GREEN POINT/FLORAVILLE WILDLIFE STUDY

LAKE MACQUARIE CITY COUNCIL
1992

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1.0 EXECUTIVE SUMMARY

Aims

The overall objective of the study was to determine the abundance and distribution of different species of wildlife occurring in Green Point Estate and the Floraville Ridge area, and assess the need for, and likely success of, a wildlife corridor between the two parcels of land (*Figure 1*).

Remnant Bushland and Wildlife Corridors

Small, isolated bushland remnants typically have fewer species present than large bushland areas. It is therefore important to maintain or create links between remnant areas, effectively making one larger remnant. In this way the chance of retaining a wide variety of species is increased.

Wildlife corridors aim to link patches of bushland. As yet there is little hard scientific evidence indicating the success of wildlife corridors, but most ecologists believe they are worthwhile. In simple terms, a wildlife corridor is a continuous strip of the same or similar habitat to the areas it is linking. Factors such as width, length and complexity of habitat govern their effectiveness.

To determine the viability of a corridor linking Green Point Estate and the Floraville Ridge area it was necessary to know what fauna and flora are present. To this end, vegetation associations were mapped and sites representative of habitat types present were selected. Fauna at these sites were surveyed by call and scat identification, trapping and sighting.

Bushland values, as listed in the State Environment Planning Policy number 19 - Bushland in Urban Areas.

Specific values of urban bushland and wildlife to the community are recognised in SEPP-19. The values of Floraville Ridge and Green Point are listed below.

* They are representative of the plant communities which preceded urban development.
* They are of a size which enables the plant and animal communities to survive in the long-term, although it is uncertain whether all species will be sustainable.
* The vegetation forms part of a proposed vegetation corridor linking Lake Macquarie with coastal vegetation communities.
* The area has significant recreation potential, which is discussed in a 1989 survey commissioned by the Lake Macquarie City Council (Forsite,1989).
* The area has potential as an outdoor education resource, with several schools close by, and easy access.
* The areas is very accessible to people travelling by bus, roads, and waterways.

In addition, bushland plants and animals often perform unknown services for people, which are often only recognised once the species has declined or disappeared. A spectacular example is the role sugar gliders play in controlling insects which contribute to dieback of *Eucalyptus* trees in rural areas (Smith 1992).

General Fauna

No species of animals were found which are listed on the current list of threatened, rare and vulnerable species in New South Wales (New South Wales National Parks and Wildlife and wildlife Service, 1992). This list is currently under revision, and an interim list only is available.

There are significant populations of arboreal mammals. There are healthy populations of Ringtail possums and Sugar gliders present in both parcels of land. Brushtail possums were rarely seen and apparently prefer the fringes of the areas, closer to residences. Although not encountered during the survey, injured feathertail gliders have been rescued in the area in 1991 by members of the Newcastle branch of the Native Animal Trust Fund.

Results of trapping for terrestrial mammals were very poor, with the majority of captures being the introduced Black Rat *Rattus rattus*. A

greater variety of terrestrial fauna were identified in the Floraville Ridge area, with a Common Dunnart and a Northern Brown Bandicoot trapped.

At least 120 bird species utilise the Green Point/ Floraville Ridge area. Some of these are migratory, and not present at all times of the year.

Five species of frog and eight species of reptile were identified. There is likely to be more species, but the survey fo these animals was less intensive than the survey for mammals and birds.

The Corridor Option

Urbanisation appears to have had a serious effect on terrestrial mammals. However arboreal mammals and bird species are still prolific in the Green Point/ Floraville Ridge area. The bushland alongside Croudace Bay Road under study for a wildlife corridor (*Figure 8*) was found to be used by these species, and they would be the main beneficiaries of such a link.

In its present state the corridor is already usable by the majority of bird species and probably sugar gliders. However much can be done to improve its effectiveness. Of particular importance is need for a concerted effort to improve the habitability of Green Point Estate and Floraville Ridge. This would include removal of weed species and replacement with appropriate native plants, control of domestic and feral animals, revegetation of unnecessary tracks and protection of hollow-bearing trees. Further development within the land parcels should be avoided, and, where possible, ridges and catchment areas free from urban runoff should be retained as high quality bushland areas. Trees should be replanted, if not retained, as soon as road-widening ceases along Croudace Bay Road. If future roads are to be constructed through the areas, it is recommended they incorporate suitably designed culverts, and have trees planted within a median strip and immediately alongside the road.

2.0 INTRODUCTION

Wildlife in 2 parcels of land in Northeastern Lake Macquarie was studied during the summer of 1991-1992. One parcel, known as Green Point Estate, is approximately 220 ha, while the other, known as Floraville Ridge, is approximately 100 ha (*Figure 1*). Forsite (1989) has comprehensively described site characteristics of the Green Point Estate, and only those features relevant to wildlife are considered in this report. The Floraville Ridge immediately adjoins the Green Point Estate, separated only by Croudace Bay Road, and thus many of the general site characteristics (Forsite 1989) apply to Floraville Ridge also. Relevant differences between the two areas are discussed where appropriate.

The aims of the survey are listed below.

- To comprehensively survey, by sighting, trapping or other appropriate techniques, the populations of mammals, reptiles, amphibians, and birds which inhabit or utilise either parcel of land.
- To identify plant species occurring over the Floraville Ridge area, and map the distribution of the main vegetation associations.
- Review the adequacy of the previous vegetation surveys undertaken on the Green Point Estate.
- To make recommendations on the retention of habitat to facilitate wildlife survival on both parcels of land, and the need, if any, for a wildlife corridor to connect them.
- To report on the practical management implications of all recommendations.

3.0 EFFECT OF SUBURBAN DEVELOPMENT ON NATIVE WILDLIFE

The major threat to wildlife in the Green Point/ Floraville Ridge area is suburban development. To consider how wildlife responds to suburban development we need to explore the impact of development on wildlife habitat. Habitat is all the resources available to organisms within an area. In the Green Point/ Floraville Ridge area, forest provides the major wildlife habitat.

Different types of habitat can be described according to the structure and species composition of the vegetation. The habitat types present at Green Point Estate and Floraville Ridge are described in Section 5.

Habitat can also be usefully divided into core habitat and edge habitat. **Core habitat** refers to the conditions found within a relatively large area of uniform vegetation. Some species are confined to core habitat, and are known as **core species**. Core species are rarely found outside this habitat, and even find the edges of the core habitat hostile, perhaps due to danger of predation. **Edge habitat** refers to the conditions found at the edge of two different habitat types, e.g forest and suburbs. **Edge species** needs are best met in these zones.

The main processes by which wildlife habitat is disturbed are listed below.

* Directly removing habitat by clearing vegetation.
* Altering vegetation structure and species composition. This can occur in the following ways:
  - Direct removal of some plant species eg. for timber.
  - Altering the fire regime.
  - Introducing plants not previously found in the area.
  - Altering the hydrology of the area by construction of drainage works, and damming of watercourses.
  - Altering the level of nutrient inputs by addition of fertilisers, and by increasing soil erosion.
* Creating small islands of vegetation surrounded by roads and buildings. The roads and buildings can be barriers to daily foraging, seasonal dispersal or migratory movements of animals.
* Introducing non-native animals which either compete with or prey upon native animals.

The habitat value of an area diminishes most dramatically during the construction phase. As a suburb ages, and residents' gardens grow, the value of the area as habitat for some animals increases. However, the habitat available in established suburban areas differs markedly with the

habitat available in native bushland remnants, even when the suburb has many native plants and significant native gardens.

The major differences between forest remnants and suburban habitat are listed below.

* Forests have continuous vegetation cover, while suburban vegetation is fragmented by roads and buildings.
* Forests have trees and shrubs of mixed ages. Older trees are required to provide nesting hollows for many animals.
* Forests have a well developed understorey of shrubs and fully grown grasses. Suburban understorey consists primarily of mown grass.
* Forests have a full functioning ecosystem, providing a wide range of resources for plant and animal life. Suburban gardens are a disturbed ecosystem in which many resources are missing, or removed. For example, insects are often sprayed with insecticide, snakes removed, and wet areas supporting frogs drained.
* Introduced predators are common in both forest remnants and suburbs.

Some animals are suited to the fragmented habitats of suburbia, and thrive there e.g the Common Brushtail Possum. Others rarely live in suburbia e.g large macropods. These animals either find refuge in remnants of the original habitat, or become locally extinct. Of all the animal groups in Australia, mammalian species are on the whole least resilient to the pressures of fragmented environments (Friend, 1990).

Animals can be usefully classified according to their habitat preferences. These preferences influence their response to habitat fragmentation. In the Floraville/Green Point area four broad groups of species can be identified.

* **Forest species**. Animals that are obligate forest dwellers. The survival of these species depends on large areas of forest habitat as they rarely cross over barriers into other patches of suitable habitat. The species may require a particular food source, or breeding territory with limited occurrence. These species tend to be susceptible to predation.
* **Generalist species**. Animals that survive equally well in suburban and forest habitat.
* **Suburban species**. Animals that survive best in suburban habitat.
* **Forest/suburban edge species**. Animals that survive best at the edge of the forest and suburbs.

3.1 PRESERVATION OF SPECIES RICHNESS

Species richness is the number of different species present in an area. In our time of human-accelerated extinctions, preservation of species richness is a major international goal.

Minimum viable populations - the dangers of inbreeding

An important question in preservation of species is what is the minimum population which can be sustained indefinitely. Frankel and Soule (1981) consider the genetic problems of small populations, primarily inbreeding. They suggest a population which contains 50 sexually mature and actively breeding individuals with approximately equal numbers of each sex, will not have excessive inbreeding, and will be genetically sustainable.

When including other criteria for population survival, eg. danger of disease epidemics or the need to adapt to changing climate, a population of 500 is considered a rough estimate of the minimum sustainable population.

Both of these estimates are based on limited knowledge, and will apply to different species with different degrees of accuracy. They do, however, indicate the problems associated with populations of animals isolated in the forest fragments at Green Point and Floraville.

Species richness in a fragmented habitat

The richness of species in a patch of remnant vegetation depends on the following features:

* The size of the remnant. A large remnant can support a large population of a particular species without overcrowding. The larger the population, the greater its resilience to disturbance, catastrophe, and environmental change.
* The edge to core ratio. Small forest remnants have a greater edge to core ratio, adversely affecting species restricted to core habitat.
* The variety of habitat types in the remnant. A large variety of habitat types provides resources for a wider variety of species.
* How long ago the area was fragmented. A remnant recently isolated may contain a high proportion of the species originally present in the unfragmented bushland. Some of the populations are likely to be unsustainable and lost at a later date, especially rarer species with small populations.
* The original species composition, and introductions of new species. Introductions may be natural or human induced.
* How connected the remnant is with other remnants. Good connectivity between remnants permits genetic mixing between populations. Good

connectivity also allows recolonisation if a catastrophe causes extinction of one of the populations.

* The natural regime of disturbance e.g the fire regime. Many plants and animals are adapted to an established pattern of disturbance, and may be deprived of essential resources if this regime is altered.

3.2 OBSTACLES AFFECTING THE SPECIES RICHNESS IN A FRAGMENTED SUBURBAN ENVIRONMENT

Personal experience suggests richness of native animal species is low in suburbia. In addition to the disturbance of suburban development, the this is often preceded by years of disturbance due to logging, agriculture, mining, and other human activity. This is certainly the case at Green Point Estate and Floraville Ridge. Wildlife can, however, thrive in suburban areas. A spectacular example is the survival of the endangered Eastern Barred Bandicoot, which is restricted to a car body dump in Hamilton, Victoria (Strahan, 1988; Sanders, 1991).

The major reasons for species decline in suburban remnants are listed below.

* **Edge effects.** Features of the suburban environment - e.g garden weeds, cats and dogs - invade into the remnant creating a separate habitat type which is hostile to core species, and favoured by edge species. The species excluded from this edge are typically those which are in most danger of local extinction. Edge effects can be increased by extensive track systems into the remnant, and in some cases the entire remnant is effectively an edge.
* **Inbreeding** within small populations is likely to lead to genetic problems which reduce the fitness of individuals, and reduce the ability of the population to adapt to environmental change.
* **Overpopulation** of the remnant by individuals of species which rely on regular dispersal of young into new areas. Overcrowding can seriously degrade the habitat in the remnant through processes such as overgrazing by herbivores.
* **Catastrophes** which affect an entire remnant (e.g fire) may lead to permanent extinction of local populations. Isolation will prevent recolonisation of the area from other populations.
* **Recreation pressure.** Pressures resulting from use of the remnant for other purposes, e.g trailbike riding, horse riding, collecting wood.
* **Habitat simplification.** Reduction in the diversity of habitat, caused by disturbance. For example, rainforest areas can be lost entirely if the

closed canopy is disturbed by fire, logging, windstorms, or vandalism. *Lantana camara* will dominate regrowth, and the rainforest may be lost.

* **Altered disturbance regime.** Imposition of a disturbance regime which suits people, but may not suit the animals.

3.3 WILDLIFE CORRIDORS

The problems of inbreeding, overpopulation, and catastrophic extinction can be overcome by an effective link between habitat remnants. An effective corridor permits the movement of wildlife between larger remnants. The movement need not include daily foraging movements, but must allow dispersal and/or migration of individuals. The effectiveness of a corridor is enhanced by:

* Good vegetation structure and species diversity.
* Habitat accessible to the species for which the corridor is intended. This habitat must be continuous with similar habitat in the remnants.
* Width. The wider the corridor, the greater the area of core habitat to edge habitat. This allows the more vulnerable core species to pass through or establish populations within the corridor.
* Short length. The shorter the distance between the remnants, the more likely animals are to pass through the corridor safely. This requirement is nullified if the species can establish viable populations within the corridor itself.
* Absence of features deleterious to the wildlife e.g introduced predators, introduced competitors, patches of unsuitable habitat, partial barriers like roads or fences.

It should be noted that while most ecologists believe corridors are worthwhile in animal conservation, there is a lack of scientific data showing this worth. Experiments seeking to evaluate the value of corridors are still in their infancy (Nicholls and Margules, 1991). As well as positive effects, corridors can have a negative effect on wildlife if the corridor encourages the spread of disease and feral animals.

4.0 VEGETATION

Fauna is the primary focus of the survey, and vegetation was studied in relation to habitat for fauna. The vegetation of Green Point Estate has been described previously (Forsite, 1989). Generally the vegetation associations and species present extend from Green Point Estate to Floraville Ridge. There are some major differences between the two areas, which are outlined below. Where possible, the extensive species list for Green Point was expanded.

Figures 2 and *3* are maps of the major vegetation associations of Green Point Estate and Floraville Ridge. A species list for Floraville Ridge is included in *Appendix B.1.* This is not a complete list, and treats some groups of plants (e.g grasses) superficially.

FLORA OF SIGNIFICANCE

Tetratheca juncea

There is a significant population of *Tetratheca juncea* on Floraville Ridge and another on a ridge on the Green point Estate. This plant was not seen during the previous vegetation survey (Forsite 1989), but was seen many times during this survey because of its highly visible flowers.

Coded 3VCi by Briggs and Leigh (1989), it has a restricted distribution confined to the Central Coast and lower North Coast of New South Wales. It is threatened by the extensive coastal development in the area and is already believed extinct in Sydney (Beadle et al 1982). The 3VCi code means it is vulnerable - but not endangered or under immediate threat - and although a population is reserved in the Glenrock State Recreation area, this is considered inadequate (Briggs and Leigh 1989). The status of this plant in the Lake Macquarie area is currently under formal investigation by local consultants.

Eucalyptus Haemostoma

The Scribbly gum community (*Eucalyptus Haemostoma / E. gummifera / Angophora costata*) is the only vegetation community found on Floraville Ridge not also found at Green Point. *Eucalyptus Haemostoma* is a scribbly barked gum restricted to the Central Coast and lower North Coast of New South Wales. While still common in the area, concern over clearing this and other scribbly gum species has been expressed by the National Parks and Wildlife Service of New South Wales (Sanders,1991).

Acacia irrorata ssp. irrorata

Both adult and juvenile members of this species are common on both Green Point Estate and Floraville Ridge. This wattle., and other closely related bi-pinnate leaved wattles, are important food plants for *Petaurus breviceps* (sugar glider). The gum of these wattles is an important winter food source (Smith 1992; Suckling 1984).

ADDITIONS TO THE FLORA OF GREEN POINT AS CONTAINED IN FORSITE (1989)

The vegetation survey of Green Point was checked and was generally found to be thorough and accurate. Nine additional species were found during this survey, and they are included in *Appendix B.2.*

The orchid flora of Green Point has been supplemented by a local resident as part of his Horticulture Certificate at the Charlestown T.A.F.E. (Presland, 1992). These are listed in *Appendix B.3.*

The present study rectified a plant identification error in the Foresite(1989) study. *Oxylobium ellipticum* was listed as occurring at Green Point Estate. This contradicts the accepted geographical distribution of the species. Beadle (1982) reported that it occurs in the "higher parts of the Blue Mountains". *O. ellipticum* was not observed during the present study, but the morphologically similar *O. ilicifolium* was a common ocurrence. This suggests that *Oxylobium ilicifolium* has been mistaken for *Oxylobium ellipticum.*

5.0 FAUNA

The mammals, birds, reptiles and amphibians of Green Point Estate and Floraville Ridge were surveyed over a period of 10 weeks. This included a 5 week period of intensive survey work when the authors spent almost all their working time in the field.

The emphasis of the field work was on mammals. This was because mammals are the faunal group that is most affected by clearing and habitat fragmentation (Friend 1987). Consequently the mammals provide a good indication of the ecological effects of suburban development.

Sites for trapping and surveys were chosen to include a wide cross section of habitat types, and to answer questions concerning the feasibility and desirability of a wildlife corridor connecting the Floraville Ridge and Green Point Estate areas. The habitat types are listed below.

HABITAT TYPES PRESENT IN THE STUDY AREA

Disturbed Closed forest.
Two areas of favourable SE aspect and with intermittent streams in Floraville Ridge area. The canopy is patchy due to clearing, allowing weed invasion.

Closed littoral forest (rainforest)
Structurally intact and relatively undisturbed rainforest at Green Point Estate. It is based around the only permanent water course in the Green Point area.

Open forest- *Eucalyptus maculata / E. propinqua* association, and *E.gummifera / Angophora costata* association.
This covers the majority of both sites, and thus is the most important habitat for fauna. In general there is an open canopy of *Eucalyptus* trees about 20m high, although taller trees occur in the wetter, more sheltered spots. Selective logging of the area, particularly for *E. Paniculata,* and clearing for roads, quarries etc has occurred.
Sufficient old trees with hollows remain to provide accommodation for hollow dependent fauna.

Within the open forest there is considerable diversity in structure, due to differences in aspect, drainage, topography and soil type. There is one permanent watercourse both Green Point Estate and Floraville Ridge, and several gullies which retain pools of water after significant rainfall. These are breeding grounds for frogs, and support Eastern Water Dragons.

The following structural units can be identified, according to which understorey stratum is dominant.

Open forest with ground layer as the dominant understorey e.g leaf litter, grasses, ferns, sedges. Occupies a relatively small area, often as a result of disturbance e.g fire, or clearing for the transmission line and the dump. Of note are thick patches of the sedge *Gahnia sp.* in some gullies. High trapping rates are often associated with such patches. The best patch is found in a gully at Floraville.

Open forest with shrub layer as the dominant understorey.
This structural classification can be further divided into:

* Areas with an immature shrub layer due to recent disturbance e.g fire and clearing. This habitat is found at both Green Point Estate and Floraville Ridge.

* Areas with a mature shrub layer including many shrubs which are sexually mature providing flowers and fruits for fauna. Of particular interest is the presence, density and size of *Acacia irrorata* shrubs and trees in the understorey. This species and other related *Acacia* species provide an important winter food source for sugar gliders. Occurs at both Green Point Estate and Floraville Ridge.

* Gullies with *Lantana camara* dominant in the understorey. This is restricted to gullies of Green Point Estate whose catchment is predominantly urban.

