Conservation and Development
Opportunities at Ellenbrook

(Responses to Conditional
Environmental Approval)

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ELLENBROOK FAUNA

1. Report on Fauna Conservation Values of the Northern Section of the Ellenbrook Project Area (Watkins D.G. & Bamford M.J. & A.R)

2. Survey for Western Swamp Tortoises (Burbridge A.A. & Fuller P.J)

ELLENBROOK FAUNA

Report on Fauna Conservation Values of the Northern Section of the Ellenbrook Project Area

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1.0 INTRODUCTION

The Environmental Protection Authority (EPA) has assessed a Public Environmental Review prepared for the Ellenbrook development project (Ellenbrook Management Pty Ltd 1992, EPA 1992). In giving approval for residential development at Ellenbrook, the Minister for the Environment has required the proponents to meet a number of conditions. Condition 4.1 requires the proponent, to the satisfaction of the Minister for the Environment and upon advice from EPA, Department of Conservation and Land Management (CALM) and Department of Planning and Urban Development (DPUD), to:

(a) define the conservation values of the site;

(b) determine which areas should be protected and which may be developed.

Initial discussions with the EPA and CALM regarding the scope of the fauna investigations indicated that studies should focus on confirmation of the presence/absence of the Short-necked Tortoise *Pseudemydura umbrina* and the Quenda or Southern Brown Bandicoot *Isoodon obesulus*. Subsequent advice from the EPA suggested that the assessment should be broadened to include other mammals, birds and reptiles in general, with comparisons from nearby areas such as Melaleuca Park and Whiteman Park to gauge the regional significance of the fauna. This report is restricted to defining the fauna conservation values of the northern section of Ellenbrook Management's landholding (hereafter referred to as the study area or study site); see Figure 1, page 21.

The study area includes a small area cleared for agriculture in the north-east, a seasonal watercourse, seasonal wetlands and a high dune ridge of the Bassendean system (see Fig. 1). The site is on the eastern margin of the sandy soils of the coastal plain; the presence of seasonal wetlands in the dune swales is related to the movement of groundwater on the eastern edge of the Gnangara unconfined aquifer. Because of the variety of landform, the vegetation is complex and has been examined in detail elsewhere (Weston *et al.* 1992). As a habitat for fauna, the vegetation and landform can be broadly divided into: sandy uplands, primarily of *Banksia* woodland; and wetlands. The wetlands are particularly complex but significant features for fauna are areas of tall woodland including *Eucalyptus* spp. and *Melaleuca* spp. which fringe some wetlands, and areas of dense shrublands that occur over most of the seasonal wetlands.

The bushland is a remnant linked, via CALM-managed bushland, with Melaleuca Park to the north-west, and almost connected by a narrow corridor of bushland within the Gnangara Pine Plantation with Whiteman Park to the south-west. Cleared land lies to the north, south and east, although Sawpit

Gully almost links with corridors of bushland along the railway reserve and Ellen Brook, which in turn link with Ellen Brook and Twin Swamps Nature Reserves (Figure 1).

2.0 THE ASSESSMENT OF CONSERVATION VALUE

The evaluation of conservation values is an important aspect of the process of environmental impact assessment, but what constitutes conservation value is frequently poorly-defined in assessment documents. An extensive literature related to assessing the value of conservation reserves does exist, however (eg. Margules *et al.* 1982). This literature discusses a range of guidelines and criteria used in such assessments (Margules and Usher 1981). We have summarized these into four general approaches and feel that these approaches provide a general framework for the assessment of conservation value that can also be applied to the process of environmental impact assessment.

2.1 Anthropocentric Approach

Historically, conservation areas were selected on the basis of perceived natural beauty, recreation value and importance for tourism. More recently, issues of landscape, education and scientific values have been seen to be important.

2.2 Biocentric Approach

The selection of reserves for the conservation of particular species or communities; usually those which are considered to be rare. This approach is exemplified by the declaration of reserves such as Two Peoples' Bay Nature Reserve for the Noisy Scrub-Bird and Twin Swamps and Ellen Brook Nature Reserves for the Short-necked Tortoise.

2.3 Biogeographic Approach

This involves the selection of reserves which are representative of ecosystems within a region and of sufficient size to maintain viable populations of all species. Techniques used for selecting sites for nature reserves to ensure maximum representation of species and habitat types are discussed by Austin and Margules (1984), and Nilsson (1986). Representativeness is often based on vegetation units; IUCN (1989) guidelines call for a minimum of 10% of broadly-defined vegetation units to be conserved. This biogeographical approach has been used in Western Australia in the preparation of conservation proposals for the Goldfields (Biological Surveys Committee 1984) and the Nullarbor (McKenzie and Robinson 1984). Both biocentric and biogeographic approaches were used in the evaluation of the conservation value of the Mt Lesueur area (Burbidge *et al.* 1990).

2.4 Integrative Approach

Biocentric and biogeographic approaches are essentially static and consider the fauna of the study area as existing in isolation from that of other conservation areas and the landscape. In contrast, the integrative approach takes into account the position of the study area within the landscape and the dynamics of the fauna in that landscape. Habitat fragmentation is recognised as a major threat to biodiversity (Wilcox and Murphy 1985) and conservation strategists are increasingly being urged to consider

"*entire corridor networks and integrated systems of protected areas with interconnecting movement corridors*" (Harris and Scheck 1991). Noss and Harris (1986) discuss the role of reserves and corridors for conservation across landscapes and time, while Noss (1987) argues for a landscape conservation strategy that involves conservation areas, interconnection of managed areas by means of broad corridors and multiple-use buffer zones.

2.5 Synthesis

In applying these approaches to the assessment of conservation value, it is important to refer to the framework of policies that have been developed by the Federal and State Governments in consultation with the community.

The importance of a landscape approach to the assessment of conservation values has been emphasised by the Working Groups on Biodiversity who have called for a regional framework and integrated management to be applied to conservation reserves (Office of the Chief Scientist 1992). The draft national biodiversity strategy that has been developed calls for:

"Conservation - integrated planning and management at regional and local level;
- fill gaps in reserve system;
- special protection for threatened species;
Wise Use - minimize impacts, protect from people, pests and weeds."

These recommendations, along with the commitments made in the State Conservation Strategy to sustainable development and the integration of conservation with development have implications for the process of environmental impact assessment in Western Australia (Department of Conservation and Environment 1987). The four main objectives of the State Conservation Strategy are:

* to maintain essential ecological processes and life-support systems;
* to preserve genetic diversity;
* to ensure the sustainable utilization of species and ecosystems;
* to maintain and enhance environmental qualities.

(Department of Conservation and Environment 1987).

To prevent the decline of species and genetic diversity and adequately protect and manage representative areas of the state, the State Conservation Strategy specifically recognises:

(a). the need to "*adequately protect ... areas of high conservation value*";

(b). the "*importance of corridors for the maintenance of flora and fauna*" (Department of Conservation and Environment 1987).

The approaches used in the selection of conservation reserves and the recommendations of Federal and State Government bodies suggest a working definition of conservation value. Conservation value is most usefully viewed as a cumulative function of: anthropocentric values; the biota of the site - that is, the species present (biocentric); the representativeness of the biota of the site within a regional context (biogeographic); and the interaction of the biota of the site with the biota of the broader landscape, including other natural areas (integrative).

This general definition of conservation value can be made more specific with direct reference to the fauna of the study area. Components of fauna conservation value upon which this report is based are as follows:

A. Anthropocentric

Not dealt with in detail in this report.

B. Biocentric

This conservation value depends upon the uniqueness of the fauna in terms of:

B.1 Rare and endangered or otherwise threatened species.

B.2 Isolated populations or populations that are on the margin or even beyond the margin (extra-limital) of the recognised distribution of a species.

B.3 Species richness; the number of species.

C. Biogeographic

This conservation value depends upon the representation of the fauna of the site in other areas, particularly conservation reserves.

D. Integrative

This conservation value depends upon the regional context of the fauna.

D.1 The site may provide linkage between natural areas, including designated conservation reserves. Such linkage may be important for fauna movements and for maintaining viable populations. The site, in effect, is part of a greater whole which might be diminished by the

alienation of the site to a greater extent than might be expected on the basis of size alone.

D.2 The site might be important for migratory and/or nomadic fauna. This conservation value can range from a remnant of bushland in an urban area acting as a focus for native birds which would otherwise be absent from the suburb, to a wetland being part of the global migratory pathway of a shorebird.

3.0 VERTEBRATE FAUNA OF THE STUDY AREA

While detailed fauna surveys were not conducted by the proponent as part of the Public Environmental Review, considerable information is available on the fauna of the coastal plain between the Swan and Moore Rivers. Studies include: information from a range of sites within this region from the WA Museum (Storr *et al.* 1978); detailed surveys at Whiteman Park immediately south of the site (Arnold *et al.* 1991); a site near Gingin, some 50 km north of the site (Bamford 1986). Furthermore, information has been made available from surveys at Ellenbrook that were conducted by the Royal Australasian Ornithologists Union (RAOU 1992) and the Western Australian Society of Herpetologists (WASH 1992). Tables 1, 2 and 3 present species lists for amphibians & reptiles, birds and mammals respectively, based on existing data for the site and nearby areas and personal knowledge on some poorly-sampled groups, such as bats. Because techniques and intensities of sampling varied between the sources of data, lists for sites may not be complete and comparisons between sites can only be made with caution.

3.1 Fishes

One native fish species of conservation value may occur on the study site. *Galaxiella munda* occurs mainly in rivers along the south coast from the Blackwood River to Albany, but there is a record of it from Ellen Brook between Muchea and Gingin (WA Museum records, J. Allen, pers. comm.). If the Ellen Brook population is extant and occurs in the Middle Swan region, then it may enter Sawpit Gully when this flows in winter, possibly to breed.

