Amphibians, Reptiles and Mammals

Systematic trapping for amphibians, reptiles and mammals took place at 5 sites. These sites are described in Table 1. All were located on the CBI property, and they were arranged to sample the range of habitats as described above. They were also placed close to the sites sampled in June 1998, or in habitats similar to those sampled previously.

At Sites A-E, the trapping layout consisted of:

- 10 assisted pitfall traps placed at approximately 20m intervals, each 28cm in diameter and 40cm deep, with a 25cm high drift-fence extending 3m on either side of the pitfall. Pitfall traps were in transects except at Site C, where shallow soil meant that the pitfalls were arranged roughly in a grid, but still with at least 20m between pits.
- 20 medium Elliott Traps, with one placed at each end of the drift-fence.
- 5 cage traps, located in the vicinity of every alternate pitfall.

Site F was on a limestone ridge adjacent to site E, and consisted of 5 cage traps, and 10 medium Elliott traps arranged in a transect.

Sampling at Sites A and B took place for 6 nights from 16th –22nd December, and the traps at Sites C-F were operated for 5 nights from 17th – 22nd December.

All specimens captured were identified, basic measurements taken and were then released or retained as specimens and lodged with the WA Museum. Trapping and collection were carried out under a Licence to Take Fauna for Scientific Purposes No. SF004041.

Bird Censussing and Observations

Bird censussing was carried out twice at each site. This involved 20 minute searches of approximately 2ha areas, with all birds identified and counted within this period and area. Censussing took place before 0900 on all occasions.

Bird observations were carried out at each of the five trapping sites on the property whenever the traps were checked. They thus took place in the mornings from 17th–22nd December. The order of checking traps was varied so that the bird observations were not carried out at the same time of day at each site on every morning, although all bird surveys was carried out between 0700 hours and 1130 hours. During the bird surveys, all birds observed from the trapping site were noted. The number of surveys carried out corresponded to the number of mornings each trapping site was checked. Therefore, sites A and B were surveyed for birds 6 times and sites C-F were surveyed 5 times.

Observations on birds were also gathered opportunistically (see below).

Spotlighting

Spotlighting for nocturnal birds, mammals and reptiles took place twice (18th and 19th December), and was carried out from a vehicle using the vehicle headlights and two hand-held spotlights. Notes were made whenever an animal was seen and included the odometer reading.

Bat Surveys

Bats were surveyed through the use of a harp-trap, an Anabat II ultrasonic detector and when spotlighting (both visually and aurally). The harp-trap was based on the design of Tidemann and Woodside (1978) and was located on a track adjacent to site C, for six nights from 17th – 22nd December. The Anabat was used only on the McLarty property where it could be closely monitored. This was about 6 km north of the CBI land in Tuart and Peppermint woodland similar to that of the study area. Recordings of bat calls for later identification were made on the nights of 17th to 19th December.

Searching for Reptiles

Searching for reptiles was carried out opportunistically in suitable habitat at all sites, and involved at least 2 people for half an hour on each occasion. Searching involved turning over logs, raking through leaf-litter and looking under loose bark and inside dead grasstrees *Xanthorrhoea* sp..

Opportunistic surveys

At all times, observations of fauna were noted when they contributed to the accumulation of information on the fauna of the area. These included observations of birds seen whilst travelling between sites. Fauna observations made on the adjacent McLarty property, immediately to the north of the CBI land, were also recorded, as the habitat of open Tuart woodland over Peppermints was very similar in the two areas.

Sources of Information

Because even an intensive field study cannot be expected to record all species present in an area, the survey results were supplemented with records from a number of sources. These included publications that provide information on the general distribution of frogs (Tyler *et al.* 2000), reptiles (Storr *et al.* 1983, 1986, 1990 and 1999), birds (Blakers *et al.* 1984 and Johnstone and Storr 1998), and mammals (Strahan 1995). In addition, specimen records of frogs, reptiles and mammals held by the WA Museum were obtained for the region bounded by 32° 30' to 33° 00'S, and 115° 40' to 115° 50'E. CALM's Threatened Fauna Database was also searched for records from this region. The Threatened Fauna Database includes threatened invertebrates but no threatened invertebrates were listed for the area.

These supplementary sources of information were used to create lists of species expected to occur at the site. As far as possible, expected species are those that are very likely to utilise the project area, and such lists exclude species that have been recorded in the general region as vagrants. Particularly among the birds, for example, vagrants can be recorded almost anywhere.

Taxonomic orders and names used in this report generally follow Tyler *et al.* (1994) for amphibians, Storr *et al.* (1983, 1986, 1990 and 1999) for reptiles, Strahan (1995) for mammals and Christidis and Boles (1994) for birds. Where recent taxonomic revisions have occurred, such as those recognised by the WA Museum (2001), earlier names are given in parenthesis.

Assessment of conservation significance

For the determination of conservation significance, the conservation status of fauna species is assessed under Federal and State Acts such as the Commonwealth Environment Protection and Biodiversity Conservation Act (EPBC Act) and the WA

Wildlife Conservation Act. The EPBC Act uses levels of significance recommended by the International Union for the Conservation of Nature and Natural Resources (IUCN) and reviewed by Mace and Stuart (1994). The WA Act has four Schedules with species within these also assigned to some of the IUCN categories. These categories and Schedules are described in Appendix 1. In addition, Environment Australia has supported the publication of reports on the conservation status of reptiles (Cogger *et al.* 1993) and birds (Garnett and Crowley 2000). These publications also use the IUCN categories, although those used by Cogger *et al.* (1993) differ in some respects as this report pre-dates Mace and Stuart's review.

In Western Australia, the Department of Conservation and Land Management has produced a supplementary list of Priority fauna, being species that are not considered Threatened under the WA Act but for which the Department feels there is cause for concern. Levels of Priority are described in Appendix 1.

In addition to the assessment of fauna under CALM's Priority list and the IUCN categories, some fauna are recognised under international treaties such as the China Australia Migratory Bird Agreement (CAMBA) and the Japan Australia Migratory Bird Agreement (JAMBA). These are also listed as migratory under the EPBC Act. Species listed under these agreements are mostly migrants that spend part of the year in each country, although some of the species are non-migrants but occur in both countries.

In this report, species listed under the EPBC Act, either under IUCN categories or as migratory, species listed under the WA Act and species given a Priority listing by CALM are considered to be of National Conservation Significance. Species that are not listed under any of the above categories are considered of Regional Conservation Significance if they are at the limit of their distribution or are common but within a very restricted range. All species of Regional or National Conservation significance are listed in Appendix 7.

In the Perth Bush Forever documents (Department of Environmental Protection 2000), almost half of the bird species recorded from the Perth area are listed as significant because they have declined in the metropolitan region. Many of these would not otherwise be recognised as of National or Regional conservation significance as described above. Species in this category are recognised in the present report although the study area is not within the Perth metropolitan region.

FAUNA OF THE CBI LANDHOLDING

Tables 2, 3 and 4 list the vertebrate fauna known from the region of the CBI Landholding, based on general patterns of distribution, and indicate those recorded by the WA Museum (frogs, reptiles and mammals), recorded in the 1998 survey, or that were recorded during this field survey. Species presumed extinct in the region are presented in Table 5. The detailed results of the December 2002 field survey are presented in Tables 6, 7, 8, 9 and 10, while an annotated bird list appears in Appendix 2.

Amphibians

Of the 9 frog species expected to occur on the property, 2 species were observed, the Motorbike Frog and the Slender Treefrog. Both of these species were found near sites of permanent water, either in wells near Boundary Lake and Linda's Lagoon, or in created wetlands in the Quindalup dune system near Site A. The Slender Treefrog was particularly abundant in the created wetlands. Three additional species, the Moaning Frog, Squelching Frog and Pobblebonk, were observed in the 1998 survey.

The most important natural areas for frogs on the CBI landholding are freshwater seeps near Boundary Lake and Linda's Lagoon, while their use of created wetlands reflects the opportunistic nature of the Motorbike Frog and Slender Treefrog. The Squelching Frog and Pobblebonk may also use these created wetlands, but the Moaning Frog probably relies on natural wetlands because its breeding biology is linked to natural changes in water level. Both the moaning Frog and Pobblebonk range widely in upland habitats outside the breeding season.

None of the frogs recorded or expected in the project area is of conservation significance, although the Turtle Frog (expected to be present but not recorded) is close to the southern limit of its coastal plain distribution in the area. The Turtle Frog is unusual among frogs in being strictly terrestrial.

Reptiles

Of the 42 species of reptile expected to occur on the site, 16 were recorded: 2 geckoes, 1 dragon, 1 pygopod, 10 skinks and 3 snakes (Table 2). The majority of these were recorded in pitfall traps, with the Dugite and Tiger Snake observed crossing the road near Linda's Lagoon. Of the 16 species recorded on this field survey, 9 were not recorded in the previous June 1998 survey. However, 6 species recorded in 1998 were not recorded in this survey, which brings the total number of species recorded to 22. The majority of the reptile species are likely to be widespread in the site, although some species may be associated with particular habitats. The reptile list includes one sea snake, listed by the WA Museum and probably based on a beach-washed specimen.

Between 5 and 6 species of reptile were recorded at each site with pitfalls (Table 6). The most common captures were of the Spiny-tailed Gecko *Strophurus spinigerus* (14 captures) followed by *Hemiergis quadrilineata* (9 captures) and the Bobtail *Tiliqua rugosa* (9 captures). *H. quadrilineata* was present at all sites, while the Bobtail and Spiny-tailed Gecko were recorded at most sites.

Sites A and B were located in the Quindalup Dune system, with Site B being the only site where Jan's Banded Snake *Simoselaps bertholdi* and the Perth Lined Lerista *Lerista lineata* were recorded, and Site A the only site where *Lerista elegans* was recorded. All three species are adapted to the soft sands of the dune system but probably occur on all sandy soils of the site. The *L. lineata* that was captured is the second only record of this species in the area, the previous being in 1989 (Youngson and Harold 1989). Other records for this species are from north of Mandurah and near Busselton (Storr *et al.* 1999), so the Yalgorup population may be isolated.

Site C was the only site at which *Morethia lineoocellata* was recorded, but this is usually a widespread species at coastal plain sites. Similarly, Site D, adjacent to Linda's Lagoon, had three species that were recorded only at that site, *Egernia napoleonis*, *Menetia greyii* and Burton's Legless Lizard *Lialis burtonis*, but these species are probably more widespread than indicated.

Site E, located in a stand of Mallee at the base of a limestone outcrop, was the only site at which the Bearded Dragon *Pogona minor* and *Lerista lineopunctulata* were recorded. The Bearded Dragon would be widespread throughout the study area, but the record of *L. lineopunctulata* was unusual and the specimen was lodged with the WA Museum. It represents the southernmost record of this species to date, with the previous most southerly records from north of the Swan River. The presence of this species highlights the lack of fauna work carried out in the region, and raises the possibility that some other reptile species considered not to occur south of the Perth region may be present.

There are 3 species of national conservation significance that were either observed or are expected to occur on the site: the Southern Carpet Python *Morelia spilota imbricata (*listed as other specially protected fauna under the WA Wildlife Conservation Act and as Vulnerable by Cogger *et al.* 1993) the Perth Lined Lerista (listed as Rare or Insufficiently Known by Cogger *et al.* 1993) and the Black-striped Snake (listed as Endangered by Cogger *et al.* (1993).

The Carpet Python favours areas of heath and limestone, and could be found in any part of the site where this habitat prevails. It was observed at Dawesville in 1988 (M. Bamford, pers. obs.). The Black-striped Snake is known from sandy soils on the coastal plain from Lancelin to Mandurah (Bush *et al*, 1995). Given the understudied nature of the area, it is possible that it could occur on the CBI landholding, particularly in areas of sandy soils. If present, it would be at the extreme southern limit of its range. As noted above, the Perth Lined Lerista is present, at least in the Quindalup dune system.

Both the Perth Lined Lerista and the Black-striped Snake have been removed from the WA Wildlife Conservation Act in recent years, so they may only be of regional rather than national significance. The skink *L. lineopunctulata* is also of regional conservation significance because it occurs at the southern limit of the species' range, and possibly as an outlying population. Other species of regional conservation significance are the Red-legged Skink, because it has a limited distribution on the coastal plain, and the Reticulated Whip Snake, which is at the southern limit of its distribution in the area.

Conservation of the reptile species present on the site depends upon retention of the existing areas of native vegetation wherever possible. Emphasis should be given to ensuring that as broad a range of vegetation types as possible is protected. Although reptiles have been found to persist in small, isolated areas of native vegetation for decades, linkage with adjacent areas to the north and south will be beneficial. This is especially important for large species that occur at low population densities, such as the Carpet Python.

Birds

Of the 128 birds expected to occur on the site, 57 were observed during the 2002 survey, being the total number of bird species recorded at the site to 67 (Table 3). The list of expected species contains both landbirds and waterbirds. Due to the highly mobile nature of birds, almost any species that occurs in the region could occasionally occur on the site, however, only those most likely to occur and use the site regularly have been listed.

Most of the species listed would occur anywhere on the site, but some species favour or are restricted to particular habitats. The Rock Parrot would be restricted mainly to the coastal heath and is often found right on the beach, while the Splendid Fairy-wren and White-browed Scrubwren favour dense, low vegetation as occurs on the coastal dune system, in limestone areas and around some wetlands. Species such as the Weebill and Purple-crowned Lorikeet are eucalypt specialists, and would occur mainly in the Tuart forest to the east of the site.

The woodlands and forest will be important for many birds and, because of the mobility of birds, there will be species that move across habitat boundaries as seasonal conditions change. Honeyeaters in particular need a range of vegetation types to be able to secure a nectar supply throughout the year. Many of the birds also utilise hollows in large trees for roosting or nesting, including the parrots, owls, frogmouth, pardalotes and Tree Martins.

The most common species were the Silvereye and Tree Martin, with most other species only occurring in low densities (Tables 7 and 8). Site B had both the highest density of birds and the highest number of species recorded. The four species that occurred at all trapping sites were the Inland Thornbill, Golden Whistler, Grey Fantail and Silvereye (Table 7). These species were widespread throughout the site, and the Silvereye was particularly abundant.

The Yalgorup Lakes, including Linda's Lagoon, Boundary lake and Lake Clifton, are important for waterbirds and are part of the Peel-Yalgorup Ramsar Site, in part recognised on the basis of waterbird numbers. At the time of the survey, Boundary Lake and Linda's Lagoon were being used by Banded Stilt, Black-winged Stilt, Common Greenshank, Australian Shelduck, Red-capped Plover, Red-necked Stint, Silver Gull and Hooded Plover (Table 10). Several of these species are listed under the EPBC Act as migratory, and other migratory species have been recorded on the lakes during other surveys (Lane and Jaensch 1993). The numbers of birds and species that utilise the lakes would vary depending on the time of year and the pattern of rainfall throughout the year. Although not part of the CBI property, the presence of these lakes and significant waterbirds needs to be considered because of potential impacts of development in nearby areas.

Nine bird species of national conservation significance have been recorded or are expected to use the site:

- Eastern Curlew (Priority 4 according to CALM and listed as Migratory under the EPBC Act);

- Hooded Plover (Priority 4 according to CALM, listed as Near-Threatened by Garnett and Crowley 2000 but not listed under the EPBC Act);
- Square-tailed Kite (listed as Least Concern by Garnett and Crowley 2000 and not listed under the EPBC Act);
- Peregrine Falcon (Schedule 4 (Other Specially Protected Fauna) of the WA Wildlife Conservation Act, not listed by Garnett and Crowley 2000 or under the EPBC Act);
- Carnaby's (Short-billed) Black-Cockatoo (Schedule 1 (Endangered) of the WA Wildlife Conservation Act, also Endangered under the EPBC Act and according to Garnett and Crowley 2000);
- Baudin's (Long-billed) Black-Cockatoo (Schedule 1 (Vulnerable) of the WA Wildlife Conservation Act, also Vulnerable under the EPBC Act but listed only as Near-Threatened by Garnett and Crowley 2000);
- Forest Red-tailed Black-Cockatoo (Priority 3 according to CALM and listed as Near-Threatened by Garnett and Crowley 2000);
- Barking Owl (southern race) (Priority 2 according to CALM, listed as near-Threatened by Garnett and Crowley 2000);
- Masked Owl (southern race) (Priority 4 according to CALM, listed as Near-Threatened by Garnett and Crowley 2000).

In addition to the above species, three sandpiper and one plover species that have been recorded or are expected on the Yalgorup lakes are listed as migratory under the EPBC Act. Several other sandpiper species are probably also seasonally present.

The Eastern Curlew is an international migrant but is more typical of estuaries than lakes, but may visit lakes in the Yalgorup area occasionally. In contrast, the Yalgorup lakes population of the Hooded Plover is recognised as being small but stable and relatively secure (Raines 2002). The lakes are important for the Hooded Plover as they provide both feeding and breeding habitat. A pair was recorded on Boundary Lake (Table 10), and the species is known to use Linda's Lagoon (Appendix 2). This species has declined due to human disturbance and fox predation (Garnett and Crowley 2000).

The Square-tailed Kite is more common in the South-West in winter than in summer (Blakers *et al.* 1984), and individuals range widely. Therefore, the site could be utilised occasionally for part of the year by one or two kites, although it would be significant if the birds nested on the site. Square-tailed Kites tend to forage over heathland but nest in tall trees, and one was recorded in Dawesville in February 2002, so the species is likely to be a regular visitor to the CBI property. The Peregrine Falcon may similarly be present in small numbers and could nest in tall trees anywhere in the Tuart woodland in the east of the CBI landholding.

Carnaby's (Short-billed) Black-Cockatoo is a seasonal visitor to the Coastal Plain over summer but breeds in the wheatbelt. It feeds on eucalypts and a range of proteaceous species such as *Dryandra sessilis*, *Hakea trifurcata* and *Banksia attenuata*, whereas Baudin's (Long-billed) Black-Cockatoo feeds many on eucalypts. The latter species occurs mainly in forests but was recorded on the property in the 1998 survey. Short-billed Black Cockatoos were observed feeding in heathland on limestone areas near the southern boundary of the landholding (Appendix 2), and in 1998, flocks of up to 150 were observed feeding in limestone areas (ATA

Environmental, 1998). Both of these species would occur on the CBI land-holding wherever suitable feeding habitat occurs, the limestone areas and in the small stands of *Banksia attenuata* for the Short-billed Black Cockatoo and the Tuart woodland for the Long-billed Black Cockatoo. The Red-tailed Black-Cockatoo is unusual on the coastal plain but has reliably been reported from the general area.

Of the remaining two species, the Barking Owl is infrequently reported from the coastal plain, but one was seen in the southern suburbs of Perth in April 2001 (Maddeford 2001). Its favoured habitat is tall forest and woodland, particularly close to wetlands. The Masked Owl has been reported occasionally from Tuart forest north of Bunbury and therefore has been included on the list because there is Tuart woodland in the east of the site, and the site is adjacent to other stands of Tuart. The Masked Owl has been recorded in the area by the WA Museum and there is an old record on CALM's threatened fauna database (Table 3). Large eucalypt trees containing hollows are important for this species.

Six bird species are considered of Regional Conservation Significance (see Table 3), mainly because they are uncommon or have declined on the coastal plain. In addition, 45 species considered to be significant birds in the Perth metropolitan area (Department of Environmental Protection 2000) are present or expected. Some of these are also of Regional or National Conservation Significance.

The assemblage of bird species on the site is substantially complete, with only a small number of species locally extinct (Table 5). This reflects the large area of more or less continuous native vegetation that is present on the CBI property and surrounding areas, whereas much of the coastal plain to the north and west has been substantially cleared. Furthermore, the CBI landholding forms an important linkage between two areas of the Yalgorup National Park.

Mammals

Of the 25 mammal species expected to occur on the site, 11 were recorded in total from the two surveys, with four of these being introduced (Table 4).

The Western Grey Kangaroo was common and widespread throughout the CBI landholding, and was seen in all habitats. The Brush-tailed Possum probably occurs in the parts of the site with Tuart and Peppermint woodland, or areas of tall heath with some trees. One possum was caught at Site C (Table 6), and several were recorded during spotlighting surveys (Table 9). The length of the spotlighting traverse was similar to one used repeatedly in the Ludlow National Park, near Busselton, where approximately 20 Brush-tailed Possums were seen on each survey (M. Bamford, unpub. data). In comparison, three to six possums were seen on the CBI and McLarty properties combined, suggesting a lower density than at Ludlow. It should be noted, however, that the density of Brush-tailed Possums in Ludlow National Park is very high, and visibility is much better than in the Yalgorup area because the understorey is more open.

During spotlighting, all species were found to be more abundant on the McLarty property compared with the CBI landholding (Table 9). This was probably because

the former property had parkland cleared areas that were attractive to Grey Kangaroos and Rabbits, while these parkland cleared areas also made species such as possums and frogmouths more visible.