Open forest with small tree layer as the dominant understorey. *Melaleuca stypheliodes* forms a small tree layer in two gullies. One of the gullies has a permanent watercourse, and the other has pools of water after rain. There is also a herbaceous ground cover. Restricted to Floraville.

Moist open forest- *Eucalyptus tereticornis* and *E. propinqua var propinqua* association.
Restricted to the Green Point site. Provides similar habitat to the ther open forest associations, with gully areas of very thick ground cover.

Open forest in areas sometimes inundated with water *Casuarina glauca* and *Melaleuca styphelioides*. Restricted to Green Point Estate.

Wetland. Patches of *Typha sp.* swamp which support frogs not found in the wet gullies of open forest. One patch at Floraville Ridge, and three at Green Point Estate.

Lake edge. Shores of sand with rock outcrops, low shrubs grading into forest, and a marine rock ledge with seagrass meadows. Habitat for fishing birds. This habitat is restricted to Green Point Estate.

Grassed areas. Cleared areas now covered with grass, surrounded by forest, and providing edges for species who need two or more habitat types to meet all their needs. Found at both Green Point Estate and Floraville Ridge.

Culverts underneath Croudace Bay Road. Drainage pipes beneath the road can possibly be used by animals as an alternative to crossing the road.

Bare rock. Small areas at both Green Point Estate and Floraville Ridge.

LOCATION AND HABITAT OF THE GROUND MAMMAL TRAPPING SITES

Trapping was undertaken at 10 separate sites at Floraville, and 11 sites at Green Point. These are located on *Figures 4* and *5*. The sites chosen represent a wide cross-section of the habitat types listed above, with special emphasis on the feasibility and desirability of providing a corridor for wildlife across Croudace Bay Road. The areas immediately adjacent to the road were given more attention than other parts of the study area. *Table 5.1* contains a summary of the habitat sampled at each of the trap sites.

***Table 5.1*: Habitat type sampled at each trap site in Green Point Estate (G) and Floraville Ridge area (F). Date = Date of commencement of trapping. Trapping then proceeded for four nights.**

DATE	TRAPSITE	HABITAT
20/1/92	F1	open forest with *Melaleuca* understorey
20/1/92	F2	open forest with *Melaleuca* understorey and a permanent watercourse.
20/1/92	F3	wetland
6/1/92	F4	open forest with immature shrubs
13/1/92	F5	open forest with a grass understorey and a cleared area of *Themeda australis* grass
6/1/92	F6	open forest with *Melaleuca* understorey
13/1/92	F7	open forest with grassy understorey
13/1/92	F8	open forest with mature shrub understorey and a thick patch of *Gahnia* in the gully
13/1/92	F9	grassed area due to previous clearing
6/1/92	F10	culverts
20/1/92		
6/1/92	G11	culverts
20/1/92		
27/1/92	G12	open forest with mature shrub understorey
20/1/92	G13	open forest with mature shrub understorey
27/1/92	G14	wetland
27/1/92	G15	open forest with groundcover understorey
3/2/92	G16	open forest with grass understorey
27/1/92	G17	gully with *Lantana camara* understorey in open forest
3/2/92	G18	closed littoral rainforest with a permanent watercourse
3/2/92	G19	open forest with groundcover understorey
3/2/92	G20	open forest of *Casuarina glauca* and *Melaleuca styphelioides*

5.1 SURVEY METHODS

MAMMALS

Arboreal mammals were surveyed by stagwatching and spotlighting. Stagwatching involved selecting trees with an abundance of hollows and dead branches ('stags'). An observer then waited quietly watching the tree from sundown till about 40 minutes later. In this way natural light was used, disturbing and alerting the animals as little as possible. Animals observed climbing out of the tree were identified using a torch and binoculars if necessary. This was followed by two to three hours of spotlighting, which involved nocturnal observation using a 40W spotlight while walking. Smaller head-torches were used to supplement the main light. This was mostly done along tracks and watercourses but a few cross-country transects were carried out (*Figures 4* and *5*).

Terrestrial mammals were surveyed using Elliott aluminium box traps (9 X 9 X 33 cm) for small mammals and wire cage traps (6 of each: 30 X 30 X 60 cm and 20 X 20 X 55 cm) for larger animals. All traps were placed in plastic bags to provide protection from rain. Where possible, three lines of nine Elliott traps were set 10 to 15 metres apart in a grid pattern. Otherwise two longer lines or small clumps were laid (*Figures 4* and *5*). 91 Elliott traps were set for four day periods over five weeks, giving 1804 trapnights. Standard peanut butter, rolled oat and honey baits were used, and at three trapsites (sites F1, F2 and G13) some rancid meat included for the first two days. The cage traps were located within or very close to the Elliott trap grid in positions that appeared most promising for capturing animals, such as on animal runways or near clumps of *Gahnia sp.*, well-known for harbouring mammals. Three or four cages were placed at each site. These were baited with peanut butter type baits as well as a segment of apple, a slice of carrot and some rancid meat.

Pitfall traps were constructed in three sites, aiming to capture small mammals as well as reptiles and frogs (*Figures 4* and *5*). These consisted of two holes 4 metres apart, 0.5 metres deep and lined with 160 mm stormwater pipe. A drift fence constructed of 8 metres of plastic bisected the holes, extending 2 metres either side.

Nesting sites, scats, bones, scratch-marks and tracks were searched for during daylight to identify other animals that may have been present.

Bats were not surveyed, but their presence was noted when encountered during night spotlighting runs.

BIRDS

Birds were identified by call and by sightings using binoculars. Birds seen during nocturnal spotlighting runs were also noted. Lists provided by local birdwatchers were taken into accoun. These gave a more thorough record of birds sighted over the last decade. In addition, a one-morning bird survey was carried out with members of the Hunter Bird Observers Club who were experienced with bird surveying. Observers recorded all birds in allocated portions of both sites. This aimed to allow comparison between areas, in terms of distribution of bird species.

Four sites in Green Point Estate were surveyed and two in Floraville Ridge (*Figure 6* and *7*). These were:

1. The strip of forest between the quarry and Croudace Bay Road, Green Point Estate.
2. The area immediately south of Leichhardt St, Green Point Estate.
3. The patch of rainforest just north of Green Pt.
4. The ridgeline near Cardiff Point, Green Point Estate.
5. Land south of the dump around the head of Mills Ck, Floraville.
6. Floraville, along part of the escarpment, and briefly along the ridgetop north of this area.

REPTILES AND AMPHIBIANS

Pitfall traps were constructed for the capture of reptiles and amphibians, as well as small mammals. These are described above, under Mammals. Daylight searches were carried out by overturning logs, rocks, sheets of iron and other movable habitats as well as by digging through leaf litter. Frogs were identified by call or captured both by day and during night spotlighting runs.

5.2 RESULTS

TRAPPING FOR GROUND MAMMALS, REPTILES AND AMPHIBIANS

Trapping results are summarised below (*Table 5.2*). Full results are given in *Appendix D.2*. Trap results were poorer than expected with only 47 captures over 1981 trapnights (number of traps X number of nights set). Of these, 42 were the introduced black rat *Rattus rattus*, including three recaptures. This did not provide enough data for population estimations or statistical interpretation.

There was a much higher rate of capture using cage traps than Elliott traps, with about 12% occupied compared with 1% of Elliott traps.

Higher trapping rates of rats were recorded when a meat bait was used.

No mammals and few reptiles and amphibians were caught in any of the pitfall traps.

Fox and dog scats were found in both Green Point Estate and Floraville Ridge area.

SPOTLIGHTING FOR MAMMALS AND BIRDS

Stagwatching proved an effective way of identifying animals in both areas. About 20% of 'stags' (trees with hollows and dead branches) were seen to be occupied by common ringtail possums (*Pseudocheirus peregrinus*), often with multiple numbers present. Sugar-gliders (*Petaurus breviceps*) were observed to depart from 16% of 'stags', usually occurring in pairs. Brushtail possums (*Trichosurus vulpecula*) and Tawny Frogmouths were sighted on occasions while stagwatching. In total, 43 'stags' were watched, of which 18 were inhabited. This is only a small proportion of the total number of 'stags' in the areas. (*Appendix D.3*)

Spotlighting was also successful, with many animals identified. These were treated in terms of sightings per human hours (no. of hours spent X no. of people with good torches). Overall, about 2.7 animals were seen per human hour, with a total of 36.5 human hours spent.

The vast majority of animals sighted by spotlighting were ringtail possums, with an average of 2.4 per human hour but reaching up to 7 in some areas. They also made up the majority of sightings while stagwatching, but were closely followed by sugar gliders. (*Appendix D.4*)

Calls thought to be flying foxes were heard in some areas. Other unidentified calls were also heard. Attempts to tape record these calls proved unsuccessful.

***Table 5.2*: Mammals trapped, sighted or otherwise identified in Green Point Estate (G) and Floraville Ridge area (F) during the study period.**

Common Name	***Scientific Name***	**Area**
Common ringtail possum	*Pseudocheirus peregrinus*	G, F
Common brushtail possum	*Trichosurus vulpecula*	G, F
Sugar glider	*Petaurus breviceps*	G, F
Black rat	*Rattus rattus*	G, F
House mouse	*Mus musculus*	G, F
Common dunnart	*Sminthopsis murina*	F
Northern brown bandicoot	*Isoodon macrourus*	F
Brown hare	*Lepis capensis*	F
Fox	*Vulpes vulpes*	G, F

BIRDS

Lists were compiled for both Floraville Ridge and Green Point areas (*Appendices C.1, C.2*). The species are divided into 2 groups, confirmed species and unconfirmed species. **Confirmed species** have been sighted and/or heard by the authors, or members of the Hunter Bird Observers Club (HBOC), and are expected in the area according to the Royal Australian Ornithologists Union (Blakers, Davies & Reilly, 1984). **Unconfirmed species** are those which for various reasons cannot be quoted with complete confidence. They include birds recorded only once by observers with limited experience, and some of the birds are out of their normal distribution according to Blakers et al (1984).

120 confirmed species of birds over the two areas are recorded. These include birds observed over a 10 year period by a HBOC member who lives near Green Point and observes birds there regularly. An additional **14 unconfirmed species** are reported but presence could not be verified by HBOC members. Advice on the relative likelihood of some of the unconfirmed species has been given by a HBOC member who is employed at the Shortland Wetlands Centre, a well-known consultancy, education facility and bird sanctuary.

Of the **unconfirmed sightings**, it is unlikely that Crested Terns are utilising Green Point Estate as these are coastal birds. It is also unlikely that Forest Kingfishers are present in the Green Point Estate. Reported sightings of the Bar-Shouldered Dove in Green Point Estate and the ground-dwelling Wonga Pigeon in the Floraville Ridge area are possible, and it is highly likely that the Golden Bronze Cuckoo lives in the Green Point Estate. Flycatchers were reported during the one-morning survey but

could not be positively identified as Satin or Leaden Flycatchers. A Little Corella sighted at Floraville was probably an escaped pet, this being outside its distribution range.

AMPHIBIANS

Confirmed species. Altogether six species of frog were identified, four occurring in Green Point Estate and five in the Floraville Ridge area (*Table 5.3*; *Appendix E*). The Red-backed toadlet, *Pseudophryne coriacea*, was apparently the most widespread and abundant species present, its call heard in most moist areas of Floraville Ridge and Green Point Estate. It is possible that other *Pseudophryne* species were present as the call cannot be distinguished within the genus, but every call tracked to its source revealed *P. coriacea*. This species has been known to hybridize with the Brown toadlet (*P. bibronii*), the offspring bearing varying resemblance to both species. All specimens captured resembled *P. coriacea*..

Table 5.3: **Frogs identified in Green Point Estate (G) and the Floraville Ridge area (F).**

Scientific Name	**Common Name**	**Location**
Crinia signifera	Common froglet	G & F
Litoria peronii	Peron's tree frog	F
Litoria phyllochroa	Leaf green tree frog	F
Litoria fallax	Dwarf tree frog	G & F
Lymnodynastes peronii	Brown striped frog	G
Pseudophryne coriacea	Red-backed toadlet	G & F

The Common froglet (*Crinia signifera*) and the Dwarf tree frog (*Litoria fallax*) were also identified on both sites. The Striped marsh frog (*Lymnodynastes peronii*) was only found on Green Point Estate. The distinctive call of Peron's tree frog (*Litoria peronii*) was heard in one gully in the Floraville Ridge area, and a single call by the Leaf Green Tree Frog (*Litoria phyllochroa*) was tape-recorded in Floraville Ridge at Site 3 (*Figure 5*).

REPTILES

Very few reptiles were trapped in the pitfall traps, resulting in low numbers identified in both areas.

Confirmed species.
Six species of reptile were sighted in Green Point Estate and six in Floraville Ridge, with a total of seven species found (*Table 5.4*; *Appendix E*). Eastern Water Dragons (*Physignathus lesueurii*), Land Mullets (*Egernia major*), Blue-Tongued Lizards (*Tiliqua scincoides*) and Garden Skinks (*Lampropholis delicata*) were seen regularly at both Green Point Estate and Floraville Ridge, while Jacky Lizards (*Gemmatophora muricata*) and Weasel Skinks (*Lampropholis mustelina*) were commonly observed at Green Point Estate only. A Three-toed Skink (*Saiphos equalis*) was found in leaf litter in the Floraville Ridge area. A Red-Bellied Black Snake (*Pseudechis porphyriacus*) was caught in an Elliott trap at Floraville Ridge.

***Table 5.4*: Reptiles identified at Green Point Estate (G) and Floraville Ridge area (F).**

Scientific Name	Common Name	Location
Gemmatophora muricata	Jacky lizard	G
Physignathus lesueurii	Eastern water dragon	G & F
Egernia major	Land mullet	G & F
Lampropholis delicata	Grass skink	G & F
Lampropholis mustelina	Weasel skink	G
Saiphos equalis	Three-toed skink	F
Tiliqua scincoides	Blue-tongued lizard	G & F
Pseudechis porphyriacus	Red-bellied black snake	F

Unconfirmed species.
Diamond pythons (*Morelia spilota*) have been reported by residents in the Floraville Ridge area and in Green Point Estate but none were sighted during the survey. None have been reported in the last five years. The Diamond Python is listed in Schedule 12 of the National Parks and Wildlife Act, 1974 as "fauna of special concern". The Common Tree Snake (*Dendrelaphis punctulata*) was reported as present at Green Point Estate during the study period, and a Blind snake (*Typhlina nigrescens*) has been sighted at Floraville Ridge.

Bearded dragons (*Pogona barvata*), a Lace monitor (*Varanus varius*) and a long-necked tortoise (*Chelodina longicollis*) have been reported at Floraville Ridge (*Appendix E*).

5.3 DISCUSSION

COMMENTS ON METHODS

After the first week of trapping, different baits were tried to see if this would increase captures of native fauna. The relatively high rates of capture at sites F1, F2 and G13 are thought to be influenced by the inclusion of meat in addition to the standard peanut butter balls as bait in all Elliott and cage traps for the first two days of trapping. The numbers dropped as soon as this practice was ceased. The carrot included in cage trap baits was rarely consumed by captured animals. This shows the importance of type of bait used during fauna surveys, with different species attracted by different baits, biasing the results. It was also noticed that there were slightly more rats trapped on nights when it rained, indicative of the influence of weather on trapping results.

The design of the pitfall traps may have been responsible for the fact that few animals were caught in them. A slightly greater diameter hole would have been preferable, but we were limited by materials available.

There was a much higher rate of capture using cage traps than Elliott traps, with about 12% occupied compared with 1% of Elliott traps (*Appendix D.2*). This really only applied to rats, as captures of mice and the common dunnart were restricted to Elliott traps, these animals probably being too small to trigger a cage trap. The bandicoot would not have fitted into an Elliott trap.

The method of stagwatching gives an absolute count of mammals present in the tree rather than estimating the number seen per unit area. Counting of 'stags' in the areas would enable an estimate of population sizes of ringtail possums and sugar gliders, given the proportion of 'stags' which are occupied. Nearly as many sugar gliders were sighted as ringtail possums while stagwatching, but only a few while spotlighting. This suggests that stagwatching is a better method for surveying sugar gliders than spotlighting. In addition, it suggests roughly equal populations of ringtail possums and sugar gliders. Spotlighting is particularly suited for the surveying of ringtail possums.

COMMENTS ON DENSITY AND DISTRIBUTION OF MAMMALS

The highest densities of ringtail possums occurred along the sides of the ridge just north-east of Green Pt. They were also found to be populous near trapsite F6 in the Floraville area, and in the north-western part of Green Point Estate near Dilkera Avenue. In general, the highest numbers

sighted were midway up slopes in areas with medium height canopy and a good understorey.

Brushtail possums were rarely seen but are reported as common by residents living around both areas. Apparently they prefer living close to urban development.

No mammalian life was detected in either of the swamps surveyed (sites F3 and G14, *Figures 3* and *4*). It was thought that *Rattus lutreolus* may be found at these sites. It was also possible that other mammals use these as watering points. A disturbance in the past may have eliminated possible populations at G14. Its extreme isolation means that it would not be reinvaded readily. F3 is not so isolated but extinction may have occurred none the less. The small size of both of these sites may limit their habitat potential.

It could be seen that more rats were caught near human residences, such as at sites G16 and G17 than in more remote areas. Rats were also more prolific along the roadside in the culvert sites (sites F10 and G11).

The 'corridor' strip of land between the quarry and Croudace Bay Rd on the Green Point Estate *(Figure 8)* had relatively low numbers of ringtail possums, but it was considered significant that this area was being used. On the Floraville side of the road, very healthy populations of ringtail possums were present, and a sugar glider was sighted.

BIRDS

Of the confirmed species, 117 species were on the Green Point Estate. This includes waterbirds utilising the shoreline. Also taken into account was a list put together for the Conservation and Recreation study of Green Point Estate (Forsite, 1989) of birds likely to live in the area. The majority of these birds were found to be present and it is likely that some not found are indeed present. Some of the listed birds are migratory and not present during all seasons. The Scarlet Robin, the Rose Robin and the Spangled Drongo are winter migrants and hence not in this region during the study period. The Spangled Drongo has been sighted in the Green Point Estate at a different time of year. It has also been reported in the Floraville Ridge area. (*Appendix C.2*)

Fewer species were confirmed for Floraville Ridge, with a total of 52. This is more likely to be a reflection of less intensive survey over the past decade by birdwatchers than a poorer habitat. In fact the numbers of species counted on the one day survey were not too dissimilar, with 48 in

Green Point Estate and 37 in Floraville Ridge, despite slightly more intensive survey at Green Point Estate, and inclusion of waterbirds, which only occur along the lake edge. Aside from waterbirds, the bird population of Floraville Ridge was generally of similar composition to Green Point Estate.

Few large predatory birds were identified due to difficulty of observation. Of note is a White-Breasted Sea Eagle seen on most visits to the Green Point foreshore. While a nest was not found, it obviously uses the area to a great degree.

During the study period, several Tawny Frogmouths and a Southern Boobook owl were sighted, but were more often heard without being seen. Calls were heard on most spotlighting runs. Many nocturnal birds are difficult to positively identify, and it is likely that some were missed.

Other nocturnal birds have been recorded by a local member of the Hunter Bird Observers Club. These sightings are considered confirmed, and are included in *Appendices C.1 and C.2.*

Bird Survey

Birds recorded in the various sites during the one-morning bird survey (*Figure7*) are listed in *Appendix C.3.* Site 3 contained the greatest number of species. Most species were present in more than one site, usually occurring in both the Green Point estate and Floraville Ridge area.

Birds utilising vegetation on the corridor strip of land.

In the strip of land between Croudace Bay Road and the gravel quarry on Green Point Estate, 15 bird species were identified. This is the area under study for a wildlife corridor *(Figure 8).* The lower number of species identified could be due to particularly loud background noise from road traffic relative to other areas, drowning out calls necessary for identification. It is also possible that the degenerate nature of this strip of land and proximity to the road are not so conducive to bird habitation.