3.2 Amphibians

The amphibian species recorded on the site (Table 1) are typical of areas of remnant vegetation on the coastal plain north of Perth (Howe and Dell 1989). The four species listed as possibly at the study site are typical of more northerly or escarpment locations, but are known to occur nearby at Bullsbrook and Middle Swan. The possibility of these species being present reflects the site's position in an area transitional from the coastal sandplain to the

TABLE 1. Amphibian and reptile species recorded on the coastal plain between the Swan and Moore Rivers, indicating those species known (+) or expected (?) at Ellenbrook and species recorded at Whiteman and Melaleuca Parks.

Species	Ellenbrook	Whiteman Park	Melaleuca Park
Leptodactylidae (ground frogs)			
Crinia georgiana	+	+	+
Crinia glauertii	+		+
Crinia insignifera	+	+	+
Heleioporus albopunctatus	?		
Heleioporus barycragus	?		
Heleioporus eyrei	+	+	+
Heleioporus psammophilus	?		
Limnodynastes dorsalis	+	+	+
Myobatrachus gouldii	+	+	
Neobatrachus pelobatoides	?		
Pseudophryne guentheri	+	+	+
Hylidae (tree frogs)			
Litoria adelaidensis	+		+
Litoria moorei	+		
Chelidae (side-neck tortoises)			
Chelodina oblonga	+	+	+
Pseudemydura umbrina			
Gekkonidae (geckoes)			
Crenadactylus ocellatus			
Diplodactylus alboguttatus	?	+	
Diplodactylus polyopthalmus			
Diplodactylus spinigerus	+		+
Phyllodactylus marmoratus	?	+	
Underwoodisaurus milii			
Pygopodidae (legless lizards)			
Aclys concinna			
Aprasia pulchella			
Aprasia repens	+	+	
Delma frazeri	+		+
Delma grayii	?		
Lialis burtonis	+	+	+
Pletholax gracilis	+	+	
Pygopus lepidopodus	?	+	+
Agamidae (dragon lizards)			
Pogona minor	+	+	+
Tympanocryptis adelaidensis	+	+	+
Varanidae (monitors or goannas)			
Varanus gouldii	+	+	
Varanus rosenbergi	?	+	
Varanus tristes	?		
Scincidae (skink lizards)			

Bassiana trilineata	+	+	+
Cryptoblepharus plagiocephalus	+	+	+
Ctenotus fallens	+	+	+
Ctenotus gemmula	+	+	+
Ctenotus impar	?	+	
Ctenotus lesueurii	+	+	+
Egernia napoleonis	+	+	+
Egernia luctuosa			
Egernia kingii			
Hemiergis peronii	+		
Lerista christinae	+		
Lerista elegans	+	+	+
Lerista lineopunctulata	?		
Lerista praepedita	+		+
Menetia greyii	+	+	+
Morethia lineoocellata	+	+	+
Morethia obscura	+	+	+
Omelepida branchialis			
Tiliqua occipitalis	+	+	
Tiliqua rugosa	+	+	+
Typhlopidae (blind snakes)			
Ramphotyphlops australis	+	+	
Ramphotyphlops bituberculata	?		
Boidae (pythons)			
Morelia spilotes	?		
Morelia stimsoni	?		
Elapidae (front-fanged snakes)			
Demansia reticulata	?		
Notechis curtus	?		
Notechis scutatus	+	+	
Notechis coronata	?		
Pseudechis australis	?		
Pseudonaja affinis	+	+	+
Pseudonaja nuchalis	?		
Rhinoplocephalus gouldii	+	+	+
Vermicella bertholdi	+		+
Vermicella bimaculata	?		+
Vermicella calonotus	+	+	+
Vermicella semifasciata	+		
Vermicella fasciolata	?	+	

Totals	coastal plain	known	possible		
frogs	13	9	4	6	7
tortoises	2	1		1	1
geckoes	6	1	2	2	1
pygopodids	8	4	2	4	3
dragons	2	2		2	2
goannas	3	1	2	2	
skinks	20	15	2	13	12
snakes	15	7	10	6	5
all	69	40	22	36	31

heavier alluvial soils of river floodplains and the base of the escarpment. If present, these species would be on the very edge of their range at the study area.

The three species present at the study area but absent from Whiteman and/or Melaleuca Parks are widespread on the coastal plain but require the use of appropriate sampling techniques. The four species which might be present at the study site would not be expected at the other two areas, as these are located slightly to the west and therefore more completely on the sandy soils of the coastal plain.

All amphibian species except *Myobatrachus gouldii* have an aquatic larval stage but *Heleioporus eyrei* and *Limnodynastes dorsalis* are known to move several kilometres from wetlands outside the breeding season (Bamford 1992). *M.gouldii* breeds terrestrially (Roberts 1981) and is most abundant on well-drained sands, avoiding low-lying areas (Bamford unpub. data). None of the amphibian species is considered to be "rare and endangered or in need of special protection".

3.3 Reptiles

Like the amphibians, the reptile species (Table 1) recorded on the site are typical of remnant vegetation on the coastal plain just north of Perth (Storr *et al.* 1978). Differences between the study area, Whiteman Park and Melaleuca Park are mostly due to differences in sampling intensity, with some possible exceptions.

Lerista christinae has only previously been recorded from Gingin north to Badgingarra on the coastal plain (Bamford 1986, Storr *et al.* 1981). The population at the study area may be a southern isolate resulting from the presence of massive sand-dunes on the site. Intense drainage on these dunes may mimic the xeric conditions of more northerly coastal plain locations, thus creating microclimatic conditions favoured by *L.christinae*.

The presence of two races of *Diplodactylus spinigerus*, *D. s. inornatus* and *D. s. spinigerus* is also notable, as the latter is typical of the coastal plain whereas the former is the Darling Range race which has not previously been recorded on the coastal plain (WASH 1992).

Reptiles noted as possibly present but not found are generally cryptic or occur at low population densities. Species recorded for the coastal plain but not expected at the site have specific habitat requirements not met by the site. Several geckoes, for example, occur on the coastal plain only in areas of exposed limestone (Storr *et al.* 1978).

Specific habitat requirements of reptiles are generally not well known but most species recorded or expected at the site are probably widespread, being absent from only the dampest areas of the wetlands (with the exception of the aquatic tortoise *Chelodina oblonga*). *L.christinae* (see

above) may be confined to the deepest sands of the high dune ridge, although several specimens were found at a site described as low-lying (WASH 1992). A few species are likely to be restricted to the margins of the wetlands, including *Bassiana trilineata* (Storr *et al.* 1981) and the Tiger Snake *Notechis scutatus* (Storr *et al.* 1986).

The Carpet Python *Morelia spilota* is the only species of reptile classed as "rare and endangered or in need of special protection" that is likely to occur on the site. The site apparently does not contain suitable habitat for the critically endangered Short-necked Tortoise *Pseudemydura umbrina* which occurs nearby (Burbidge and Fuller 1993). Several species, however, do have restricted distributions and are at their south-eastern limit on the site. These include the snake *Vermicella calonotus* and the lizards *L.christinae* and *Pletholax gracilis*.

3.4 Birds

The bird list (Table 2) contains only those species recorded at the study area (RAOU and pers. obs.) or in nearby Whiteman Park (Arnold *et al.* 1991). Adequate data do not exist for Melaleuca Park. Many more than the 80 species given on Table 2 have been recorded on the coastal plain north of Perth (Storr *et al.* 1978 list 223 species), but this reflects the diversity of habitats of this region and also the mobility of birds.

The suite of bird species found or expected at the study area is typical of remnant vegetation on the coastal plain north of Perth. It includes 18 species identified in the RAOU's submission on the Ellenbrook development as having declined in the urbanized areas of Perth. The list also includes several species that reflect the site's proximity to the escarpment, such as the Red-eared Firetail and Golden Whistler. The record of a "chestnut-winged" fairy-wren by the RAOU is interesting, as this was probably the Variegated Fairy-wren *Malurus lamberti* close to the southern end of its range on the coastal plain. Alternatively, it could have been the first record of a Red-winged Fairy-wren *Malurus elegans* on the coastal plain near to Perth since 1907 (Serventy and Whittell 1976). This species has a restricted distribution in the South-West and near Perth it is now confined to riparian vegetation in the Darling Scarp; it once occurred around many coastal plain wetlands in the Perth region.

A number of other species are close to the limit of their distribution. The Red-capped Robin, Hooded Robin, Crested Bellbird, Crested Pigeon and Masked Woodswallow are widespread species which are close to the southern limit of their coastal plain distribution at the study site. The Western Rosella is restricted to the South-West and is rarely recorded north of Perth.

TABLE 2. Species of birds known (+) or expected (?) at Ellenbrook. Known species are based on RAOU surveys and personal records, expected species on records from Whiteman Park, January 1990 to January 1991 (Arnold *et al.* 1991). Introduced species are indicated (I).