Four species of bats were recorded on the 2002 survey (Table 4). Two species, the Southern Forest Bat and the Lesser Long-eared Bat, were captured in the harp-trap at site C (Table 6), while the White-striped Bat was identified by its distinctive call, and was recorded whilst spotlighting (Table 9). Gould's Wattled Bat was identified on the basis of Anabat recordings made at the McLarty Homestead (see Appendix 6) and a specimen was observed near the CBI property during the 1998 survey. The bat species, which may forage widely at night, probably roost in hollow branches and under loose bark of large trees in the woodland, and under the 'skirts' of *Xanthorrhoea preissii* in the dune and heath areas. Site C, in particular, contained some very old, large *X. preissii* that had very thick 'skirts' due to the long period between fires.

Two introduced species were caught in traps: the House Mouse and the Rabbit. Both were common and widespread throughout the site, and House Mice represented a large proportion of captures in pitfalls and Elliotts at all sites (Table 6). Foxes and cats were identified as being present on the basis of tracks, but neither species was observed despite the amount of spotlighting carried out. Low densities of Foxes, at least, may be due to baiting in the nearby Yalgorup National Park.

Five species of national conservation significance are expected to occur on the site: the Brush-tailed Phascogale (Priority 3), Chuditch (Schedule 1(Vulnerable) under the WA Act and Vulnerable under the EPBC Act), Southern Brown Bandicoot or Quenda (Priority 4, Conservation Dependent), Western Ringtail Possum (Schedule 1(Vulnerable)), Brush Wallaby (Priority 4), bat *Falsistrellus mackenziei* (Priority 4) and the Rakali or Water-Rat (Priority 4). None of these was recorded in either survey.

The Brush-tailed Phascogale inhabits forests and woodlands, so could be present in the areas of Tuart on the site. It has been recorded in Tuart/Peppermint woodland, and in Banksia/Jarrah woodland near Bunbury (M. Bamford, unpub. data).

The Chuditch has been reported by CALM from the northern sector of Yalgorup National Park, and has been seen in the Kemerton area to the south (M. Bamford, pers. obs), so may be present in low numbers throughout the region.

The Quenda was not recorded in the study area, despite the availability of suitable habitat and extensive trapping and searching for diggings. It is also not listed on CALM's rare fauna database, but is recorded from the general area on the basis of WA Museum records. These records come from the vicinity of the Peel Inlet. It would appear that the species is absent from the property, but suitable habitat makes it likely that it will recolonise, particularly with ongoing Fox control.

The Western Ringtail Possum was not recorded on the site despite extensive spotlighting and hunting for dreys in suitable habitat. However, the species persists in Yalgorup National Park to the south, and has been re-introduced to the park in the north, so may be present in low numbers on the CBI landholding, or may colonise the

area in the future. Ringtail Possums favour areas of Peppermint woodland, such as that found in association with the Tuart in the east and the south of the site.

The Brush Wallaby favours dense vegetation, and is present in Yalgorup National Park. It is a mobile species and could occur in suitable habitat on the CBI landholding.

The bat *F. mackenziei* is listed on CALM's threatened fauna database for the area on the basis of an old record, and was caught in the Kemerton area to the south in the early 1980s (M. Bamford, unpub. data). It was not detected despite the effort to record bats, but can be assumed to be present. The Kemerton record was from the margin of a wetland surrounded by Tuart/Peppermint woodland.

The Rakali or Water-Rat has not been reported by the WA Museum or CALM, but occurs in wetlands in the Kemerton area (M. Bamford, unpub. data) and may be present along the Yalgorup Lakes.

Several of the mammal species not listed as of national conservation significance can be considered to be of regional conservation significance. The Honey Possum, Pygmy Possum and Brush-tailed Possum have declined on the coastal plain and therefore surviving populations are of interest. The Brush-tailed Possum appears to be abundant on the property and appears to have increased in abundance in the Yalgorup region generally as a result of Fox control. It is likely to occur mainly in areas where Tuart trees provide hollows for shelter. The Honey Possum and Pygmy Possum are very likely to be present as both have been reported from large remnants of native vegetation in the general region between Mandurah and Bunbury. The Honey Possum in particular requires large, unbroken tracts of vegetation to allow for seasonal movements. Pygmy Possums are usually associated with eucalypt forests and woodlands. These two species are usually readily trapped in pitfalls when abundant, but their levels of abundance are likely to be low because of dry conditions during 2002. This has been noted at other study sites north of Perth (M. Bamford, unpub. data).

The mammal fauna is missing a number of species that are regionally extinct (Table 5). This level of extinction is typical for sites in southern, mainland Australia and is associated with changed fire regimes and the impact of introduced predators (Burbidge and McKenzie 1989).

DISCUSSION AND CONCLUSIONS

The vertebrate fauna of the region is rich and includes species of regional and national conservation significance. The faunal assemblage is particularly significant because large areas to the north and east in particular have depauperate assemblages because of massive land clearing and development, although it should be noted that the fauna and fauna habitats are also represented in the adjacent Yalgorup National Park. It is unlikely that there are any vertebrate fauna species in the CBI landholding that are not also present in the national park.

The richness of the faunal assemblage on the CBI landholding can be attributed to:

- Its position situated between two sections of the Yalgorup National Park, thus being part of a continuous area of native vegetation and forming a link between the two parts of the national park.
- The range of habitats available, from coastal heaths to woodlands, small freshwater wetlands and large saline lakes.
- The isolated nature of the site (located between Lake Clifton and the coast) reducing the chances of human disturbance.

Development in the area would potentially impact upon the fauna through loss of habitat, the fragmentation of existing habitat and through increased levels of human activity in the area. All habitats have some significance for fauna, and without an extremely comprehensive survey to identify local patterns of distribution in relation the vegetation and landform, it is possible to make only the following general statements concerning the importance of different habitats.

- The saline lakes are seasonally important for large numbers of waterbirds, including threatened species such as the Hooded Plover, and some that are migratory. While not part of the CBI landholding, potential disturbance from development of the property is a concern.
- The wetland margins, that include freshwater soaks, and the Tuart/Peppermint woodland, are particularly rich in fauna species because of the structural and floristic diversity of the habitat. Several of the species observed or expected in these habitats are of conservation significance. The southern part of the CBI property, that was not surveyed in 1998, contains particularly good examples of Peppermint woodland that are the most likely part of the property to support the Western Ring-tailed Possum.
- The limestone heaths are likely to support fewer species than the woodlands, but may be seasonally important for significant species such as Carnaby's Black-Cockatoo. They may also be used seasonally by Honey Possums and several honeyeater species. On the basis of one specimen of *L. lineopunctulata*, it cannot be concluded that the apparently outlying population of this species is restricted to the rare mallee that grows on the margin of the limestone heath.
- The coastal heaths can be expected to support the fewest species, as the habitat is structurally uniform and the plant diversity probably lower than elsewhere. These heaths may be seasonally important for some bird species, and some of the reptile species may be found to be restricted or largely restricted to this habitat. The coastal heaths are also important for dune stabilisation.

Overall, the woodlands and limestone heaths close to the Yalgorup wetlands probably support the greatest number of fauna species.

In the light of the above points, any proposed development needs to consider the following:

- Retention of as much native vegetation and as great a range of habitat types as possible (eg. through building envelopes, clearing restrictions, landscaping using native vegetation). While examples of all habitat types should be protected, the most important habitats for fauna are most likely the woodlands, limestone heaths and wetland margins.
- Maintenance of the linkage function between the two areas of Yalgorup National Park. The native vegetation on the CBI landholding probably

complements the fauna values of the national park by providing additional habitat and linkage.

- Management strategies to control disturbance and other impacts on the Yalgorup lakes (eg. controlled access to lakes, fencing to exclude domestic pets, restrictions on groundwater use to protect freshwater soaks and groundwater dependent vegetation).
- Protection of the National Park (eg. fire, weed invasion, dieback, domestic pets, restraints on park management such as Fox control).
- Protection of the coastal environment and fore-dunes.

TABLE ONE. Descriptions of fauna sampling sites. Traps at sites A and B were operated for 6 nights from 16th –22nd December, and the traps at sites C-F were operated for 5 nights from 17th – 22nd December. Sites A to E had 10 assisted pitfalls, 20 Elliott and 5 cage traps, while Site F had 10 Elliott and 5 cage traps. Birds were recorded during each site visit, and formal bird censusing (20 minute, 2 hectare counts) were carried out twice at each site during the sampling.

Site	Latitude and Longitude	Site Description
A	32 46 40 S, 115 37 45 E	Heath on stabilized sand-dunes. *Melaleuca acerosa* over sedges on upper slopes, *Acacia rostellifera* thickets in sheltered valleys. Habitat similar to Site 6 sampled in 1998.
B	32 47 01 S, 115 37 39 E	Coastal heath on secondary dunes. Loose white-grey sand. *Spyridium globulosum* and *Acacia rostellifera* form a tall heath to 2m. Habitat similar to Site 4 sampled in 1998.
C	32 46 07 S, 115 38 43 E	Tuart and peppermint woodland with scattered Banksia over a shrubby understorey of *Melaleuca huegelii*, *Dryandra sessilis* and *Xanthorrhoea*. Near Site 2 as used by ATA Environmental in June 1998. Soil is grey sand with limestone close to the surface in places.
D	32 46 46 S, 115 38 39 E	Fringing vegetation around Linda's Lagoon, with traps in transition between *Melaleuca rhaphiophylla* over swordgrass in peaty soil and Tuart/peppermint woodland in sand over limestone. Near Site 3 as sampled in 1998.
E	32 47 40 S, 115 38 53 E	Mallee in sand over limestone, at base of limestone hill supporting *Melaleuca huegelli* and *Dryandra sessilis* limestone heath. Near Site 5 sampled in 1998.
F	32 47 40 S, 115 38 53 E	Adjacent to Site E, going through low limestone heath with very shallow soil.

TABLE TWO. Amphibian and reptile species of the CBI property, indicating those species observed recorded by the WA Museum (WAM) observed on this survey (+) or observed on the 1998 survey (x). The Status column indicates taxa of Regional or National Conservation significance (RCS and NCS), and introduced species (intro.). The comments column provides some information on habitat preferences.

Species		Observed	Status	Comments
FROGS				
Myobatrachidae (ground frogs)				
Quacking Frog	*Crinia georgiana*	WAM		
Glauert's Froglet	*Crinia glauerti*	WAM		
Squelching Frog	*Crinia insignifera*	WAM x		
Moaning Frog	*Heleioporus eyrei*	WAM x		
Pobblebonk	*Limnodynastes dorsalis*	WAM x		
Turtle Frog	*Myobatrachus gouldii*		RCS	
Guenther's Toadlet	*Pseudophryne guentherii*	WAM		
Hylidae (tree frogs)				
Motorbike Frog	*Litoria moorei*	+		
Slender Tree Frog	*Litoria adelaidensis*	+ x		
REPTILES				
Chelidae (freshwater tortoises)				
Long-necked Tortoise	*Chelodina oblonga*			wetlands
Gekkonidae (geckoes)				
Marbled Gecko	*Christinus(Phyllodactylus) marmoratus*	+ x		
Spiny-tailed Gecko	*Strophurus spinigerus*	+ x		
Barking Gecko	*Underwoodisaurus milli*	WAM		
Pygopodidae (legless lizards)				
Sandplain Worm Lizard	*Aprasia repens*	WAM		
Fraser's Legless Lizard	*Delma fraseri*	x		
Grey's Legless Lizard	*Delma greyii*			
Burton's Legless Lizard	*Lialis burtonis*	+		
Common Scaleyfoot	*Pygopus lepidopodus*	x		
Agamidae (dragon lizards)				
Western Bearded Dragon	*Pogona minor*	+		
Varanidae (monitors or goannas)				
Gould's Sand Goanna	*Varanus gouldii*			
Rosenberg's Goanna	*Varanus rosenbergi*			
Scincidae (skink lizards)				
South-West Cool Skink	*Acritoscincus trilineatum*	WAM x		wetland margins
Fence Skink	*Cryptoblepharus plagiocephalus*	+		
Western Ctenotus	*Ctenotus australis*	WAM		
South-west Odd-striped Ctenotus	*Ctenotus impar*	WAM		
Red-legged Skink	*Ctenotus labillardieri*	WAM	RCS	
King's Skink	*Egernia kingii*	WAM		
Western Swamp Egernia	*Egernia luctuosa*			
Salmon-bellied Skink	*Egernia napoleonis*	WAM + x		
Two-toed Earless Skink	*Hemiergis quadrilineata*	+ x		
South-western Four-toed Lerista	*Lerista distinguenda*	WAM		
West Coast Four-toed Lerista	*Lerista elegans*	+		Sandy soils
Perth Lined Lerista	*Lerista lineata*	+	NCS	Sandy soils

Table 2 (cont.)

Species	Observed	Status	Comments
West Coast Spotted Lerista *Lerista lineopunctulata*	+	RCS	Sandy soils
Dwarf Skink *Menetia greyii*	+ x		
Western pale-flecked Morethia *Morethia lineoocellata*	WAM +		Heath and limestone
Southern pale-flecked Morethia *Morethia obscura*	WAM		
Bobtail *Tiliqua rugosa*	+		
Typhlopidae (blind snakes)			
Southern Blind Snake *Ramphotyphlops australis*	WAM x		
Boidae (pythons)			
South-West Carpet Python *Morelia spilota imbricata*		NCS	Heath and limestone
Elapidae (front-fanged snakes)			
Reticulated Whip Snake *Demansia psammophis*	WAM x	RCS	
Bardick *Echiopsis curta*	WAM		
Crowned Snake *Elapognathus coronata*	WAM		
Bar-bellied Sea Snake *Hydrophis elegans*	WAM		marine
Black-naped Snake *Neelaps bimaculatus*	WAM		
Black-striped Snake *Neelaps calanotus*		NCS	Sandy soils
Tiger Snake *Notechis scutatus*	+		wetland margins
Dugite *Pseudonaja affinis*	+ x		
Gould's Snake *Parasuta(Rhinoplocephalus) gouldii*	x		
Jan's Bandy-Bandy *Simoselaps(Vermicella) bertholdi*	+ x		Sandy soils
Black-naped Snake *Simoselaps(Vermicella) bimaculata*			Sandy soils
No. frog species expected (recorded 1998 plus 2002):	9 (5)		
No. reptile species expected (recorded 1998 plus 2002):	42 (22)		

TABLE THREE. Bird species expected at the CBI landholding, indicating those species observed recorded by the WA Museum (WAM), included on CALM's threatened fauna database for the area (CALM), observed on this survey (+) or observed on the 1998 survey (x). The Status column indicates taxa of Regional or National Conservation significance (RCS and NCS), those listed as significant birds under Perth Bush Forever (sb) and introduced species (intro.). The comments column provides some observations and information on habitat preferences.

Species	Observed	Status	Comments
Casuariidae (emus and cassowaries)			
Emu *Dromaius novaehollandiae*	+ x	sb	With young
Phasianidae (pheasants and quails)			
Brown Quail *Coturnix ypsilophora*			
Stubble Quail *Coturnix pectoralis*	WAM		
Anatidae (ducks, geese and swans)			
Black Swan *Cygnus atratus*			Lakes
Grey Teal *Anas gracilis*			Lakes
Pacific Black Duck *Anas superciliosa*	x		Nest in trees
Australian Shelduck *Tadorna tadornoides*	+ x		Nest in trees
Australian Shoveler *Anas rhynchotis*		sb	Lakes
Australian Wood Duck *Chenonetta jubata*			Nest in trees
Musk Duck *Biziura lobata*	WAM	sb	Lakes
Freckled Duck *Stictonetta naevosa*	WAM	sb	Lakes
Podicipediae (grebes)			
Australasian Grebe *Tachybaptus novaehollandiae*			Lakes
Hoary-headed Grebe *Poliocephalus poliocephalus*			Lakes
Great Crested Grebe *Podiceps cristatus*			Lakes
Anhingidae (darters)			
Darter *Anhinga melanogaster*	WAM		Lakes
Phalacrocoracidae (cormorants)			
Great Cormorant *Phalacrocorax carbo*	WAM		Coast/lakes
Little Pied Cormorant *Phalacrocorax melanoleucos*	WAM		Lakes
Little Black Cormorant *Phalacrocorax sulcirostris*	WAM		Lakes
Pied Cormorant *Phalacrocorax varius*	+		Coast/lakes
Pelecanidae (pelicans)			
Australian Pelican *Pelecanus conspicillatus*	WAM		Coast/lakes
Ardeidae (herons and egrets)			
White-faced Heron *Egretta novaehollandiae*			Lakes
White-necked Heron *Ardea pacifica*			Lakes
Great Egret *Ardea alba*			Lakes
Nankeen Night Heron *Nycticorax caledonicus*		sb	Lakes
Threskiornithidae (ibis)			
Australian White Ibis *Theskiornis molucca*			Lakes, paddocks
Straw-necked Ibis *Threskiornis spinicollis*			Lakes, paddocks
Yellow-billed Spoonbill *Platalea flavipes*			Lakes
Accipitridae (kites, hawks and eagles)			
Black-shouldered Kite *Elanus notatus*			
Square-tailed Kite *Lophoictinia isura*		NCS sb	

Table 3 (cont.)

Species		Observed	Status	Comments
Whistling Kite	*Haliastur sphenurus*	+	sb	
Swamp Harrier	*Circus approximans*			Lakes
Brown Goshawk	*Accipiter fasciatus*		sb	
Collared Sparrowhawk	*Accipiter cirrhocephalus*	+ x	sb	
Wedge-tailed Eagle	*Aquila audax*	+	sb	
Little Eagle	*Hieraaetus morphnoides*	x	sb	
Falconidae (falcons)				
Peregrine Falcon	*Falco peregrinus*	CALM	NCS sb	
Australian Hobby	*Falco longipennis*	x		
Brown Falcon	*Falco berigora*	+ x	sb	
Nankeen Kestrel	*Falco cenchroides*	+ x		
Rallidae (rails and crakes)				
Buff-banded Rail	*Gallirallus philippensis*			Lakes
Baillon's Crake	*Porzana pusilla*			Lakes
Australian Spotted Crake	*Porzana fluminea*			Lakes
Spotless Crake	*Porzana tabuensis*			Lakes
Purple Swamphen	*Porphyrio porphyrio*			Lakes
Eurasian Coot	*Fulica atra*			Lakes
Turnicidae (button-quails)				
Painted Button-quail	*Turnix varia*		sb	
Scolopacidae (stints, sandpipers and curlews)				
Eastern Curlew	*Numenius madagascariensis*	CALM	mig sb	Lakes
Common Greenshank	*Tringa nebularia*	WAM +	mig sb	Lakes
Red-necked Stint	*Calidris ruficollis*	+	mig sb	Lakes
Curlew Sandpiper	*Calidris ferruginea*		mig sb	Lakes
Recurvirostridae (stilts and avocets)				
Black-winged Stilt	*Himantopus himantopus*	+		Lakes
Banded Stilt	*Cladorhynchus leucocephalus*	WAM +		Lakes
Red-necked Avocet	*Recurvirostra novaehollandiae*	+		Lakes
Charadriidae (lapwings and plovers)				
Banded Lapwing	*Vanellus tricolor*			Lakes
Hooded Plover	*Thinornis rubricollis*	+	NCS	Lakes
Red-capped Plover	*Charadrius ruficapillus*	+		Lakes
Greater Sand Plover	*Charadrius leschenaulti*	WAM	mig sb	Coast/lakes
Black-fronted Dotterel	*Elseyornis melanops*	WAM		Lakes
Laridae (gulls and terns)				
Silver Gull	*Larus novaehollandiae*	WAM +		Coast/lakes
Crested Tern	*Sterna bergii*	+		Coast/lakes
Fairy Tern	*Sterna nereis*	WAM		Coast/lakes
Columbidae (pigeons and doves)				
Laughing Turtle-Dove	*Streptopelia senegalensis*		Intro.	
Common Bronzewing	*Phaps chalcoptera*	+ x		
Crested Pigeon	*Ocyphaps lophotes*			
Cacatuidae (cockatoos)				
Red-tailed Black-Cockatoo	*Calyptorhynchus banksii*	CALM	NCS sb	
Short-billed Black-Cockatoo	*Calyptorhynchus latirostris*	CALM + x	NCS sb	
Long-billed Black-Cockatoo	*Calyptorhynchus baudinii*	CALM x	NCS sb	
Galah	*Cacatua roseicapilla*	+ x		

Table 3 (cont.)