Migratory Birds

Among the many birds which use the Green Point/ Floraville Ridge area are some migratory birds. These include the Spine-tailed Swift, the Cicadabird, the Rufous Fantail and the Spectacled Monarch. Migratory robins, flycatchers and cuckoos also use the area. Areas capable of

sustaining birdlife, such as the Green Point Estate and Floraville Ridge, are vital to these birds even if they do not utilise them all year round.

Habitat requirements of the birds found at Green point Estate and Floraville Ridge: forest birds vs suburban birds

Catteral, Green and Jones (1991) studied in detail the daily movements of 53 bird species in a 500 ha forest remnant surrounded by Brisbane suburbs. Their major findings are relevant to the present study and summarised as follows:

* Many birds cannot survive in suburbs. Bird species can be divided into several groups according to their habitat requirements and preferences. These are:
  Forest species - Birds which are obligate forest dwellers (Table 5.5).
  Generalist species - Birds which survive and breed in both forest and suburban habitat, e.g Grey-breasted silvereyes, Noisy Friarbirds, Rainbow Lorikeets, and Laughing Kookaburras.
  Suburban species - Birds which prefer suburban habitat, e.g Welcome swallows, Black-faced Cuckoo-shrikes, Figbirds, Spotted Turtledoves, House sparrows, and Starlings.
  Edge species - Birds which prefer the edge between suburb and forest e.g Australian Magpies, Eastern Spinebills, Noisy Miners, and Magpie Larks..

* Forest species tend to be small (8-18 cm long), and feed on insects on plant leaves. In this respect, they play a role in reducing insect damage to plants. They tend "not to venture even 50 metres outside the forest edge", even into suburban gardens with thick native vegetation. Note that these movements are daily foraging movements, and exclude migratory movements. The Rose Robin, for example, covers considerable distance during migration north from Victoria for winter.

* Edge species tend to be larger and more aggressive than forest species, and exclude the forest species from small forest remnants (< 10 hectares) and narrow corridors connecting forest remnants.

***Table 5.5*: Obligate forest species found in Green Point Estate and Floraville Ridge.**
(note: this includes only species listed as forest species by Catteral et al (1991). Other species at Green Point Estate and Floraville Ridge could be considered as obligate forest dwellers.)

	Green Point Estate	Floraville Ridge	Green point corridor	Floraville corridor
Rose robin	*	w	w	w
Brown thornbill	*	*		*
Eastern yellow robin	*	*	*	*
Grey fantail	*	*		*
Golden whistler	*	*		*
Rufous whistler	*	*		
Grey shrike-thrush	*	*	*	*
White-throated tree creeper	*	*	*	*
Spotted pardalote	*	*	*	*
Mistletoe bird	*			
Yellow-faced honeyeater	*	*	*	*
White-naped honeyeater	*			
Red browed firetail	*	*	*	*

* = confirmed observation
w = Winter visitor to the area, and could not have been observed during the survey period.

*Table 5.5*lists the forest species as included in Catterall (1990). The list is not a complete list of obligate forest dwellers, but is a group of species that have been well researched with respect to forest remnants in suburban areas, and movement along corridors. The conclusions of Catterall (1990) thus have considerable relevance in examining the feasibility and desirability of a corridor from Green Point to Floraville Ridge. In particular it concludes "that day to day movements among small isolated remnants are unlikely for most forest species; that narrow connecting corridors are likely to be dominated by aggressive edge species; and that this could inhibit movements within them by forest species."

All of the forest species discussed in Catterall (1990) have been observed at Green Point Estate, whereas three species have not been observed at Floraville Ridge (*Table 5.5)*. These three may occur at Floraville, and may have escaped detection.

Clearly both Green Point Estate and Floraville Ridge have forest suitable for the success of forest species. The success of a corridor between these areas depends on whether the species can exist either side of Croudace Bay Road, and whether they can cross the road. *Table 5.5* shows that 9 of the forest species live directly beside the road on the Floraville side, and 6 live directly beside the road on the Green Point side. It seems likely these birds will cross the road at certain times, either regularly or as chance events. and retention of the roadside vegetation will not isolate the Green Point and Floraville populations.

The forest remnants left in their present state provide a corridor access for birds restricted to the forests.

HABITAT NEEDS OF MAMMALS KNOWN TO OCCUR IN THE AREA

Bandicoots are mostly nocturnal and live in dense vegetation. They are soil-foraging insectivores. Usually solitary, they have a home range of two to three hectares, males dispersing over greater areas than females. In natural vegetation they prefer habitats in an early stage of succession (which is normally associated with a high abundance of beetle larvae, a favoured source of food). They are apparently capable of rapid movement into recently burnt or cleared habitats, allowing them to exploit farmland and rubbish dumps. This is thought to be due to their high reproductive rate, the fastest of any marsupial (Lee & Cockburn, 1985). This means they can reinvade areas rapidly. Given this, it is surprising that more were not found. It is possible that predators such as foxes and dogs, which are known to be present in the area, are reducing the populations. Fragmentation of the area may have reduced dispersal by preventing reinvasion from other areas. Forest fragmentation is known to have had a severe impact on the Southern brown bandicoot (*Isoodon obesulus*) and the Long-nosed bandicoot (*Perameles nasuta*) in South-west Victoria (Bennett, 1990).

Anecdotal evidence suggests the number of bandicoots has declined over recent years (Lee, 1992). The number of bandicoot roadkills has notably declined, as has the incidence of bandicoot diggings in the backyards of residents.

The **Common dunnart** (*Sminthopsis murina*) is also well adapted for reinvading disturbed areas, having a high reproductive rate. It is a carnivore with an almost exclusively arthropod diet. Populations reach a peak three to four years after fire but it is present at all stages of recovery (Fox & McKay, 1981). Thus it seems it benefits from periodic burning of patches of its habitat, provided it can reinvade from

surrounding areas. By rapidly reinvading disturbed areas it avoids major competition for resources It is difficult to trap, more readily caught in pitfall than Elliott traps (Strahan, 1988), possibly influencing our results. Fragmentation of forest lands is expected to be detrimental to this species as it limits its chance of dispersal to recently disturbed areas.

Sugar gliders (*Petaurus breviceps*) are small, nocturnal arboreal mammals capable of gliding up to 50 metres using a membrane stretched between their front and hind limbs. They nest and sleep in tree hollows in the branches and trunks of large old trees. Their ability to glide allows them to exploit patchy food resources, and they will disperse up to hundreds of metres across open pasture. They feed on gums, saps and invertebrates according to what is seasonally available. Some acacia gums are particularly good food sources, including *Acacia irrorata ssp* which is common at Green Point Estate and Floraville Ridge. *Acacia decurrens* is also a food source and has been recorded at Green Point Estate. They can survive at high densities in linear forest habitats of little more than a single tree in width, and thus will disperse along wildlife corridors (Suckling, 1984; Smith, 1992). One way in which the situation at Green Point Estate and Floraville Ridge differs from Smith's study is the abundance of domestic predators in this area, which may affect the survival of sugar gliders in narrow strips of forest. Suckling (1984) and Timmins (1992) report evidence of cats taking sugar gliders. There are plenty of trees with suitable hollows in the area and it is important that these be retained for sugar glider survival. Smith recommends a density of at least four for every hectare of forest.

The **Common ringtail possum** (*Pseudocheirus peregrinus*) is the most visible arboreal mammal in both Green Point Estate and Floraville Ridge, occurring in dense patches. It lives in a wide variety of vegetation types where shrubs form dense, tangled foliage, and nests in tree hollows, bunches of mistletoe and in dense undergrowth. It is a leaf-eater but will also eat flowers and fruits (Strahan 1988). Individuals were sighted in trees along the verge of Croudace Bay Rd, indicating that it uses fairly narrow forest strips provided trees with hollows are present.

Common brushtail possums (*Trichosurus vulpecula*) were only sighted on three occasions but residents in the areas report them as common around their houses. This phenomenon of preferring immediate proximity to human habitation has also been noted in a study of mammalian fauna in South-west Victoria (Bennett, 1990), recorded in only two forest patches out of 39 surveyed. They sleep by day in tree-hollows and other dark recesses including house roofs if available. Their diet consists of leaves, fruit, buds and bark, but they will eat meat if it is offered (Strahan 1988).

Injured **Feathertail gliders** (*Acrobates pygmaeus*) have been captured at Floraville Ridge in 1991 (Timmins 1992). As an animal carer for the Native Animal Trust Fund, Judy Timmins nursed 2 adult male feathertail gliders found injured at Floraville Ridge in 1991. This tiny arboreal mammal is not restricted to the forest canopy and will forage through thick shrub layer such as lantana (Strahan 1988). It feeds on nectar, sap and insects and makes globular nests of eucalyptus leaves. It has also been known to nest in plastic bags, telephone junction boxes and even an old coat (Turner 1984). It can travel up to 20 metres in one glide. Subject to a wide range of predators, it is not expected to be able to disperse along narrow, exposed corridors. The current status of this glider within Green Point Estate and Floraville Ridge is not known.

MAMMALS CONSIDERED POSSIBLE BY FORSITE (1990) BUT NOT FOUND DURING THE SURVEY

Other arboreal mammals mentioned by Forsite (1990) as possibly being present at Green Point Estate are the koala (*Phascolarctos cinereus*), the Eastern Pygmy-possum (*Cercartetus nanus*) and the Brush-tailed phascogale (*Phascogale tapoatafa*). The Lake Macquarie Natural Areas Study (Winning,1990) lists these animals as occurring around parts of Lake Macquarie but not in this province. It considers remaining populations/individuals to be remnants due to surrounding urban development pressures involving habitat clearance and predation by feral and domestic dogs, cats and foxes

The koala may have occurred at Green Point in the past but has not been sighted recently. It is considered that if a population exists at all, it is near extinction, if not already extinct. Remaining koala populations around Lake Macquarie are all seriously threatened by loss of habitat. Motor vehicle injuries and attacks by dogs are also contributing to their decline (Clulow and Lim, 1991, *Appendix D.5*). A recent reported sighting along Croudace Bay Rd near the former dump by a local resident was investigated but could not be confirmed.

Re-introduction of koalas may be possible given appropriate management, however this is beyond the scope of the present study.

Terrestrial mammals considered possible by Forsite (1989) but were not surveyed include *Rattus fuscipes* and *Rattus lutreolus*, both native rats; *Antechinus flavipes*; *Antechinus stuartii*; the Long-nosed bandicoot and the echidna (*Tachyglossus aculeatus*). None of these are mentioned by Winning (1990). (*Appendix D.1*)

Rattus fuscipes is known to prefer bushland away from domestication but of similar habitat to that utilised by the introduced *Rattus rattus.* As one moves further from development, the introduced species grades into the native species. In addition, *Rattus fuscipes* occurs in areas in later stages of regeneration after disturbance, its density rapidly increasing after about four years. It requires sufficient litter on the forest floor to support arthropods which it eats (Fox & McKay, 1981). It is possible that there are no areas in Green Point Estate and Floraville Ridge sufficiently undisturbed for this species to occur, and, due to the isolated nature of the areas, little chance of reinvasion.

Antechinus stuartii is most abundant where there is thick ground cover and abundant fallen logs. It does not appear until well into the second year after disturbance by fire, preceded by the house mouse and *Sminthopsis murina* and followed by *Rattus fuscipes* (Fox & McKay, 1981). In South-western Victoria it was found to be common in most forest remnants larger than 5 ha including some where the natural understorey had been considerably altered due to grazing by cattle (Bennett, 1990). Little is known about the effect of disturbance on *Antechinus flavipes*, but it is still sometimes seen around houses and gardens in suburban areas (Strahan, 1988). Disturbance and predation may have eliminated these populations and isolation of the remnants may mean reinvasion is unlikely.

COMMENTS ON THE SIZE OF ANIMAL POPULATIONS, AND WHETHER THE CROUDACE BAY ROAD IS A BARRIER TO THEIR MOVEMENTS

The survey aimed to provide information on the size of the animal populations, particularly the size of populations considered to be isolated within either remnant. This was not possible given the time period of the survey. As an example of the time required for more thorough population studies, Bell (1980) dedicated 156 days over a 13 month period to estimate bird densities in a 3 square kilometre site in the Australian Capital Territory.

Only one Common Dunnart, and one Northern brown bandicoot were found (*Appendix D.2*) which suggests these populations are smaller than 50 individuals. Without extra information on these populations, it can be assumed the populations are in immediate danger of genetic problems which could lead to local extinction (Frankel and Soule,1981).

The Feathertail Glider population is also assumed to be small. The fact that none were seen probably reflects inadequacies of the survey technique and a small population size. They can glide 20 metres, and

Croudace Bay Road may represent a barrier to them, especially with the road-widening and straightening occurring at the time of writing.

The Ringtail Possum populations are strong in both Green Point Estate and Floraville Ridge (*Appendices D.3, D.4*). It is likely that the Croudace Bay Road isolates the two populations to some extent. These animals travel in the canopy of trees, and are thus isolated within the forest fragments. The populations may have problems of overcrowding at some stage due to lack of ability to disperse to other forests.

Few Sugar Gliders were seen while spotlighting (*Appendix D.4*). However, the number of sugar gliders seen stagwatching (11) was nearly as high as the number of ringtail possums (13). We conclude that the size of the sugar glider populations are similar to the size of the ringtail possum populations, based on the discovery of nest sites while stagwatching. Sugar gliders are able to glide up to 50 metres, and are known to glide across narrow country roads (Suckling 1984). Croudace Bay Road is not necessarily a barrier to them, but the high traffic density may affect their movements.

No attempt was made to estimate the densities of birds, reptiles, frogs, or amphibians. There are, however, several observations worth mentioning.

* The birds are least likely of fauna species present to be affected by the Croudace Bay road, although "forest species" do not venture beyond the forest during daily foraging activity (*Table 5.5*).
* Many of the lizards are regularly encountered in suburban backyards, and one blue-tongue lizard was found squashed on the Croudace Bay Road.
* There are strong breeding populations of red-backed toadlets on both parcels of land.

6.0 MANAGEMENT RECOMMENDATIONS

Values of bushland and wildlife in suburban and urban areas, with reference to State Environmental Planning Policy Number 19-Bushland in Urban Areas (SEPP-19).

Specific values of urban bushland and wildlife to the community are recognised in SEPP-19. The values of Floraville Ridge and Green Point are listed below.

* They are representative of the plant communities which preceded urban development.
* They are of a size which enables the plant and animal communities to survive in the long-term, although it is uncertain whether all species will be sustainable.
* The plant *Tetratheca juncea* which is listed as "vulnerable" according to Briggs and Leigh (1989)(see section 4 of this report) occurs on both sites.
* The vegetation forms part of a proposed vegetation corridor linking Lake Macquarie with coastal vegetation communities (Newcastle and Lake Macquarie City Councils, 1987).
* The area has significant recreation potential, which is discussed by Forsite (1989).
* The area has potential as an outdoor education resource, with several schools close by, and easy access.
* The areas is very accessible to people travelling by bus, roads, and waterways.

In addition, bushland plants and animals often perform unknown services for people, which are often only recognised once the species has declined or disappeared. A spectacular example is the role sugar gliders are considered to play in reducing dieback of *Eucalyptus* trees (Smith 1992).

WILDLIFE CORRIDOR BETWEEN GREEN POINT ESTATE AND FLORAVILLE RIDGE

The larger the area of bushland, the less chance of extinction of species due to fire, disease outbreak, drought or other such disturbances. A wildlife corridor would reduce the isolation of both areas by providing a refuge and a source for recolonisation in the event of disturbance. In effect, the two small areas would be linked as one larger area.

The corridor identified in *Figure 8* will be most effective for birds, moderately effective for sugar gliders, and minimally effective for possums and ground dwelling animals. The effectiveness for possums can

be enhanced if the canopy of trees on either side the roadside are managed so as to form a continuous canopy over the road.

To be effective, the corridor does not need to facilitate daily movements of animals. Less regular crossing is enough to provide some genetic exchange, provide an escape route from fire, and allow recolonisation of either area if one population is lost.

No native ground mammals were found in the roadside corridor area.

Recommendations

* Maintain the bushland strip along Croudace Bay Road as a wildlife corridor (*Figure 8*).
* Consider areas adjacent to, but outside the study area of this survey, which have been suggested as corridors by Forsite (1989). Time limits precluded us from looking at these areas.

Inclusion of Floraville Ridge and Green Point Estate as part of a Green Corridor between Lake Macquarie and the Coast

Green Point Estate and Floraville Ridge are included in the Green Corridors network map included in Newcastle and Lake Macquarie City Councils (1987) open space study The two parcels of land are part of a corridor to link Lake Macquarie with coastal vegetation between Swansea and Redhead.

The Green Corridor concept is built around preserving the vegetation on well-vegetated ridges in urban areas. The corridors are designed to link urban areas with forested lands on the outskirts, and provide "visual relief ... visual containment (of city eyesores), open space corridors and trails, wildlife corridors, and microclimatic improvements" (Department of Planning, 1989).

The problem of urban run-off for maintaining native vegetation

Undeveloped ridges and water catchments are seen as valuable vegetation conservation features in urban areas because of the absence of urban run-off. Urban areas have a vastly altered hydrology. Drainage works divert water from natural drainage lines; impermeable surfaces like roads increase the volume of run-off; and fertilizers, detergents and other nutrients are washed away with the run-off. The altered water and nutrient regime can favour weed plants over native plants, largely because Australian vegetation communities are adapted to low nutrient conditions.

Consequently, the vegetation along ridge lines, and in undeveloped catchments is often less infested with weeds than areas subject to urban run-off.

Recommendation
* Retain ridges and catchments free from urban run-off as high quality bushland areas.

Construction of new Roads

The proposed Macquarie Drive link which would cut through Floraville will have steep cuttings and a width of about 40 metres. There is an additional buffer of 30 metres on each side which will presumably be replanted after construction. At the time of construction and until trees grow back, this will total a maximum width of about 100 metres, and is considered a barrier to sugar gliders, the most mobile of arboreal mammals present.

Recommendations
* Retain mature trees close to the road and along median strip.
* Replant trees beside the road as soon as possible.

Culverts and bridges can act as passages for ground-dwelling animals. Desirable features are vegetation and rocks around both ends to offer protection from predators. In culverts a separate channel for water is preferable. Rocks could be placed in the dry channel to act as protection for animals. If possible they should be designed so that light penetrates them, allowing vegetation growth. Narrow culverts are usable by small mammals but do not permit entry to larger predators (Andrews, 1990). This is a possible means of dispersal and may allow recolonisation of areas where species have become locally extinct. Dispersal is very important for species such as the Common Dunnart and the Northern Brown Bandicoot, which occur in the Floraville Ridge area.

Recommendations
* Incorporate suitably designed culverts into future road constructions.
* Retain vegetation beneath and to either side of bridges.

Tracks and Trailbikes

There are many major and minor tracks in the Floraville Ridge area and, particularly, in the Green Point Estate. These serve as access points for the spread of weeds, and can impede the movements of terrestrial animals. Even long-unused and partially overgrown tracks can act as barriers to terrestrial mammals, further isolating them (Andrews, 1990; Barnett et al, 1978). Trailbikes create additional tracks as well as noise

disturbance and are inappropriate if wildlife is to be encouraged. Currently there is little in the way of terrestrial mammals in the study areas, but with appropriate management it may be possible to encourage population increases.

Recommendations
* Close and revegetate many of the tracks in the area.
* Restrict access by trailbike riders. Trail bike riding is popular in the area, and restrictions without adequate provision of alternative riding facilities will not work.

Residential Development

Residential development within the areas should be avoided as this creates additional 'edge' and reduces core habitat. By restricting housing to the perimeter of the areas, infiltration by domestic predators, weeds, household refuse and other human-related disturbances are reduced.

Recommendations
* Avoid development within the Green Point and Floraville Ridge areas.
* Enforce regulations preventing dumping of household refuse in the areas.

Clearing for new housing estates has a high toll on wildlife. If clearing is done during peak breeding times, animals do not have the opportunity to seek alternative nesting sites. This is particularly damaging to nest-bound young.