Species	Status at Ellenbrook
Emu *Dromaius novaehollandiae*	+
Pacific Heron *Ardea pacifica*	+
Black-shouldered Kite *Elanus notatus*	+
Brown Goshawk *Accipiter fasciatus*	+
Collared Sparrowhawk *Accipiter cirrhocephalus*	+
Wedge-tailed Eagle *Aquila audax*	+
Little Eagle *Hieraaetus morphnoides*	?
Peregrine Falcon *Falco peregrinus*	?
Australian Hobby *Falco longipennis*	+
Brown Falcon *Falco berigora*	+
Australian Kestrel *Falco cenchroides*	+
Unidentifed Quail *Coturnix* sp.	+
Painted Button-quail *Turnix varia*	?
Spotless Crake *Porzana tabuensis*	?
Laughing Turtle-Dove *Streptopelia senegalensis* (I)	?
Common Bronzewing *Phaps chalcoptera*	+
Baudin's Black-Cockatoo *Calyptorhynchus latirostris*	?
Carnaby's Black-Cockatoo *Calyptorhynchus carnabyi*	?
Galah *Cacatua roseicapilla*	?
Red-capped Parrot *Purpureicephalus spurius*	+
Western Rosella *Platycercus icterotis*	?
Port Lincoln Ringneck *Barnardius zonarius*	+
Elegant Parrot *Neophema elegans*	+
Pallid Cuckoo *Cuculus pallidus*	?
Fan-tailed Cuckoo *Cuculus pyrrhophanus*	+
Horsfield's Bronze-Cuckoo *Chrysococcyx basalis*	?
Shining Bronze-Cuckoo *Chrysococcyx lucidus*	?
Southern Boobook Owl *Ninox novaeseelandiae*	+
Barn Owl *Tyto alba*	+
Tawny Frogmouth *Podargus strigoides*	+
Australian Owlet-nightjar *Aegotheles cristatus*	+
Fork-tailed Swift *Apus pacificus*	?
Laughing Kookaburra *Dacelo novaeguineae* (I)	+
Sacred Kingfisher *Halcyon sancta*	?
Rainbow Bee-eater *Merops ornatus*	+
Welcome Swallow *Hirundo neoxena*	+
Tree Martin *Cecropis nigricans*	+
Richard's Pipit *Anthus novaeseelandiae*	?
Black-faced Cuckoo-shrike *Coracina novaehollandiae*	+
White-winged Triller *Lalage sueurii*	?
Scarlet Robin *Petroica multicolor*	+
Red-capped Robin *Petroica goodenovii*	?
Hooded Robin *Melanodryas cucullata*	+

Rufous Whistler *Pachycephala rufiventris*	+
Golden Whistler *Pachycephala pectoralis*	+
Grey Shrike-thrush *Colluricincla harmonica*	+
Crested Bellbird *Oreoica gutturalis*	?
Grey Fantail *Rhipidura fuliginosa*	+
Willie Wagtail *Rhipidura leucophrys*	+
Splendid Fairy-wren *Malurus splendens*	+
White-winged Fairy-wren *Malurus leucopterus*	?
unidentified, chestnut-winged fairy-wren *Malurus* sp.	+
Weebill *Smicrornis brevirostris*	+
Western Gerygone *Gerygone fusca*	+
Inland Thornbill *Acanthiza apicalis*	+
Western Thornbill *Acanthiza inornata*	+
Yellow-rumped Thornbill *Acanthiza chrysorrhoa*	+
Varied Sittella *Daphoenositta chrysoptera*	+
Red Wattlebird *Anthochaera carunculata*	+
Little Wattlebird *Anthochaera chrysoptera*	+
Yellow-throated Miner *Manorina flavigula*	+
Singing Honeyeater *Lichenostomus virescens*	+
Brown-headed Honeyeater *Melithreptus brevirostris*	?
Brown Honeyeater *Lichmera indistincta*	+
New Holland Honeyeater *Phylidonyris novaehollandiae*	+
White-cheeked Honeyeater *Phylidonyris nigra*	+
Tawny-crowned Honeyeater *Phylidonyris melanops*	+
Western Spinebill *Acanthorhynchus superciliosus*	+
Mistletoebird *Dicaeum hirundinaceum*	+
Spotted Pardalote *Pardalotus punctatus*	+
Striated Pardalote *Pardalotus striatus*	+
Silvereye *Zosterops lateralis*	+
Red-eared Firetail *Stagonopleura oculata*	?
Australian Magpie-lark *Grallina cyanoleuca*	+
Black-faced Woodswallow *Artamus cinereus*	+
Dusky Woodswallow *Artamus cyanopterus*	?
Masked Woodswallow *Artamus personatus*	?
Grey Butcherbird *Cracticus torquatus*	+
Australian Magpie *Gymnorhina tibicen*	+
Australian Raven *Corvus coronoides*	+
known species	57
expected species	80

The bird fauna of the coastal plain north of Perth includes a number of species which vary in abundance seasonally. Some, such as the Rainbow Bee-eater, Sacred Kingfisher and cuckoos are complete migrants, arriving in winter (cuckoos) or spring (bee-eater and kingfisher) and departing in late summer. Other species, such as many honeyeaters, are present throughout the year but vary in abundance seasonally. Bamford (1986) found the abundance of honeyeaters at Gingin to peak biannually, corresponding with the winter flowering of *Banksia menziesii* and the summer flowering of *Banksia attenuata*.

A few of the bird species present or expected have specific habitat requirements that are significant within the Ellenbrook context. The majority of species could be expected throughout the *Banksia* woodland, although Bamford and Bamford (1992) recorded higher bird densities in *Banksia* woodland close to wetlands than in upland *Banksia* woodland at a site near Cataby. Some species, including the Splendid Fairy-wren, Inland Thornbill and Western Thornbill, could be expected to occur principally in dense vegetation around the wetlands, including areas with tall eucalypts. The areas with tall eucalpyts may also be significant for hole-nesting species, including parrots, kingfishers, pardalotes, owls and owlet-nightjars.

Four species present or expected on the site, the Peregrine Falcon, Red-eared Firetail, Carnaby's Black-Cockatoo and Baudin's Black-Cockatoo, are gazetted as "in need of special protection". The two cockatoos are listed as "Vulnerable" and "Insufficiently Known" respectively by Garnett (1992). The main cause of decline of the two cockatoos is loss of nesting hollows. Breeding is very unlikely to occur on the study area.

3.5 Mammals

The list of mammals confirmed for the study area (Table 3) is small as no systematic surveys specifically for mammals have taken place at the site. The list of expected species does not include species that may once have occurred on the site but which have declined dramatically throughout the South-West since European settlement. Both the Chuditch and the Brush-tailed Possum are species that have declined on the coastal plain; Smith *et al.* (1989) note the last record of the Chuditch in Yanchep National Park as 1972, and that the Brush-tailed Possum has not been recorded in recent years. They are listed as possibly present at the study area as occasional sightings are still made in the region, including a Brush-tailed Possum 5 km north of Muchea in 1992 (pers. obs.) and a Chuditch on the study area in 1989 (L.Strawbridge pers. comm.). If present at the site, the Brush-tailed Possum would most likely occur in the areas of

TABLE 3. Species of mammals known (+) or expected (?) at Ellenbrook, on the basis of records at Whiteman Park (Arnold *et al.* 1991) and personal records for the general region.

Species	Ellenbrook	Whiteman Park
Tachyglossidae (echidnas)		
Tachyglossus aculeatus Echidna	?	+
Dasyuridae		
Sminthopsis griseoventer dunnart	?	
Dasyurus geoffroii Chuditch	?	
Peramelidae (bandicoots)		
Isoodon obesulus Quenda or Southern Brown Bandicoot	+	+
Phalangeridae (possums)		
Trichosurus vulpecula Brush-tailed Possum	?	
Burramyidae (pygmy possums)		
Cercartetus concinnus Western Pygmy Possum	?	
Tarsipedidae (honey possum)		
Tarsipes rostratus Honey Possum	?	+
Macropodidae (kangaroos and wallabies)		
Macropus fuliginosus Western Grey Kangaroo	+	+
Macropus irma Brush Wallaby	+	+
Mollosidae (mastiff bats)		
Tadarida australis White-striped Bat	?	
Mormopterus planiceps	?	
Vespertilionidae (vesper bats)		
Chalinolobus gouldii Gould's Wattled Bat	?	
Chalinolobus morio Chocolate Wattled Bat	?	
Eptesicus regulus	?	
Nyctophilus geoffroyi Lesser Long-eared Bat	?	
Nyctophilus major Greater Long-eared Bat	?	
Muridae (rats and mice)		
Hydromys chrysogaster Water-rat	?	+
Mus musculus House Mouse (I)	?	+
Pseudomys albocinereus Ashy-grey Mouse	?	+
Rattus fuscipes Southern Bush-Rat	?	
Rattus rattus Black Rat (I)	?	+
Leporidae (rabbits and hares)		
Oryctolagus cuniculus Rabbit (I)	+	+

TABLE 3 (cont.).

Species	Ellenbrook	Whiteman Park
Canidae (foxes and dogs)		
Vulpes vulpes European Red Fox (I)	+	+
Felidae (cats)		
Felis catus Feral Cat (I)	?	
Number of species known	5	11
Number of species known and possible	24	

tall eucalpyts around some of the wetlands. This vegetation may also be important for the Chuditch.

Almost all the mammal species listed as either present or expected have disappeared from the urban areas of Perth. The dunnart *Sminthopsis griseoventer* and the Ashy-grey Mouse are close to the southern limit of their coastal plain distribution. The Ashy-grey Mouse was recorded in Whiteman Park in 1975 but was not in 1990 (Arnold *et al.* 1991), suggesting that it may have become extinct there. It was recorded in Melaleuca Park in the 1980's (R.Howe pers. comm.). The dunnart is common near Gingin (Bamford 1986) even in bushland remnants in areas partly cleared for agriculture, but it appears to be scarce or absent from large areas of bushland close to Perth.

In contrast with the dunnart and Ashy-grey Mouse, the Quenda or Southern Brown Bandicoot is close to the northern limit of its range at the study area. The Quenda is gazetted as "likely to become extinct, or is rare" (Government Gazette 1990). While its status was debated in the Public Environmental Review, the Quenda has declined over much of its distribution and is also within the critical weight range identified for native mammals (Burbidge and McKenzie 1989). The population in the study area may become a northern isolate as Perth expands and consolidates.