Species		Observed	Status	Comments
Psittacidae (lorikeets and parrots)				
Purple-crowned Lorikeet	*Glossopsitta porphyrocephala*			
Regent Parrot	*Polytelis anthopeplus*	+		
Red-capped Parrot	*Purpureicephalus spurius*	+ x		
Western Rosella	*Platycercus icterotis*		RCS sb	
Australian Ringneck	*Barnardius zonarius*	WAM + x		
Elegant Parrot	*Neophema elegans*			
Rock Parrot	*Neophema petrophila*		sb	Coastal dunes
Cuculidae (cuckoos)				
Pallid Cuckoo	*Cuculus pallidus*	+		
Fan-tailed Cuckoo	*Cuculus pyrrhophanus*	x		
Horsfield's Bronze-Cuckoo	*Chrysococcyx basalis*	WAM		
Shining Bronze-Cuckoo	*Chrysococcyx lucidus*	+		
Strigidae (hawk-owls)				
Barking Owl	*Ninox connivens*		NCS sb	
Southern Boobook Owl	*Ninox novaeseelandiae*	+		
Tytonidae (barn owls)				
Masked Owl	*Tyto novaehollandiae*	WAM, CALM	NCS sb	
Barn Owl	*Tyto alba*	+		
Podargidae (frogmouths)				
Tawny Frogmouth	*Podargus strigoides*	WAM +		
Apodidae (swifts)				
Fork-tailed Swift	*Apodus pacificus*	WAM		
Halcyonidae (forest kingfishers)				
Laughing Kookaburra	*Dacelo novaeguineae*	+ x	Intro.	
Sacred Kingfisher	*Todiramphus sanctus*			
Meropidae (bee-eaters)				
Rainbow Bee-eater	*Merops ornatus*	WAM +		
Maluridae (fairy-wrens)				
Southern Emu-wren	*Stipiturus malachurus*		sb	heaths
Splendid Fairy-wren	*Malurus splendens*	WAM + x	sb	
Pardalotidae (pardalotes and thornbills)				
Spotted Pardalote	*Pardalotus punctatus*	x	RCS	
Striated Pardalote	*Pardalotus striatus*	WAM + x		
White-browed Scrubwren	*Sericornis frontalis*	+ x		heaths
Western Gerygone	*Gerygone fusca*	+		
Weebill	*Smicrornis brevirostris*	+ x	sb	tuart
Inland Thornbill	*Acanthiza apicalis*	+ x	sb	
Western Thornbill	*Acanthiza inornata*		sb	
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*	+	sb	
Meliphagidae (honeyeaters)				
Red Wattlebird	*Anthochaera carunculata*	WAM + x		
Western Wattlebird	*Anthochaera lunulata*	WAM	sb	
Singing Honeyeater	*Lichenostomus virescens*	WAM + x		
White-naped Honeyeater	*Melithreptus lunatus*	WAM	sb	
Brown-headed Honeyeater	*Melithreptus brevirostris*	WAM		
Brown Honeyeater	*Lichmera indistincta*	WAM + x		
New Holland Honeyeater	*Phylidonyris novaehollandiae*	WAM + x	sb	

Table 3 (cont.)

Species	Observed	Status	Comments
White-cheeked Honeyeater *Phylidonyris nigra*		sb	heath
Tawny-crowned Honeyeater *Phylidonyris melanops*		sb	heath
Western Spinebill *Acanthorhynchus superciliosus*	WAM x		
White-fronted Chat *Epthianura albifrons*	WAM +		Lakes
Petroicidae (Australian robins)			
Western Yellow Robin *Eopsaltria griseogularis*	WAM	RCS sb	
Scarlet Robin *Petroica multicolor*	WAM + x	sb	
Neosittidae (sittellas)			
Varied Sittella *Daphoenositta chrysoptera*	WAM +	sb	
Pachycephalidae (whistlers)			
Golden Whistler *Pachycephala pectoralis*	WAM + x	RCS sb	
Rufous Whistler *Pachycephala rufiventris*	WAM + x		
Grey Shrike-thrush *Colluricincla harmonica*	WAM + x	sb	
Dicruridae (flycatchers)			
Magpie-lark *Grallina cyanoleuca*			
Restless Flycatcher *Myiagra inquieta*	x	RCS	
Grey Fantail *Rhipidura fuliginosa*	WAM + x		
Willie Wagtail *Rhipidura leucophrys*	WAM + x		
Campephagidae (cuckoo-shrikes)			
Black-faced Cuckoo-shrike *Coracina novaehollandiae*	WAM + x		
White-winged Triller *Lalage tricolor*	WAM		
Artamidae (woodswallows)			
Black-faced Woodswallow *Artamus cinereus*	+	sb	
Dusky Woodswallow *Artamus cyanopterus*	WAM x	sb	
Grey Butcherbird *Cracticus torquatus*	+ x		
Australian Magpie *Gymnorhina tibicen*	WAM + x		
Grey Currawong *Strepera versicolor*	WAM	RCS sb	
Corvidae (ravens and crows)			
Australian Raven *Corvus coronoides*	WAM + x		
Motacillidae (pipits and true wagtails)			
Richard's Pipit *Anthus novaeseelandiae*			
Dicaeidae (mistletoebird)			
Mistletoebird *Dicaeum hirundinaceum*	x		
Hirundinidae (swallows)			
Welcome Swallow *Hirundo neoxena*	WAM + x		
Tree Martin *Hirundo nigricans*	+ x		
Sylviidae (old world warblers)			
Little Grassbird *Megalurus gramineus*	WAM		Lakes
Clamorous Reed-Warbler *Acrocephalus stentoreus*			Lakes
Zosteropidae (white-eyes)			
Silvereye *Zosterops lateralis*	WAM + x		
Number of bird species expected: 128	128		
Number of bird species observed (1998 plus 2002)	67		

TABLE FOUR. Mammal species expected at the site, indicating those species observed during the 2002 survey (+), and those observed on the 1998 survey (x). The Status column indicates taxa of regional or national conservation significance (RCS and NCS); introduced (intro.) species are also indicated in this column. Species known to be extinct in the region appear on Table 5.

Species		Observed	Status
Dasyuridae (dunnarts and allies)			
Brush-tailed Phascogale	*Phascogale tapoatafa*		NCS
Chuditch	*Dasyurus geoffroii*		NCS
Tachyglossidae (echidnas)			
Echidna	*Tachyglossus aculeatus*		
Peramelidae (bandicoots)			
Quenda or Southern Brown Bandicoot	*Isoodon obesulus*	WAM	NCS
Tarsipedidae (honey possum)			
Honey Possum	*Tarsipes rostratus*		RCS
Phalangeridae (possums)			
Brush-tailed Possum	*Trichosurus vulpecula*	WAM + x	RCS
Pseudocheiridae (ring-tailed possums)			
Western Ring-tailed Possum	*Pseudochierus occidentalis*		NCS
Burramyidae (pygmy possums)			
Western Pygmy Possum	*Cercartetus concinnus*	WAM	RCS
Macropodidae (kangaroos and wallabies)			
Western Grey Kangaroo	*Macropus fuliginosus*	WAM + x	
Brush or Black-gloved Wallaby	*Macropus irma*	WAM	NCS
Mollosidae (mastiff bats)			
White-striped Bat	*Tadarida australis*	+	
	Mormopterus planiceps		
Vespertilionidae (vesper bats)			
Gould's Wattled Bat	*Chalinolobus gouldii*	WAM + x	
Chocolate Wattled Bat	*Chalinolobus morio*		
	Falsistrellus mackenziei	WAM, CALM	NCS
Southern Forest Bat	*Vespadelus (Eptesicus) regulus*	WAM +	
Lesser Long-eared Bat	*Nyctophilus geoffroyi*	+	
Gould's Long-eared Bat	*Nyctophilus gouldii*		
Greater Long-eared Bat	*Nyctophilus major*		
Muridae (rats and mice)			
Rakali or Water-Rat	*Hydromys chrysogaster*		NCS
Moodit or Southern Bush Rat	*Rattus fuscipes*	WAM	
House Mouse	*Mus musculus*	WAM + x	Intro
Black Rat	*Rattus rattus*	WAM x	Intro
Leporidae (rabbits and hares)			
Rabbit	*Oryctolagus cuniculus*	+ x	Intro
Canidae (foxes and dogs)			
European Red Fox	*Vulpes vulpes*	+	Intro
Felidae (cats)			
Feral Cat	*Felis catus*	+ x	Intro
Number of mammal species expected:		25	
Number of mammal species observed (1998 and 2002):		11	

TABLE FIVE. Vertebrate species that are known or believed to have become extinct in the region since European settlement. Note that this list is not complete, and a number of other mammal and bird species known to have declined or disappeared in the South-West may have been present in the region.

Species		Status under WA Act
Psittacidae (parrots)		
Ground Parrot	*Pezoporus wallicus*	Schedule 1 (Endangered)
Pardalotidae (pardalotes and allies)		
Western Bristlebird	*Dasyornis longirostris*	Schedule 1 (Vulnerable)
Petroicidae (Australian robins)		
White-breasted Robin	*Eopsaltria georgiana*	
Passeridae (finches)		
Red-eared Firetail	*Stagonopleura oculata*	
Dasyuridae (dunnarts and allies)		
dunnart	*Sminthopsis gilberti*	
Potoroidae (potoroos)		
Woylie	*Bettongia penicillata*	Conservation Dependent
Boodie	*Bettongia lesueur*	Schedule 1 (Extinct on mainland)
Macropodidae (kangaroos and wallabies)		
Tammar	*Macropus eugeni*	Conservation Dependent
Quokka	*Setonix brachyurus*	Schedule 1 (Vulnerable)
Muridae (rats and mice)		
Noodji	*Pseudomys albocinereus*	

TABLE SIX. Numbers of captures of, reptiles and mammals at Sites A to F in December 2002. Note that traps at sites A and B were operated for 6 nights, and those at C, D, E and F were operated for five nights. Note also that site F consisted of cage and Elliott traps only.

Species	Site A	Site B	Site C	Site D	Site E	Site F	Total
Reptiles							
Christinus marmoratus	1		4		1		6
Strophurus spinigerus	4	5		1	4		14
Lialis burtonis				1			1
Pogona minor					1		1
Cryptoblepharus plagiocephalus			3	1			4
Egernia napoleonis				1			1
Hemiergis quadrilineata	3	1	2	2	1		9
Lerista elegans	2						2
Lerista lineata		1					1
Lerista lineopunctulata					1		1
Menetia greyii				4			4
Morethia lineoocellata			1				1
Tiliqua rugosa	1	1	3		1	3	9
Simoselaps bertholdi		1					1
Mammals							
Trichosurus vulpecula			1				1
Vespadelus regulus			1				1
Nyctophilus geoffroyi			2				2
Mus musculus	11	11	2	7	8	4	43
Oryctolagus cuniculus		1					1
Number of species	6	7	9	7	7	2	21
Number of reptile specimens	11	9	13	10	9	3	55
Number of mammal specimens	11	12	6	7	8	4	48

TABLE SEVEN. Summary of daily bird observations for Sites A to F in December 2002. The values in the table indicate the number of surveys (out of 7 for sites A and B, and out of 6 for sites C-F) on which a species was recorded at a site.

Species	Site A	Site B	Site C	Site D	Site E+F
Whistling Kite		1			
Wedge-tailed Eagle			1		
Brown Falcon	1				
Nankeen Kestrel					1
Osprey		1			
Common Bronzewing	1				
Australian Ringneck				2	
Red-capped Parrot	1		2		
Regent Parrot				1	
Shining Bronze-cuckoo		1	1		
Laughing Kookaburra				2	
Splendid Fairy-wren	2	4	3		1
Striated Pardalote				1	
White-browed Scrubwren		4	2		
Inland Thornbill	2	4	5	2	2
Weebill			4	1	
Western Gerygone				2	
Red Wattlebird		1		1	
Singing Honeyeater		5			
New Holland Honeyeater				1	
Brown Honeyeater		1			
White-fronted Chat					1
Rufous Whistler		1	1	1	
Golden Whistler	2	4	6	1	2
Grey Shrike-thrush		2	4	1	
Grey Fantail	2	2	5	2	1
Black-faced Cuckoo-shrike					2
White-winged Triller					1
Australian Magpie	1				1
Australian Raven	1	1			
Tree Martin	1	1		1	
Silvereye	4	7	1	3	4
TOTAL SPECIES:	**11**	**16**	**12**	**15**	**10**

TABLE EIGHT. Mean number of each species per 2ha census.

Species	Site A	Site B	Site C	Site D	Site E+F
Osprey	-	0.25	-	-	-
Australian Ringneck	-	-	-	0.50	-
Red-capped Parrot	-	-	0.50	-	-
Regent Parrot	-	-	-	0.75	-
Shining Bronze-cuckoo	-	0.25	-	-	-
Laughing Kookaburra	-	-	-	0.25	-
Splendid Fairy-wren	1.0	1.5	1.0	-	0.75
Striated Pardalote	-	-	-	0.5	-
White-browed Scrubwren	-	1.75	0.25	0.25	-
Inland Thornbill	1.5	1.0	0.25	1.5	4.0
Weebill	-	-	1.25	0.5	-
Western Gerygone	-	-	-	0.75	-
Red Wattlebird	-	0.25	-	-	-
Singing Honeyeater	-	2.0	-	0.25	-
New Holland Honeyeater	-	-	-	0.5	-
Rufous Whistler	-	-	0.25	-	-
Golden Whistler	0.75	1.25	1.5	0.25	-
Grey Shrike-thrush	-	0.25	-	-	-
Grey Fantail	0.75	0.5	0.5	1.0	-
Black-faced Cuckoo-shrike	-	-	-	-	0.25
Australian Magpie	-	-	-	-	1.0
Grey Butcherbird	-	-	-	0.25	-
Australian Raven	-	1.25	-	-	0.25
Tree Martin	5.75	0.75	2.0	1.75	-
Silvereye	5.25	9.25	1.0	3.75	7.0
Mean Total birds:	14.75	20.25	8.5	12.75	13.25

TABLE NINE. Results of spot-lighting.

Survey 1. 18/12/'02. 2030-2130hrs. From McLarty Homestead past Boundary Lake and Linda's Lagoon to close to Site E.

0km. McLarty Homestead.

0-1 km.	7 Grey Kangaroo, 2 Rabbit.
1-2 km.	27 Grey Kangaroo.
2-3 km.	10 Grey Kangaroo, 4 Laughing Kookaburra, 1 bat
3-4 km.	1 Brush-tailed Possum.
4-5 km.	1 Brush-tailed Possum, 2 Rabbit, 4 Tawny Frogmouth.
5-6 km.	7 Grey Kangaroo, 5 Rabbit, 3 Brush-tailed Possum, 2 White-striped Bats.
6-7 km.	4 Grey Kangaroo, 1 bat.
7-7.9 km.	1 Grey Kangaroo. (Cable gate at 7.9km, entering CBI property).
7.9-9 km.	1 Rabbit.
9-10 km.	7 Grey Kangaroo.
10-11 km.	2 Grey Kangaroo, 1 Rabbit, 1 White-striped Bat, 1 Laughing Kookaburra.
11-11.9 km.	4 Grey Kangaroo, 1 Rabbit, 1 Brush-tailed Possum.

Totals (McLarty Property, 7.9km):

Grey Kangaroo:	56
Brush-tailed Possum:	5
Rabbit:	9
White-striped Bat:	2
Tawny Frogmouth:	3
Laughing Kookaburra:	4

Totals (CBI Property, 4km):

Grey Kangaroo:	13
Brush-tailed Possum:	1
Rabbit:	3
White-striped Bat:	1
Tawny Frogmouth:	1
Laughing Kookaburra:	1

Return journey (partial count). 2130-2200. From near site E.

0-1 km.	6 Grey Kangaroos, 1 Brush-tailed Possum, 1 Tawny Frogmouth.
1-2 km.	1 Grey Kangaroo, 1 *Tadarida australis*.
2-3 km.	4 Grey Kangaroo, 1 Tawny Frogmouth.
3-3.9 km.	Cable Gate and end of Sarich property.

Survey end, but 2 Tawny Frogmouths and 1 *Tadarida australis* noted on McLarty property on drive back to Homestead.

Survey 2. 19/12/'02. 2010-2120hrs. From south-east corner of CBI property, along boundary track to chain gate, past Linda's Lagoon and Boundary Lake.

0km.	South-east corner of CBI property.
0-1km.	1 Grey Kangaroo, 3 bats.
1-2km.	3 Grey Kangaroo, 1 Tawny Frogmouth.
2-3km.	1 Grey Kangaroo, 1 Brush-tailed Possum.
3-4km.	5 Grey Kangaroo, 3 Laughing Kookaburra, 1 White-striped Bat.
4-5km.	1 Tawny Frogmouth.
5-6km.	2 Grey Kangaroo, 1 White-striped Bat.
6-6.7km.	1 Spiny-tailed Gecko, 1 White-striped Bat, 1 Rabbit.
6.7km.	Cable Gate and end of CBI property.

Survey end, but 1 Tawny Frogmouth and 2 Brush-tailed Possum noted on McLarty property on drive back to Homestead.

Totals (CBI property, 6.7km):

Grey Kangaroo:	12
Brush-tailed Possum:	1
Rabbit:	1
White-striped Bat:	2
Tawny Frogmouth:	2
Laughing Kookaburra:	3
Spiny-tailed Gecko:	1

TABLE TEN. Waterbird counts of Duck Pond, Boundary Lake and Linda's Lagoon. Counts were carried out by standing on one shore of the lake and counted all waterbirds. One count was carried out at each of Duck Pond and Linda's Lagoon, and three counts were carried out at Boundary Lake.

Duck Pond. 18/12/02

Australian Shelduck:	240
Red-necked Avocet:	290
Banded Stilt:	20

Linda's Lagoon. 17/12/'02

Australian Shelduck:	60
Common Greenshank:	1
Red-necked Stint:	40
Banded Stilt:	1
Red-capped Plover:	5

Boundary Lake. 20/12/02

11:00am

Australian Shelduck	7
Silver Gull	1
Common Greenshank	1

4:30pm

Australian Shelduck	12
Black-winged Stilt	23
Banded Stilt	2
Silver Gull	3

6:45pm

Australian Shelduck	50
Black-winged Stilt	22
Banded Stilt	2
Silver Gull	12
Common Greenshank	2
Hooded Plover	2

REFERENCES

Alan Tingay and Associates (1998). Vertebrate Fauna Lake Clifton Land Exchange Proposal. Unpub. report for Cape Bouvard Invertments Pty Ltd.

Blakers, M., Davies, S.J.J.F., Reilly, P.N. (1984). The Atlas of Australian Birds. Royal Australasian Ornithologists Union and Melbourne University Press, Melbourne.

Burbidge, A.A. and McKenzie, N.L. (1989). Patterns in the modern decline of Western Australia's vertebrate fauna: causes and conservation implications. Biol. Cons. 50: 143-198.

Bush, B., Maryan, B., Browne-Cooper, R. and Robinson, D. (1995). A Guide to the Reptiles and Frogs of the Perth Region. University of Western Australia Press, Perth.

Christidis, L. and Boles, W.E. (1994). The Taxonomy and Species of Birds of Australia and its Territories. Royal Australasian Ornithologists Union, Monograph 2.

Cogger, H.G., Cameron, E.E., Sadlier, R.A. and Eggler, P. (1993). The Action Plan for Australian Reptiles. Endangered Species Programme Project Number 124, Australian Nature Conservation Agency, Canberra.

Department of Environmental Protection (2000). Bush Forever. Vol. 2. Directory of Bush Forever Sites. Department of Environmental Protection, Perth.

Fullard, J.H., Koehler, C., Surlykke, A. and McKenzie, N.L. (1991) Echolocation Ecology and Flight Morphology of Insectivorous Bats (Chiroptera) in South-western Australia. *Australian Journal of Zoology*. 39: 427 – 438.

Jaensch, R. and Lane, J. (1993). Western Australia *in* A Directory of Important Wetlands in Australia. Australian Nature Conservation Agency, Canberra.

Maddeford, W. (2001). Barking Owl at Blue Gum Lake. WA Bid Notes 99: 16.

Paton, D.C. (1991). Loss of Wildlife to Domestic Cats. Pp. 64-69 in: The Impact of Cats on Native Wildlife, C. Potter (ed). Australian National Parks and Wildlife Service.

Raines, J. (2002). Hooded Plover Management Plan (2002-2012) Western Australia. Western Australian Bird Notes Suppl. No. 7.

Storr, G.M., Smith, L.A. and Johnstone, R.E. (1983). Lizards of Western Australia. II. Dragons and Monitors. W.A. Museum, Perth.

Storr, G.M., Smith, L.A. and Johnstone, R.E. (2002). Snakes of Western Australia. W.A. Museum, Perth.

Storr, G.M., Smith, L.A. and Johnstone, R.E. (1990). Lizards of Western Australia. III. Geckoes and Pygopodids. W.A. Museum, Perth.