Recommendation
* Clear subdivisions outside of peak breeding seasons. The major breeding seasons are spring and summer, as this is when the majority of foods are available e.g insects and flowers (Ford 1989).

Habitat management for wildlife

Dense undergrowth is favoured by many birds. One study found increased bird species along a powerline clearing due to creation of an additional habitat of dense shrubs and groundcover with a maximum height of 3 metres (Bell, 1980). Small mammals also favour dense undergrowth, some requiring fallen timber and leaf litter to be present.

A healthy wattle and other flowering shrub understorey will encourage sugar glider populations. Many species are dependent on the presence of hollow-bearing trees, and these need to be maintained for survival of the species.

Maintain a mosaic community, with different patches in various stages of succession after disturbance. The Common Dunnart survives best in areas disturbed 2-4 years previously. The Northern Brown Bandicoot is similarly adapted to recolonising after disturbance. Other species are better adapted to a later stage of succession. Such a mosaic would provide areas suitable to the varying needs of mammal populations. A mosaic also has the advantage of retaining areas of refuge during disturbance from which recolonisation can occur.

Recommendations
* Promote areas of dense undergrowth. This may be suitable under the powerlines which cross both parcels of land.
* Restrict collecting of wood.
* Encourage growth of wattles and other flowering shrubs.
* Maintain significant numbers of hollow-bearing trees.

Fire for management of wildlife habitat

Fire is important for maintaining many species of native fauna and flora. A succession of ground mammals recolonising areas after fire occurs after many years. To accommodate a succession it is is to have a mosaic of adequately sized patches at various stages since burning.

Recommendation
* Carry out a study of fire requirements of species in the area and install an appropriate fire management program.

Buffer zones between bushland and residential areas

Urban bushland poses a fire risk to adjacent residences. A service trail could be constructed a short distance into the areas as recommended by Winning (1990a) The zone between the trail and houses could be kept as a reduced fuel zone. This could serve a duel purpose of reducing fire risk for residents and providing a barrier to be treated by staff or volunteers as the limit of weed invasion etc.

Recommendation
* Construct a service trail and reduced fuel zone.

Exotic Fauna

Presence of exotic fauna is damaging to native populations. In particular, foxes and domestic and feral cats and dogs prey on native fauna and need to be restricted for the survival of ground-dwelling animals. Hares and

presumably rabbits are present and are very effective competitors for resources with native animals.

Domestic pets are particularly threatening to native wildlife. They have a reliable source of food and are hence unaffected by depletion of resources (e.g drought, or decline of prey species). They can cause a native population to go to extinction, without going hungry themselves. In contrast, a feral predator population will be under stress, and numbers will fall before the prey becomes extinct.

Similarly, a mixture of feral predators and rabbits can also cause extinction of native animals. Rabbits provide a plentiful food source, just like pet owners. Native species can be eaten out of existence without a single feral cat, dog or fox going hungry.

Timmins (1992) records rescuing 3 ringtail possums, 1 sugar glider, and 1 feathertail glider who had suffered cat attacks ; and 1 ringtail possum suffering from dog attack. These all occurred from 31/1/92 to 13/12/91 in the area between Belmont North and Valentine. This is not regarded as a complete inventory of all attacks, but shows that feral and/or domestic predators do seriously threaten fauna in the area.

Recommendations

* Ensure residents keep their pet dogs and cats under control. This may include having bells on the collars of all cats, and securing pets at night when native animals are most active.
* Control feral animals in the area. Live animal trapping, and termination by the Royal Society for the Prevention of Cruelty to Animals (R.S.P.C.A.) is the most humane method. Other methods are discussed by Breckwoldt (1983).

Weed Infestation

Much of the Green Point Estate and, to a lesser extent, Floraville Ridge, is infested by lantana and bitou bush. It is desirable that this be removed and replaced by native species in such a way that no loss of dense scrub habitat occurs. Currently, the favoured method of bush regeneration for *Eucalyptus* forest is the Bradley Method (Buchanan 1989), while a different method for rainforest is described by Harden (1990) of the Sydney Royal Botanical Gardens. The slow nature of these regeneration methods suggests that effort by local volunteers may prove most successful. The Green Point Action Committee has already expressed interest in undertaking this regeneration.

Trial and error has shown that large-scale, short-term weed eradication does not work because of the time required by native species to regenerate. The regeneration process can be sped up by planting of native species, and sensible use of fire and weed-killers.

Recommendation

* Encourage and assist long-term bush regeneration projects.

Relevance of the findings to future development of undisturbed areas.

Evidence suggests the native ground mammal fauna at Green Point Estate and Floraville Ridge has been reduced to small populations of two species, the Common Dunnart and Northern Brown Bandicoot. If other species are present, they must also have small populations.

Over time the pattern of development of the North Eastern lake edge has acted to exclude many ground mammals, such as all macropods. Different approaches to development in areas of new suburban and urban development may serve to maintain ground fauna populations.

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FIGURES

Figure 1

LOCALITY MAP FOR THE TWO STUDY AREAS

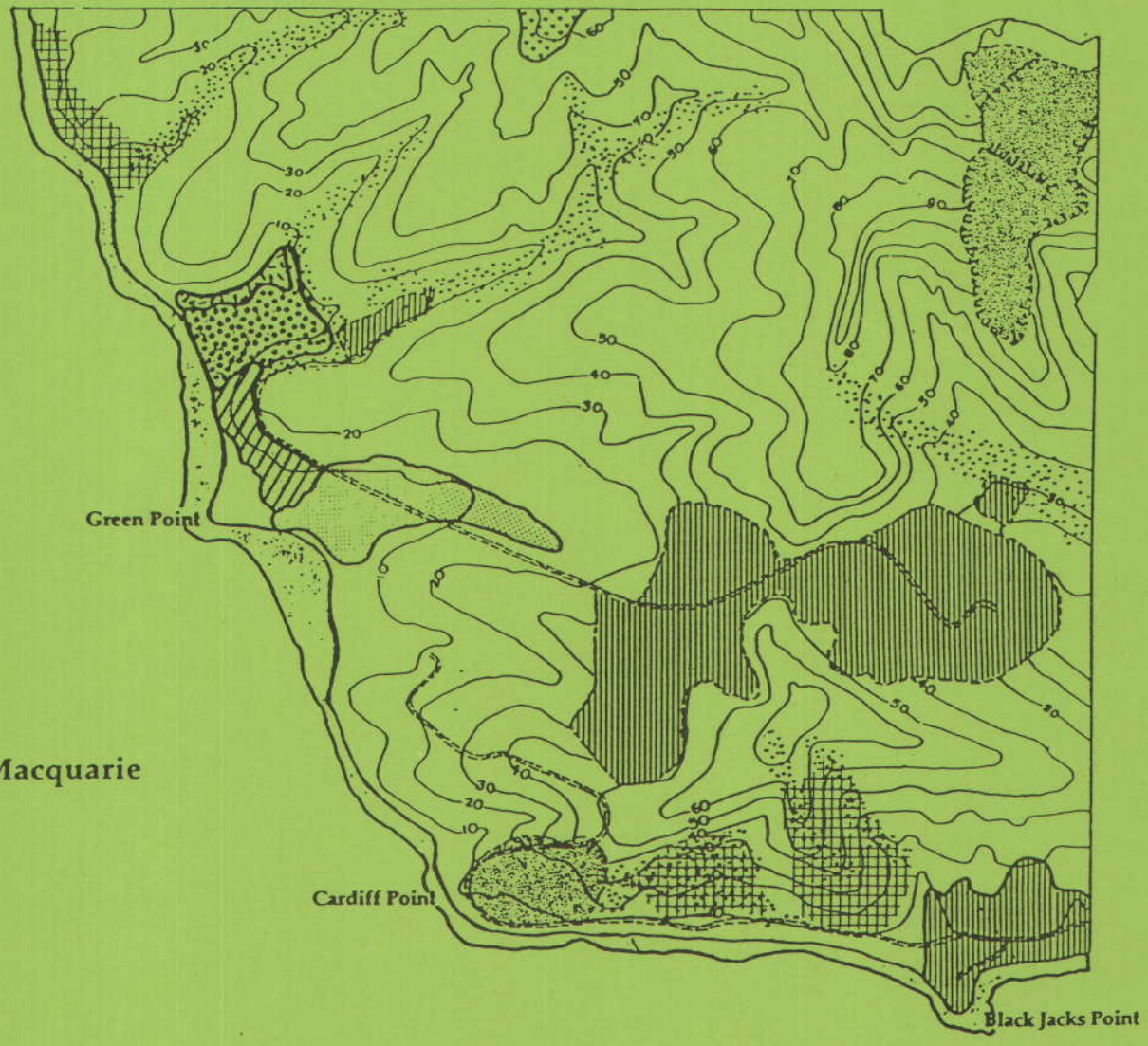


Figure 2

VEGETATION COMMUNITIES

Legend

CONSERVATION VALUE

5 Closed Littoral Forest
Cassine australis
Cupaniopsis anacardioides

5 Low Open Littoral Forest
Melaleuca styphelioides
Carex appressa

4 Open Forest
Casuarina glauca
Melaleuca styphelioides

4 Open Forest
Eucalyptus tereticornis,
Eucalyptus propinqua

3 Open Forest
Eucalyptus gummifera,
Angophora costata

3 Open Forest
Eucalyptus maculata,
E. paniculata, E. propinqua

2 Grassland

1 No vegetation cover

Closed Seagrass Meadow
Zostera capricorni

Invasion of Lantana camara

Invasion of
Chrysanthemoides monilliferum

CONSERVATION & RECREATION STUDY

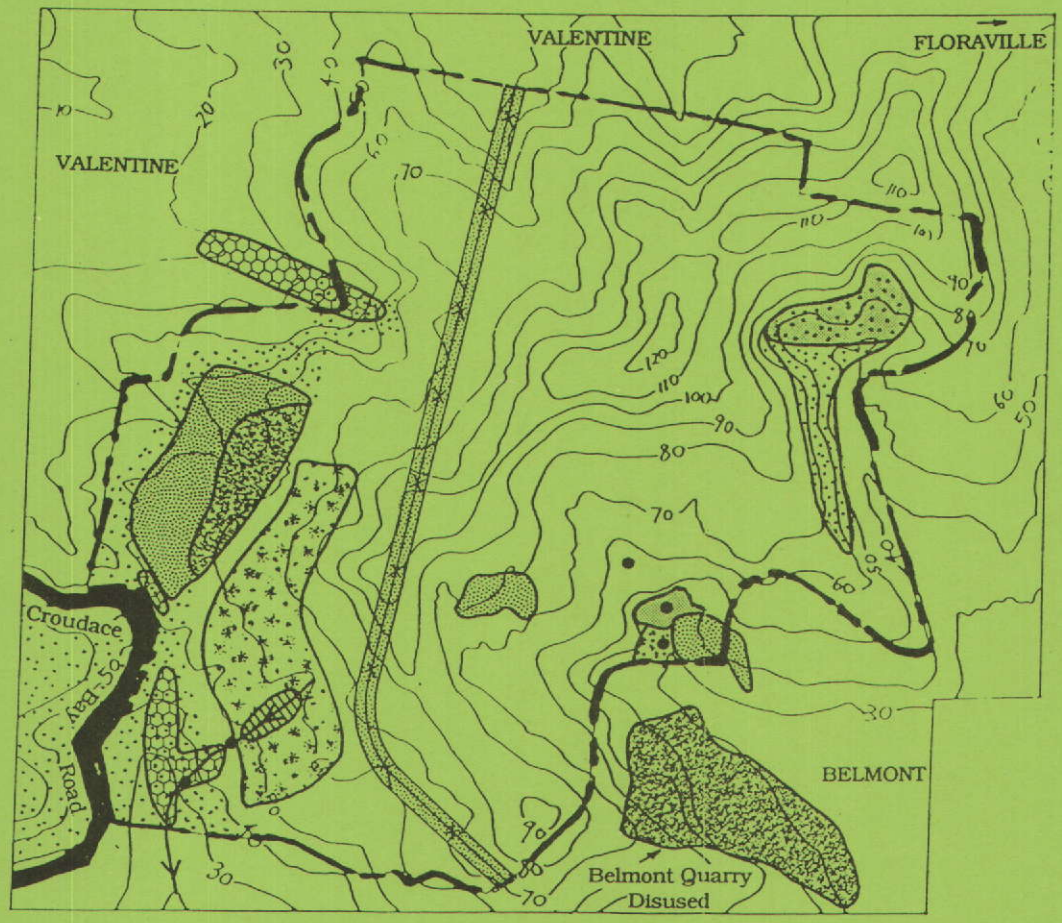
GREEN POINT ESTATE

0 100 200 300 M

Forsite Landscape Architects and Planners

FLORAVILLE RIDGE VEGETATION COMMUNITIES

Figure 3



LEGEND

- Open Forest
  Eucalyptus maculata/E. paniculata alliance, with ridge-top patches of Angophora costata/E. gummifera alliance
- Open Forest
  Eucalyptus maculata/E. paniculata with Melaleuca styphelioides understorey
- Open Forest
  Eucalyptus haemastoma/Angophora costata, E.gummifera
- Closed Forest
  Guioa semiglauca
  Cassine australis
- Wetland
  Typha sp.
  Melaleuca linariifolia
- Grassland
- Weed infestation
  Lantana camara
  Chrysanthemoides moniliferum
- No vegetation cover
- Transmission line
- Permanent water course/ watercourse with pools
- Study area boundary

10 m Contour interval

0 100 200 300 400m

SCALE 1:8000

N

GREEN POINT ESTATE TRAPPING & SPOTLIGHTING SITES

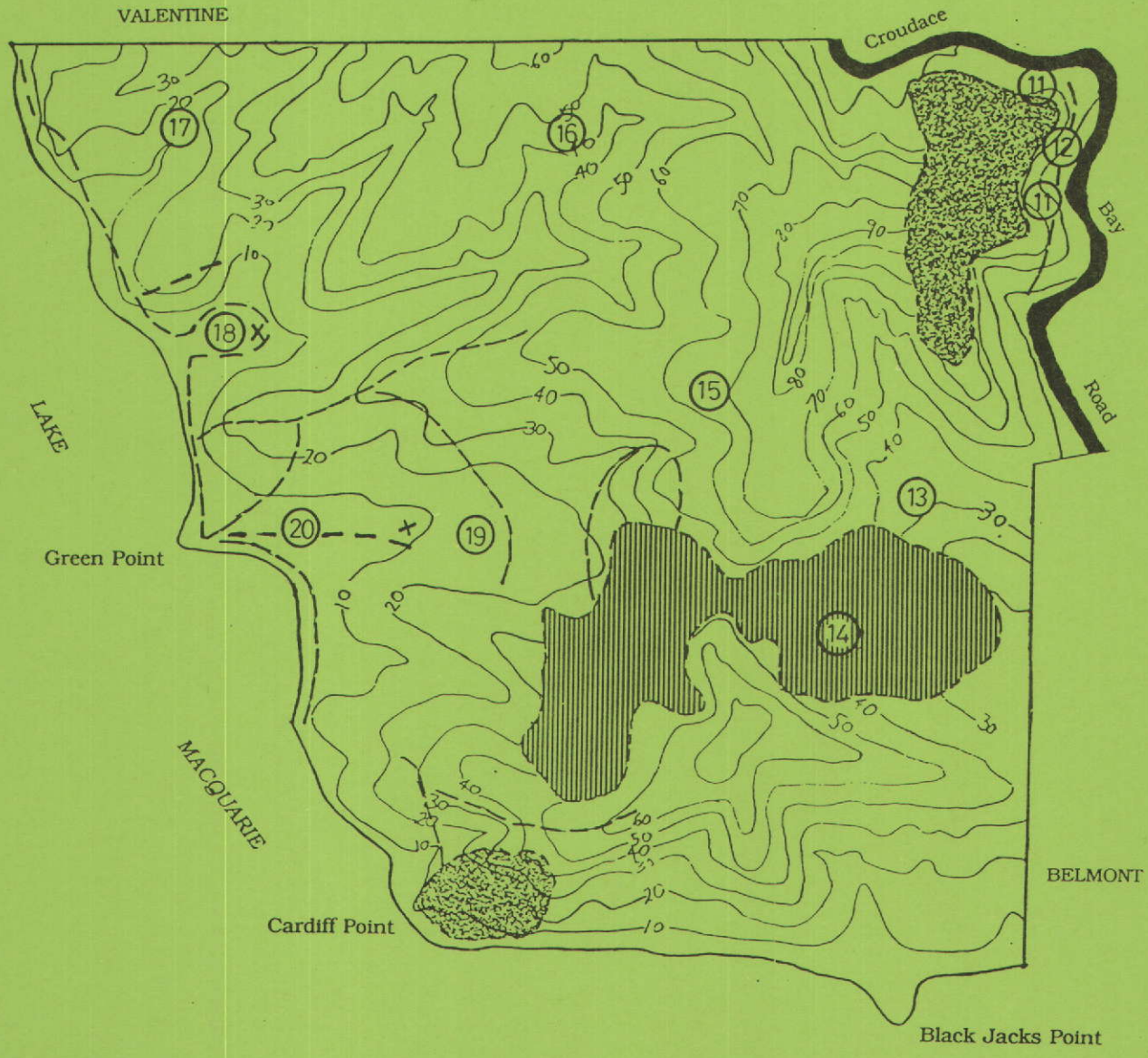


Figure 4

LEGEND

- No vegetation cover
- Grassland
- spotlight transect
- (5) Ground mammal trapsite
- X Pitfall trap

10 m Contour interval

0 100 200 300 400 m

SCALE 1:8000

N

FLORAVILLE RIDGE TRAPPING & SPOTLIGHTING SITES

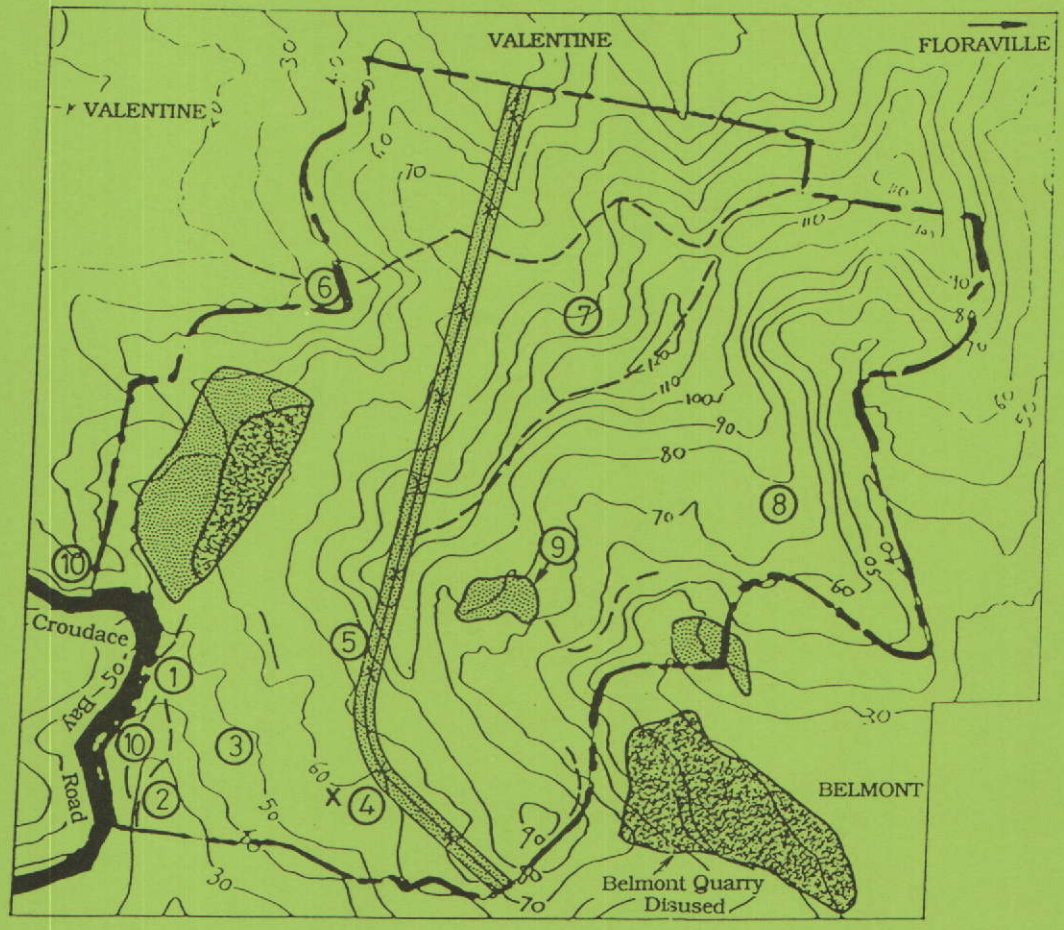


Figure 5

LEGEND

- No vegetation cover
- Grassland
- X Pitfall trap
- Spotlighting transect
- (5) Ground mammal trapsite