According to Braithwaite (1984), the Quenda favours "scrubby habitats", particularly where a mosaic of burnt and unburnt vegetation is maintained through the careful use of fire in management. At the study area, such "scrubby habitats" occur mainly around the wetlands where evidence of Quendas (characteristic diggings) was concentrated (pers. obs.). Friend (1991) notes that Quendas occur mainly in dense vegetation around wetlands on the coastal plain. Bamford (1986) has also recorded Quendas in long-unburnt (*ca.* 20 years) *Banksia* woodland several kilometres from the nearest wetland. Studies at Harry Waring Nature Reserve south of Perth have determined densities of Quendas of 1 animal per 1.6 ha (Nagy *et al.* 1991). This reserve consists mostly of dense, shrubby vegetation which provides suitable habitat for the Quenda, and is fenced to exclude predators (principally the Red Fox). Using the density estimate from Harry Waring Nature Reserve, the population of Quendas on the potential development area was estimated to be 126 (see Appendix 1). The adjacent Lexia conservation area, mostly owned by Mt Lawley Nominees, is estimated to contain an additional 125 Quendas (Appendix 1).

In recent years, the EPA has applied special conditions to development projects that may affect species gazetted as "rare and endangered or in need of special protection". For example, the Main Roads Department has been required to

relocate Quendas from wetlands affected by the extension of the Roe Highway.

The Honey Possum is known to survive on the periphery of the metropolitan area and is common in Whiteman Park (S.Davies, pers. comm.). Arnold *et al.* (1991) found it in all vegetation types dominated by *Banksia* spp. in Whiteman Park. The Honey Possum is a nectarivore and *Banksia* spp. are its major source of nectar and pollen. It is almost certainly abundant in the *Banksia* woodlands on the site and may still occur within the Vines development, depending upon the impact of domestic cats.

The presence of the Brush Wallaby is also significant, as this species is reported to have declined over the past decade and its management in Whiteman Park is considered to be of importance (Arnold *et al.* 1991). At Whiteman Park, the Brush Wallaby occurs in low-lying areas with dense understorey vegetation (Arnold *et al.* 1991), so it is probably most abundant around wetland areas on the study area.

Bats were not included in surveys at Whiteman Park but a number of species are known from the outer suburbs. Bats are reported to have declined in the metropolitan area despite surviving in some inner suburbs until recently (Wykes 1991). Tree hollows are important roosting and maternity sites.

Of the three native rodents listed, the Water-rat is one of the few native mammals to persist in urban areas, still being present along the Swan River at Alfred Cove and at Lake Goolellal in Kingsley (pers. obs.). Although Arnold *et al.* (1991) concluded that it was absent from Whiteman Park, they did not carry out any appropriate sampling for this species. It is likely to occur along Ellen Brook and may occur along Sawpit Gully when this contains water.

The Southern Bush-Rat has a patchy distribution north of Perth and has declined in Yanchep National Park (Smith *et al.* 1989). There are insufficient data on its distribution and habitat preferences to predict its status at the site.

The introduced species of mammals are probably all common at the site and the numbers of feral cats would be expected to increase as a result of urbanization in the area.

3.6 Summary of vertebrate fauna

In summary, the vertebrate fauna of the study area has a number of important features.

1. The number and range of species is typical of the coastal plain north of Perth and the assemblage includes many species that do not survive urbanization or

disturbance. The study area may be the closest coastal plain site to Perth to have a more or less intact vertebrate fauna, given the recent apparent disappearance of the Ashy-grey Mouse from Whiteman Park, which can reasonably be supposed to survive on the study area.

2. A number of the species found at the study area are at the southern or northern limits of their range on the coastal plain.

3. Several species present on the study area may exist as isolated populations at the edge of or beyond the normal range for the species. This may be the case with the lizard *Lerista christinae* and may apply to the Quenda as Perth expands.

4. The vertebrate fauna includes or may include a number of species more typical of the escarpment than the coastal plain, reflecting the site's transitional location.

4.0 DISCUSSION OF THE CONSERVATION VALUE OF THE FAUNA

Conservation values of the fauna of the study site must be viewed from a regional perspective and in the context of remnant vegetation as habitat. The site is on the eastern edge of the Swan Coastal Plain, which is a discrete geological and biological unit of some 780,000 ha. This plain extends approximately from Capel north to Lancelin and only 26% of the natural vegetation remains (Burbidge and Rolfe unpub. data). Perth is a major artificial discontinuity within this landscape, stretching unbroken from the coast to the 'Scarp. Clearing has been more extensive south of Perth than to the north.

As a result of extensive clearing and habitat modification, fauna has declined on the Coastal Plain and continues to decline with ongoing habitat fragmentation and habitat degradation, the latter due to weed invasion and inappropriate fire regimes. Conservation reserves are only adequate for some vegetation types. In "A Nature Conservation Strategy for Western Australia (CALM 1992), the discussion of principles for the selection of conservation areas in fragmented landscapes states that:

> *"...most areas of remaining vegetation contribute to nature conservation. Size, "manageability", the presence of poorly reserved species or ecosystems and the potential for regional linkage of the reserve system are important criteria during the selection process."*

Overall, the study site is of conservation significance because it is a remnant of a biotic system which has substantially declined since European settlement and continues to decline. Conservation values of the site can

be considered more specifically under the headings discussed in Section 2 of this report (Table 4).

4.1 Anthropocentric

The fauna of the study area has potential anthropocentric conservation value because it is close to Perth and therefore has potential for research, education and recreation.

4.2 Biocentric

The Quenda is the only gazetted rare species confirmed at the site although several other gazetted rare species may be present (Table 4). The population of the Quenda on the potential development site may be in the order of 125 animals with a population of similar size on the adjacent Lexia conservation area. As Perth expands, this population will become increasingly isolated. The extremely rare Short-necked Tortoise is unlikely to occur on the site as the habitat is considered to be unsuitable (Burbidge and Fuller 1993).

The site contains what is probably an isolated, extra-limital population of the lizard *L. christinae*, which otherwise has a restricted distribution on the coastal plain from Gingin to Badgingarra. Nearby Ellen Brook may still contain an extra-limital population of the fish *G.mundas*, which could breed in Sawpit Gully. The site also supports or may support a number of species which are on the edge of their range (Table 4). The most significant of these also have small distributions or have declined in their range. These include: the skink *L. christinae*, legless lizard *P.gracilis*, Black-striped Snake *V. calonotus*, dunnart *S. griseoventer*, Quenda *I. obesulus* and Ashy-grey Mouse *P. albocinereus*. Because of the mobility of birds, occasional records on the edge of their range are of less significance than with more sedentary reptiles and mammals.

The site supports a rich fauna because of low levels of disturbance, varied habitats ranging from a high dune ridge to seasonal wetlands, and the presence of both coastal plain and some escarpment species. Comparisons of species richness between the study area and nearby conservation reserves cannot be carried out because of differences in sampling; species lists for all sites are probably incomplete.

4.3 Biogeographic

All species of fauna at the site are represented elsewhere in nearby reserves. The assemblage of species is also largely represented elsewhere with the exception of some mixing of coastal plain and escarpment species. Vegetation types capable of supporting all the fauna recorded or expected at the site are well-represented in reserves.

In a biogeographic sense, the site is significant because it is close to Perth and many of the species found at the site have disappeared from urban areas. These include many reptile, bird and mammal species. There is evidence for a decline in some species in Whiteman Park, so the study area may represent the most complete coastal plain fauna close to Perth.

4.4 Integrative

The site is of great importance when viewed in the context of a landscape comprised of conservation areas, privately-owned bushland, agricultural land and expanding urban areas. Most importantly, it lies between the Gnangara Biological corridor and the Avon Valley Regional Park proposed by the Department of Planning and Urban Development (1990). Conservation of biodiversity is recognised as depending upon linkage (Noss and Harris 1986), and the study area is strategically located between conservation areas to the north (Melaleuca Park), south (Whiteman Park) and east (Twin Swamps and Ellen Brook Nature Reserves, Walyunga National Park); see Figure 1. Arnold *et al.* (1991), emphasise the importance of linkage for maintaining biodiversity in Whiteman Park; the study area is part of that linkage.

Habitat linkage and movement corridors are important because they help to maintain the viability of populations. With the exception of some birds, most fauna requires linkage between areas of habitat for movement to occur between them. A small, isolated population can die out whereas a small population linked, even tenuously, to a larger population, is more likely to persist. CALM's (1992) draft Nature Conservation Strategy for Western Australia stresses the importance of linkage between conservation areas in fragmented landscapes.

The viability of populations is dependent upon many factors and the minimum viable population (the population required for long-term survival) for a species is difficult to calculate. Soule and Simberloff (1986), suggest that minimum viable populations for animal species are rarely lower than a few hundred. In the case of the Quenda, for example, this suggests that all animals and linkages need to be preserved for a viable regional population.

Approval has already been given for further residential development adjacent to the study site. This will involve the loss of *ca.* 100 ha of remnant vegetation supporting an estimated 40 Quendas. Some of these animals may be displaced into the study area during development.

The importance of remnants that provide linkage within the urban landscape is recognised in the Department of Planning and Urban Development's (1990) "Metroplan", where it is stated that the department will give:

TABLE 4. Summary of the conservation values of the study area. Species included in this list are either known to be present or may occur on the site.

Anthropocentric

A more or less intact, diverse ecosystem close to Perth and therefore of value for research and recreation.

Biocentric rare species

Carpet Python *Morelia spilotes*
Peregrine Falcon *Falco peregrinus*
Baudin's cockatoo *Calyptorhyncus baudinii*
Carnaby's Cockatoo *Calyptorhyncus latirostris*
Chuditch *Dasyurus geoffroyi*
Quenda or Southern Brown Bandicoot *Isoodon obesulus*

species with extra-limital distributions or on the edge of their range

Spotted Burrowing Frog *Heleioporus albopunctatus*
burrowing frog *Heleioporus barycragus*
burrowing frog *Heleioporus psammophilus*
burrowing frog *Neobatrachus pelobatoides*
Spiny-tailed Gecko ('scarp sub-species) *Diplodactylus spinigerus inornatus*
skink *Lerista christinae*
legless lizard *Pletholax gracilis*
Black-striped Snake *Vermicella calonotus*
Western Rosella *Platycercus icterotis*
Variegated Fairy-wren *Malurus lamberti*
Hooded Robin *Melanodryas cucullata*
Red-capped Robin *Petroica goodenovii*
Crested Bellbird *Oreoica gutturalis*
Red-eared Firetail *Emblema oculata*
Masked Woodswallow *Aratamus personatus*
dunnart *Sminthopsis griseoventer*
Quenda or Southern Brown Bandicoot *Isoodon obesulus*
Ashy-grey Mouse *Pseudomys albocinereus*

species richness

frogs: possibly 12 species
reptiles: possibly 40 species
birds: possibly 80 species regularly
mammals: possibly 20 species.