Storr, G.M., Smith, L.A. and Johnstone, R.E. (1999). Lizards of Western Australia. I. Skinks. 2nd edition. W.A. Museum, Perth.

Strahan, R. (Ed.) (1995). The Mammals of Australia. Australian Museum/Reed Books, Sydney.

Tidemann, C.R. and Woodside, D.P. (1978). A collapsible bat trap and a comparison of results obtained with the trap and with mist nets. Aust. Wildlife Research 5: 355-362.

Tyler, M.J., Smith, L.A. and Johnstone, R.E. (2000). Frogs of Western Australia. W.A. Museum, Perth.

WA Museum. (2001). Checklists of the Vertebrates of Western Australia. Records of the WA Museum Supplement No. 63.

Youngson, K. and Harold, G. (1989). A range Extension of the skink *Lerista lineata*. West. Aust. Nat. 17: 8.

APPENDIX ONE. Categories used in the recognition of conservation significance and referred to in this report.

WA Wildlife Conservation Act.

Schedule 1. Fauna which is rare or likely to become extinct

Schedule 2. Fauna presumed to be extinct

Schedule 3. Birds protected under an international agreement

Schedule 4. Other specially protected fauna.

WA Department of Conservation and Land Management (species not listed under the Conservation Act, but for which there is some concern).

Priority 1. Taxa with few, poorly known populations on threatened lands.

Priority 2. Taxa with few, poorly known populations on conservation lands; or taxa with several, poorly known populations not on conservation lands.

Priority 3. Taxa with several, poorly known populations, some on conservation lands.

Priority 4. Taxa in need of monitoring.

International Union for the Conservation of Nature and Natural Resources (IUCN) These categories are used by Garnett (1992) and Cogger *et al.* (1993). Note that the IUCN categories were refined in 1994 (Mace and Stuart 1994) but that the following categories are still applicable.

Extinct. Taxa not definitely located in the wild during the past 50 years.

Endangered. Taxa in danger of extinction and whose survival is unlikely if the causal factors continue to operate.

Vulnerable. Taxa believed likely to become Endangered in the near future if the causal factors continue to operate.

Rare. Taxa with small populations that are not considered Endangered or Vulnerable, but which are threatened (if only by virtue of their small population size).

Insufficiently Known. Taxa suspected of being Rare, Vulnerable or Endangered, but whose true status cannot be determined without more information.

APPENDIX TWO. Annotated list of birds observed around the site for 16th – 22nd December 2002.

Emu. Regularly around homestead, including adult with 3 half-grown chicks. One seen near Boundary Lake (16/12)

Wedge-tailed Eagle. One seen overhead in vicinity of Site C on several occasions.

Whistling Kite. Pair near Site D (17/12).

Brown Falcon. Pair near Site A (16/12).

Brown Goshawk. One bird seen most mornings at McLarty Homestead. One seen in Peppermint in southern part of CBI landholding.

Nankeen Kestrel. One seen near site E.

Black Swan. On Lake Clifton, and 1000+ on Martin's Tank.

Australian Shelduck. On all lakes.

Pied Cormorant. Up to 60 on beach.

Common Greenshank. Few on Lake Clifton (16/12) and one on Linda's Lagoon.

Red-necked Stint. Flock of 40 on Linda's Lagoon (18/12).

Black-winged Stilt. About 10 on Boundary Lake (16/12).

Banded Stilt. Small numbers on Boundary Lake

Red-necked Avocet. About 290 on Duck Pond.

Red-capped Plover. Five on Linda's Lagoon (18/12).

Hooded Plover. 2-3 on Boundary Lake and Linda's Lagoon.

Silver Gull. Several feeding on Boundary Lake (16/12). Several on beach.

Crested Tern. 16 on beach (southern end) 21/12.

Short-billed (Carnaby's) Black Cockatoo. Flock of up to 40 most evenings near McLarty Homestead. Also smaller numbers in woodland of CBI landholding, and small numbers feeding in limestone areas in south of landholding.

Galah. Two over McLarty Homestead (16/12).

Australian Ringneck. Widespread in woodland areas.

Red-capped Parrot. Widespread in woodland areas. Also occasionally in coastal and near-coastal heaths.

Regent Parrot. Flocks of up to 10 seen throughout woodland areas. A flock of about 30 seen near Boundary Lake (20/12).

Common Bronzewing. Widespread, in pairs.

Shining Bronze-Cuckoo. One calling near McLarty Homestead (18/12).

Pallid Cuckoo. One seen on McLarty property near Duck Pond.

Laughing Kookaburra. Widespread in woodland areas, particularly around Boundary Lake.

Southern Boobook. Up to 4 calling around McLarty Homestead each evening.

Barn Owl. One calling around McLarty Homestead (18/12).

Tawny Frogmouth. Several seen while spot-lighting on McLarty property and on CBI landholding.

Rainbow Bee-eater. Widespread, particularly where some clearing has occurred. Nest with adults in attendance at McLarty Homestead.

Splendid Fairy-wren. Widespread, from heaths to woodlands. Also around McLarty Homestead.

Striated Pardalote. Heard occasionally amongst eucalypts on both properties.

White-browed Scrubwren. Widespread in dense heaths and understorey.

Western Gerygone. In woodland around Boundary Lake and Linda's Lagoon.

Weebill. Present amongst eucalypts.

Inland Thornbill. Present occasionally at Sites B and C, widespread.

Yellow-rumped Thornbill. See occasionally in degraded Tuart/Peppermint woodland near Boundary Lake.

Red Wattlebird. Occasionally in heath and Peppermint.

Singing Honeyeater. Occasionally in heath.

Brown Honeyeater. Occasionally in heath and woodland.

White-fronted Chat. Small flock in short heath near site E.

Rufous Whistler. McLarty Homestead and occasionally on CBI property.

Golden Whistler. Widespread on CBI property, from woodlands to heath.

Grey Shrike-thrush. Common in areas of dense understorey in woodland, such as Sites C and D.

Varied Sittella. Party around McLarty Homestead most days.

White-winged Triller. Seen occasionally in parkland cleared paddocks of both properties and over limestone heath on CBI property.

Black-faced Cuckoo-shrike. Single birds and pairs seen occasionally.

Grey Fantail. Widespread.

Willie Wagtail. Around McLarty Homestead.

Welcome Swallow. Around McLarty Homestead. Recently fledged young on verandah.

Tree Martin. Around McLarty Homestead, but smaller numbers than the Welcome Swallow. Small numbers over dunes (Site B)

Black-faced Woodswallow. Seen regularly in areas of blackboy regrowth.

Grey Butcherbird. Widespread.

Australian Magpie. Widespread.

Australian Raven. Widespread.

Silvereye. Widespread and abundant.

APPENDIX THREE. Capture records and morphometric data for all for reptile (A.) and mammal (B.) captures caught in the trapping grids for the trapping period 16/12/02 – 22/12/02.

Column abbreviations are:
SVL = Snout to vet length (mm)
Total = Total length (mm)
Wt = Weight (g)

(A.) Reptiles.

Date	Site	Trap type	Species	SVL	Total	Notes
17/12	A	pitfall	*H. quadrilineata*			
17/12	A	pitfall	*S. spinigerus*			
18/12	A	cage	*T. rugosa*		340	male
18/12	A	pitfall	*H. quadrilineata*	38	88	
18/12	A	pitfall	*L. elegans*			
18/12	C	cage	*T. rugosa*	285	370	male
18/12	D	pitfall	*L. burtonis*	140	320	yellow morph
18/12	D	pitfall	*C. plagiocephalus*	43	96	
18/12	E	pitfall	*S. spinigerus*	60	105	female
18/12	E	pitfall	*S. spinigerus*	65	97	male, regrown tail
18/12	E	pitfall	*P. marmoratus*	53	105	female
19/12	A	pitfall	*S. spinigerus*	71	111	female
19/12	A	pitfall	*S. spinigerus*	57	105	male
19/12	A	pitfall	*S. spinigerus*	52	101	male
19/12	B	pitfall	*S. bertholdi*	175	205	
19/12	C	pitfall	*C. plagiocephalus*	46	93	
19/12	C	pitfall	*P. marmoratus*	53	97	Female (eggs)
19/12	C	pitfall	*P. marmoratus*	51	113	Female (eggs)
19/12	D	pitfall	*H. quadrilineata*	47	110	
19/12	D	pitfall	*H. quadrilineata*	58	131	
19/12	D	pitfall	*E. napoleonis*	102	228	
19/12	E	pitfall	*S. spinigerus*	58	108	Male
19/12	E	cage	*T. rugosa*	195	255	
19/12	E	pitfall	*L. lineopunctulata*	75	141	
19/12	E	pitfall	*H. quadrilineata*	41	78	
20/12	A	pitfall	*P. marmoratus*	38	80	
20/12	B	pitfall	*S. spinigerus*	62	108	
20/12	B	pitfall	*H. quadrilineata*	42	97	
20/12	C	pitfall	*M. lineoocellata*	45	91	Male
20/12	C	pitfall	*P. marmoratus*	35	72	
20/12	D	pitfall	*M. greyii*	27	66	
20/12	D	pitfall	*M. greyii*	27	68	
20/12	D	pitfall	*M. greyii*	28	72	
20/12	D	pitfall	*M. greyii*	30	66	
20/12	E	pitfall	*P. minor*	94	274	
20/12	F	Cage	*T. rugosa*	290	354	

Reptiles cont.

Date	Site	Trap type	Species	SVL	Total	Notes
20/12	F	Cage	*T. rugosa*			
21/12	A	pitfall	*H. qradrilineata*	32	77	
21/12	B	cage	*T. rugosa*	230	301	Female
21/12	B	pitfall	*S. spinigerus*	63		Dead in pit
21/12	B	pitfall	*S. spinigerus*	72	123	Female
21/12	B	pitfall	*L. lineata*			Dead in pit
21/12	C	Pitfall	*H. qradrilineata*	42	98	
21/12	C	Pitfall	*H. qradrilineata*	41	109	
21/12	C	pitfall	*P. marmoratus*	50	93	Female (eggs) regrown tail
21/12	D	pitfall	*S. spinigerus*	56	107	Male
22/12	A	pitfall	*L. elegans*	38	81	
22/12	B	pitfall	*S. spinigerus*	60	110	male
22/12	B	pitfall	*S. spinigerus*	62	103	male
22/12	C	Elliott	*T. rugosa*	280	355	female
22/12	C	pitfall	*C. plagiocephalus*			
22/12	C	pitfall	*C. plagiocephalus*			
22/12	C	cage	*T. rugosa*	285	355	female
22/12	E	pitfall	*S. spinigerus*	65	113	gravid female
22/12	F	Elliott	*T. rugosa*			

(B.) Mammals.

Date	Site	Trap type	Species	Wt	Sex	Notes
17/12	A	pitfall	*M. musculus*			
17/12	B	Elliott	*M. musculus*			
17/12	C	Harp-trap	*V. regulus*		Female	
18/12	A	pitfall	*M. musculus*			
18/12	A	Elliott	*M. musculus*			
18/12	B	Elliott	*M. musculus*			
18/12	D	Elliott	*M. musculus*			
18/12	E	pitfall	*M. musculus*			
18/12	E	Elliott	*M. musculus*			
18/12	E	pitfall	*M. musculus*			
19/12	A	Elliott	*M. musculus*			
19/12	B	Elliott	*M. musculus*			
19/12	B	Elliott	*M. musculus*			
19/12	E	Elliott	*M. musculus*			
19/12	F	Elliott	*M. musculus*			
19/12	F	Elliott	*M. musculus*			
20/12	A	Elliott	*M. musculus*			
20/12	A	Elliott	*M. musculus*			
20/12	B	Elliott	*M. musculus*			
20/12	B	Elliott	*M. musculus*			
20/12	B	Elliott	*M. musculus*			

Mammals cont.

Date	Site	Trap type	Species	Wt	Sex	Notes
20/12	C	Cage	*T. vulpecula*	1600g	Male	Crn: 83.7mm
20/12	C	Harp-trap	*N. geoffroyi*		Male	
20/12	C	Harp-trap	*N. geoffroyi*		Female	
20/12	D	Elliott	*M. musculus*			
20/12	D	pitfall	*M. musculus*			
20/12	E	Elliott	*M. musculus*			
20/12	E	Elliott	*M. musculus*			
21/12	A	Elliott	*M. musculus*			
21/12	A	Elliott	*M. musculus*			
21/12	A	Elliott	*M. musculus*			
21/12	B	Elliott	*M. musculus*			
21/12	B	Elliott	*M. musculus*			
21/12	B	pitfall	*M. musculus*			
21/12	B	pitfall	*O. cuniculus*			juvenile
21/12	C	Elliott	*M. musculus*			
21/12	C	Elliott	*M. musculus*			
21/12	E	Elliott	*M. musculus*			
21/12	E	Elliott	*M. musculus*			
21/12	F	Elliott	*M. musculus*			
21/12	F	Elliott	*M. musculus*			
21/12	F	Elliott	*M. musculus*			
22/12	A	Elliott	*M. musculus*			male
22/12	A	Elliott	*M. musculus*			
22/12	B	Elliott	*M. musculus*			
22/12	D	Elliott	*M. musculus*			
22/12	D	pitfall	*M. musculus*			
22/12	D	pitfall	*M. musculus*			
22/12	D	pitfall	*M. musculus*			

APPENDIX FOUR. Raw bird observations at each site.

Site A.

Species	16/12	17/12	18/12	19/12	20/12	21/12	22/12
Brown Falcon	+						
Common Bronzewing				+			
Red-capped Parrot		+					
Splendid Fairy-wren	+				+		
Inland Thornbill					+	+	
Golden Whistler					+	+	
Grey Fantail					+	+	
Australian Magpie	+						
Australian Raven				+			
Tree Martin						+	
Silvereye		+		+	+	+	

Site B.

Species	16/12	17/12	18/12	19/12	20/12	21/12	22/12
Whistling Kite				+			
Osprey						+	
Shining Bronze-cuckoo					+		
Splendid Fairy-wren			+	+	+	+	
White-browed Scrubwren		+	+		+	+	
Inland Thornbill		+	+		+	+	
Red Wattlebird					+		
Singing Honeyeater	+		+	+	+	+	
Brown Honeyeater			+				
Rufous Whistler			+				
Golden Whistler			+	+	+	+	
Grey Shrike-thrush			+		+		
Grey Fantail			+			+	
Australian Raven						+	
Tree Martin						+	
Silvereye	+	+	+	+	+	+	+

Site C.

Species	17/12	18/12	19/12	20/12	21/12	22/12
Wedge-tailed Eagle	+					
Red-capped Parrot				+	+	
Shining Bronze-cuckoo			+			
Splendid Fairy-wren		+	+		+	
White-browed Scrubwren		+			+	
Weebill	+		+		+	+
Inland Thornbill	+	+	+	+	+	
Singing Honeyeater						
Golden Whistler	+	+	+	+	+	+
Rufous Whistler			+			
Grey Shrike-thrush	+	+	+			+
Grey Fantail	+	+	+		+	+
Silvereye					+	

Site D.

Species	17/12	18/12	19/12	20/12	21/12	22/12
Regents Parrot					+	
Australian Ringneck			+		+	
Laughing Kookaburra			+		+	
Striated Pardalote					+	
Weebill					+	
Western Gerygone	+				+	
Inland Thornbill			+		+	
Red Wattlebird		+				
New Holland Honeyeater					+	
Golden Whistler	+					
Rufous Whistler			+			
Grey Shrike-thrush						+
Grey Fantail			+		+	
Australian Magpie						
Tree Martin					+	
Silvereye			+	+	+	

Site E + F.

Species	17/12	18/12	19/12	20/12	21/12	22/12
Nankeen Kestrel					+	
Splendid Fairy-wren					+	
Inland Thornbill				+	+	
Singing Honeyeater						
White-fronted Chat				+		
Golden Whistler		+	+			
Grey Fantail			+			
Black-faced Cuckoo-shrike				+	+	
White-winged Triller				+		
Black-faced Woodswallow				+		
Australian Raven				+		
Australian Magpie					+	
Silvereye	+	+	+		+	

APPENDIX FIVE. Raw bird census data.

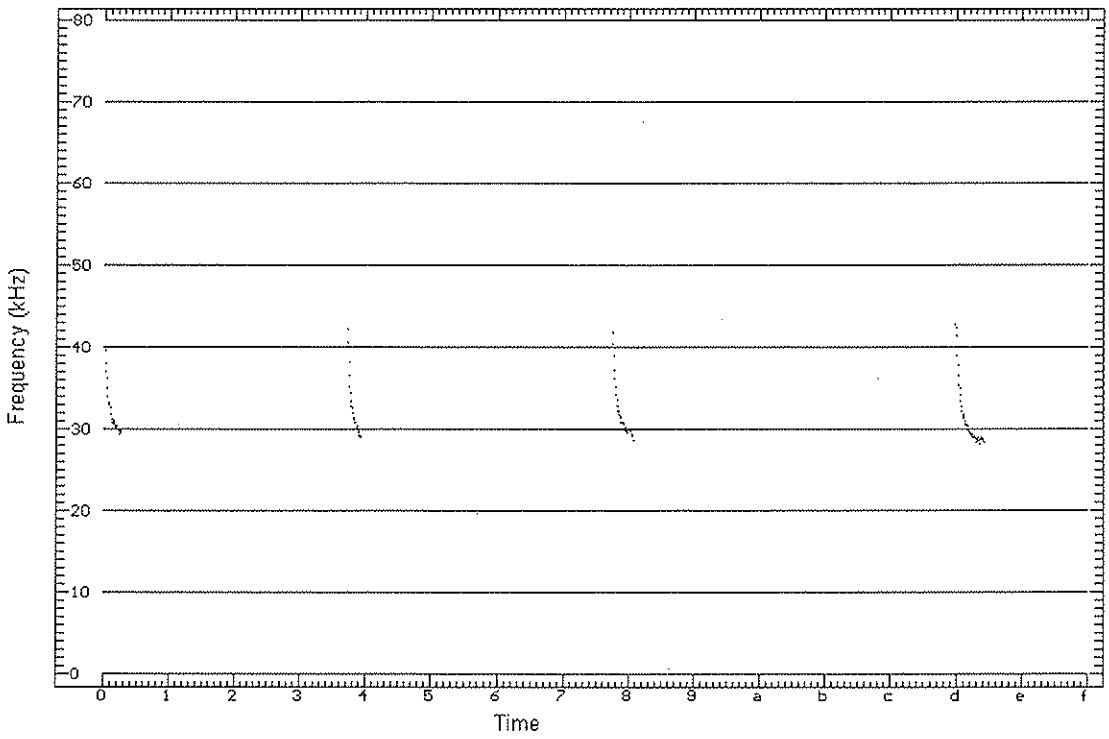
Species	Site A	Site B	Site C	Site D	Site E+F
Osprey		-,-,1,-			
Australian Ringneck				-,-,2,-	
Red-capped Parrot			-,-,-,2		
Regent Parrot				-,2,-,1	
Shining Bronze-Cuckoo		-,1,-,-			
Laughing Kookaburra				-,1,-,-	
Splendid Fairy-wren	4,-,-,-	-,2,-,4	2,-,2,-		-,2,-,1
Striated Pardalote				-,2,-,-	
White-browed Scrubwren		1,3,3,-	-,-,1,-	-,-,-,1	
Inland Thornbill	-,3,-,3	2,-,2,-	-,-,1,-	-,6,-,-	-,2,2,12
Weebill			2,3,-,-	-,2,-,-	
Western Gerygone				-,2,1,-	
Red Wattlebird		-,1,-,-			
Singing Honeyeater		1,4,-,3		-,-,1,-	
New Holland Honeyeater				-,2,-,-	
Rufous Whistler			1,-,-,-		
Golden Whistler	1,1,-,1	1,1,-,3	-,2,1,3	-,-,-,1	
Grey Shrike-thrush		1,-,-,-			
Grey Fantail	-,1,-,2	-,-,2,-	1,-,1,-	1,-,1,2	
Black-faced Cuckoo-shrike					-,-,1,-
Australian Magpie					-,-,4,-
Grey Butcherbird				1,-,-,-	
Australian Raven		-,-,-,5			1,-,-,-
Tree Martin	-,-,3,20	-,-,3,-	-,8,-,-	-,2,-,5	
Silvereye	3,5,3,10	7,6,12,12	-,-,2,2	5,8,2,-	2,7,6,13
Total birds:	8,10,5,36	13,18,23,27	6,13,8,7	7,27,7,10	3,11,13,26

APPENDIX SIX. Echolocation call characteristics (Mean (St. Error)) of Gould's Wattled Bat and the Southern Forest Bat identified at Yalgorup. Both recorded from free-flying specimens at McLarty Homestead, 16th December 2002. The figures illustrate the call sequence for D1021102 (Gould's Wattled Bat) and D1021029 (Southern Forest Bat) (Division ratio 16, realtime format, f6 expansion).