Contour interval 10m

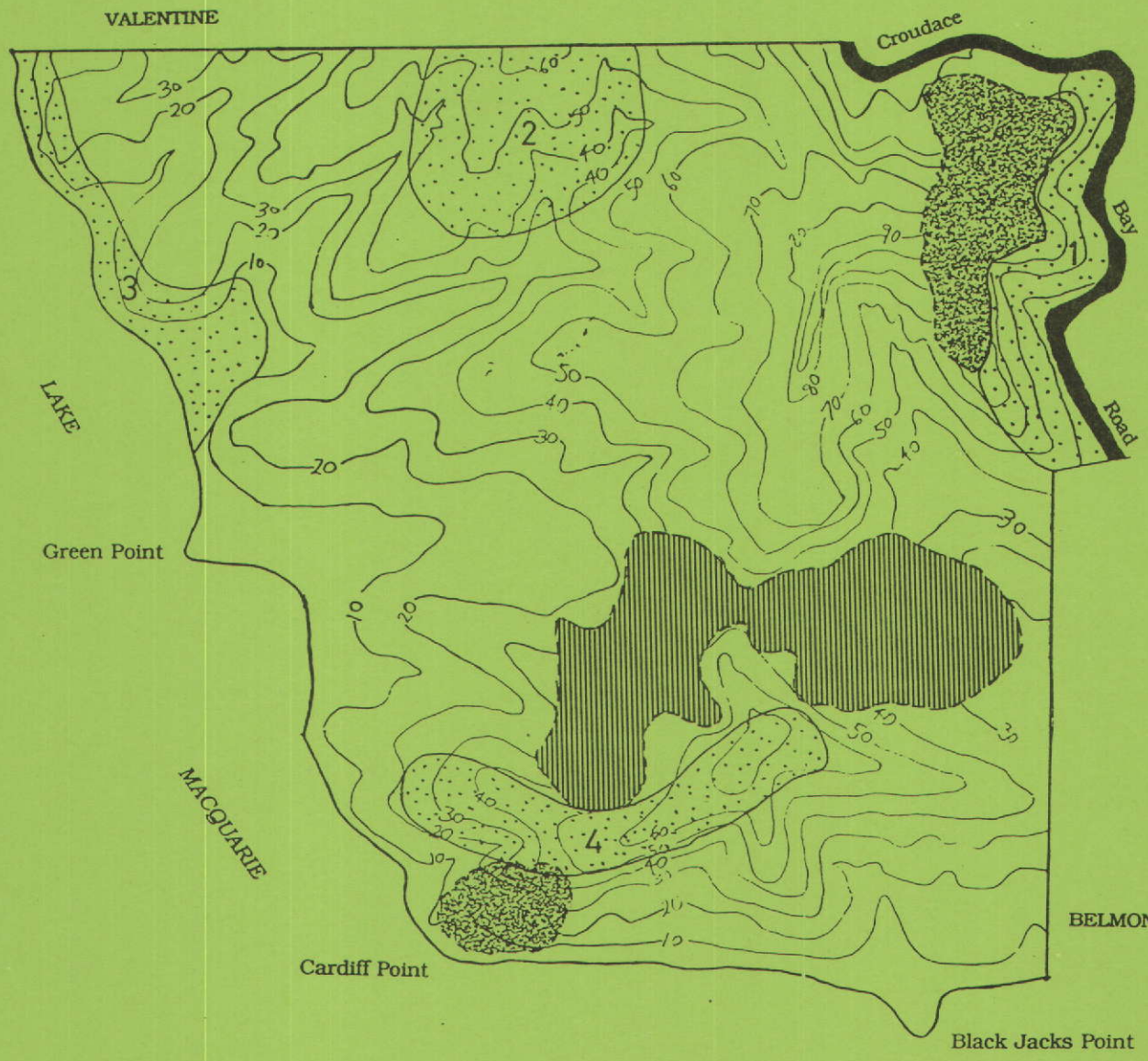
0 100 200 300 400m

SCALE 1:8000

N

GREEN POINT ESTATE BIRD SURVEY AREAS

Figure 6



LEGEND

- No vegetation cover
- Grassland
- 5 Bird survey areas

Contour interval 10m

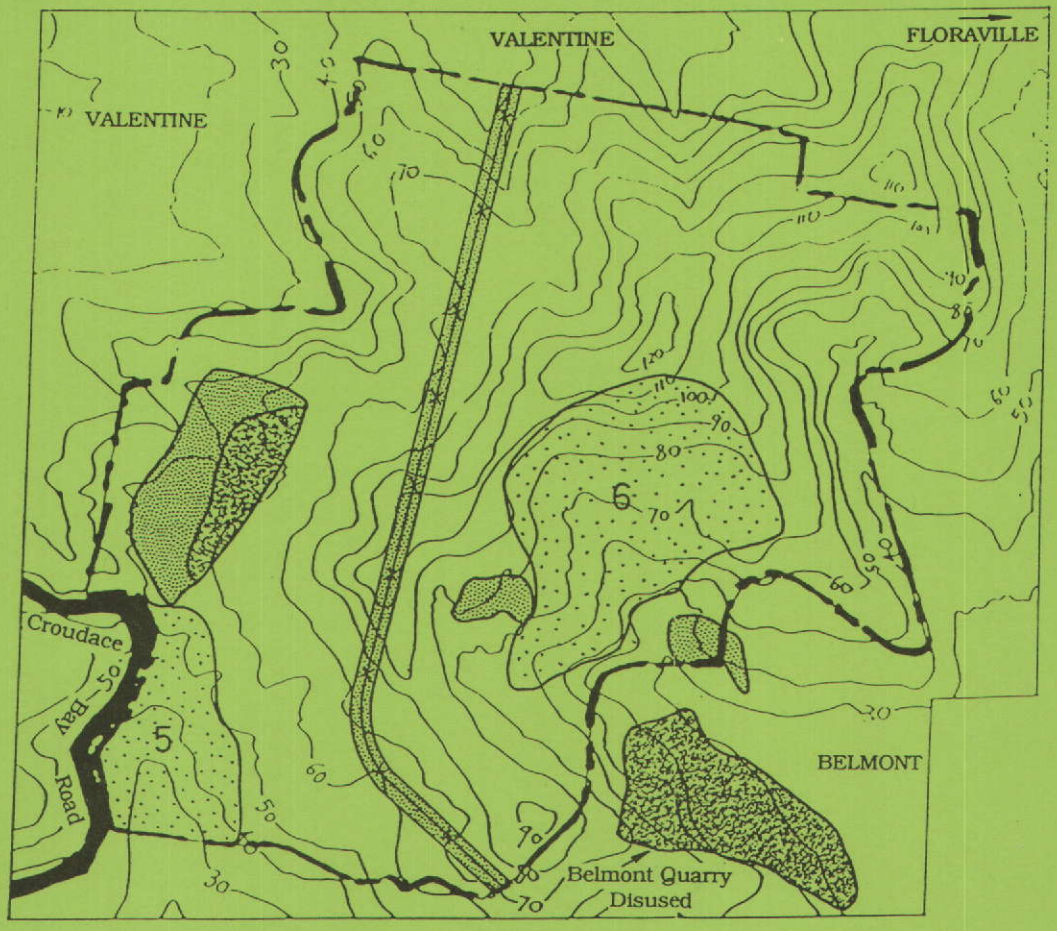
0 100 200 300 400 m

SCALE 1:8000

N

FLORAVILLE RIDGE BIRD SURVEY AREAS

Figure 7



LEGEND

- Transmission line
- No vegetation cover
- Grassland
- 5 Bird survey areas

Contour interval 10m

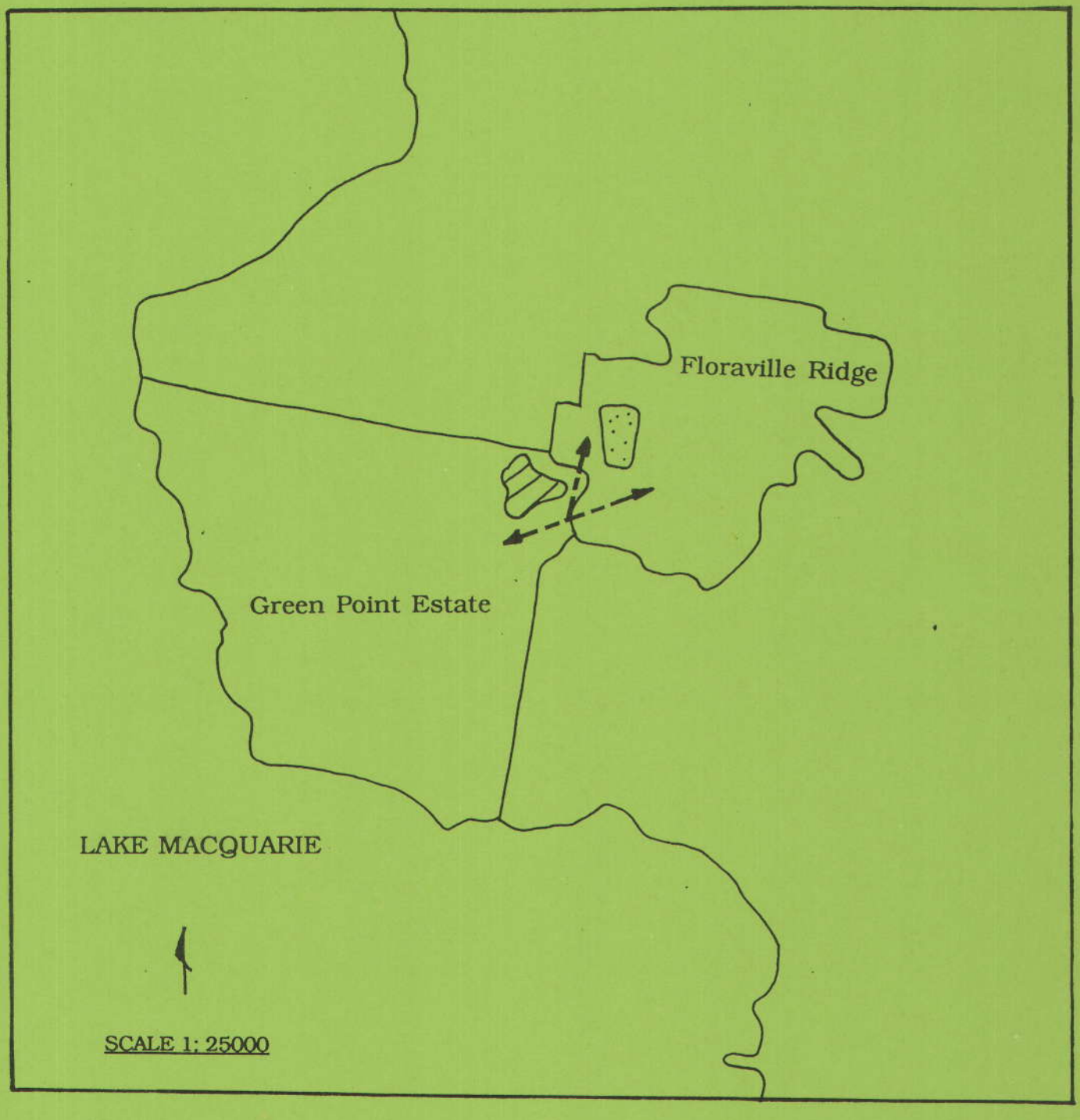
0 100 200 300 400m

SCALE 1:8000

N

Figure 8

PROPOSED WILDLIFE CORRIDOR



Corridor for the movement of wildlife

Quarry

Dump

APPENDICES

APPENDIX A: Acknowledgements

We are much indebted to the following people and organisations for their assistance with this study:

Hunter Bird Observers Society
The Wetlands Centre
LMCC Planning Department staff
Green Point Action Committee
Local naturalists
Dr John Clulow
Dr Brian Conroy

APPENDIX B.1: Plant species list for Floraville Ridge

*	=	Introduced plant from overseas
*n	=	Introduced plant that is a declared noxious weed
*A	=	Inroduced plant from another area of Australia
P	=	Plant recorded only by Presland (1992)
gf	=	ground fern
cf	=	climbing fern
ef	=	epiphytic fern
h	=	herb
s	=	shrub
c	=	climbing plant
t	=	tree
st	=	small tree
e	=	epiphyte

	PTERIDOPHYTA			COMMON NAME	HABIT
	Adiantaceae	*Adiantum*	*aethiopicum*	maidenhair fern	gf
	Adiantaceae	*Adiantum*	*hispidulum*	rough maidenhair	gf
	Adiantaceae	*Cheilanthes*	*sieberi*	rock fern	gf
	Adiantaceae	*Pellaea*	*falcata var falcata*		gf
	Adiantaceae	*Pellaea*	*paradoxa*		gf
	Aspleniaceae	*Asplenium*	*australasicum*	birds nest fern	ef
	Blechnaceae	*Blechnum*	*cartilagineum*	gristle fern	gf
	Blechnaceae	*Doodia*	*aspera*	rasp fern	gf
	Davalliaceae	*Arthropteris*	*tenella*		cf
*A	Davalliaceae	*Nephrolepis*	*cordifolia*	fish bone fern	gf
	Dennstaedtiaceae	*Pteridium*	*esculentum*	bracken fern	gf
	Polypodiaceae	*Microsorum*	*scandens*	fragrant fern	cf
	Polypodiaceae	*Pyrrosia*	*rupestris*	rock felt-fern	ef
	Thelypteridaceae	*Cyclosorus*	*interruptus*		gf
	GYMNOSPERMS				
	Zamiaceae	*Macrozamia*	*spiralis*	burrawang	cycad
	DICOTYLEDONS				
	Acanthaceae	*Brunoniella*	*australis*	blue trumpet	h
	Acanthaceae	*Pseuderanthemum*	*variabile*	pastel flower	h
*	Asclepiadaceae	*Gomphocarpus*	*fruticosus*	cotton bush	s
*n	Asteraceae	*Ageratina*	*adenophora*	crofton weed	h
*	Asteraceae	*Bidens*	*pilosa*	cobblers peg	h
*	Asteraceae	*Chrysanthemoides*	*moniliferum*	bitou bush	s
	Asteraceae	*Helichrysum*	*diosmifolium*	paper daisy	s
	Asteraceae	*Olearia*	*tomentosa*		s
	Bignoniaceae	*Pandorea*	*pandorana*	wonga wonga vine	c
*	Caesalpiniaceae	*Cassia*	*coluteoides*		s
*	Caesalpiniaceae	*Cassia*	*floribunda*		s
*	Caprifoliaceae	*Lonicera*	*japonica*	honeysuckle	c
	Casuarinaceae	*Allocasuarina*	*torulosa*	forest oak	st
	Casuarinaceae	*Casuarina*	*glauca*	swamp she-oak	
	Celastraceae	*Cassine*	*australis var australis*	red olive plum	st
	Celastraceae	*Maytenus*	*silvestris*		s
*	Convolvulaceae	*Ipomoea*	*cairica*	morning glory	c
*	Convolvulaceae	*Ipomoea*	*indica*	morning glory	c
	Cunoniaceae	*Ceratopetalum*	*gummiferum*	christmas bush	s-st
	Dilleniaceae	*Hibbertia*	*aspera*	guinea flower	s
	Dilleniaceae	*Hibbertia*	*obtusifolia*		s
	Dilleniaceae	*Hibbertia*	*scandens*	guinea flower	c
	Dioscoreaceae	*Dioscorea*	*transversa*	native yam	c
	Ebenaceae	*Diospyros*	*australis*	black plum	s-st
	Elaeocarpaceae	*Elaeocarpus*	*reticulatus*	blueberry ash	s-st
	Epacridaceae	*Epacris*	*pulchella*		s
	Epacridaceae	*Leucopogon*	*juniperinus*	bearded heath	s
	Euphorbiaceae	*Baloghia*	*inophylla*	brush bloodwood	st
	Euphorbiaceae	*Breynia*	*oblongifolia*		s
	Euphorbiaceae	*Glochidion*	*ferdinandi*	cheese tree	s-st
	Eupomatiaceae	*Eupomatia*	*laurina*	bolwarra	s-st
	Fabaceae	*Daviesia*	*squarrosa var squarrosa*		s
	Fabaceae	*Desmodium*	*rhytidophyllum*	rusty tick-foil	c
	Fabaceae	*Dillwynia*	*retorta ssp A*		s
	Fabaceae	*Glycine*	*clandestina*		c

	Fabaceae	*Hardenbergia*	*violaceae*		c
	Fabaceae	*Indigofera*	*australis*		s
	Fabaceae	*Jacksonia*	*scoparia*		s
	Fabaceae	*Kennedia*	*rubicunda*		c
	Fabaceae	*Oxylobium*	*ilicifolium*		s
	Fabaceae	*Pultenaea*	*retusa*		s
	Fabaceae	*Pultenaea*	*villosa*		s
	Flacourtiaceae	*Scolopia*	*braunii*	flintwood	st
	Goodeniaceae	*Goodenia*	*bellidoflora ssp bellidoflora*		h
	Goodeniaceae	*Goodenia*	*heterophylla*		s
	Goodeniaceae	*Goodenia*	*ovata*	hop goodenia	s
	Lamiaceae	*Plectranthus*	*parviflorous*	cockspur flowers	h
	Lamiaceae	*Prostanthera*	*incisa var incisa*	cut-leaf mint bush	s
	Lamiaceae	*Prostanthera*	*sp.*		h
*	Lauraceae	*Cinnamomum*	*camphora*	camphor laurel	t
	Lobeliaceae	*Pratia*	*purpurascens*	white root	h
* A	Meliaceae	*Schefflera*	*actinophylla*	umbrella tree	t
	Menispermaceae	*Sarcopetalum*	*harveyanum*	pearl vine	c
	Menispermaceae	*Stephania*	*japonica var discolor*	snake vine	c
* A	Mimosaceae	*Acacia*	*baileyana*	cootamundra	s-st
	Mimosaceae	*Acacia*	*brownei*		s
	Mimosaceae	*Acacia*	*implexa*	hickory	s-st
	Mimosaceae	*Acacia*	*irrorata ssp irrorata*		st
	Mimosaceae	*Acacia*	*suaveolens*		s
	Mimosaceae	*Acacia*	*ulicifolia*	prickly moses	s
	Mimosaceae	*Pararchidendron*	*pruinosum*	snow wood	st
	Monimiaceae	*Wilkiea*	*huegeliana*		s-st
	Moraceae	*Ficus*	*coronata*	sandpaper fig	t
	Moraceae	*Ficus*	*rubiginosa*	rusty fig	t
	Moraceae	*Maleisia*	*scandens*		c
	Myrsinaceae	*Rapanea*	*variabilis*	muttonwood	s-st
	Myrtaceae	*Acmena*	*smithii*	lilly pilly	s-t
	Myrtaceae	*Angophora*	*costata*	apple	t
	Myrtaceae	*Backhousia*	*myrtifolia*	grey myrtle	st
	Myrtaceae	*Eucalyptus*	*globoidea*	white stringybark	t
	Myrtaceae	*Eucalyptus*	*haemastoma*	scribbly gum	t
	Myrtaceae	*Eucalyptus*	*maculata*	spotted gum	t
	Myrtaceae	*Eucalyptus*	*paniculata*	grey ironbark	t
	Myrtaceae	*Eucalyptus*	*propinqua var propinqua*	small fruited grey	t
	Myrtaceae	*Eucalyptus*	*umbra ssp umbra*	bastard mahogany	t
	Myrtaceae	*Eucalyptus*	*punctata*	grey gum	t
	Myrtaceae	*Leptospermum*	*sp*		s
	Myrtaceae	*Leptospermum*	*sp*		s
	Myrtaceae	*Melaleuca*	*linearifolia*		st
	Myrtaceae	*Rhodamnia*	*acuminata*	scrub turpentine	s-st
	Myrtaceae	*Syncarpia*	*glomulifera*	turpentine	t
*	Oleaceae	*Ligustrum*	*sinense*	small-leaf privet	s-st
	Oleaceae	*Notelaea*	*longifolia*	mock olive	s
	Piperaceae	*Peperomia*	*leptostachya*		h
	Pittosporaceae	*Billardiera*	*scandens*	apple berry	c
	Pittosporaceae	*Bursaria*	*spinosa*		s
	Pittosporaceae	*Citriobatus*	*pauciflorus*	orange thorn	s
	Pittosporaceae	*Pittosporum*	*revolutum*		s-st