Biogeographic

All species and assemblages represented elsewhere but some mixing of coastal plain and escarpment species.

Integrative

A good quality remnant in a landscape mosaic of cleared land, uncleared, privately-owned land and conservation reserves.

Provides linkage with other reserves: Whiteman Park, Melaleuca Park, Twin Swamps Nature Reserve, Ellen Brook Nature Reserve, Walyunga National Park. East-west linkage important in the light of Perth's radial growth.

Bushland remnants closer to Perth have depauperate fauna relative to the study area.

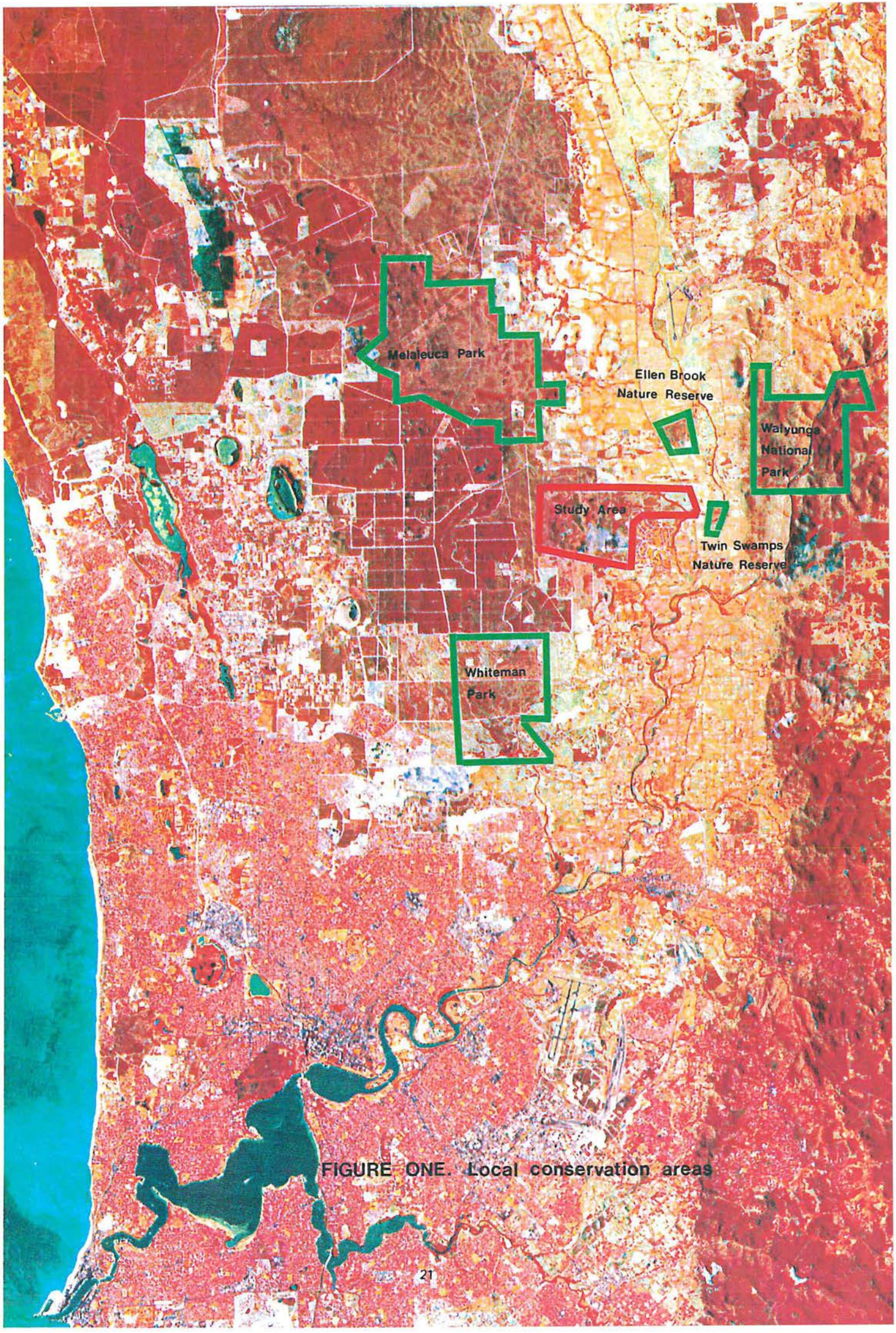

FIGURE ONE. Local conservation areas

"*special consideration ... to the inter-linking of regional parks with other areas of open space*". (Policy 8.3) "Metroplan" further states that this will be based on:

" *... Maintaining the diversity of the Region's natural landscape, ... and developing linkages between ecological systems*" and that these "*will be progressively developed as the built-up area expands*" (Department of Planning and Urban Development 1990).

Preservation of the linkage function of the study area is clearly in accord with the Department of Planning and Urban Development's position on Regional Open Space. An examination of aerial photography of the region shows it to be the only opportunity to maintain a linkage of native vegetation across the north-east corridor. Some additional vegetation establishment would enhance the linkage function between Twin Swamps Nature Reserve and the proposed Avon Valley Regional Park.

5.0 CONCLUSION

In conclusion, the study area is of high conservation value for fauna. It complements the conservation function of Melaleuca and Whiteman Parks.

The major conservation values of the site are:

a). Linkage between remnant vegetation of the coastal plain and the Darling 'Scarp;

b). A large population of the Quenda or Southern Brown Bandicoot;

c). A high species richness for a coastal plain site close to Perth.

These conservation values will be compromised by both direct (habitat loss) and indirect (habitat modification) impacts of development. These effects need to be considered when meeting other aspects of the Ministerial Conditions for approval of the Ellenbrook development.

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APPENDIX 1. POPULATION ESTIMATES OF THE QUENDA.

In the EPA recommendations on the Ellenbrook development, it was proposed that 450 ha be maintained for conservation purposes. This area was called the Lexia Wetlands and includes 130 ha of the study area. In calculating the Quenda population, the EPA's conservation line has been used to distinguish the Lexia conservation area from the potential development area.

An estimate of the number of Quendas in the potential development area was made by dividing vegetation types into four categories (based on their suitability as Quenda habitat) and arbitrarily assigning Quenda densities to each category (Table 1, Figure 1). The density found by Nagy *et al.* (1991) in good Quenda habitat (1 Quenda/1.6 ha) was used as the basis for Quenda densities, with this value being used for the best quality habitat and being progressively halved for lower quality habitats. From these figures, an estimate of the size of the Quenda population on the study area was made (Table 2).

Table 1. Quenda density classes and vegetation types.

Quenda density	Vegetation types (after Weston *et al.* (1992).
High:	C1, C2, C4, D, E1, E2, E4, F1, F2, G, H, L, M.
Medium:	A2, A3, E3, C3, K.
Low:	B, J.
Negligible:	A1, A4.

Table 2. Estimated numbers of Quendas in the potential development area.

Quenda density		Area (ha)	N Quendas
High	1/1.6 ha.	121	75
Medium	1/3.2 ha.	138	43
Low	1/6.4 ha.	51	8
Negligible			272
TOTAL NUMBER OF QUENDAS			126

The same process can be used to estimate the size of the population of Quendas in the proposed Lexia conservation area, giving an estimate of 125 Quendas.

These estimates do not take account of the impact of fox predation upon Quendas in the study area.