Fmax = Maximum Frequency (kHz)
Fmin = Minimum Frequency (kHz)
DUR = Duration of pulse (milliseconds)
n = number of pulses in each call sequence

Gould's Wattled Bat

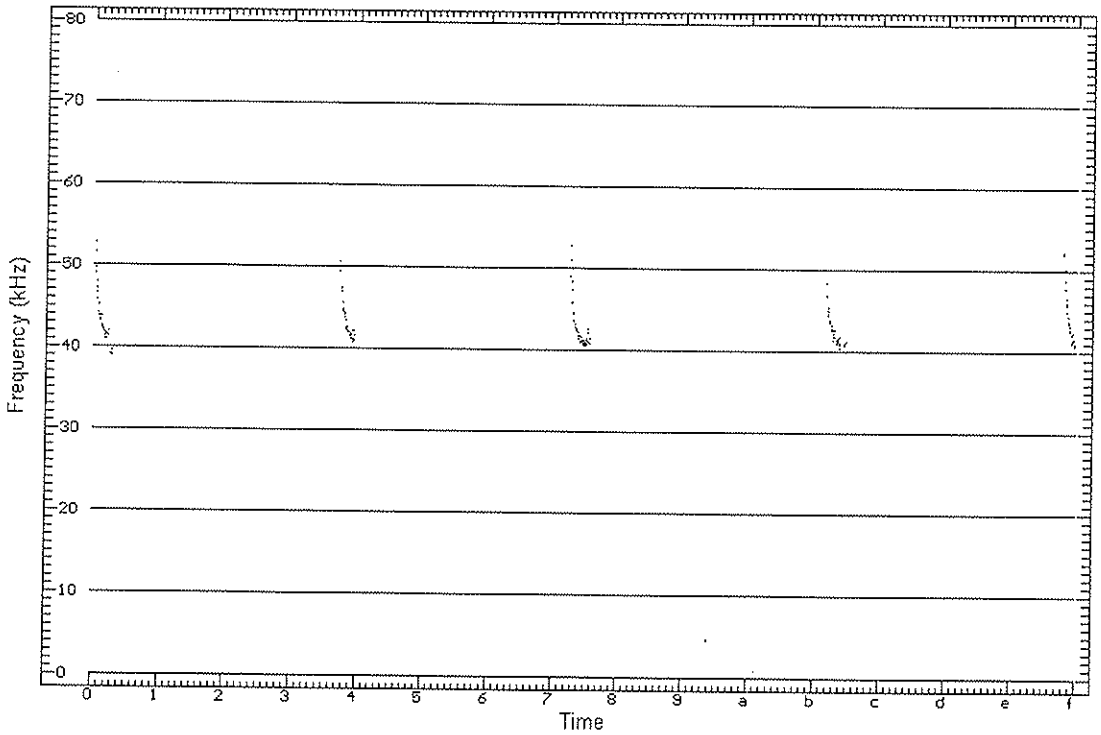
Source:	Yalgorup				Fullard *et al.* (1991)
Sequence	D1021040.30	D1021041.22	D1021047.44	D1021102.14	
Fmax	34.21 (0.58)	41.09 (1.16)	35.19 (0.58)	35.69 (0.80)	106.1 (16.2)
Fmin	28.73 (0.30)	30.14 (0.44)	29.36 (0.35)	28.76 (0.28)	29.6 (0.5)
DUR	7.7 (1.06)	5.2 (0.91)	6.5 (1.09)	5.5 (0.95)	2.7 (0.1)
n (pulses)	36	45	26	12	10



Appendix 6 (cont.)

Southern Forest Bat

Source:	Yalgorup				Fullard *et al.* (1991)
	D102114.26	D1021101.46	D1021021.53	D1021019.56	
Fmax	56.80 (1.00)	53.93 (0.70)	50.16 (0.81)	55.96 (1.03)	106.1 (16.2)
Fmin	42.84 (0.07)	41.11 (0.09)	40.36 (0.70)	42.32 (0.19)	29.6 (0.5)
DUR	4.75 (0.59)	4.62 (0.32)	3.37 (0.74)	3.38 (0.54)	2.7 (0.1)
n (pulses)	24	16	30	37	10



APPENDIX SEVEN. Summary of species of Regional (RCS) or National (NCS) Conservation Significance. Species listed as migratory (mig) are included under the EPBC Act and are therefore of National Conservation Significance.

Frogs and reptiles

Turtle Frog	*Myobatrachus gouldii*	RCS
Red-legged Skink	*Ctenotus labillardieri*	RCS
Perth Lined Lerista	*Lerista lineata*	NCS
West Coast Spotted Lerista	*Lerista lineopunctulata*	RCS
South-West Carpet Python	*Morelia spilota imbricata*	NCS
Reticulated Whip Snake	*Demansia psammophis*	RCS
Black-striped Snake	*Neelaps calanotus*	NCS

Birds

Square-tailed Kite	*Lophoictinia isura*	NCS
Peregrine Falcon	*Falco peregrinus*	NCS
Eastern Curlew	*Numenius madagascariensis*	mig
Common Greenshank	*Tringa nebularia*	mig
Red-necked Stint	*Calidris ruficollis*	mig
Curlew Sandpiper	*Calidris ferruginea*	mig
Hooded Plover	*Thinornis rubricollis*	NCS
Greater Sand Plover	*Charadrius leschenaulti*	mig
Red-tailed Black-Cockatoo	*Calyptorhynchus banksii*	NCS
Short-billed Black-Cockatoo	*Calyptorhynchus latirostris*	NCS
Long-billed Black-Cockatoo	*Calyptorhynchus baudinii*	NCS
Western Rosella	*Platycercus icterotis*	RCS
Barking Owl	*Ninox connivens*	NCS
Southern Boobook Owl	*Ninox novaeseelandiae*	
Masked Owl	*Tyto novaehollandiae*	NCS
Spotted Pardalote	*Pardalotus punctatus*	RCS
Western Yellow Robin	*Eopsaltria griseogularis*	RCS
Golden Whistler	*Pachycephala pectoralis*	RCS
Restless Flycatcher	*Myiagra inquieta*	RCS
Grey Currawong	*Strepera versicolor*	RCS

Mammals

Brush-tailed Phascogale	*Phascogale tapoatafa*	NCS
Chuditch	*Dasyurus geoffroii*	NCS
Quenda or Southern Brown Bandicoot	*Isoodon obesulus*	NCS
Honey Possum	*Tarsipes rostratus*	RCS
Brush-tailed Possum	*Trichosurus vulpecula*	RCS
Western Ring-tailed Possum	*Pseudochierus occidentalis*	NCS
Western Pygmy Possum	*Cercartetus concinnus*	RCS
Brush or Black-gloved Wallaby	*Macropus irma*	NCS
Rakali or Water-Rat	*Hydromys chrysogaster*	NCS

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PEEL PRESTON PLANNING STUDY

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WATERBIRD SURVEY
SUMMARY OF FINDINGS

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Prepared by

J.A.K. LANE

April 1976

"PEEL-PRESTON" WATERBIRDS SURVEY - SUMMARY OF FINDINGS

J.A.K. LANE APRIL 1976

PEEL-HARVEY ESTUARY

The Peel-Harvey Estuary supports large populations of a wide diversity of waterbird species. As a conservation area for waterbirds it is probably the most important estuary in South-Western Australia, rivalled only by the Wonnerup-Vasse.

60 species of waterbirds, have been recorded on Peel-Harvey (see list). Of these, 16 are summer migrants from the northern hemisphere. The remainder have their breeding grounds within Western Australia. By comparison, 50 species of waterbirds were recorded during a 12 month study of Leschenault Inlet (Bunbury) and 55 species were recorded during a similar study of Hardy Inlet (Augusta).

Some of the most outstanding features of the Peel-Harvey's birdlife are :

1. Pelicans Peel Inlet is the only estuary in Western Australia which has a breeding colony of Pelicans. This colony is one of only 8 which are known to exist in W.A., and is the only colony occurring south of Shark Bay. The Peel-Harvey estuary has the largest pelican population of any estuary in the south-west of the state, varying from a low of 600 birds in August 1975 to a high of 1100 in January 1976. The Peel-Harvey population represents approximately 60% of the total number of pelicans known to occur on all estuaries of the south-west.

2. Waterfowl (Ducks and Swans). On a regular basis, the Peel-Harvey estuary supports a larger waterfowl population than any other estuary in the south-west. Grey Teal, Black Duck and Mountain Duck are the most abundant duck species, and during the study period their total population reached an estimated peak of 8-10,000 birds.

   Black Swan were also abundant. A 3-day aerial survey of all south-west estuaries in November 1975 revealed that the Peel-Harvey estuary, with a population of more than 2,500 birds, supported 41% of the total south-west estuaries swan population.

   The most important areas of waterfowl habitat are the extensive shallows around the southern and eastern shores of Peel Inlet, and Harvey Estuary south of, and including, the Herron Point ford. The Harvey River Delta area is of particular importance during late summer as thousands of ducks congregate on its banks. The shallows of the northern shore of Peel and the eastern shore of Harvey are also significant as waterfowl habitats.

3. Wading Birds Many thousands of resident and migratory wading birds inhabit the Peel-Harvey estuary. Migratory species are present in large numbers from October to April and resident species from midsummer to late autumn.

Peel Inlet supports a larger population of Stilt (both Banded and Pied) than any other estuary in the south-west. Total numbers were estimated (from aerial photographs) at 15-20,000 in February 1976. Most of the Stilt were in Austin Bay.

Though accurate surveys of migratory wader populations were not possible, Peel-Harvey estuary appears to support larger numbers of these birds than any other estuary in the south-west, with the possible exception of Wonnerup-Vasse.

The most important areas of wader habitat are the extensive shallows and marshes of the northern, eastern and southern shores of Peel, and the eastern shoreline of Harvey Estuary.

LESCHENAULT INLET

Although Leschenault Inlet does not support as great a number and variety of waterbirds as does the Peel-Harvey estuary, it is still of considerable importance as a waterbird habitat.

During a 12 month study of its birdlife commencing July 1973, 50 species of waterbirds were recorded (see list).

Some of the most notable features of the estuary's birdlife are :

1. Waterfowl (Ducks and Swans). The inlet is an important summer refuge for a number of waterfowl species. Black Duck and Black Swan populations may each exceed 1,000 birds, and flocks of many hundred Grey Teal and Musk Duck are commonly observed.

   The most important areas of habitat for these species are the northern end of the estuary including the Parkfield wetlands, and the freshwater soaks on the western shore of the inlet, opposite Australind.

2. Pelicans Of the south-west estuaries, Leschenault Inlet has the second largest Pelican population. Summer numbers regularly exceed 120 birds.

3. Migratory Waders Leschenault Inlet supported approximately 2,000 migratory waders of 15 species during the summer of 1973-74. Their habitats were the tidalflats of Koombana, Anglesea Island, the Preston River mouth, the Collie River Delta and the northern shores of the inlet. The saltmarsh pools of the western shore, particularly at the northern end, were also important as wader habitat.

WATERBIRD SPECIES RECORDED ON PEEL-HARVEY ESTUARY AND LESCHENAULT INLET.

SPECIES	PEEL-HARVEY - Feb '76	LESCHENAULT Jul '73 - Jun '74
Hoary-headed Grebe (Podiceps poliocephalus)	X	X
Crested Grebe (Podiceps cristatus)	X	
Australian Pelican (Pelecanus conspicillatus)	X	X
Black Cormorant (Phalacrocorax carbo)	X	X
Little Black Cormorant (Phalacrocorax sulcirostris)	X	X
Pied Cormorant (Phalacrocorax varius)	X	X
Little Pied Cormorant (Phalacrocorax melanoleucos)	X	X
Darter (Anhinga rufa)	X	X
Nankeen Night Heron (Botaurus poiciloptilus)		X
Reef Heron (Egretta sacra)	X	
Little Egret (Egretta garzetta)	X	
White Egret (Egretta alba)	X	X
White-faced Heron (Ardea novaehollandiae)	X	X
White-necked Heron (Ardea pacifica)	X	
White Ibis (Threskiornis moluccа)	X	
Straw-necked Ibis (Threskiornis spinicollis)	X	X
Glossy Ibis (Plegadis falcinellus)	X	
Yellow-billed Spoonbill (Platalea flavipes)	X	
Black Swan (Cygnus atratus)	X	X
Mountain Duck (Tadorna tadornoides)	X	X
Black Duck (Anas superciliosa)	X	X
Grey Teal (Anas gibberifrons)	X	X
Chestnut Teal (Anas castanea)		X
Blue-winged Shoveller (Anas rhynchotis)	X	X
Pink-eared Duck (Malacorhynchus membranaceus)	X	
White-eyed Duck (Aythya australis)	X	
Musk Duck (Biziura lobata)	X	X
Whistling Eagle (Haliastur sphenurus)	X	X
White-breasted Sea Eagle (Haliaeetus leucogaster)	X	
Swamp Harrier (Circus approximans)	X	X
Osprey (Pandion haliaetus)	X	X
Dusky Moorhen (Gallinula tenebrosa)		X
Swamphen (Gallinula porphyrio)	X	X
Coot (Fulica atra)	X	
Pied Oystercatcher (Haematopus ostralegus)	X	X
Black-fronted Dotterel (Charadrius melanops)	X	
Red-capped Dotterel (Charadrius ruficapillus)	X	X
*Mongolian Dotterel (Charadrius mongolus)	X	
*Large Sand-dotterel (Charadrius leschenaultii)	X	X
*Grey Plover (Pluvialis squatarola)	X	X
*Turnstone (Arenaria interpres)		X
*Whimbrel (Numenius phaeopus)	X	X
*Eastern Curlew (Numenius madagascariensis)	X	X
*Greenshank (Tringa nebularia)	X	X
*Common Sandpiper (Tringa hypoleucos)	X	X
*Grey-tailed Tattler (Tringa brevipes)		X
*Terek Sandpiper (Tringa cinerea)	X	X
*Knot (Calidris canutus)	X	X
*Great Knot (Calidris tenuirostris)	X	X

* Summer migrants from the northern hemisphere.

SPECIES		PEEL-HARVEY -Feb '76	LESCHENAULT Jul '73 - Jun '74
*Sharp-tailed Sandpiper (Calidris acuminata)		X	X
*Pectoral Sandpiper (Calidris melanotos)		X	
*Red-necked Stint (Calidris ruficollis)		X	X
*Curlew Sandpiper (Calidris ferruginea)		X	X
*Black-tailed Godwit (Limosa limosa)		X	
*Bartailed Godwit (Limosa lapponica)		X	X
Pied Stilt (Himantopus himantopus)		X	X
Banded Stilt (Cladorhunchus Leucocephalus)		X	
Avocet (Recurvirostra novaehollandiae)		X	X
Silver Gull (Larus novaehollandiae)		X	X
Kelp Gull (Larus dominicanus)			X
Caspian Tern (Sterna caspia)		X	X
Crested Tern (Sterna bergii)		X	X
Whiskered Tern (Sterna hybrida)		X	X
Fairy Tern (Sterna nereis)		X	
Sacred Kingfisher (Halcyon sancta)			X
Little Grassbird (Megalurus gramineus)		X	X
White-fronted Chat (Epthianura albifrons)		X	X
TOTALS	67	60	50

* Summer migrants from the northern hemisphere.

LAKE PRESTON AND LAKE CLIFTON

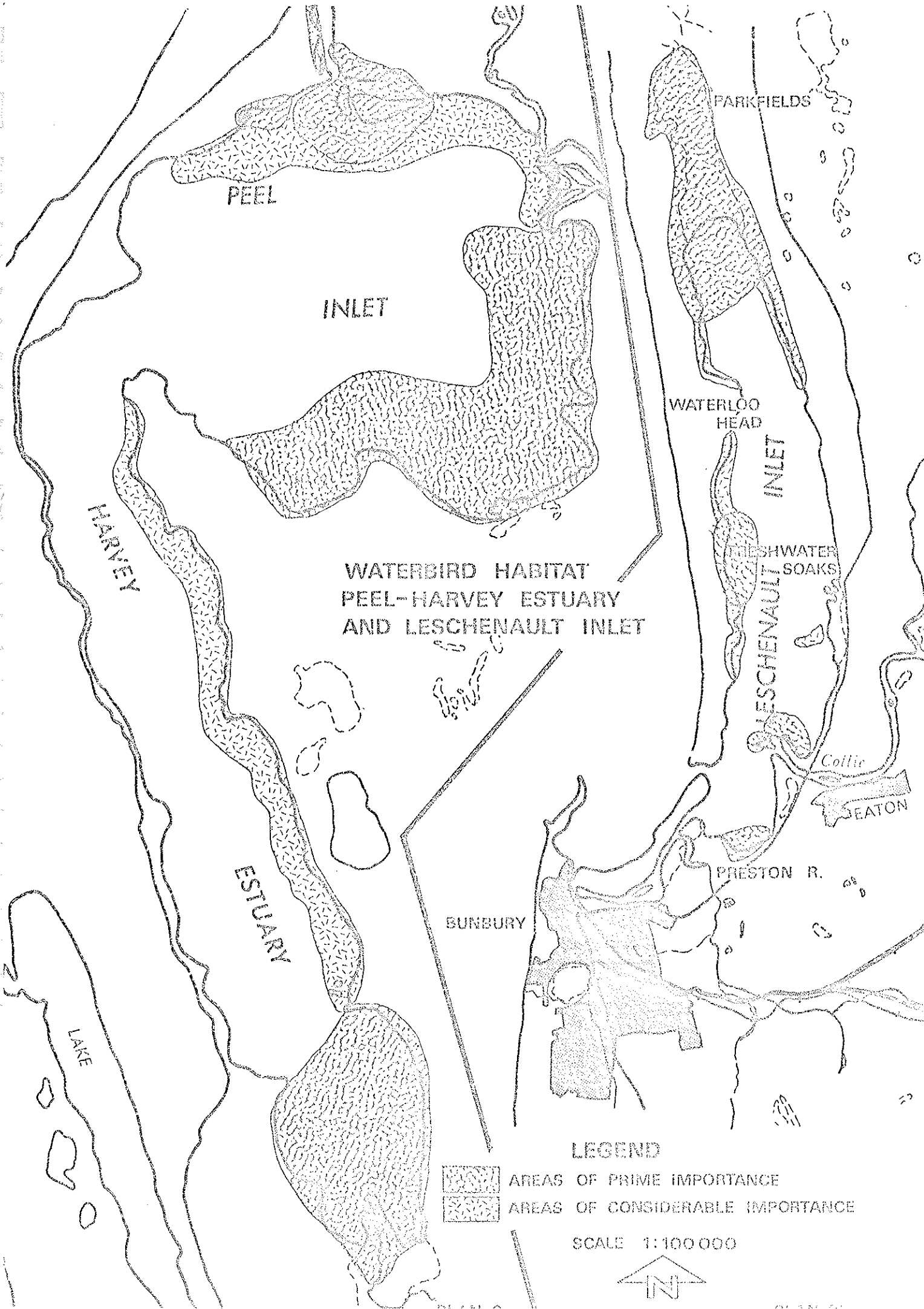
Lakes Preston and Clifton have long been recognized as waterfowl refuges of great importance. Jenkins (1971) recorded more than 1,000 Musk Duck and Coot and many hundreds of Black Swan, Hoary-headed Grebe, Black Duck and Grey Teal during regular surveys of a 2 mile section of Lake Clifton towards the end of the 1969, 1970 drought period.

Unfortunately, no other published information exists concerning waterfowl numbers on the two lakes. Their relative importance and the importance of various areas within each lake is therefore not known.

The present study provided little useful information. Waterfowl numbers were very low during December 1975 and January 1976 and increased only slightly during February. It would appear that Preston and Clifton harbour large numbers of birds only during drought periods or perhaps at the very end of summer. Further studies are required to determine the extent to which these lakes are used by waterfowl of the south-west.

Reference:

Jenkins, C.F.H. (1971). Pressure on the waterfront with special reference to the Mandurah - Murray Region. W. Aust. Nat. 12 (2) : 28-31.


PARKFIELDS
PEEL
INLET
WATERLOO
HEAD
INLET
LESCHENAULT
FRESHWATER
SOAKS
HARVEY
WATERBIRD HABITAT
PEEL-HARVEY ESTUARY
AND LESCHENAULT INLET
Collie
EATON
PRESTON R.
BUNBURY
ESTUARY
LAKE
LEGEND
AREAS OF PRIME IMPORTANCE
AREAS OF CONSIDERABLE IMPORTANCE
SCALE 1:100 000
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PEEL PRESTON PLANNING STUDY

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REPORT ON THE ZOOLOGICAL SURVEY

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Prepared by

S.A. CLARKE & A.E. WRIGHT
ZOOLOGY DEPARTMENT
UNIVERSITY OF WESTERN AUSTRALIA

January 1976

REPORT ON THE ZOOLOGICAL SURVEY

IN THE PRESTON-PEEL PROJECT AREA

S.A. Clarke and A.E. Wright

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1. INTRODUCTION

1.1 Terms of reference.

The terms of reference were to;

make a survey of terrestrial animals and compile an inventory of these animals in the followong areas:

a. coastal sand dunes
b. swamps
c. lake, estuary and river foreshores
d. sand and limestone ridges and swales and
e. pine forests.

on completion of the survey make recommendations on areas which should be protected to preserve the habitat of a species or association of species.