	Pittosporaceae	*Pittosporum*	*undulatum*	sweet pittosporum	s-st
	Polygalaceae	*Comesperma*	*ericinum*	matchheads	s
*	Polyganaceae	*Rumex*	*sagittatus*	potato vine	c
	Proteaceae	*Banksia*	*spinulosa var collina*		s
	Proteaceae	*Hakea*	*sericea*	bushy needlebush	s
	Proteaceae	*Persoonia*	*lanceolatus*		s
	Proteaceae	*Persoonia*	*levis*	smooth geebung	s
	Proteaceae	*Persoonia*	*linearis*	geebung	s
	Ranunculaceae	*Clematis*	*aristata*	old man's beard	c
	Rosaceae	*Rubus*	*hillii*		s-c
	Rutaceae	*Zieria*	*smithii*	sandfly zieria	s
	Santalaceae	*Exocarpus*	*cupressiformis*	native cherry	s-st
	Sapindaceae	*Alectryon*	*subcinereus*	native quince	s
	Sapindaceae	*Dodonaea*	*triquetra*	common hop bush	s
	Sapindaceae	*Guioa*	*semiglauca*		st
	Stylidaceae	*Stylidium*	*graminifolium*	trigger plant	h
	Tremandraceae	*Tetratheca*	*juncea*		s
*n	Verbenaceae	*Lantana*	*camara*		s
*	Verbenaceae	*Verbena*	*bonariensis*	purple top	h
	Violaceae	*Hybanthus*	*enneaspermum*		h
	Violaceae	*Viola*	*hederacea*	ivy-leaved violet	h
	Vitaceae	*Cissus*	*antarctica*	water vine	c
	Vitaceae	*Cissus*	*hypoglauca*	water vine	c
	MONOCOTYLEDONS				
	Araceae	*Gymnostachys*	*anceps*	settlers flax	h
	Arecaceae	*Archontophoenix*	*cunninghamiana*	bangalow palm	t
	Arecaceae	*livistona*	*australis*	cabbage tree palm	t
	Commelinaceae	*Commelina*	*cyanea*	scurvey weed	h
*	Commelinaceae	*Tradescantia*	*albiflora*	wandering jew	h
	Cyperaceae	*Cyperus*	*sp*		sedge
	Cyperaceae	*Gahnia*	*sp*		sedge
	Cyperaceae	*Gahnia*	*sp*		sedge
*	Iridaceae	*Crocosmia*	*aurea*		h
	Juncaceae	*Juncus*	*usitatus*		rush
	Liliaceae	*Dianella*	*caerulea var producta*		sedge
	Liliaceae	*Thysanotus*	*tuberosus*	fringe lilly	h
	Orchidaceae	*Calochilus*	*robertsonii*	bearded orchid	h
	Orchidaceae	*Cryptostylis*	*subulata*	tongue orchid	h
	Orchidaceae	*Cymbidium*	*suave*		e
	Orchidaceae	*Dendrobium*	*speciosum var speciosum*	rock orchid	e
	Orchidaceae	*Dipodium*	*punctatum*	hyacinth orchid	h
	Orchidaceae	*Erythrorchis*	*cassythoides*	climbing orchid	c
	Philesiaceae	*Eustrephus*	*latifolius*	wombat berry	c
	Philesiaceae	*Geitonoplesium*	*cymosum*	scrambling lilly	c
*n	Poaceae	*Cortaderia*	*selloana*	pampas grass	
	Poaceae	*Themeda*	*australis*	kangaroo grass	grass
	Smilacaceae	*Smilax*	*australis*		c
	Smilacaceae	*Smilax*	*glyciphylla*	sarsaparilla	c
	Typhaceae	*Typha*	*sp*	bullrush	reed
	Xanthorrhoeaceae	*Lomandra*	*longifolia*		sedge
	Xanthorrhoeaceae	*Xanthorrhoea*	*macronema*	grass tree	s

APPENDIX B.2: Plants found at Green Point Estate which did not appear in Forsite (1989).

s = shrub
c = climbing plant
t = tree
s t = small tree
e = epiphyte

			COMMON NAME	HABIT
Fabaceae	*Oxylobium*	*ilicifolium*		s
Fabaceae	*Jacksonia*	*scarparia*		
Fabaceae	*Daviesia*	*squarrosa*		s
Goodeniaceae	*Goodenia*	*ovata*		s
Mimosaceae	*Acacia*	*irrorata ssp. irrorata*		s-st
Moraceae	*Maclura*	*cochinchinensis*	cockspus thorn	c
Moraceae	*Streblus*	*brunonianus*	whalebone tree	st
Myrtaceae	*Eucalyptus*	*punctata*	grey gum	t
Orchidaceae	*Calochilus*	*robertsonii*	bearded orchid	h

APPENDIX B.3: Orchids found on Green Point or Floraville by Presland (1992)

Orchidaceae	*Acianthus*	*exsertus*
Orchidaceae	*Acianthus*	*fornicatus*
Orchidaceae	*Caladenia*	*carnea*
Orchidaceae	*Caladenia*	*catenata*
Orchidaceae	*Calochinus*	*paludosus*
Orchidaceae	*Corybas*	*aconitiflorus*
Orchidaceae	*Corybas*	*fimbriatus*
Orchidaceae	*Corybas*	*pruinosus*
Orchidaceae	*Diuris*	*sulphurea*
Orchidaceae	*Glossodia*	*major*
Orchidaceae	*Microtis*	*unifolia*
Orchidaceae	*Prassophyllum*	*elatum*
Orchidaceae	*Pterostylus*	*baptistii*
Orchidaceae	*Pterostylus*	*curta*
Orchidaceae	*Pterostylus*	*grandiflora*
Orchidaceae	*Ptèrostylus*	*longifolia*
Orchidaceae	*Pterostylus*	*nutans*
Orchidaceae	*Pterostylus*	*obtusa*
Orchidaceae	*Pterostylus*	*parviflora*
Orchidaceae	*Pterostylus*	*pedunculata*

APPENDIX C.1

Table: List of all birds recorded in Green Point Estate and Floraville Ridge areas. This includes confirmed and unconfirmed sightings over the past decade as well as those during the study period.

Included are species considered to possibly occur in the area by Forsite (1989). Some of these only occur in the Lake Macquarie area in winter, and consequently could not have been sighted during the summer study period.

Not all of the confirmed species were predicted by Forsite (1989).

? = unconfirmed
• = confirmed
(M) = summer migrant
(WM) = winter migrant
(WV) = winter visitor
(*) = summer migrant, some overwinter
L = likely
NL = not likely
P = possible
G = Green Point Estate
F = Floraville Ridge

COMMON NAME	Forsite Green Point	Sighted in Green Point	Sighted in Floraville
Fork-tailed swift		•	
Spine-tailed swift	P	•	
Welcome swallow	P	•	
Fairy martin	P		
Richard's pipit	P		
Cicada bird	P	•	•
Black-faced cuckoo-shrike	P	•	•
Masked lapwing	P	•	
Spotted quail-thrush	P		
Eastern whip-bird	P	•	•
White winged chough	P		
Scarlet robin	P		
Rose robin	P	•	
Jacky Winter	P	?	
Australian reed-warbler		•	
Golden-headed cisticola		•	
Southern emu-wren		•	
Superb blue wren	P	•	•
Variegated wren	P	•	•
Brown warbler	P	•	•
White-throated warbler	P	•	
Brown thornbill		•	•
Striated thornbill	P	•	
Yellow thornbill	P	•	
Buff-rumped thornbill	P	•	•
Yellow-rumped thornbill	P	•	
White-browed scrubwren	P	•	•
Dusky woodswallow	P	•	
White-breasted woodswallow		•	
Eastern yellow robin	P	•	•
Willie wagtail	P	•	•
Rufous fantail	P	•	•
Grey fantail	P	•	•
Leaden flycatcher	P	? L	? L
Satin flycatcher		? NL	? NL
Restless flycatcher	P		
Spectacled monarch		•	
Blackfaced monarch	P	•	
Golden whistler	P	•	•
Rufous whistler		•	•
Grey shrike-thrush	P	•	•
Orange-winged sitella	P		
White-throated tree creeper	P	•	•
Crested shrike-tit	P	•	
Spotted pardalote	P	•	•
Striated pardalote	P	?	
Mistletoe bird	P	•	
Grey-breasted silvereye	P	•	•
Scarlet honeyeater	P	•	
Eastern spinebill	P	•	•
Lewin honeyeater	P	•	•

Yellow-faced honeyeater	P	•	•
Yellow-tufted honeyeater		•	
White-eared honeyeater		•	
White-plumed honeyeater	P	•	
Fuscous honeyeater		•	
White-naped honeyeater	P	•	
Brown-headed honeyeater	P	•	
Black-chinned honeyeater		•	
Regent honeyeater	P		
White-cheeked honeyeater	P	•	?
New Holland honeyeater	P	•	
Tawny-crowned honeyeater		•	
Bell miner	P	•	
Noisy miner	P	•	•
Red wattlebird	P	•	
Little wattlebird	P	•	?
Little friarbird		•	
Noisy friarbird	P	•	•
Red browed firetail	P	•	•
Double-barred finch		•	
Common myna		•	
Olive-backed oriole	P	•	
Figbird		•	
Australian magpie	P	•	•
Magpie lark	P	•	•
Australian raven	P	•	•
Grey butcher bird	P	•	•
Pied butcher bird	P		
Green catbird	P		? P
Satin bowerbird	P	•	
Regent bowerbird	P	•	•
Spangled drongo	P	•	? P
Pied currawong	P	•	•
Little pied cormorant		•	
Little black cormorant		•	
Great/ Black cormorant		•	
Pied cormorant		•	
Australian pelican		•	
Little egret		•	
Intermediate egret		•	
Great egret		•	
White-faced heron		•	
White-necked heron		•	
Royal spoonbill		•	
Sacred ibis		•	
Black swan		•	
Wood duck		•	•
Black duck			•
Peregrine falcon	P		
Little falcon	P		
Brown falcon	P		
Nankeen kestrel	P	•	
Brown goshawk	P		

Collared sparrowhawk	P		
Crested hawk/ Pacific baza	P	•	? P
Black-shouldered kite	P	•	
Whistling kite	P	•	
White-breasted sea-eagle		•	•
Wedge-tailed eagle			•
Painted button quail	P		
Stubble quail	P	•	
Brown quail	P	•	
Silver gull		•	
Crested tern		•	
Common tern		? NL	
Spotted turtle-dove		•	•
Brown pigeon	P		
Bar-shouldered dove	P	? P	
Common bronzewing	P	•	
Brush bronzewing	P		
Crested pigeon	P	•	
Wonga pigeon	P		? P
Little lorikeet	P		
Musk lorikeet	P		
Scaly-breasted lorikeet	P	•	
Rainbow lorikeet	P	•	•
Yellow-tailed black cockatoo	P		
Glossy cockatoo	P		
Gang-gang cockatoo	P	? NL	
Sulphur-crested cockatoo	P	•	•
Galah	P	•	•
Little corella			•
King parrot	P	•	•
Crimson rosella	P		
Eastern rosella	P	•	•
Dollar bird	P	•	•
Fantailed cuckoo	P	•	•
Brush cuckoo	P		
Golden bronze cuckoo	P	? L	
Horsfield's bronze cuckoo	P		
Pallid cuckoo	P	•	
Channel-billed cuckoo	P	•	•
Pheasant coucal	P	•	•
Koel	P	•	•
Laughing kookaburra	P	•	•
Sacred kingfisher	P	•	•
Forest kingfisher		? NL	
Azure kingfisher		•	
White-throated nightjar	P	•	
Owlet nightjar	P	•	
Tawny frogmouth	P	•	•
Southern boobook owl	P	•	•
Barking owl		•	
Barn owl	P		
Masked owl	P		
Nankeen night heron	P	•	

APPENDIX C.2

Table: Breakdown of bird observations in the Green Point (G) and Floraville Ridge (F) areas. This includes confirmed (•), unconfirmed (?), likely (L), possible (P) and not likely (NL) species:
Forsite: List of birds which may occur in the Green Point Estate according to Forsite (1989).
Us: Sightings by the authors during the study period.
M. Noonan: Birds sighted over the past decade by Michael Noonan of the Hunter Bird Observers Club.
Incidentals: Sightings by miscellaneous sources not otherwise listed.
Survey: Birds sighted during a one-morning bird survey conducted by members of the Hunter Bird Observers Club.

COMMON NAME	FORSITE	US	M. Noonan	INCIDENTALS		SURVEY	SURVEY
	G	G	G	F	G	G	F
Fork-tailed swift			•				
Spine-tailed swift	P		•				
Welcome swallow	P		•				
Fairy martin	P						
Richard's pipit	P						
Cicada bird	P	•	•	•		•	•
Black-faced cuckoo-shrike	P	•	•	•		•	•
Masked lapwing	P		•				
Spotted quail-thrush	P						
Eastern whip-bird	P	•	•	•		•	•
White winged chough	P						
Scarlet robin	P						
Rose robin	P		•				
Jacky Winter	P				?		
Australian reed-warbler			•				
Golden-headed cisticola			•				
Southern emu-wren			•				
Superb blue wren	P	•	•	•		•	•
Variegated wren	P	•	•	•		•	•
Brown warbler	P	•	•	•			•
White-throated warbler	P		•				
Brown thornbill		•	•	•		•	•
Striated thornbill	P		•			•	
Yellow thornbill	P		•				
Buff-rumped thornbill	P	•	•	•			•
Yellow-rumped thornbill	P		•				
White-browed scrubwren	P		•	•		•	•
Dusky woodswallow	P		•				
White-breasted woodswallow			•				
Eastern yellow robin	P	•	•	•		•	•
Willie wagtail	P		•	•			
Rufous fantail	P	•	•	•		•	•
Grey fantail	P	•	•	•		•	•
Leaden flycatcher	P					? L	
Satin flycatcher						? NL	
Restless flycatcher	P						
Spectacled monarch		•					
Blackfaced monarch	P				•	•	
Golden whistler	P		•	•		•	•
Rufous whistler			•	•		•	•
Grey shrike-thrush	P	•	•	•		•	•
Orange-winged sitella	P						
White-throated tree creeper	P		•	•		•	•
Crested shrike-tit	P	•	•				
Spotted pardalote	P	•	•	•		•	•
Striated pardalote	P				?		
Mistletoe bird	P		•				
Grey-breasted silvereye	P	•	•	•		•	
Scarlet honeyeater	P		•				
Eastern spinebill	P		•	•		•	•
Lewin honeyeater	P	•	•	•		•	•
Yellow-faced honeyeater	P	•	•	•		•	•

Yellow-tufted honeyeater		•	•				
White-eared honeyeater			•				
White-plumed honeyeater	P		•				
Fuscous honeyeater		•	•				
White-naped honeyeater	P		•				
Brown-headed honeyeater	P		•				
Black-chinned honeyeater			•				
Regent honeyeater	P						
White-cheeked honeyeater	P		•	?			
New Holland honeyeater	P		•				
Tawny-crowned honeyeater			•				
Bell miner	P	•				•	
Noisy miner	P		•	•			•
Red wattlebird	P		•				
Little wattlebird	P		•				
Little friarbird			•				
Noisy friarbird	P	•	•	•		•	
Red browed firetail	P	•	•	•		•	•
Double-barred finch		•	•				
Common myna			•			•	
Olive-backed oriole	P	•	•			•	
Figbird			•				
Australian magpie	P	•	•	•		•	•
Magpie lark	P		•	•			
Australian raven	P	•	•	•		•	•
Grey butcher bird	P	•	•	•		•	•
Pied butcher bird	P						
Green catbird	P			? P			
Satin bowerbird	P		•			•	
Regent bowerbird	P		•	•			
Spangled drongo	P		•	? P			
Pied currawong	P	•	•	•		•	•
Little pied cormorant		•	•			•	
Little black cormorant			•				
Great/ Black cormorant			•			•	
Pied cormorant			•				
Australian pelican			•			•	
Little egret		•	•				
Intermediate egret			•				
Great egret			•				
White-faced heron		•	•			•	
White-necked heron			•				
Royal spoonbill					•		
Sacred ibis					•		
Black swan					•		
Wood duck			•	•			
Black duck				•			
Peregrine falcon	P						
Little falcon	P						
Brown falcon	P						
Nankeen kestrel	P		•				
Brown goshawk	P						
Collared sparrowhawk	P						

Crested hawk/ Pacific baza	P		•	? P			
Black-shouldered kite	P		•				
Whistling kite	P		•				
White-breasted sea-eagle		•	•	•			
Wedge-tailed eagle				•			
Painted button quail	P						
Stubble quail	P		•				
Brown quail	P		•				
Silver gull		•	•			•	
Crested tern						•	
Common tern					? NL		
Spotted turtle-dove		•	•	•		•	•
Brown pigeon	P						
Bar-shouldered dove	P				? P		
Common bronzewing	P		•				
Brush bronzewing	P						
Crested pigeon	P	•	•			•	
Wonga pigeon	P			? P			
Little lorikeet	P						
Musk lorikeet	P						
Scaly-breasted lorikeet	P		•				
Rainbow lorikeet	P		•			•	•
Yellow-tailed black cockatoo	P						
Glossy cockatoo	P						
Gang-gang cockatoo	P				? NL		
Sulpher-crested cockatoo	P	•	•	•		•	•
Galah	P	•	•	•		•	•
Little corella							•
King parrot	P	•	•	•		•	
Crimson rosella	P						
Eastern rosella	P	•	•	•		•	•
Dollar bird	P	•	•	•		•	•
Fantailed cuckoo	P	•	•	•			•
Brush cuckoo	P						
Golden bronze cuckoo	P				? L		
Horsfield's bronze cuckoo	P						
Pallid cuckoo	P		•				
Channel-billed cuckoo	P		•	•			
Pheasant coucal	P		•	•			•
Koel	P		•	•		•	•
Laughing kookaburra	P	•	•	•		•	•
Sacred kingfisher	P	•	•	•		•	•
Forest kingfisher					? NL		
Azure kingfisher		•					
White-throated nightjar	P		•				
Owlet nightjar	P		•				
Tawny frogmouth	P		•	•			
Southern boobook owl	P		•	•			
Barking owl			•				
Barn owl	P						
Masked owl	P						
Nankeen night heron	P		•				

APPENDIX C.3

Table Areas in which birds were sighted during the one-morning survey on 25/1/92. Where noted, birds identified by call are designated 'H', and those sighted are designated 'S'. Flycatchers sighted were unable to be positively identified due to poor light conditions and so are designated '?'.