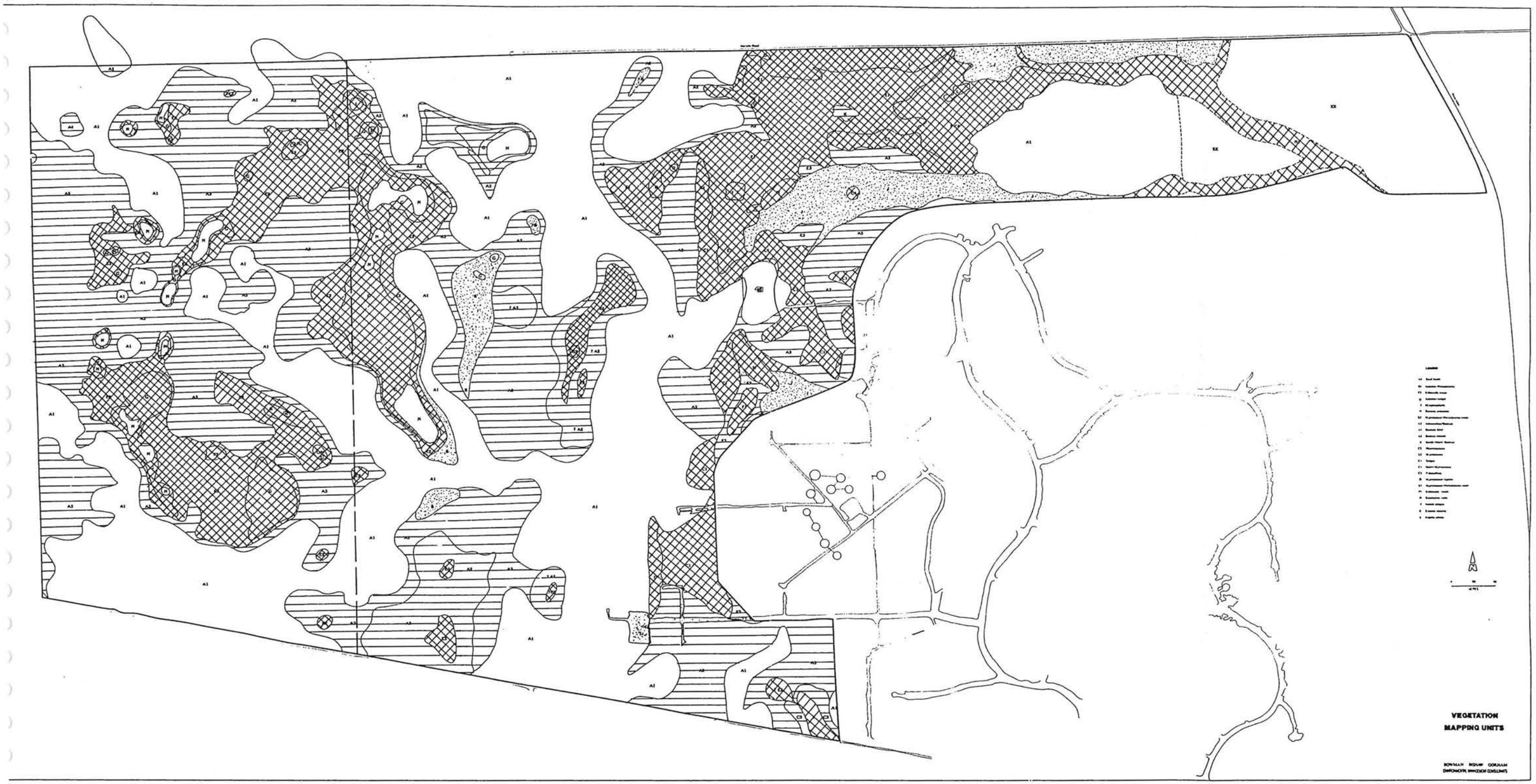

FIGURE ONE. Density of Quendas.

Low

Medium

High

ELLENBROOK DEVELOPMENT PROJECT

SURVEY FOR WESTERN SWAMP TORTOISES

by

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and

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1. BACKGROUND

The Ellenbrook Development project covers an area of 1797 ha, 20 km north-east of Perth city. A Public Environmental Review (PER) was prepared pursuant to the requirements of the Environmental Protection Act for Ellenbrook Management Pty Ltd in April 1992 (Feilman Planning Consultants 1992) and was assessed by the Environmental Protection Authority (EPA), following a period of public comment (EPA 1992).

The EPA made recommendations on the project to the Minister for the Environment in August 1992. Recommendation 3 stated that the proponents should set aside land for conservation in the Sawpit Gully area and that the final boundary should be determined to meet the requirements of the Minister for the Environment following advice from the Department of Conservation and Land Management and the Department of Planning and Urban Development. The EPA considered that a decision to rezone land in the northern part of the area should be deferred pending further, more detailed, environmental investigations and that the studies should include survey for the Western Swamp Tortoise.

In September 1992, Bowman Bishaw Gorham, Environmental Management Consultants, contacted us with a request that we undertake the Western Swamp Tortoise survey. The work was commissioned on 5 October 1992.

This report is not an official publication of the Department of Conservation and Land Management.

2. THE WESTERN SWAMP TORTOISE

2.1 Status

The Western Swamp Tortoise (*Pseudemydura umbrina*), also known as the Short-necked Tortoise, is the world's rarest and most endangered tortoise or turtle. It is a declared Threatened Species under the W.A. Wildlife Conservation Act, is listed as Endangered nationally (ANPWS 1991), as Endangered in the IUCN Amphibia-Reptilia Red Data Book (Groombridge 1982), as Priority 1 in the Action Plan for Tortoises and Freshwater Turtles (IUCN/SSC 1989), and is categorised as Critical under the draft new IUCN categories of Mace and Lande (1991). In 1991 there was only one wild population, of about 30 animals (only 7 adult females known to be alive) in Ellen Brook Nature Reserve (EBNR), plus 48 captives, of which only 6 were adult females.

CALM published a Management Program for the species in 1990 (Burbidge *et al.* 1990). A Recovery Plan has been prepared for the period 1993 to 2002 (Burbidge and Kuchling in press) and funding is being provided by CALM, Perth Zoo, the Australian National Parks and Wildlife Services' Endangered Species Program and the World Wide Fund for Nature with the aid of a donation from Land Management International. Several other organisations are helping with the Recovery Plan, including the W.A. Water Authority, The University of W.A.'s Zoology Department, Bundesverband für fachgerechten Natur-und Artenschutz (Germany) and the British Chelonia Society. Much of the information on the species' biology and ecology provided here is taken from the Recovery Plan.

2.2 Distribution and Habitat requirements

Western Swamp Tortoises have been recorded only from scattered localities in a narrow (3 to 5 km wide) strip of the Swan Coastal Plain with largely alluvial soils, roughly parallel with the Darling Scarp, running from Perth Airport at Guildford to near Pearce Royal Australian Air Force Base at Bullsbrook. Anecdotal information (Burbidge 1967, 1981) suggests that

their stronghold was the clay soils of the Swan Valley, the first part of Western Australia developed for agriculture. Almost all this land is now cleared and either urbanised or used for intensive agriculture or the extraction of clay for brick and tile manufacture.

During the 1960s to 1980s there were two significant populations; one in each of Twin Swamps Nature Reserve (TSNR) and EBNR, which were created to protect its habitat in 1962. By 1985 the population at TSNR was effectively extinct; this decline is thought to have been caused by a combination of fox predation, the marginal nature of the habitat in the reserve, and drought (see section 2.3).

P. umbrina inhabits shallow, ephemeral, winter-wet swamps on clay or sand over clay soils with nearby suitable aestivation refuges. They have a low fecundity (3 - 5 eggs per clutch, maximum of one clutch per year), and a very slow growth rate, not reaching sexual maturity until an age of between 10 and 20 years (depending on habitat and annual rainfall).

Perth has a Mediterranean climate with cool, wet winters and hot, dry summers. The mean annual rainfall is about 800 mm. After the swamps fill in June or July the tortoises can be found in water, feeding when water temperatures are high enough (> 12^{o} -14^{o}C). They are carnivorous, eating only living food such as insect larvae, small crustaceans and small tadpoles. As the swamps warm in spring and swamp life becomes plentiful, the tortoises' food intake increases and fat supplies are laid down for the forthcoming summer. When the swamps are nearly dry and water temperatures rise above *ca* 28^{o}C, usually in November or early December, the tortoises leave the water to aestivate during the summer and autumn. Aestivation refuges vary with the soil type: at EBNR they are naturally-occurring holes in the gilgai clay, while at TSNR most aestivated under *Banksia* leaf litter or fallen branches, but a few find holes in the ground dug by other animals or left by a rotting tree root.

2.3 Reasons for threatened status

There are a number of compounding reasons for the current critically endangered status of the Western Swamp Tortoise;

i) a very small geographic range, most of which has been converted to agricultural, industrial or urban use,

ii) protection of habitat solely in two small nature reserves that include only marginal habitat,

iii) a specialised biology that includes dependence on a rare habitat, a wholly carnivorous diet, low fecundity and slow growth rates, mitigated to some extent by great longevity,

iv) increasing aridity, a factor compounded by the marginal nature of the remaining habitat and which will become worse if current climatic predictions are correct, and

v) the presence of exotic predators, particularly the European Red Fox.

3. AREA EXAMINED

General descriptions of the area, prepared by Dames and Moore, are provided in Appendix A of the PER (Feilman Planning Consultants 1992).

The area to be surveyed for possible Western Swamp Tortoise populations was defined by the EPA (their Figure 4) and is shown in Figure 1. Within this area five 'damplands', in addition to Sawpit Gully creek itself, were shown. In addition there are several swamps that

the EPA decided should be included in a conservation reserve (the 'Lexia wetlands'). The damplands and swamps have been numbered for easy description (see Figure 1).

4. METHODS

We visited the area on seven occasions: 11 September, 13 October, 16 October, 21 October, 3 November, 10 November and 12 November 1992.

All the 'dampland' areas were visited and repeated searches were made of areas with standing water until they dried. Dry areas were not visited again. We also visited and searched parts of the swamps within the proposed conservation area to the west.

All areas of shallow, standing water were searched. Our methods were:

- visual searching (walking slowly through an area looking for tortoises), and

for areas where the water was too deep or too dark for visual searching to be effective,

- puddling (feeling with the hands and/or feet for animals).

The second method is only effective in relatively small areas and is usually only reliable when the area of water shrinks as swamps dry up. Although the swamp waters in the study area were tannin-stained, they were not so dark as to prevent efficient visual searching of areas with a depth of less than 20 to 30 cm. Only areas vegetated with reeds were deeper than this during all of our visits.

5. RESULTS

No Western Swamp Tortoises were located. One Oblong Tortoise (*Chelodina oblonga*) was captured in Swamp 4 (area D).

6. THE DAMPLANDS AND SWAMPS AS WESTERN SWAMP TORTOISE HABITAT

6.1 The damplands

We consider that all areas shown as 'damplands' in the EPA report are not suitable swamp tortoise habitat. There are two reasons for this assessment.

1. Period and depth of standing water.

All dampland areas are very shallow and in 1992 held water for only a short time during the winter and spring. Areas 5, 6 and 7 had extensive shallow water (< 5 cm) present during our September 11 (day 255[1]) visit. By 13 October (day 287) very little water remained and by 16 October (day 290) all were dry except for a pool in a firebreak into which water was flowing from cleared land to the north. This pool was dry on 21 October (day 295).

Areas 1, 2, 3 and 10 were dry on 13 October (day 287) and area 9, which was examined later is considered from its vegetation and appearance to have been dry on this date.

[1] days of the year are provided to facilitate comparison with Figures 2 to 4.