1.2 Procedures.

The field work and data interpretation were done by S.A. Clarke and A.E. Wright and this report was prepared by S.A. Clarke.

All field work in the study area was done between 10.11.75 and 6.12.75 at dawn, dusk and night as this is when animals are active. Many plant species in the region were in flower or in seed and provided one possible food source for wildlife. During the survey 24 mm of rain were recorded at Harvey (9 a.m. 15.11.75 to 9 a.m. 17.11.75).

Mammals

1. Each of the areas (para. 1.1) was trapped and location of the trapping sites are shown in Figure 1. The traps used included:

41 snap traps for small animals e.g. rats and mice,
70 Sherman traps for small mammals e.g. rats, mice and honey possums,
18 National traps for medium sized animals e.g. bandicoots,
6 possum traps also for medium sized animals,
4 wire traps suitable for medium large mammals, e.g. quokkas,
7 pen traps, a 5 post, mesh trap with a wire gate for wallaby sized animals e.g. woylies and tammars.

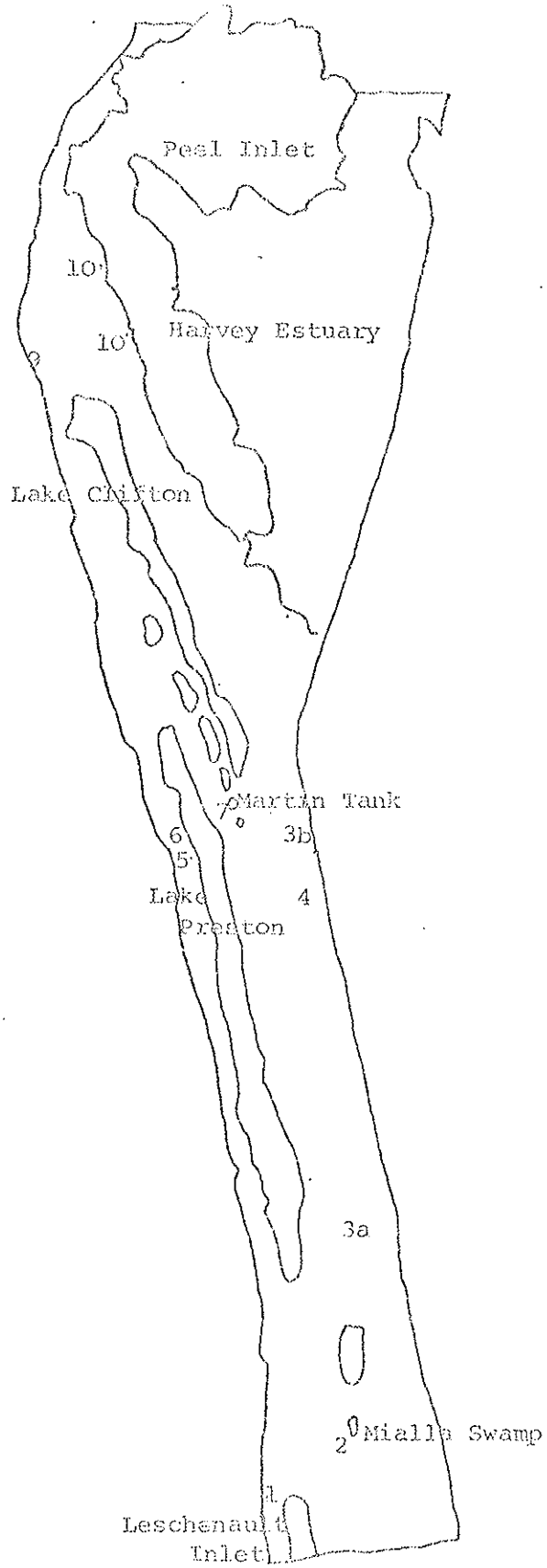

Fig. 1. Project area showing locations surveyed.
1. Dunes etc., Wellington C.G.7; 2. Mialla swamp; 3a. Centrebreak Forestry Rd ; 3b. Johnson Rd.; 4. Jarrah woodland 3 miles south of Preston Beach Rd., 5. Lake foreshore Wellington C.G.128; 6. Camping and recreation A 22091; 7. Martin Tank Pt. A. A 11710; 8. Lake foreshore Wellington C.G.129; 9. Dunes etc. A 12189; 10. Murray loc. 644 and Tim's Thicket Rd., 11. Camping A 13987.

Six lines of traps were set for two consecutive five-day periods and the total number of trap nights was 1460. This is a trapping intensity similar to that of museum surveys. At least one line of traps was set in each of the areas (para. 1.1) except for the sand dunes and ridges where two trap lines were set through adjacent areas.

The traps were cleared each morning and rebaited. The bait used was peanut paste, rolled oats and raisins or apple.

Although there were fewer large traps which may have provided a bias toward trapping small animals other survey methods were used which favoured observation on the larger mammals.

2. Transect observations were carried out at dusk in order to observe the larger mammals which could not be trapped, for example the brush wallaby and grey kangaroo.

3. Several areas were surveyed at night by spotlight to observe the larger nocturnal animals, particularly arboreal species.

4. Tree stumps and fallen logs in woodlands were examined for small nocturnal animals which usually hide in such places.

5. Tracks left by animals walking in sand or mud were identified as far as possible and the presence of fecal pellets was also used as an indication of the presence of animals in certain areas.

6. During field trips 3200 kilometers of road were travelled between Mandurah and Bunbury. All mammals found dead on the road were tagged, preserved and the location was recorded. The specimens collected were donated to the museum.

Birds

1. A bird list was compiled from all sightings in the study area.

2. A fifteen minute period was considered adequate to record most bird species present in a large number of areas in the limited time available (any rare species would be excluded). The presence

of bird species, observed by either sight or sound, was noted in all areas where mammals were trapped except the beach at White Hill Rd., Lake Clifton and the Harvey Estuary (Fig. 1). Both sight and sound observations were recorded because the vegetation in some areas was dense and only the larger birds which moved frequently were seen.

Due to the high plant diversity in some areas, for example the swamp and lakes, three replicate observation periods were made in each of the areas to include a more representative sample of the bird species present. In each of the sub-sampled areas the height of foliage used by each of the species was recorded in order to assess their habitat requirements.

1.3 Available data

Few observations on the wildlife have been made in this area but studies done elsewhere are relevant to the present survey.

1.3.1 Literature.

General. The main effect of the activities of man (such as farming, fire and public access) on natural habitats is to decrease the area available for wildlife species. This decreased size of habitat is often accompanied by increased separation of populations or the formation of 'island' habitats (Diamond 1975). Hence the size of the area and distance from other such areas will be important in determining the number of successful species. For example, the number of successful bird species has been found to increase with island size and decrease with increasing distance between island and source (Diamond, *op. cit.*). Mammals and other less mobile animals which have poorer dispersal powers are likely to show a more rapid fall off in the number of species with increasing separation distance.

Birds. Serventy (1930) and Jenkins (1971) reported on the bird life in the area (Table 3).

1.3.2 There were no museum records of animals captured in this area.

1.3.3

1. Evidence of bandicoots (*Osoodon obesulus*) is scarce and they are particularly difficult to catch at this time of year (A. Baynes and A. Start pers. comm.).

2. Local farmers reported that water rats (*Hydromys chrysogaster*) were present in the swampy areas of the hind dunes north of the Leschenault Inlet. They also reported the presence of the wambenger (*Phascogale tapoatafa*) throughout this southern region 20-30 years ago and remarked on the disappearance of the species. Wambengers are arboreal and their disappearance coincides with the development of agricultural land and hence the disappearance of woodland.

3. The National Park Ranger reported that grey kangaroos (*Macropus fuliginosus*) and brush wallabies (*Macropus irma*) were plentiful.

1.3.4 Results of survey

The mammal species present in each of the areas are shown in Table 1. The grey kangaroo (*Macropus fuliginosus*) had a wide distribution and was often seen in disturbed areas. Brush-tailed possums (*Trichosurus vulpecula*) were observed only at the river location and the semi-disturbed estuary site. Introduced rats and mice were found in all areas except the State forest. A trapping effort of 1460 trap nights and observations is expected to sample any mammal species present in the trapped areas (A. Baynes, pers. comm.) even though seed was present as an alternative food source. The mamal list is given in table 2.

Table 1. Mammal species present in each of the surveyed areas.

AREA	dune, sand ridge & swale		dune, limestone ridge & swale	State forest pineforest	State forest woodland	lakes		swamp	river	estuary	
DISTURBED HABITAT	Semi		no	yes	no	yes	no	semi	semi	yes	semi
Native species											
grey kangaroo	+		+	+	+	+				+	
brush wallaby											
brushtail possum									+		+
bats					+[1]						
Introduced species											
house mouse	+		+			+	+	+	+	+	+
rats							+	+			+
fox				+							
rabbit	+		+								

1. This was the only area where observations and identification was carried out; 3 species were found.

Table 2.

MAMMAL LIST

Native Species

MACROPODIDAE

Macropus fuliginosus - grey kangaroo; several throughout the State forest (areas 3 and 4 Fig. 1); agricultural land (area 5); Estuary Rd. (area 10) and the dunes, ridges and swales (areas 1 and 9).

Macropus irma - brush wallaby, 3 road kills north of Dawesville, 1 White Hill Rd.

PHALANGERIDAE

Trichosurus vulpecula - brush tail possum, 2 at the Harvey River (area 11); 2 at the Harvey Estuary (area 10).

VESPERTILIONIDAE

Chalinolobus gouldii - Gould's wattled bat,

Eptesicus pumilus - little bat and

Pipistrellus tasmaniensis - Tasmanian pipistrelle,

several of each species in the Tuart and Jarrah woodland (area 4).

Introduced Species

CANIDAE

Vulpes vulpes - fox, 1 road kill (Bagieau Rd.).

LEPORIDAE

Oryctolagus cuniculus - rabbit, very common dunes (areas 1 and 9), area 6, along the Old Coast Rd.

MURIDAE

Mus musculus - house mouse, 3 in dunes (area 1); 5 in hind dunes (area 9); 8 at the swamp (area 2); 3 at Lake Preston (area 6); 3 at Lake Preston (Area 5); 1 at the Harvey River (area 11); 7 at the Harvey Estuary (area 10).

Rattus rattus - bush rat, 3 at Mialla Swamp (area 2); 2 at Lake Clifton (area 8); 1 at Martin Tank (area 7); 1 at the Harvey Estuary (area 10).

Bird species were better represented with a total of 43 species exluding the marsh and water birds. This list is compared with the species recorded in 1930 and 1971 (Table 3). Data from the lake suggest that a greater number of species are present where the habitat is undisturbed (Table 4). Many bird species (49%, n = 75) utilized the mid dense-dense canopy which consisted of the following species: *Agonis flexuosa, Banksia attenuata, B. grandis, B. ilicifolia, B. menzesii, Eucalyptus calophylla, E. gomphocephala* and *E. marginata* and a further 13% utilized the mid and understoreys.

2. DEVELOPMENT OF THE SWAN COASTAL PLAIN

Possible development is considered briefly because of its impact on and importance to the problem of conservation.

2.1 Proximity of Perth, Mandurah and Bunbury.

The proximity of the relatively large city and suburban areas makes the bush-land of the project area popular for recreation.

2.2 Land usage

In the project area, the main land usages are for agriculture, State forest, residences and resorts, National Park as well as camping and recreation reserved.

2.2.1 Agriculture.

Blocks are small, farmed intensively and are owned generally by non resident farmers. The land supplements grazing pasture in the winter and is also used to grow vegetables. Some areas are irrigated for growing lucerne. Where the land is farmed intensively the natural bush has been completely cleared.

2.2.2 State forest

A large area has been planted with pines (Fig. 1). Since the 1920's, plots of natural bushland have been cleared every few years for pine plantation however, some land still remains uncleared.

Table 3.

BIRD LIST

Dromaius novaehollandiae - Emu, fresh tracks in the sand dunes (area 1); tracks in Myalup pine plantation (area 3); 1 along Wellesley Rd. (Wellington C.G. 801).

Haliastur sphenurus - Whistling eagle, 1 lake Preston; 1 Mialla swamp (area 2); 1 Harvey River (area 11).

Circus approximans - Swamp harrier, 1 over samphire flats (area 1).

* *Falco cenchroides* - Nankeen kestrel, 1 in dunes (area 1).

Falco berigora - Brown hawk, one in young pines along Johnson Rd.

Phaps sp. - bronzewing pigeon, 1 White Hill Rd.; 1 in Jarrah south-west of Martin Tank Chain; 1 in *Acacia* along Estuary Rd. (area 11).

Calyptorhynchus baudini - White-tailed black cockatoo, 5 in pine forest at area 3.

Platycercus icterotis - Western rosella, heard calling near Mialla Swamp (area 2) and in the pine forest (area 3).

Purpureicephalus spurius - Red-capped parrot, 2 flying over swamp (area 2).

Barnardius zonarius - Twenty-eight parrot, common. Heard near Lake Clifton Tavern; in pines (Forestry Rd.); in disturbed tuart farmland (area 5); 2 seen in Banksias and Eucalypts in area 6; 5 at Mialla Swamp, one along Estuary Rd. and 2 along White Hill Rd.

Ninox novaeselandiae - Boobook owl, 1 heard calling in eucalypt woodland (area 3).

Dacelo gigas - Kookaburra, common. Two in Mialla Swamp; in the State forest woodland (area 3); 2 in *Banksia* and eucalypts near Martin Tank (area 7); 1 heard in peppermints and tuarts of the hinddunes (area 1); 1 near the Harvey River (area 11); 1 at Lake Clifton in peppermints (area 8); 1 in area 6 and 2 in agricultural land at Lake Preston (area 5).

Halcyon sancta - Sacred Kingfisher, 3 near Harvey River (area 11); 6 along Preston Beach Rd.; 1 in peppermints of hind-dunes (area 1).

Merops ornatus - Rainbow bee-eater, 3 in young pines along Johnson Rd., 6 along Preston Beach Rd.; 2 in pines along Forestry Rd. and 1 near the swamp (area 2).

Table 3 - Bird List (contd.)

Hirundo neoxena - Welcome swallow, 9 at the swamp (area 2); heard in the pines along Forestry Rd., several seen along Preston Beach Rd.; and at Lake Preston (area 5); 2 in the *Olearia* on the dunes (area 1); 3 near Harvey River (area 11) and 3 in the pines along Johnson Rd.

Anthus novaehollandiae - Aust. pipit, 3 in cleared farmland (area 1).

Coracina novaehollandiae - Black-faced cuckoo-shrike, 1 in young pines along Johnson Rd., 1 in banksias and eucalypts along Preston Beach Rd., 1 at Lake Clifton (area 8).

Malurus splendens - Splendid wren, male and female near Harvey River (area 11); 3 males and 1 female in the woodland (area 4); 3 heard in young pines along Forestry Rd.; 4 females and 1 male in dunes, 1 in *Acacia* - peppermint ridges, 1 heard in peppermint hind-dunes (area 1); several heard and seen in banksias and peppermints along Preston Beach Rd. near Martin Tank; male and female at Mialla Swamp and 2 at Lake Clifton.

Gerygone fusca - Western warbler, 3 heard in peppermints in agricultural land (area 5); 3 along Lake Preston Rd.; 2 in pines along Johnson Rd., near Harvey River (area 11) and in woodlands (area 4).

Smicrornis brevirostris - Weebill, several in tuarts at the Harvey River (area 11).

Acanthiza apicalis - Broad-tailed thornbill, 1 near the Harvey River (area 11); 2 in banksias and eucalypts at Martin Tank along Preston Beach Rd. (area 7) and 2 in peppermint hind-dunes (area 1).

Acanthiza chrysorrhoa - Yellow-tailed thornbill, heard near Harvey River (area 11); heard in pines along Peppermint Grove Rd.; 3 in *Melaleucas* along Lake Preston water edge in area 5.

* *Sericornis maculatus* - Spotted scrub-wren, 2 in dense undergrowth near Harvey River; 2 in dense *Acacia* - peppermint scrub of hind-dunes (area 1).

Epthianura albifrons - White-fronted chat, flock of approx. 30 flying over samphire flats (area 1); flock of approx. 40 flying over young pines Johnson Rd.

Petroica multicolor - Scarlet robin, 2 in pines (area 4).
Rhipidura fuliginosa - Grey fantail, 2 in Mialla swamp; 1 in *Acacia* - peppermint hind-dunes (area 1); 1 in peppermints of Preston Lake (area 6); 2 in cleared marri farmland (area 5); 1 in jarrah woodland (area 4); several at the Harvey River (area 11); 4 in woodlands at Martin Tank (area 7).

Table 3 - Bird List (contd.)

Rhipidura leucophrys - Willie wagtail, 2 in cleared tuart farmland at Lake Preston (area 5); 1 along Preston Beach Rd.

Pachycephala pectoralis - Golden Whistler, heard near Harvey River (area 11); male in jarrah woodland (area 4); heard in the pine forest along Peppermint Grove Rd.; 2 in dense peppermints in area 6.

* *Pachycephala rufiventris* - Rufous Whistler, male at Mialla swamp; 1 in dense peppermints (area 6).

* *Colluricincla rufiventris* - Western shrike-thrush, 1 heard at Mialla swamp; 1 in pines (area 4); 2 heard in pines along Forestry Rd.

Pardalotus substriatus - Striated pardalote, heard in peppermint hind-dunes (area 1); 5 at Mialla swamp; heard in jarrah woodland (area 4); in cleared tuart farmland (area 5); 1 seen others heard near Martin Tank (area 7); heard near Harvey River (area 11) and along Southern Estuary Rd.

Zosterops gouldi - Western silvereye, heard in *Olearia* dunes, peppermint hind dunes and 3 in *Acacia* - peppermint hind dunes (area 1); 2 seen others heard at Mialla swamp; 2 in Jarrah woodland, 2 in pines (area 4); 5 in eucalypts near Martin Tank (area 7); 4 in *Olearia* dunes at White Hill Rd.

* *Lichmera indistincta* - Brown honeyeater, 3 at Mialla swamp; one in the Melaleuca at the edge of Lake Preston (area 5); 2 seen near Martin Tank in eucalypts (area 7) and one near the Harvey River.

Meliphaga virescens - Singing honeyeater, one feeding on *Banksia attenuata* near Martin Tank: one in *Acacia* - peppermint hind-dune (area 1).

* *Phylidonyris novaehollandiae* - New Holland honeyeater, 2 hunting insects in *Astartea* at Mialla swamp; 2 in eucalypts along Preston Beach Rd.

Acanthorhynchus superciliosus - Western spinebill, 2 at Mialla swamp.

Anthochaera carunculata - Red wattle-bird, 1 at Mialla swamp, 4 in pines along Forestry Rd.; one in jarrah (area 4); one in cleared tuart farmland; several along Preston Beach Rd. (2 feeding on *B. attenuata*); 1 along Southern Estuary Rd. and 3 near the Harvey River (area 11).

* *Grallina cyanoleuca* - Magpie Lark, 2 in agricultural land (area 1).

Artamus cyanopterus - Dusky wood-swallow, one in young pines along Johnson Rd.

Cracticus torquatus - Grey butcher-bird, one in cleared tuart farmland, one in *Acacia* - peppermint hind-dunes (area 1); 1 heard near Lake Clifton Tavern, one near Lake Clifton (area 8); 2 heard near Lake Preston (area 6) and 1 near Harvey River (area 11).

Table 3 - Bird List (contd.)

Cymorhina dorsalis - Western magpie, 2 in cleared tuart farmland area 1 and area 5; heard near Martin Tank (area 7).

Corvus coronoides - Aust. raven, one at Mialla swamp; 4 seen in cleared tuart farmland and in *Olearia* dunes (area 1); 2 heard near young pines along Johnson Rd.; 2 near Lake Preston (area 6) and 2 seen along Southern Estuary Rd.

Sequence and nomenclature from an index of Australian bird names, CSIRO Division of Wildlife Research Technical Paper No: 20 (1969).

* Not sighted by Serventy (1930).