COMMON NAME	1	2	3	4	5	6
Cicada bird		H				S
Black-faced cuckoo-shrike	H			•	•	
Eastern whip-bird	H	H	S	•	•	S, H
Superb blue wren		S	S	•	•	S, H
Variegated wren		H		•	•	
Brown warbler					•	
Brown thornbill		H	S	•	•	
Striated thornbill		S	S			
Buff-rumped thornbill					•	
White-browed scrubwren	S		S	•	•	
Eastern yellow robin	S	S	S	•	H	S
Rufous fantail		S	S			S
Grey fantail		S	S		•	S, H
Leaden flycatcher	?		?			
Satin flycatcher	?		?			
Blackfaced monarch		H	S	•		
Golden whistler		S	S	•	•	S
Rufous whistler			S			S
Grey shrike-thrush	S	H	S		•	S, H
White-throated tree creeper	H	H	S	•	•	S
Spotted pardalote	H	H	S	•	•	
Grey-breasted silvereye	H	S	S	•		
Eastern spinebill			S			S
Lewin honeyeater		S	S	•	H	S
Yellow-faced honeyeater	H		S		•	
Bell miner			S			
Noisy miner					•	
Noisy friarbird			S			
Red browed firetail	S		H	•	•	
Common myna			S			
Olive-backed oriole		H	S			
Australian magpie	S	S	S	•	•	S, H
Australian raven	S	S	S	•	•	S
Grey butcher bird		H			•	
Satin bowerbird			S			
Pied currawong		H		•	H	
Little pied cormorant			S			
Great cormorant			S			
Australian pelican			S			
White-faced heron			S			
Silver gull			S	•		
Crested tern			S			
Spotted turtle-dove		S	S		H	
Crested pigeon			S			
Rainbow lorikeet	H		H			
Sulpher-crested cockatoo	S	S	H	•	•	
Galah			S		•	S
Little corella					•	
King parrot		S	S			

Eastern rosella		S	S		•	S
Dollar bird	S	S	S	•	•	H
Fantailed cuckoo					•	
Pheasant coucal					•	
Koel		H	S		•	H
Laughing kookaburra		S	S		•	S
Sacred kingfisher		S	S		•	

APPENDIX C.4

Table: Scientific and common names of birds.

COMMON NAME	SCIENTIFIC NAME
Australian magpie	*Gymnorhina tibicen*
Australian pelican	*Pelecanus conspicillatus*
Australian raven	*Corvus coronoides*
Australian reed-warbler	*Acrocephalus australis*
Azure kingfisher	*Ceyx azurea*
Bar-shouldered dove	*Geopelia humeralis*
Barking owl	*Ninox connivens*
Barn owl	*Tyto alba*
Bell miner	*Manorina melanophrys*
Black swan	*Cygnus atratus*
Black-chinned honeyeater	*Melithreptus gularis*
Black-faced cuckoo-shrike	*Coracina novaehollandiae*
Black-shouldered kite	*Elanus notatus*
Blackfaced monarch	*Monarcha melanopsis*
Brown falcon	*Falco berigora*
Brown goshawk	*Accipiter fasciatus*
Brown pigeon	*Macropygia amboinensis*
Brown quail	*Coturnix australis*
Brown thornbill	*Acanthiza pusilla*
Brown warbler	*Gerygone mouki*
Brown-headed honeyeater	*Melithreptus brevirostris*
Brush bronzewing	*Phaps elegans*
Brush cuckoo	*Cacomantis variolosus*
Buff-rumped thornbill	*Acanthiza reguloides*
Channel-billed cuckoo	*Scythrops novaehollandiae*
Cicada bird	*Coracina tenuirostris*
Collared sparrowhawk	*Accipiter cirrocephalus*
Common bronzewing	*Phaps chalcoptera*
Common myna	*Acridotheres tristis*
Common tern	*Sterna hirundo*
Crested hawk/ Pacific baza	*Aviceda subcristata*
Crested pigeon	*Ocyphaps lophotes*
Crested shrike-tit	*Falcunculus frontatus*
Crested tern	*Sterna bergii*
Crimson rosella	*Platycercus elegans*
Dollar bird	*Eurystomus orientalis*
Double-barred finch	*Poephila bichenovii*
Dusky woodswallow	*Artamus cyanopterus*
Eastern rosella	*Platycercus eximus*
Eastern spinebill	*Acanthorhynchus tenuirostris*
Eastern whip-bird	*Psophodes olivaceus*
Eastern yellow robin	*Eopsaltria australis*
Fairy martin	*Hirundo ariel*
Fantailed cuckoo	*Cacomantis pyrrhophamus*
Figbird	*Sphecotheres viridis*
Forest kingfisher	*Halcyon macleayii*
Fork-tailed swift	*Apus pacificus*
Fuscous honeyeater	*Lichenostomus fuscus*
Galah	*Cacatua roseicapilla*

Gang-gang cockatoo	*Callocephalon fimbriatum*
Glossy cockatoo	*Calyptorhynchus lathami*
Golden bronze cuckoo	*Chrysococcyx lucidus*
Golden whistler	*Pachycephala pectoralis*
Golden-headed cisticola	*Cisticola exilis*
Great cormorant	*Phalacrocorax carbo*
Great egret	*Egretta alba*
Green catbird	*Ailurodeus crassirostris*
Grey butcher bird	*Cracticus torquatis*
Grey fantail	*Rhipidura fuliginosa*
Grey shrike-thrush	*Colluricincla harmonica*
Grey-breasted silvereye	*Zosterops lateralis*
Horsfield's bronze cuckoo	*Chrysococcyx basalis*
Intermediate egret	*Egretta intermedia*
Jacky Winter	*Microeca leucophaea*
King parrot	*Alisterus scapularis*
Koel	*Eudynamus scolopacea*
Laughing kookaburra	*Dacelo gigas*
Leaden flycatcher	*Myiagra rubecula*
Lewin honeyeater	*Meliphaga lewinii*
Little black cormorant	*Phalacrocorax sulcirostris*
Little corella	*Cacatua pastinator*
Little egret	*Egretta garzetta*
Little falcon	*Falco longipennis*
Little friarbird	*Philemon citreogularis*
Little lorikeet	*Glossopsitta pusilla*
Little pied cormorant	*Phalacrocorax melanoleucos*
Little wattlebird	*Anthochaera chrysoptera*
Magpie lark	*Grallina cyanoleuca*
Masked lapwing	*Vanellus miles*
Masked owl	*Tyto novaehollandiae*
Mistletoe bird	*Dicaem hirundinaceum*
Musk lorikeet	*Glossopsitta consinna*
Nankeen kestrel	*Falco cenchroides*
Nankeen night heron	*Nycticorax caldeonicus*
New Holland honeyeater	*Phylidonyris novaehollandiae*
Noisy friarbird	*Philemon corniculatus*
Noisy miner	*Manorina melanocephala*
Olive-backed oriole	*Oriolus sagittatus*
Orange-winged sitella	*Daphoenositta chrysoptera*
Owlet nightjar	*Aegotheles cristatus*
Pacific black duck	*Anas superciliosa*
Painted button quail	*Turnix varia*
Pallid cuckoo	*Cuculus pallidus*
Peregrine falcon	*Falco peregrinus*
Pheasant coucal	*Centhropus phasianus*
Pied butcher bird	*Cractics nigrogularis*
Pied cormorant	*Phalacrocorax varius*
Pied currawong	*Streptera graculina*
Rainbow lorikeet	*Trichoglossus haematodus*

Red browed firetail	*Neochmia temporalis*
Red wattlebird	*Anthochaera carunculata*
Regent bowerbird	*Sericulus chrysocephalus*
Regent honeyeater	*Xanthomyza phrygia*
Restless flycatcher	*Myiagra inquieta*
Richard's pipit	*Anthus novaseelandiae*
Rose robin	*Petroica rosea*
Royal spoonbill	*Platalea regia*
Rufous fantail	*Rhipidura rufifrons*
Rufous whistler	*Pachycephala rufiventris*
Sacred ibis	*Threskiornis aethiopiea*
Sacred kingfisher	*Halcyon sancta*
Satin bowerbird	*Ptilinorynchus violaceus*
Satin flycatcher	*Myiagra cyanoleuca*
Scaly-breasted lorikeet	*Trichoglossus chlorolepidotus*
Scarlet honeyeater	*Myzomela sanguinolenta*
Scarlet robin	*Petroica multicolor*
Silver gull	*Larus novaehollandiae*
Southern boobook owl	*Ninox novaseelandiae*
Southern emu-wren	*Stipiturus malachurus*
Spangled drongo	*Dicrurus bracteatus*
Spectacled monarch	*Monarcha trivirgatus*
Spine-tailed swift	*Hirundapus caudacutus*
Spotted pardalote	*Pardalotus punctatus*
Spotted quail-thrush	*Cinclosoma punctatum*
Spotted turtle-dove	*Streptopelia chinensis*
Striated pardalote	*Pardalotus ornatus*
Striated thornbill	*Acanthiza lineata*
Stubble quail	*Coturnix novazealandiae*
Sulpher-crested cockatoo	*Cacatua galerita*
Superb blue wren	*Malurus cyaneus*
Tawny frogmouth	*Podargus strigoides*
Tawny-crowned honeyeater	*Phylidonyris melanops*
Variegated wren	*Malurus lamberti*
Wedge-tailed eagle	*Aquila audax*
Welcome swallow	*Hirundo neoxena*
Whistling kite	*Haliastur sphenurus*
White winged chough	*Corcorax melanorhampus*
White-breasted sea-eagle	*Haliaeetus leucogaster*
White-breasted woodswallow	*Artamus leucorhynctus*
White-browed scrubwren	*Sericornis frontalis*
White-cheeked honeyeater	*Phylidonyris niger*
White-eared honeyeater	*Lichenostomus leucotis*
White-faced heron	*Ardea novaehollandiae*
White-naped honeyeater	*Melithreptus lunatus*
White-necked heron	*Ardea pacifica*
White-plumed honeyeater	*Lichenostomus peniccillatus*
White-throated nightjar	*Eurostopodus mystacalis*
White-throated tree creeper	*Climacteris leucophaea*
White-throated warbler	*Gerygone olivacea*

Willie wagtail	*Rhipidura leucophrys*
Wonga pigeon	*Leucosarcia melanoleuca*
Wood duck	*Chenonetta jubata*
Yellow thornbill	*Acanthiza nana*
Yellow-faced honeyeater	*Lichenostomus chrysops*
Yellow-rumped thornbill	*Acanthiza chrysorrhoa*
Yellow-tailed black cockatoo	*Calyptorhynchus funereus*
Yellow-tufted honeyeater	*Lichenostomus melanops*

APPENDIX D: MAMMAL RESULTS AND TRAP DATA

APPENDIX D.1: Mammals Present

Table Forsite Mammals observed or thought to occur in the study area. The **Forsite** list is of mammals possibly occurring in Green Point Estate, as listed in the Conservation and Recreation Study, 1989. Also shown is a list of mammals thought to occur in the Mt Hutton province according to Winning's **Natural Areas** study, 1990. The **Green Point** and **Floraville** lists are of actual sightings by the authors, with the exceptions of the Feathertail Glider (anecdotal evidence, J. Timmins, 1992) and the fox (presence of scats).

SCIENTIFIC NAME	COMMON NAME	FORSITE	GREEN POINT	FLORA-VILLE	NATURAL AREAS
Arboreal Mammals					
Pseudocheirus peregrinus	Ringtail Possum	•	•	•	•
Trichosurus vulpecula	Brushtail Possum	•	•	•	•
Cercartetus nanus	Eastern Pygmy Possum	•			
Petaurus breviceps	Sugar Glider	•	•	•	•
Acrobates pygmaeus	Feathertail Glider	•		•	•
Phascogale tapoatafa	Brush-tailed Phascogale	•			
Phascolarctos cinereus	Koala	•			
Terrestrial Mammals					
Rattus fuscipes	Common bush rat	•			?
Rattus lutreolus	Eastern swamp rat	•			
Rattus rattus	Black Rat		•	•	
Mus musculus	House Mouse			•	
Antechinus flavipes	Yellow-footed Antechinus	•			
Antechinus stuartii	Brown Antechinus	•			?
Sminthopsis murina	Common Dunnart	•		•	?
Perameles nasuta	Long-nosed Bandicoot	•			
Isoodon macrourus	Northern Brown Bandicoot	•		•	•
Tachyglossus aculeatus	Echidna	•			•
Lepis capensis	Brown Hare			•	
Vulpes vulpes	Fox		•	•	

APPENDIX D.2: Trapping Results

Site No.	Trapnights Elliott/Cage	Species	Elliott/Cage
F1	108/15	5 X *Rattus rattus*	2/3
F2	82/8	4 X *R. rattus*	1/3
F3	40/-	-	-
F4	120/-	1 X *Sminthopsis murina*	1/-
		1 X *R. rattus*	1/-
F5	108/16	3 X *R. rattus*	-/3
F6	120/-	2 X *R. rattus*	2/-
F7	108/8	1 X Red-bellied black snake	1/-
F8	108/16	2 X *R. rattus*	-/2
		1 X *Isoodon macrourus*	-/1
F9	40/4	2 X *Mus musculus*	2/-
10 & 11	144/-	5 X *R. rattus*	5/-
G12	108/16	2 X *R. rattus*	-/2
G13	108/18	5 X *R. rattus*	2/3
G14	40/4	-	-
G15	108/16	-	-
G16	108/16	3 X *R. rattus*	2/1
G17	108/12	4 X *R. rattus*	-/4
G18	108/12	1 X *R. rattus*	1/-
G19	108/8	-	-
G20	40/8	2 X *R. rattus*	2/-

Total: 1804 Elliott trapnights (G: 912; F: 892)
177 Cage trapnights (G: 110; F: 67)

39 X *Rattus rattus* + 3 recaptures: 18 Elliott/21 Cage (G: 21; F: 18)

1 X *Sminthopsis murina*: Elliott, F
1 X *Isoodon macrourus*: Cage, F
1 X Red-bellied black snake: Elliott, F
2 X *Mus musculus*: Elliott, F

NB: Trapnights= No. traps X nights set
F = Floraville Ridge area
G = Green Point Estate
Sites 10 & 11 were culverts between Green Point Estate and Floraville Ridge

APPENDIX D.3: Stagwatching Results

Date	Place	'Stags' watched	Animals Sighted	'Stags' Occupied
2/1/92	G	5	Sugar glider X 2	1
9/1/92	F	4	Ringtail possum X 2	2
13/1/92	F	4	Ringtail possum X 5	1
			Sugar glider X 2	1
15/1/92	G	9	Sugar glider X 2	1
20/1/92	F	4	Sugar glider X 2	2
22/1/92	G	4	Ringtail possum X 1	1
29/1/92	G	4	Tawny frogmouth X 1	1
5/2/92	G	4	Ringtail possum X 2	2
			Sugar glider X 2	1
			Brushtail possum X 1	1
			Tawny frogmouth X 1	1
17/2/92	F	1	Ringtail possum X 1	1
18/2/92	F	1	Ringtail possum X 1	1
	G		Sugar glider X 1	1

F = Floraville Ridge area
G = Green Point Estate
'Stags' occupied = no. of stags the species was seen departing from.

In total:	Sugar gliders X 11	occupied 16% of stags
	Ringtail possums X 12	occupied 18% of stags
	Tawny frogmouths X 2	occupied 4% of stags
	Brushtail possums X 1	occupied 2% of stags
	45 stags watched	**40% of stags occupied**

APPENDIX D.4: Spotlighting Results

Date	Place	Person Hours	Animals Sighted
2/1/92	G	6	Ringtail possum X 4
			Southern Boobook owl X 1
9/1/92	F	4	Ringtail possum X 8
15/1/92	G	4.5	Ringtail possum X 4
			Southern Boobook owl X 1 (call)
22/1/92	G	4	Ringtail possum X 10
29/1/92	G	4.5	Tawny frogmouth X 1
			Ringtail possum X 29
			Sugar glider X 2
5/2/92	G	4.5	Ringtail possum X 3
			Brushtail possum X 1
			Tawny frogmouth X 1
17/2/92	F	5	Ringtail possum X 16
			Sugar glider X 1
			Brushtail possum X 1
			Southern Boobook owl X 1 (call)
18/2/92	F	3	Ringtail possum X 14
			Southern Boobook owl X 1 (call)
	G	2	Ringtail possum X 2
	G	3	Ringtail possum X 3
			Tawny Frogmouth X 1

F = Floraville Ridge area
G = Green Point Estate
Person hours = hours spent X no. people spotlighting

In total: Sugar gliders X 3
Ringtail possums X 93
Tawny frogmouths X 3
Brushtail possums X 2
Southern Boobook owls X 4 (1 sighted, 3 call only)
40.5 person hours spent

APPENDIX D.5: Koalas

Research application by Clulow and Lim, 1991, outlining the status of koalas around Lake Macquarie.

D.5

CONSERVATION AND MANAGEMENT OF KOALAS AROUND LAKE MACQUARIE

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26 March, 1991

0. EXECUTIVE SUMMARY

The remnant koala populations remaining in bushland areas surrounding Lake Macquarie are unlikely to survive beyond the end of this century without active management. There is a need for solid ecological data to manage the dwindling local populations. A scientifically based study of local koalas and their habitats is required to provide the required ecological data base and to understand the biology of the local populations. Support is sought for a project to evaluate the status of koalas in the Lake Macquarie area, to determine where the most significant and viable areas of habitat occur and to investigate the ecology of local populations with a view to producing recommendations for their long term management and conservation. It is anticipated that the findings presented in the final report for this Project will contain new insights into the ecology of isolated urban koala populations, will identify areas around Lake Macquarie in which efforts to conserve the koala should be concentrated and will contribute recommendations on a koala management strategy.

1. AIMS

The aims of the project are (i) to evaluate the status of the koala in the major bushland areas around Lake Macquarie (ii) to establish a sound ecological basis for management of koala populations in the Lake Macquarie area through a direct study of the ecology of one or more local koala populations.

2. BACKGROUND

2.1 Decline of the Koala in NSW

The koala (*Phascolarctos cinereus*) has experienced a major decline in NSW over the last century, with the principal cause being habitat loss as eucalypt forests were cleared and converted to farmland (Lunney and Leary, 1988; Hume, 1990; Reed and Lunney, 1990a,b; Lunney *et al*, 1990; Pahl *et al*, 1990; Reed *et al*, in press). The available historical, ecological and physiological evidence indicates that prime koala habitat in NSW consists of eucalypt forests on high nutrient soils. Most high nutrient forests have been converted to farmland, and consequently the prime habitat for koalas has largely been eliminated or severely degraded. The clearing of eucalypt forests from areas of high fertility soils largely explains the decline of the koala, with other factors such as hunting, drought and disease playing a secondary role. The consequence of the selective clearing of

prime koala habitat is that the koala is now uncommon to rare in most localities in NSW (Reed and Lunney, 1990a). The continuing decline of the koala was confirmed in the State-wide survey undertaken by the NSW National Parks and Wildlife Service in 1986-87 (Reed *et al*, in press). The results of that survey and other evidence presented at the 1988 NSW Koala Summit lead to the proposal by senior NSW NPWS scientists (Reed and Lunney, 1990a) that the koala should be reclassified as a "Rare and Vulnerable Species" (Part 2, Schedule 12 [Endangered Species], of the NSW National Parks and Wildlife Act, 1974) from its current listing as less endangered "Fauna of Special Concern" (Schedule 12, Part 1).

There are strong reasons for Lake Macquarie Council to be concerned about the future of the koala in the wild in NSW. First, koalas are poorly conserved in the established National Parks and State Forest reserve systems (Reed *et al*, in press), and there is little prospect that the establishment of new Reserves will incorporate significant additional koala populations, because most koala populations occur on freehold rural and urban lands. Second, land clearing and development seriously threaten the viability of many remaining populations (Clulow, 1989, 1990; Smith and Smith, 1990; Denny, 1991; Reed *et al*, in press). Continuing loss of habitat is the single greatest threat to koalas in the wild in NSW. Urban expansion and clearing of eucalypts on rural properties are currently the principal causes of habitat fragmentation and loss. As a result, the long term survival of populations in many areas where koalas still occur is unlikely..