A typical standing water profile for EBNR and for two swamps at TSNR is given in Figures 2 to 4. In 1992 EBNR contained water until late November (*ca* day 330), East Swamp at TSNR contained water until the first week of October (*ca* day 280) and South West Swamp at TSNR still had water in mid-December (*ca* day 350). (East Swamp is to be supplemented from groundwater, see below.)

It should be noted that, although both nature reserves support or supported populations of Western Swamp Tortoises, neither provides an ideal period of standing water for them. Desirably, standing water should be present until at least mid-December, after nesting takes place (latter half of November, early December), and that it is proposed in the Recovery Plan to dig deeper swamps at EBNR and to experimentally supplement from groundwater two swamps at TSNR, even though the latter action may lead to a deterioration in the water quality.

2. Swamp vegetation.

All the 'dampland' areas are densely vegetated with shrubs and, in some cases, with trees and blackboys (*Xanthorrhoea preissii*). The dense vegetation and the presence of blackboys shows that the damplands are very ephemeral. Dense vegetation is also considered to be unsuitable for Western Swamp Tortoises, which need relatively open areas in which to move and forage.

6.2 The swamps

We consider that the swamps are not suitable Western Swamp Tortoise habitat. There are two reasons for this opinion.

1. Swamp type and vegetation.

The swamps are mostly deep with dark, tannin-stained water and are most are vegetated with *Baumea articulata* reeds. Western Swamp Tortoises have never been located in this type of swamp, even though similar swamps are common on the Swan Coastal Plain and are located relatively near (in terms of the tortoises' walking capabilities) known tortoise populations. These swamps are inhabited by the long-necked Oblong Tortoise (*Chelodina oblonga*), which is occasionally also found in swamps inhabited by Western Swamp Tortoises.

Some of the area of the Swamps, particularly Swamp 4, have areas of reeds, but also have areas vegetated with fairly dense shrublands, dominated by *Pericalymma ellipticum*, somewhat reminiscent in appearance to some swamps at TSNR, which are vegetated with open shrublands of *Melaleuca* spp. (e.g. *M. viminea* and *M. teritifolia*). However, the former areas do not seem to support the quantities of tortoise food found at TSNR (see below).

2. Food availability.

Western Swamp Tortoises are carnivores, eating only live food, mainly invertebrates such as crustacea, aquatic insects and the larvae of terrestrial insects. They require large quantities of invertebrates, especially during late spring and early summer when fat stores are laid down for the following summer and autumn aestivation period, and when the females' follicles develop and they ovulate and lay their eggs. Inspection of swamps that contained water during late October and November revealed that they had little invertebrate biomass. At this time water in swamps at EBNR and TSNR contains copious amounts of invertebrates, concentrating to an almost soup-like appearance as the swamps dry.

7. SAWPIT GULLY

Most of the two arms of Sawpit Gully Creek are narrow and densely vegetated with an upper storey of flooded gums (*Eucalyptus rudis*) and paperbarks (*Melaleuca preissii* and *M. raphiophylla*) and, further away from the water, Coojong (*Acacia saligna)*. The lower storey along the creek itself is mostly dense with rushes and bracken. At the time of our visits, the creek water was murky, with many dead leaves and twigs, and by November it was smelly. Western Swamp Tortoises have not been found in this type of habitat. At EBNR, where tortoises have been radio-tracked, they avoided the semi-permanent water in the Ellen Brook, aestivating underground within 100 - 200 m of pools in the Brook.

At its western extremity the creek becomes shallow, with extensive areas flooding into it after heavy rain. These areas are described above under 'damplands'.

8. CONCLUSION

The searches for Western Swamp Tortoises in the Ellenbrook Development Project Area were unsuccessful. Our experience in searching for tortoises in tannin-stained water at TSNR and in slightly muddy water at EBNR suggests that we would have located tortoises in the search area if a population had been present. Locating tortoises when they are present at very low density can be difficult and is time-consuming, and our results do not prove that no tortoises were present in the area.

It is our opinion that the area does not contain suitable habitat for this threatened species.

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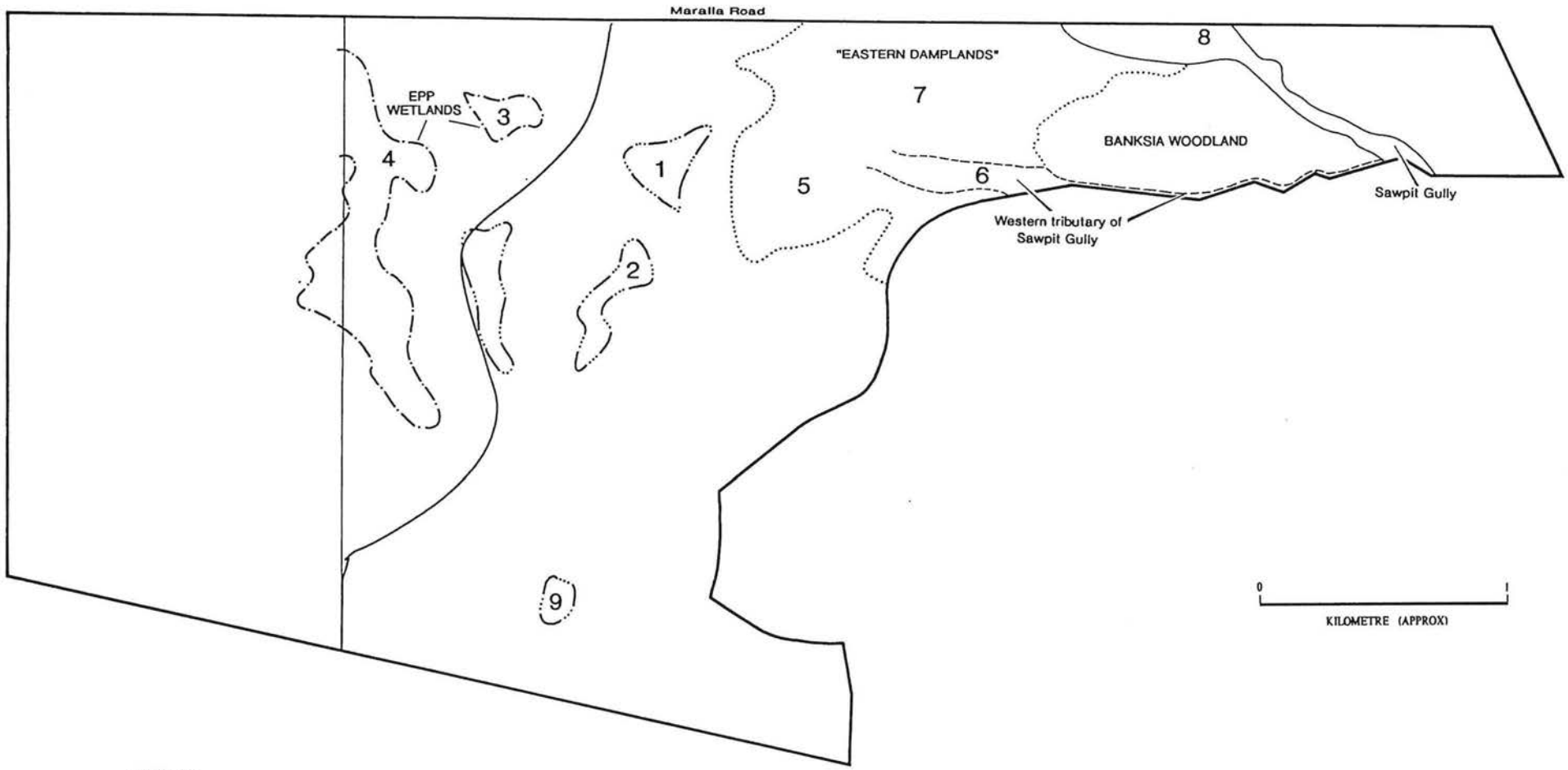