Additional species seen by Serventy (1930)
Brown quail (species not identified)
Eupodotis australis - Aust. bustard
Glossopsitta porphyrocephala - Purple-crowned lorikeet.
Lamprococcyx plagosus - Golden bronze cuckoo
Tyto alba - Barn owl
Podargus strigoides - Tawny frogmouth
Hylochelidon nigricans - Aust. tree-martin
Lalage tricolor - White-winged triller
Eopsaltria griseogularis - Western yellow robin
Neositta pileata - Black-capped nuthatch
Dicaeum hirundinaceum - Mistletoe-bird
Pardalotus punctatus - Spotted diamond-bird
Melithreptus lunatus - White-naped honeyeater
Artamus melanops - Black-faced wood-swallow
Strepera versicolor - Grey bell-magpie

Additional species seen by Jenkins (1971).
Columba livia - domestic pigeon
Streptopelia chinensis - Spotted turtledove
S. senegalensis - Senegal turtledove
Polytelis anthopeplus - Regent parrot
Cuculus pallidus - Pallid cuckoo
Cacomantis pyrrhophanus - Fan-tailed cuckoo
Phylidonyris niger - White-cheeked honeyeater
Manorhina flavigula - Yellow-throated miner

Table 4. Bird species seen and heard during 15 minute observation periods (see text).

	dune swale & ridge	swamp	pine forest	lakes		river
AREA	1	2	3a & b	5	7	11
DISTURBANCE	semi	semi	Yes	Yes	No	Semi
Emu	+					
Nankeen kestrel	+					
Brown hawk			+			
White-tailed black cockatoo			+			
Western rosella		+	+			
Twenty-eight parrot		+	+	+		
Kookaburra	+	+			+	+
Rainbow bee-eater			+			
Welcome swallow	+	+	+			
Australian pipit	+		+			
Black-faced cuckoo-shrike			+			
Splendid wren	+	+	+			
Western warbler				+		
Weebill						+
Broad-tailed thornbill	+		+		+	+
Yellow-tailed thornbill				+		+
Spotted scrub-wren	+					
White-fronted chat	+		+			
Grey fantail	+	+		+	+	+
Willie wagtail			+			
Golden Whistler		+				+
Western shrike-thrush		+	+			
Rufous whistler		+				
Striated pardalote	+	+		+	+	+
Western silvereye	+	+			+	
Brown honeyeater		+		+	+	+
Singing honeater	+				+	
New Holland honeyeater		+			+	
Western spinebill		+				
Red wattle-bird		+	+		+	+
Magpie lark	+					
Grey butcher-bird	+		+	+		+
Western magpie	+				+	
Australian raven	+	+	+			
Total number of species	17	15	16	8	11	13

This data is not comparable statistically as observations were carried out at different times of day.

2.2.3 Residences and resorts

Holiday and permanent residences are located north of Dawesville, at Melrose and Florida and along the Harvey Estuary shore. Holiday homes are also present at Myalup, Binningup and Preston Beach, and another development is proceeding along the Lake Preston foreshore. The Lake Clifton Tavern also provides accommodation.

2.2.4 Recreation

Land reserves for camping and recreation exist at the coast at Tim's Thicket Rd., south-east and north-west of Lake Preston and at the northern section of the Harvey River.

Yalgorup National Park was created in 1968 and this area represents a large portion of the remaining natural habitats of the region.

2.3 Further development

An increased usage of this land for recreation by the general public will lead to increasing pressure for more accommodation either private or rented, public golf links, horse riding facilities and sailing and skiing areas. Such changes have been characteristic of recreational areas.

3. NATURAL AREAS

Areas of natural vegetation include uncleared State forest, camping and recreation land reserves and Yalgorup National Park. Although each of these areas contributes to the diversity of natural habitats, the area of uncleared State forest is steadily diminishing, the camping and recreation reserves are likely to be subjected to heavier public use and thus Yalgorup National Park will be instrumental in maintaining existent species.

Yalgorup National Park is an extremely diverse area with a wide range in the size of vegetational units. The diversity is the result of variations in soil type, landform, rainfall and fire history. These should be considered as interacting factors and steps must be taken so as to maintain the present diversity because a varied fauna is dependent upon a high vegetational diversity. For example, MacArthur and MacArthur (1961) demonstrated that bird species

diversity increased with plant species diversity and Pianka (1966) found that bird species diversity to be correlated with foliage height diversity. Opportunistic acquisition of cleared farmland for addition to Yalgorup will increase both the diversity, because of the time required for vegetational regeneration, and the number of 'islands' each of which will depend on animal recolonization as plant regeneration proceeds.

3.1 Soil types

The survey area includes Cottesloe, Bassendean, Quindalup and Cannington soil associations but all the habitat types are not represented by each soil association. The National Park is predominantly of the richer Cottesloe and coastal Quindalup soil associations.

3.2 Landforms

Within the project area there are four major land forms which are:

1. the coastal dune
2. the limestone based ridges (in some areas the limestone is exposed).
3. the coastal swamps and lakes, and
4. the estuary and river system.

The National Park includes the first three land forms but the coastal lakes comprise a large area.

3.3 Flora and fauna

A greater diversity of animal species was found in areas which were relatively undisturbed (para. 1.3.4). Within these habitats it is apparent that the birds depended largely on the presence of a canopy while the disturbed areas for example, the pine forests and agricultural land, were found to support species which were generally not present in other areas (Table 4).

Several species are likely to have been present in the past; for example, the honey possum (*Tarsipes spenceraе*), the pigmy possum (*Cercartetus concinnus*) and the quokka (*Setonix brachyurus*). It is likely that populations of these species would have undergone decline and possibly extinction as did the wambengers. However, isolated populations of such species may remain undetected within the project area as only limited areas could be surveyed.

4. CONCLUSIONS AND RECOMMENDATIONS

The data gathered suggest that there are no species or associations of species unique to the region and that Yalgorup National Park contains land forms and soil types which are representative of the region with the exception of a) estuary and river land forms and b) some of the poorer soils and their associated flora.

Nevertheless it is clear from Diamond's (1975) work that both the size and the shape of a land reserve will limit its effectiveness as a conservation area. In both these regards Yalgorup falls short of having completely desirable attributes; for example, the small size of the islands of vegetation associations, the distances between these and the long narrow shape of the Park are three factors which combine to reduce mixing of less mobile animal populations.

Accordingly it is recommended that :

(a) an extensive survey of the fauna be carried out over a wider area in order to determine whether isolated pockets of a wider range of mammal species exist for example, the wambengers and honey possums

(b) as land becomes available it is acquired in order to extend the boundaries of the National Park and where possible additional insular conservation areas should be acquired with the aim of maintaining the species diversity and overcoming the physical disadvantages apparent from consideration of Diamond's work.

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Information about the area was given by R. Chandler; National Park Ranger.

The report was discussed with and criticised by J.C. Taylor and R.J. Whelan; Zoology Department, University of W.A.

Maps were made available by the Town Planning Department.

Traps were loaned by Fisheries and Wildlife, University of W.A. and the W.A. Museum.

The National Parks Board permitted us to trap in Yalgorup National Park.

REFERENCES

Diamond, J.M. 1975. The island dilemma: lessons of modern biogeographic studies for the design of natural reserves. Biol. Conserv., 7: 129-146.

Jenkins, C.F.H. 1971. Pressure on the waterfront with special reference to the Mandurah-Murray region. W.A. Natrualist, 12(2): 28-31.

MacArthur, R.H. and J. MacArthur. 1961. On bird species diversity. Ecology, 42: 594-598.

Pianka, E.R. 1966. Convexity, desert lizards and spatial heterogeneity. Ecology, 47: 1055-1059.

Serventy, D.L. 1930. A glimpse of the bird-life between Mandurah and Bunbury, W.A. Emu, 30: 33-38.

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PEEL PRESTON PLANNING STUDY

COASTAL ZONE - SOIL CONSERVATION ASPECTS

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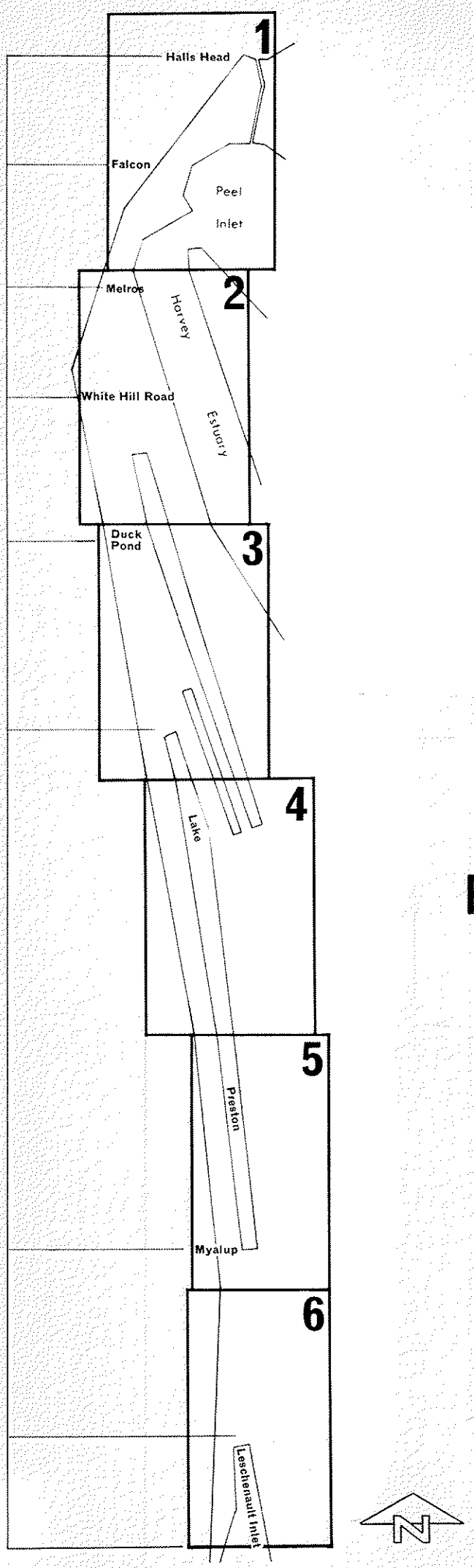


KARDUKAL PILOT STUDY

GENERAL NOTE

SOIL CONSERVATION AND USE

INTRODUCTION

Geologically recent, unconsolidated sand dunes fringe the majority of the beach interspersed with limestone, mainly along the nothern part of the study area. Inland is a mixture of unconsolidated sand, sand over limestone and limestone pavement in varying patterns.

Limestone occurs at the beach as low cliffs, as beach reef often shallowly overlain by sand, or as reef along the margin of the beach, occasionally just offshore. Its significance is as a natural protection to the beach, as an interruption to the off-shore on-shore cyclic movement of sand and as focal points for natural bays and protected water.

Limestone occurs inland mainly as gently undulating hills and ridges occasionally as almost level plains, sometimes covered by soil.

Soil erosion problems are not expected on the majority of the limestone soils and these have almost always been considered areas of low erosion risk.

The unconsolidated sands are either bare of vegetation, forming sand drifts of various forms, or stabilized by growing vegetations.

A large number of the drifts are more or less typical "blowout" forms, starting at a breach in the foredune, having a narrow hollow neck through which sand is blown and widening and gradually rising inland often to a steep eastern face over which sand spills.

Some however are just traces of bare sand apparently covering older dunes. There are many variations. Three of the larger drifts appear to be the result of several adjacent drifts coalescing into one large mass.

The vegetated dunes fall into two main groups.

* Those growing primary sand stilling plants, principally SPINIFEX hirsutus
  AUSTROFESTUCA arenaria
  but occasionally including
  SPINIFEX longifolius
  ARCTOTHECA populifolia
  CAKILE maritima

* Those growing secondary sand dune plants, of which there are a large number of species.

A complete cover of vegetation protects the soil from wind in two main ways.

* by covering the surface so the wind can not reach and move sand grains.
* by reducing the velocity of the wind. Ideally it should cause a layer of still air to form at the soil surface. The height of this layer is related to the height and density of the plant growth.

This cover of vegetation is all that prevents unconsolidated sands from becoming sand drift areas.

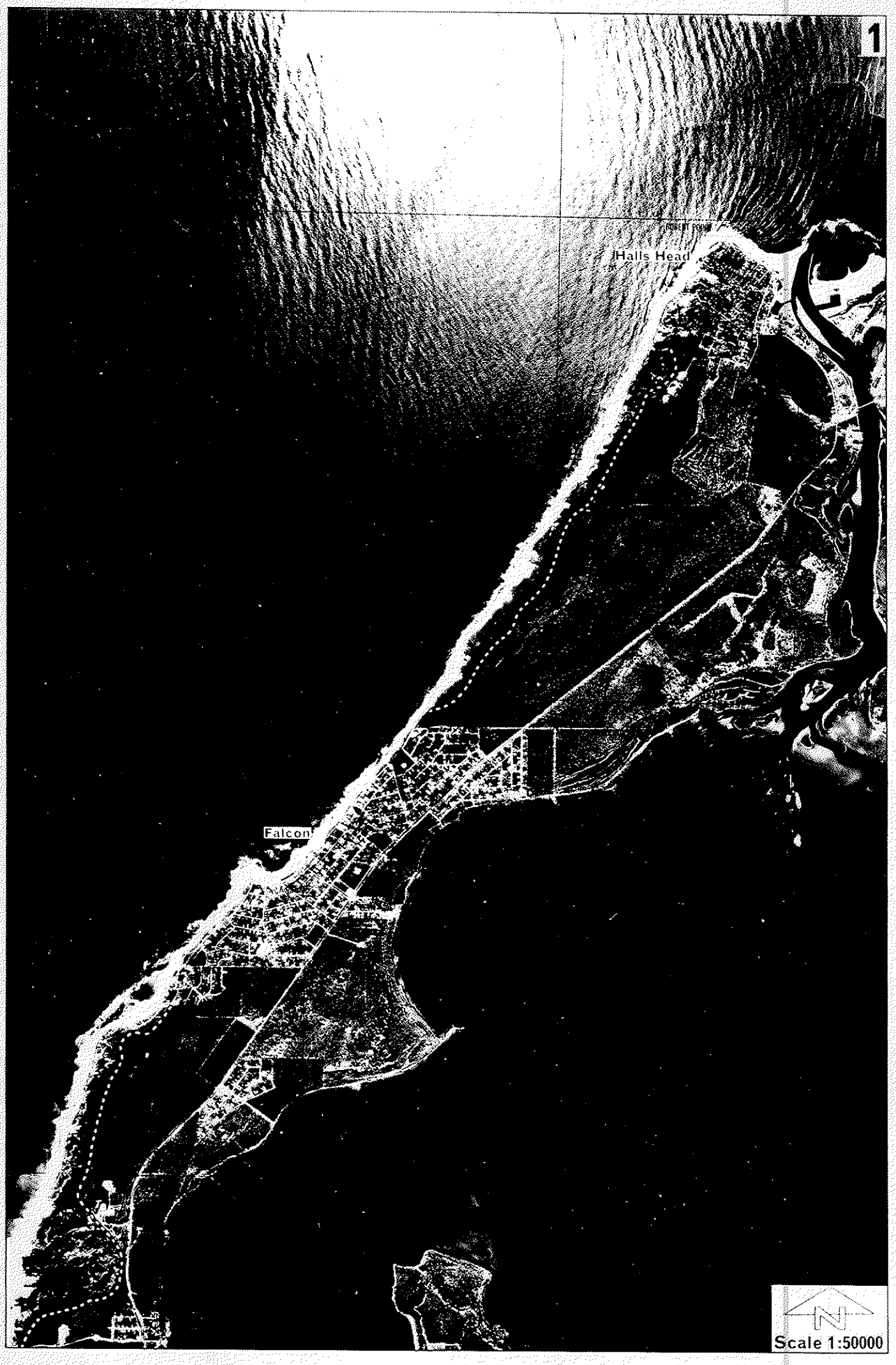
Removal of the vegetation or damage which reduces its protective ability results in soil erosion and sand drift problems.

There are a number of ways in which vegetation may be removed or damaged. They range from physical clearing by plough or bulldozer, through grazing by various types of animals to trampling and breaking by people and their vehicles. Whilst clearing is always destructive of existing vegetation, the effects of grazing and trampling vary according to intensity of use. Large numbers of animals or people result in maximum damage.

In the following discussion on soil conservation aspects of this coastal zone, assessing erosion risk has been by subjectively considering the factors mentioned above in the following way.

* composition - i.e. all sand or otherwise
* topography - height, steepness, form and complexity.
* vegetative cover - good existing growth has been equated with stable conditions for some time and probably better soil conditions for plant regeneration if slightly disturbed or damaged.
* situation - proximity to the sea has been equated with difficulty of re-establishment of vegetation.
* existing erosion - on the basis of experience, technological problems and management difficulties it has been considered that existing erosion will not improve and may well get worse.

In the following discussion the coastal zone has been divided into seven sections on the broad basis of land form as it relates particularly to soil erosion risk.


1
Halls Head
Falcon
Scale 1:50000

SECTION HALLS HEAD - MIAMI

Beach - Consists of beach reef; a thin layer of sand over rock in places, exposed rock in others.

Low limestone cliffs in at least five places.

Dunes - Mostly low, 5-10m, narrow, bare and drifting. Bare sand extends about 200m inland in one place but drifts are less extensive elsewhere. There is a small area of undulating sand hills, presently vegetated inland at the north end of the section.

Erosion risk - East of the dashed line, soil erosion on the area itself should not result from development for recreation, tourism or residential housing.

Between the beach and the dashed line is a narrow zone within which soil erosion either already exists or is very likely as a result of development.

In this zone there are four small areas where development using care, imagination and adequate finance should be possible without resulting in soil erosion problems on the developed site itself.

Following development, increased use of adjacent areas would increase the severity of existing erosion and the likelihood of erosion starting on erosion-prone land.

SECTION LIAMI - MELROS

Beach - Consists of beach reef mostly covered by a thin layer of sand with occasional bare rock or shallow reef just in the water and one small bay protected by an off-shore reef, at Avalon.

Dunes - Along a lot of this section there is a very low recent foredune. Behind this is relatively recent sand, either forming a second parallel dune or blowing up against an older and slightly higher dune. There are one small and one moderate sized old blowouts, presently vegetated and stable, inland of the beach dune system. The larger extends some 1200m inland from the sea, has a very steep ridge around its outer rim and some steep ridges within it.

Erosion risk - East of the dashed line development for residential housing, tourism or recreation should not result in soil erosion on the area developed. Between the beach and the dashed line is a zone, mostly narrow but wider at the old blowouts, within which soil erosion is already present or is very likely as a result of any disturbance.

Within this zone are small areas which either are or could be developed with minimal erosion resulting if care, imagination and adequate finance is used. There are also areas where development is already at risk from sand drifts and will continue to be so despite expenditure on control.

As with the first section, increased use of adjacent areas following development would increase the severity of existing erosion and the likelihood of erosion starting on erosion-prone land.

2
Melros
White Hill Road
SWIM
POOL
TANK
Scale 1:50000

SECTION HELROS - WHITE HILL RD

Beach - Sand over limestone beach and waterline reef, with an offshore reef forming a small bay at Tims Thicket. Black mineral sand opposite the south end of the Tims Thicket sand drift. Occasional cliffs and cliff remnants, including one huge boulder opposite the centre of the Tims Thicket drift. At the same site is a section of new low S. hirsutus foredune with limestone cliffs behind it.

Dunes - Mostly sand over limestone on the main drift and above the various cliff sections. Elsewhere appear to be sand. The main drift drops down onto a gently undulating limestone plain. Elsewhere are vegetated, apparently sandy ridges and hills out to the dashed line. The southern part of the secondary dunes are fairly high, steeply undulating ridges and peaks, apparently a now stable old blow-out with numerous ridges in the centre. The vegetation of this part of the section is low scrub.

Erosion risk - Apart from a few small cliffs the whole of the frontal dune system along this section is already drifting. Behind are mostly presently stable dunes which could easily become sand drifts if distrubed.

At Tims Thicket, the thin sand over the limestone of the main drift may mean less risk than it appears but this is only conjecture.

Eastward of the dashed line, erosion risks on - site are low but adjacent dune areas would suffer erosion as a result of increased use.

SECTION WHITE HILL RD - PUCK POND

Beach - Mostly sand, with a few outcrops of beach reef confined to the north of the section.