LOCATION OF SEARCH AREAS FOR
WESTERN SWAMP TORTOISE

Figure 1

COMPILED BY: BURBIDGE & FULLER

ELLEN BROOK NATURE RESERVE
WATER DEPTHS - GAUGE 1 - 1991

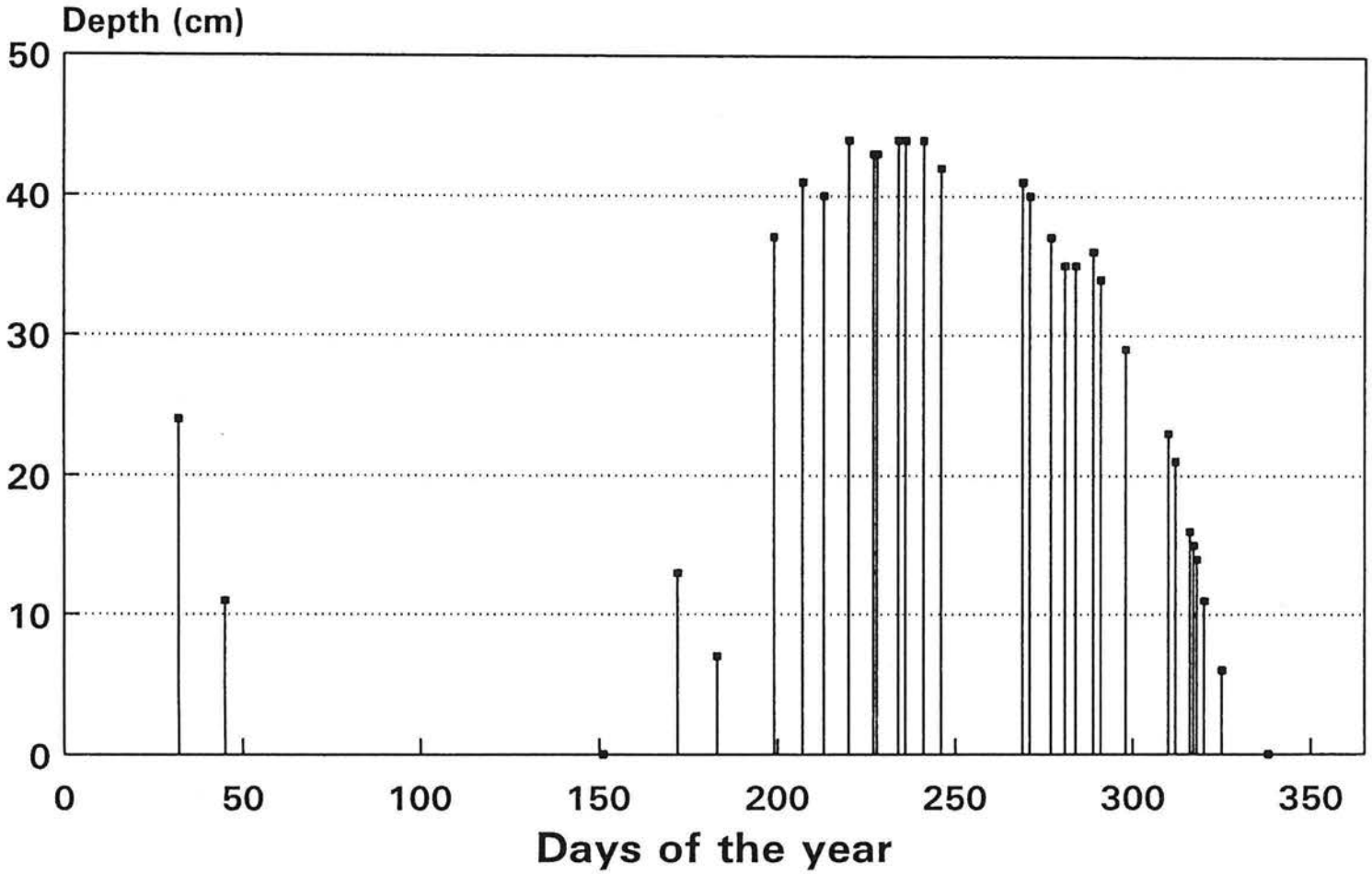

FIGURE 2

TWIN SWAMPS NATURE RESERVE
EAST SWAMP - 1991

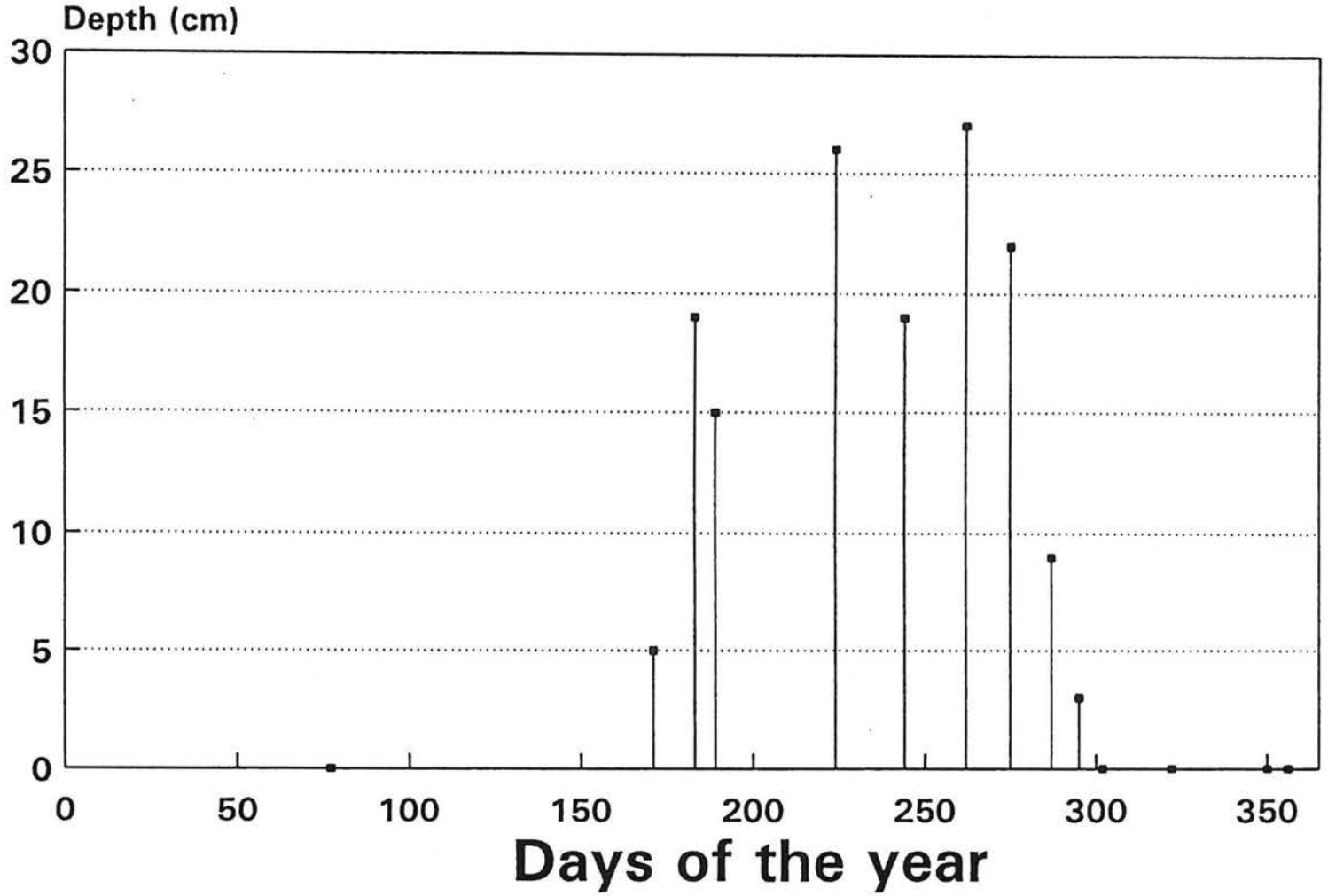

FIGURE 3

TWIN SWAMPS NATURE RESERVE
SOUTH WEST SWAMP - 1991

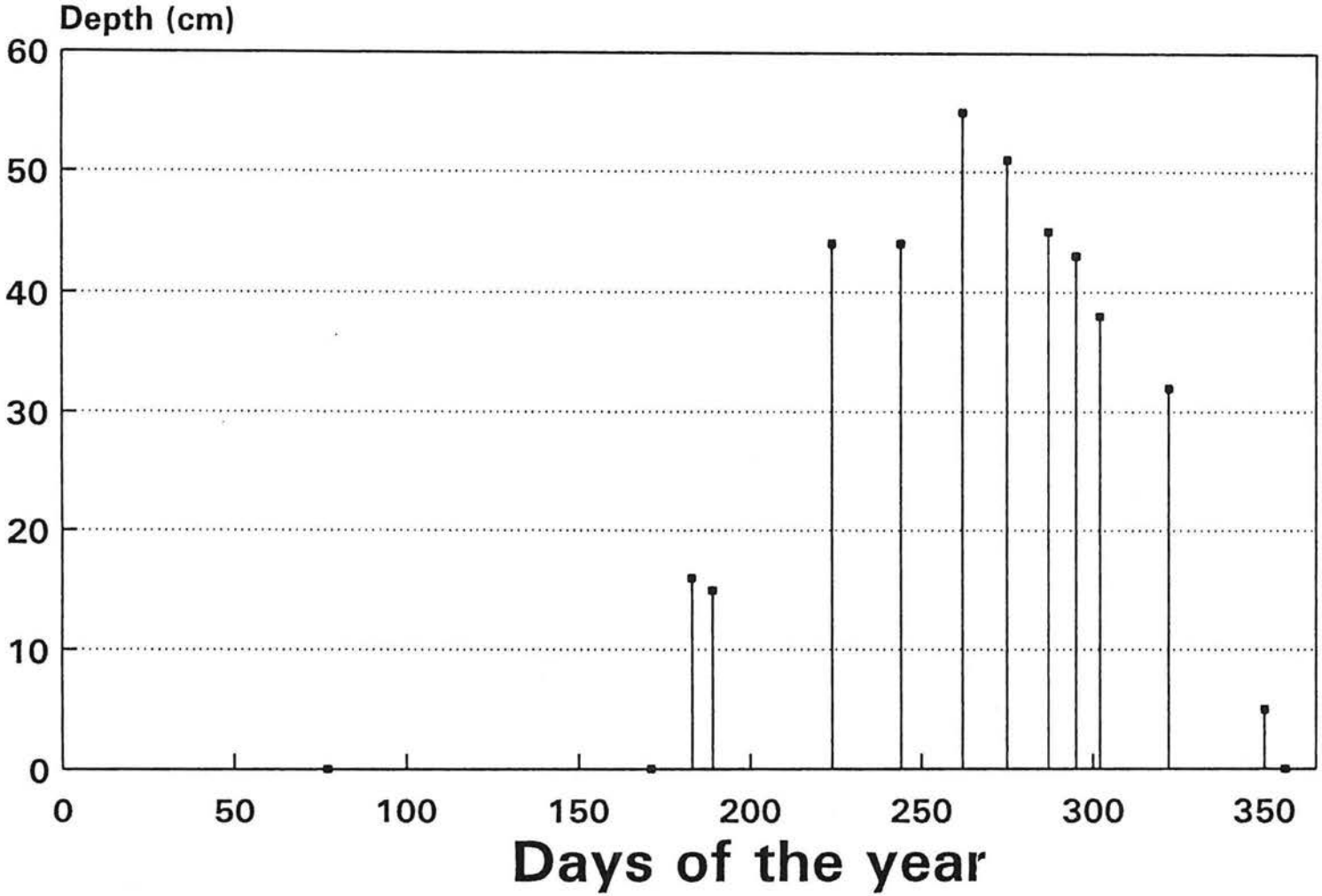

FIGURE 4