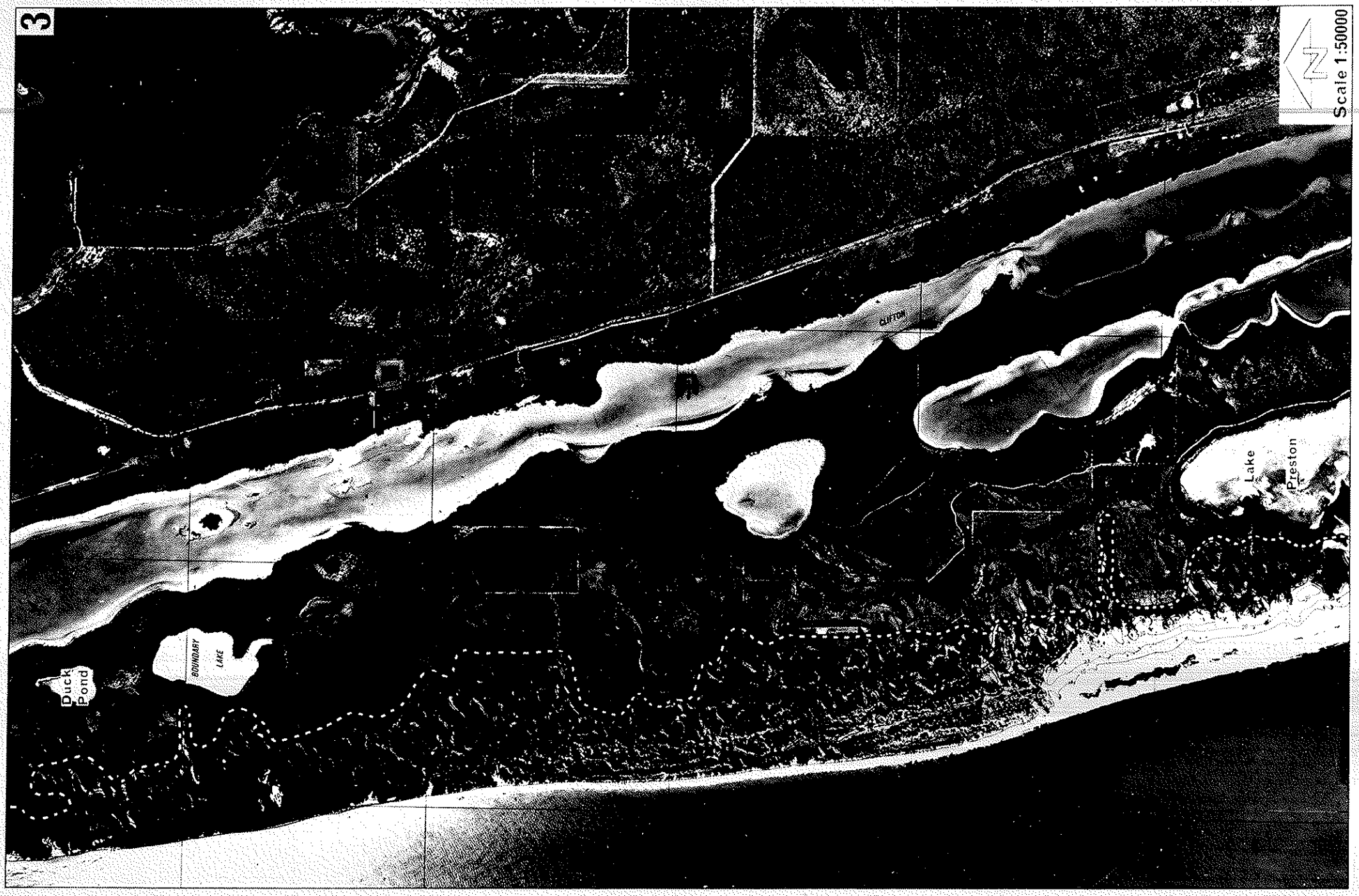
Dunes - A moderately low frontal dune system, in places up to 10m but mostly less and the majority with a steep west face. It is almost continuously interrupted by blowouts giving rise to bare sand drifts often extending into the first swale. In at least four places these extend further still, up to 400m inland of the beach. The vegetation is very sparse and nearly all primary sand colonising plants.

Inland of the frontal dune system is a zone of topographically complex moderately to steeply undulating sand dunes, ridges and peaks. The soil is thinly covered by low vegetation conspicuously thinner on the peaks and ridge lines.

Erosion risk - East of the dashed line soil erosion should not be a problem. Between the beach and the dashed line is a zone 0.5 - 1.0 km wide within which soil erosion either already exists or is very likely as a result of development.

Erosion is already extensive on the frontal dune system in the zone and it would become even more extensive if the existing very sparse vegetation were damaged or destroyed.

Most of the complexly undulating country between the frontal dune system and the dashed line would be prone to soil erosion problems if used intensively. However there are small pockets of land which, with care, might be developed for more intensive use without serious risk of erosion on the sites themselves. As with other similar areas, the effects on adjacent land would lead to soil erosion problems.


3
N
Scale 1:50000
CLIFTON
Lake
Preston
BOUNDARY
LAKE
Duck
Pond

SECTION DUCK POND - FOX LAKE JUNCTION (Loc. 1744)

Beach - Except for some small occurrences of beach reef at the northern boundary of A 11710, the beach is all sandy, mostly gently sloping.

Dunes - A recent, mostly well vegetated foredune backs the beach along the whole of this section. The vegetation is dominated by the primary sand dune plant SPINIFEX hirsutus. There are numerous very small blowouts through the foredune as well as three slightly larger ones which extend to 150m inland from the beach.

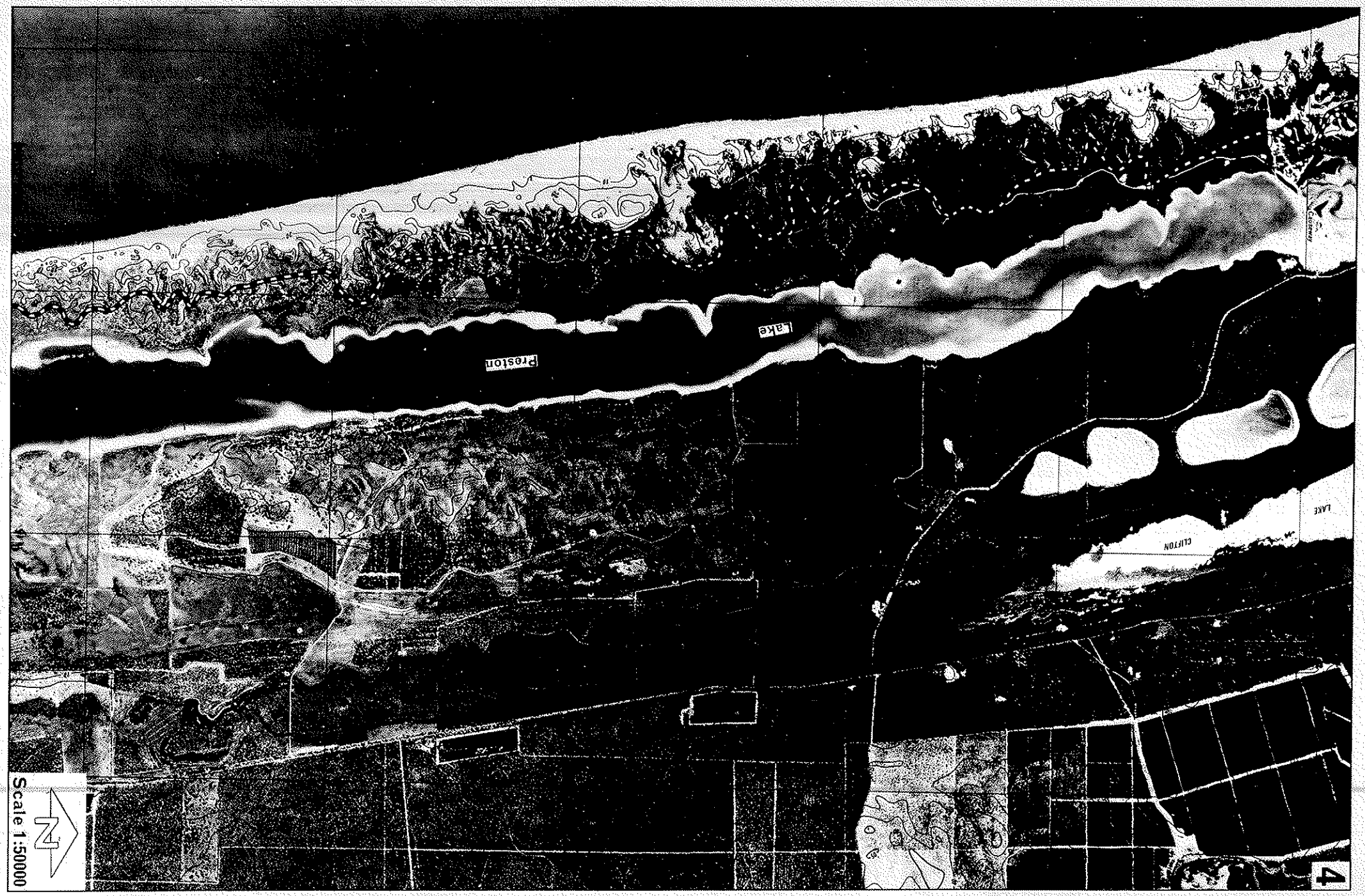
Behind the foredune along the southern part of the section are low, more or less parallel, relatively recent dunes extending inland for 0.5km at the widest part.

Opposite Boundary Lake is a larger, nowwell vegetated, stable blowout with a small area of bare sand drift in the central hollow.

Topographically complex, moderately to steeply undulating sand dunes, ridges and peaks make up the remainder of the dunes along this section. The whole dune system varies from 0.7-1.5 km in width.

Erosion risk - Except for the few patches of bare sand mentioned above, there is no soil erosion at present. The dunes are proving vegetation all over them, albeit rather thin on peaks and ridge lines.

From the beach to the dashed line marking the commencement of the low erosion risk land, all the dunes, whilst at present stable, would easily become eroded and start sand drifts if developed for more intensive uses.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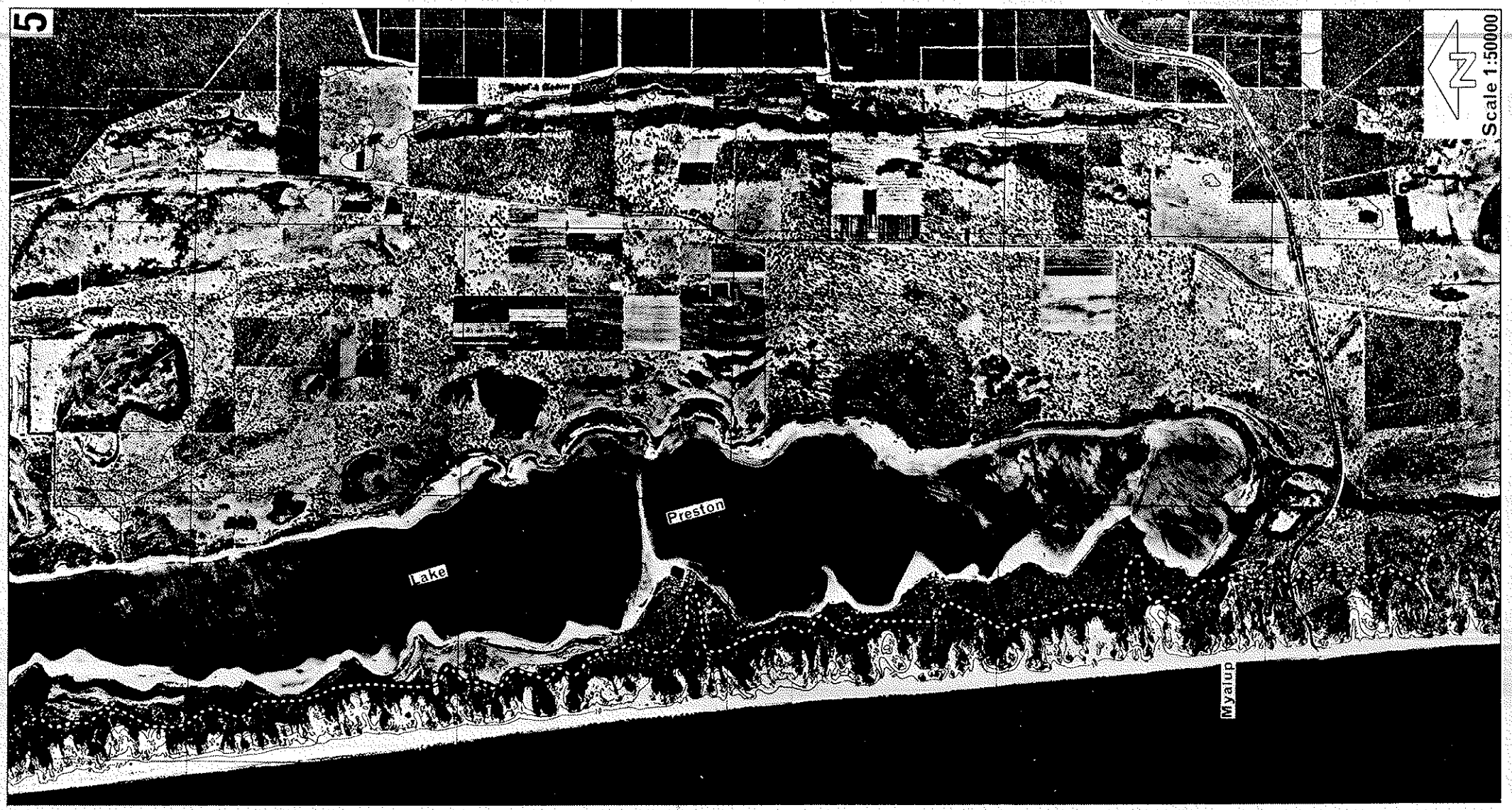
N
Froston
Lake
CLIFTON
LAKE


5
Scale 1:50000
Lake
Preston
Myalup

SECTION ADJOINING LAKE KARRINYUP (Loc. 1744 to Kyalup)

Beach - Consists of sand without beach reef or limestone cliffs for the entire length.

Dunes - The upper slope of the beach contains a more or less well developed primary dune, breached in places, growing either SPINIFEX hirsutus or AMMOPHILA arenaria. Along some ten kilometres of the centre of the section A. arenaria is dominant. Despite the well developed primary dune, extensive sand drifts occur along the entire section, in two instances extending inland 0.6 and 0.9 km. Many of the drifts have the typical "blowout" configuration of a long gradually rising west face and a short very steep east face down which sand spills. Other drifts are blowing up against and sometimes over older previously vegetated secondary dunes.

At the few places where there are no sand drifts, the beach slopes right to the base of these older type dunes.

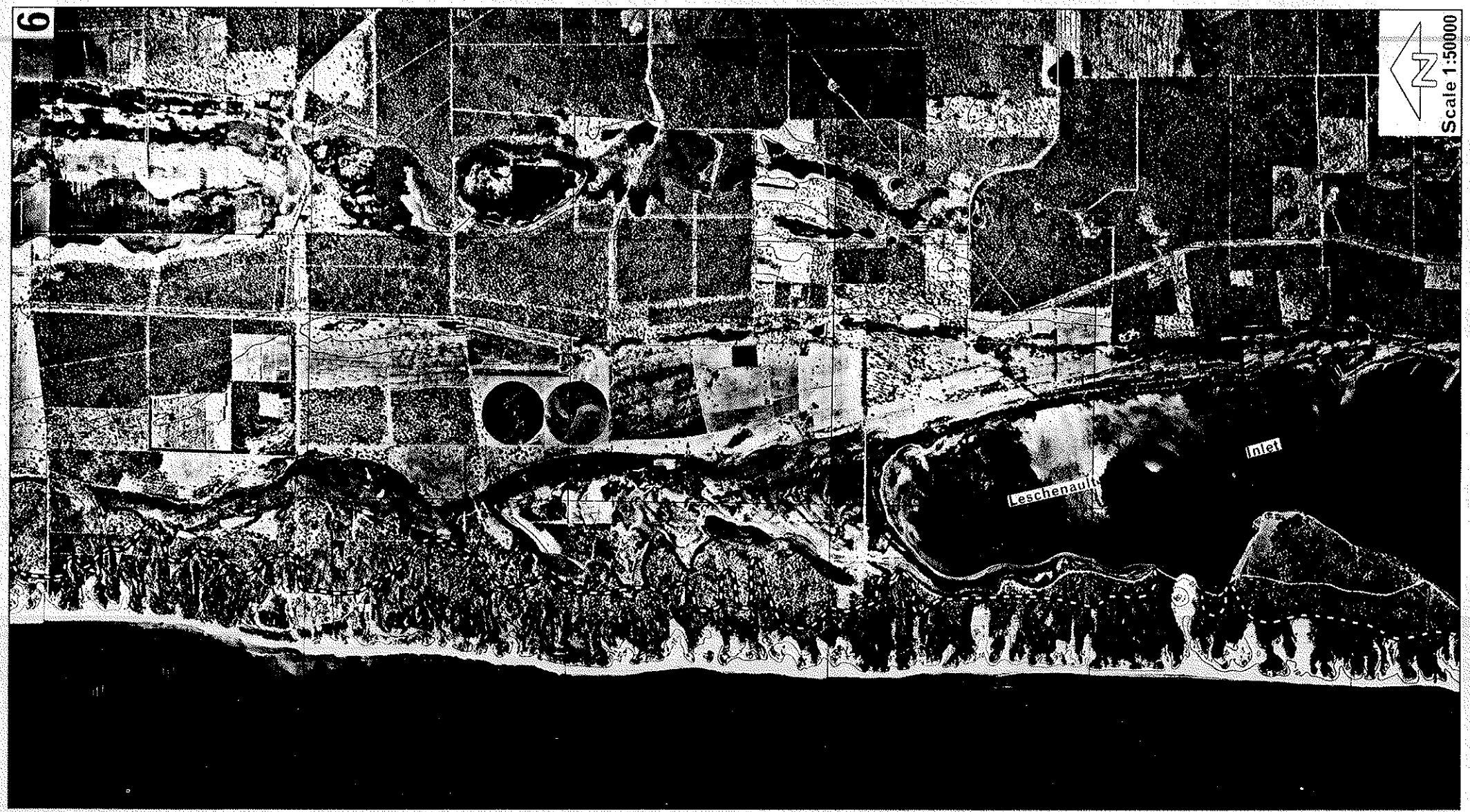
Inland is a mostly very narrow zone of vegetated, east-west sand ridges with two or three wider zones of more topographically complex vegetated sand dunes and old stabilized blowouts.

Erosion risk - Between the sea and the dashed line is a zone of either existing erosion, or erosion prone sand dunes, ridges and peaks where disturbance for development and/or more intensive use would result in soil erosion and sand drift.

Within this zone are a number of small areas of land on which the risk of soil erosion is less on the areas themselves. Development of these sites for activities resulting in increased use of adjacent erosion-prone land would lead to increased risk of erosion.

Eastward of the dashed line soil erosion should not be a problem on the land itself but effects on adjacent land would lead to soil erosion problems.

6



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SECTION MYALUP - KOORA ESCARPMENT FOOT

Beach - The sandy beach continues along this section with however some occurrences of beach reef, offshore reef and a very small protected bay, all in the vicinity of Binningup.

Dunes - A low narrow primary dune broken in places and growing both SPINIFEX hirsutus and AMMOPHILA arenaria is present along this section.

Behind it are some localized sand drifts in places between Myalup and Binningup and more extensive drifts just north of the top of the inlet.

Just north of Binningup and again about 1.5 km south are places where the primary dune joins directly onto well vegetated older secondary dunes.

For the whole section the secondary dunes are lower, less steeply sloping and topographically less complex than further north. There are a two or three areas of quite low stable well vegetated small sand dunes and ridges.

Erosion risk - East of the dashed line there should be no erosion problems.

In the zone between the sea and that line are several areas where development for a number of uses could be undertaken with little risk of erosion on the areas themselves given care and attention during the design and construction phases of development, adequate finance to carry out recommended erosion prevention methods and continuous environmental monitoring, management and maintenance.

Areas of existing erosion together with all steeper dunes and ridges would be prone to soil erosion following intensified use, both of the sites themselves or of adjacent land.

SKETCH

TUSCHEBAULT PENINSULA

Beach - Apart from a couple of very small occurrences of reef the beach is all sand.

Dunes - A low, very broken, sparsely vegetated primary dune is present along a lot of the beach, although completely absent in places.

It is backed by a much higher, up to 30m, better vegetated secondary dune, which however is extensively broken by blowouts. Some of these extend a kilometre across the peninsular and spill into the inlet.

Along the southern half of the peninsular these blowouts have joined together to form sand drifts covering the majority of the land.

On the northern half the sand drifts are less extensive and well vegetated sand ridges and hollows are present. The ridges are almost entirely east-west in direction.

There are two areas of low dunes and relatively flat land.

Erosion risk - On the two areas of low relief, east of the dashed line on the map, soil erosion problems should not result from careful development of the sites themselves.

On the remainder of the land, existing erosion or the risk of erosion would make soil erosion and sand drift an inevitable consequence of development.

Development on the two areas of low erosion risk would almost certainly be followed by more intensive use of adjacent areas which would be followed by soil erosion problems.