2.2 Impacts of Urbanization on Koalas

Koalas do not cope well with urbanization. Urbanization is the basic problem facing koalas in Lake Macquarie. There are a number of documented examples (Lee and Martin, 1988; Smith and Smith, 1990; Starr *et al*, 1990; Denny, 1991) which indicate that koala populations usually decline in the face of an expanding urban environment, and as a well-known example the population on Barrenjoey Peninsula in Sydney (Smith and Smith, 1990), is nearly extinct with the most recent population estimate being only 8 individuals. The crash of the Barrenjoey population (from well over 100 individuals in 1970) occurred after many years of gradual habitat destruction and loss of native forest in the area. The principal causes of population decline in developed areas appear to be:

(i) loss of habitat through the removal of eucalypt trees which provide food and refuge
(ii) increased mortality from motor vehicle injuries
(iii) increased mortality from attacks by domestic dogs

All of these factors may interact, for example, koalas encounter dogs and cross roads more frequently as the number of available food trees decreases and they are forced to occupy larger home ranges. Populations under nutritional and environmental stress from these causes are more likely to

experience outbreaks of debilitating chlamydial disease which can also cause high rates of infertility. The effect on populations exposed to these conditions is that mortalities may exceed the rate of recruitment to the population, with population decline and extinction a probable outcome. In some cases, there may be islands within urban areas that provide some refuge for koala populations. Such areas include natural areas such as uncleared bushland (for example areas of vacant Crown Land on Tilligerry Peninsula in Port Stephens) and occasionally modified environments occurring as a result of human activity (for example, Muree Golf Course at Raymond Terrace which provides habitat and relative safety for koalas and may be occupied by several koalas at any one time).

It is not yet known whether urban populations with some areas of natural and semi-natural bushland can be conserved in the long term, even if they are carefully managed. Nevertheless, there is little option in NSW other than to attempt to conserve such populations because a large proportion of our koala populations are under threat from urban development.

2.3 Koalas in the Lake Macquarie Area

The major remaining concentrations of koalas in NSW occur on the North Coast and adjacent ranges and slopes. Concentrations of koalas are reported from Port Stephens northwards (Reed *et al*, in press). South of Port Stephens reports of koalas become increasingly rare, even though many areas of the Central and South Coasts formerly had large populations. Lake Macquarie is one area that still contains remnant populations of koalas, although none of these populations can be regarded as secure. There is a strong possibility that no wild populations will persist in the Lake Macquarie area beyond the end of this century.

Currently, small populations are known to exist on Pulbah Island (70 ha) and on Wangi Point (60 ha). The small population sizes and the small areas of bushland available to these populations are cause for serious concern because of the potential for sudden extinction due to localised environmental disasters (eg bushfires, drought, overbrowsing, disease outbreaks) and because of the inevitable loss of genetic diversity due to the high level of inbreeding occurring as a result of small population size.

A number of reports of koala sightings in the Green Point area within the last 18 months were received by one of us (J. Clulow). However, a survey of readers of a local newspaper (The Post) in March 1991 produced few extra reports and a search of parts of Green Point by J. Clulow with members of the Hunter Koala Preservation Society yielded no conclusive signs of the presence of koalas. Taken together, these observations and reports indicate that the population in the Green Point area is very small and is in the final stages of extinction. To date, Lake Macquarie Council, unlike many other Councils, has taken no direct action to protect its remaining koala populations through

either reservation of areas specifically with the intention of conserving koala populations or by the preparation and implementation of a Koala Management Plan for the area. The problems faced in conserving the few remaining wild koalas of the Lake Macquarie area are so serious that only a co-ordinated effort based on sound scientific and ecological planning will offer any chance of success.

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APPENDIX E: Amphibians and Reptiles

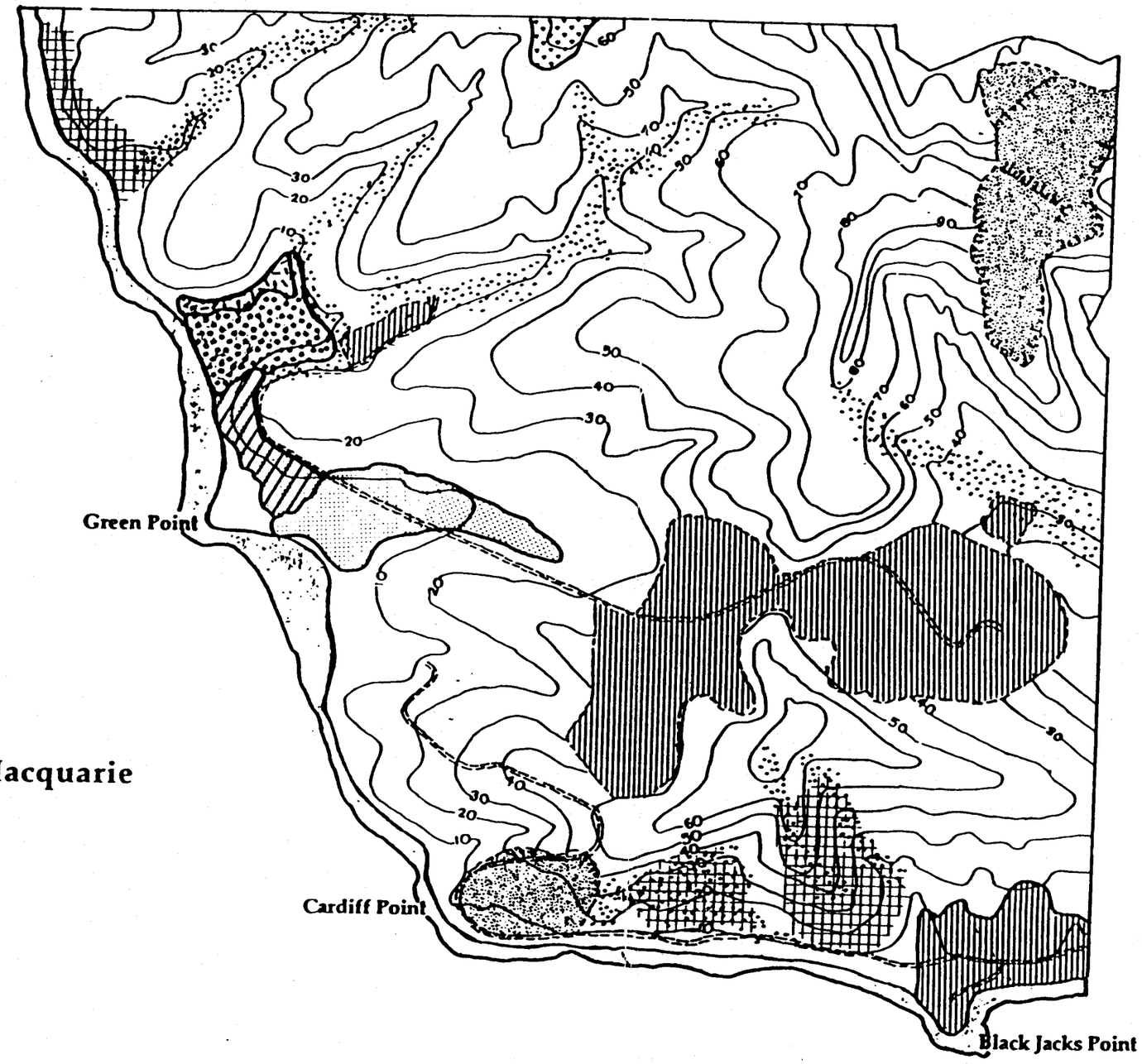
Table Amphibians and reptiles sighted in the Green Point Estate (**G**) and Floraville Ridge area (**F**). Species not sighted by the authors but reputed to have been present by local residents are deliniated '**?**'. Also listed are amphibians and reptiles thought to occur in the Mt Hutton province according to Winning's Natural Areas study, 1990 (**NA**). The Common Tree Snake was not sighted by the authors but was sighted by a resident during the study period.

SCIENTIFIC NAME	COMMON NAME	G	F	NA
Tortoises				
Chelodina longicollis	Long-necked tortoise		?	
Lizards				
Diplodactylus vittarus	Wood gecko			•
Lialis burtonis	Burton's legless lizard			•
Pygopus lepidipodus	Common scaly foot			•
Pogona barvata	Bearded dragon		?	•
Gemmatophora muricata	Jacky lizard	•		•
Physignathus lesueurii	Eastern water dragon	•	•	•
Varanus varius	Lace monitor		•	•
Anomalopus sp (3)				•
Carlia burnettii				•
Carlia tetradactyla				•
Cryptoblepharus virgatus				•
Ctenotus robustus	Striped skink			•
Egernia major	Land mullet	•	•	•
Lampropholis delicata	Grass skink	•	•	•
Lampropholis guichenoti	Grass skink			•
Lampropholis mustelina	Weasel skink	•		•
Saiphos equalis	Three-toed skink		•	•
Sphenomorphus quoli	Golden water skink			•
Tiliqua casuarinae	She-oak skink			•
Tiliqua scincoides	Eastern blue-tongued lizard	•	•	•
Snakes				
Morelia spilota	Diamond python		?	
Dendrelaphis punctulata	Common tree snake	•		•
Cacophis kreftii	Dwarf crowned snake			•
Demansia psammophis	Yellow-faced whip snake			•
Furnia diadema	Red-naped snake			•
Hemiaspis signata	Swamp snake			•
Pseudechis porphyriacus	Red-bellied black snake	?	•	•
Typhlina nigrescens	Blind snake			•

SCIENTIFIC NAME	COMMON NAME	G	F	NA
Frogs				
Crinia signifera	Common Eastern froglet	•	•	•
Litoria fallax	Dwarf tree frog	•		•
Litoria peronii	Peron's tree frog		•	•
Litoria aurea	Green & golden bell frog			•
Litoria phyllochroa	Leaf green tree frog		•	
Litoria caerulea	Green tree frog			•
Lymnodynastes peronii	Brown striped frog	•		•
Lymnodynastes tasmaniensis	Marsh frog			•
Pseudophryne coriacea	Red-backed toadlet	•	•	•
Pseudophryne bibronii	Brown toadlet			•
Adelotus brevis	Tusked frog			•
Uperoleia laevigata	Yellow-spotted toadlet			•

Figure 2

VEGETATION COMMUNITIES



Legend

CONSERVATION VALUE

5 — Closed Littoral Forest
Cassine australis
Cupaniopsis anacardioides

5 — Low Open Littoral Forest
Melaleuca styphelioides
Carex appressa

4 — Open Forest
Casuarina glauca
Melaleuca styphelioides

4 — Open Forest
Eucalyptus tereticornis,
Eucalyptus propinqua

3 — Open Forest
Eucalyptus gummifera,
Angophora costata

3 — Open Forest
Eucalyptus maculata,
E. paniculata, E. propinqua

2 — Grassland

1 — No vegetation cover

Closed Seagrass Meadow
Zostera capricorni

Invasion of Lantana camara

Invasion of
Chrysanthemoides moniliferum

CONSERVATION & RECREATION STUDY

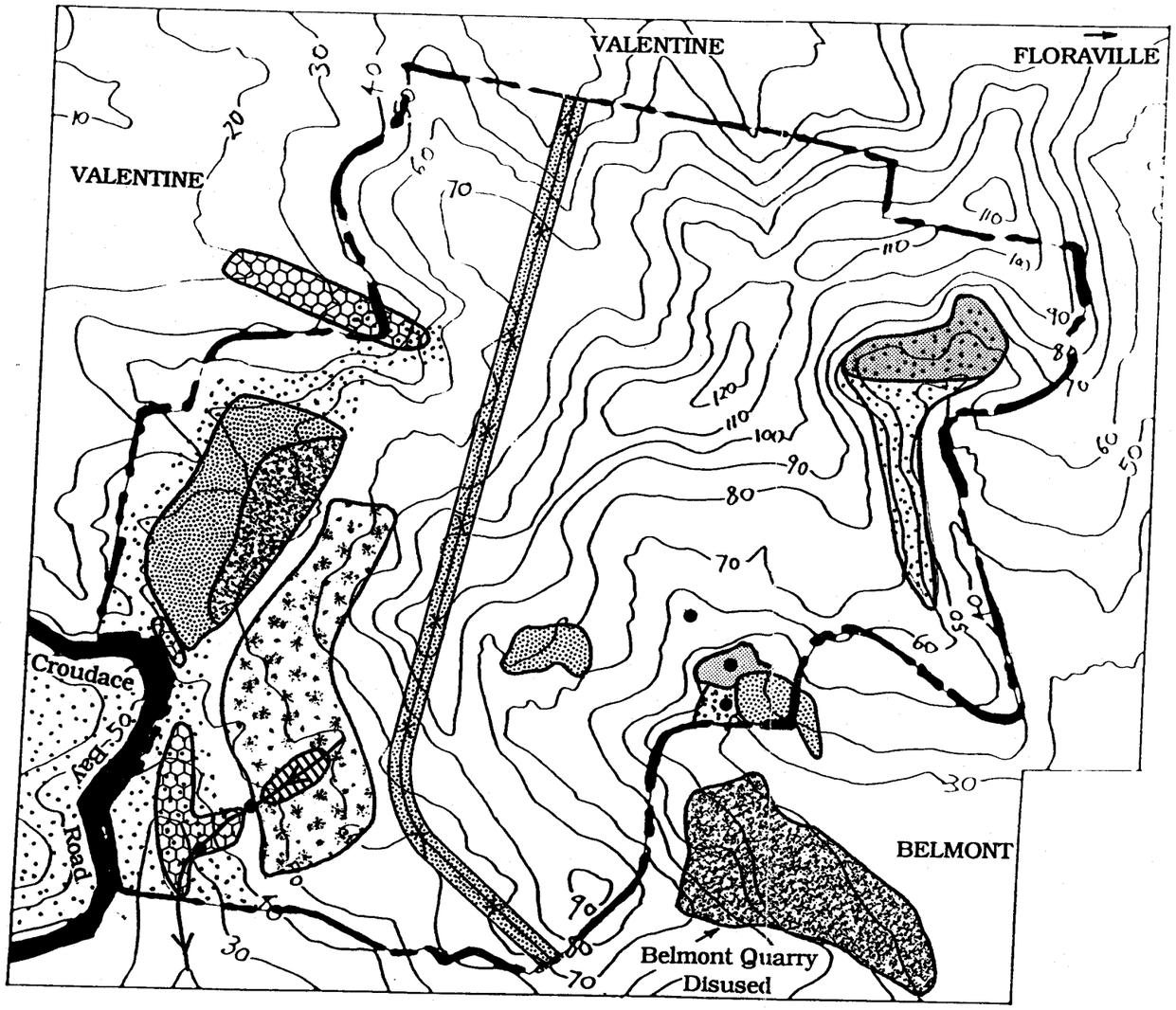
GREEN POINT ESTATE

0 100 200 300 M

Forsite Landscape Architects and Planners

FLORAVILLE RIDGE VEGETATION COMMUNITIES

Figure 3



LEGEND

- Open Forest
  Eucalyptus maculata/E. paniculata alliance, with ridge-top patches of Angophora costata/E. gummifera alliance
- Open Forest
  Eucalyptus maculata/E. paniculata with Melaleuca styphelioides understorey
- Open Forest
  Eucalyptus haemastoma/Angophora costata. E.gummifera
- Closed Forest
  Guioa semiglauca
  Cassine australis
- Wetland
  Typha sp.
  Melaleuca linariifolia
- Grassland
- Weed infestation
  Lantana camara
  Chrysanthemoides moniliferum
- No vegetation cover
- Transmission line
- Permanent water course/ watercourse with pools
- Study area boundary

10 m Contour interval

0 100 200 300 400m

SCALE 1:8000

N

GREEN POINT ESTATE TRAPPING & SPOTLIGHTING SITES

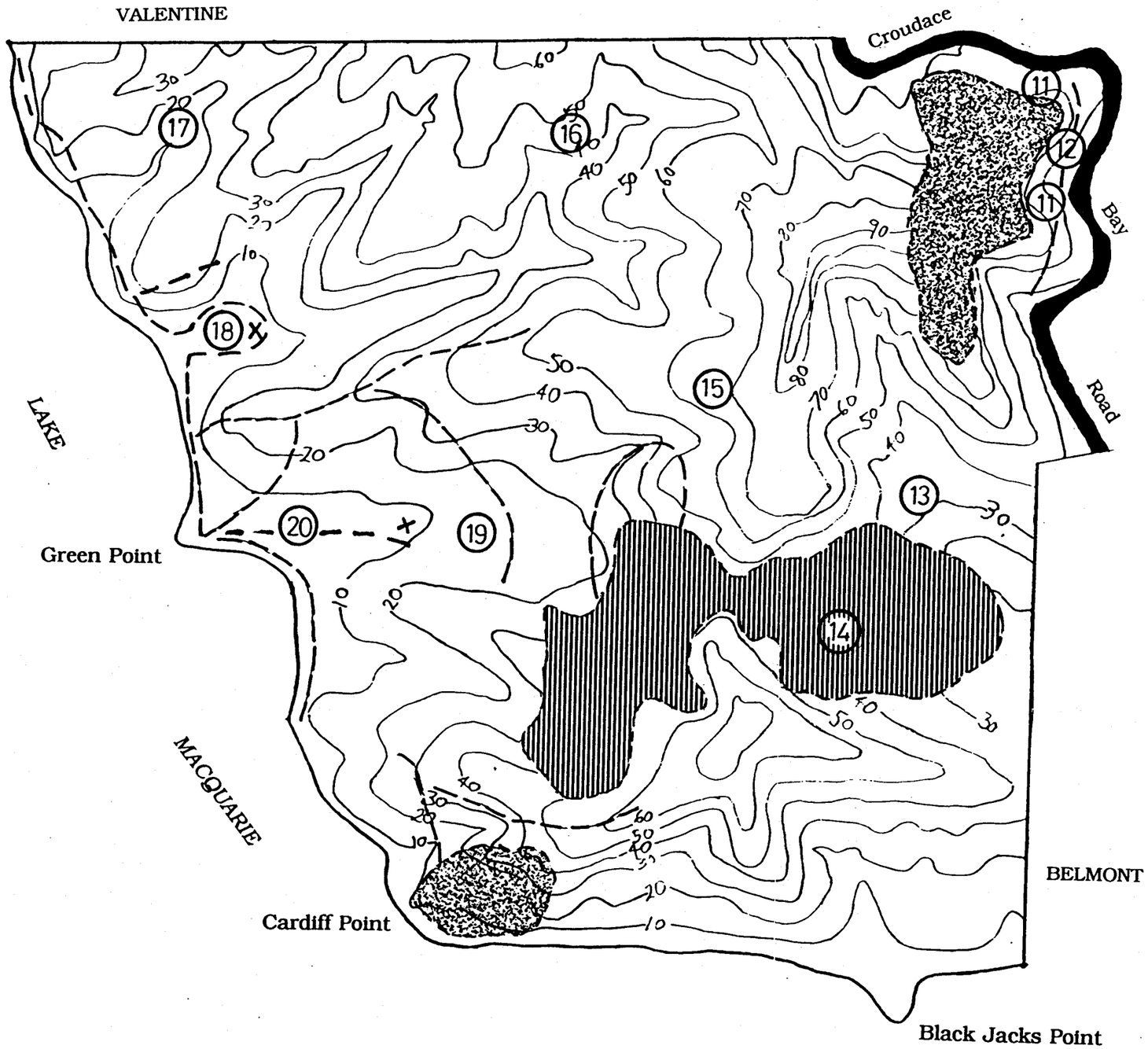


Figure 4

LEGEND

- No vegetation cover
- Grassland
- spotlight transect
- (5) Ground mammal trapsite
- X Pitfall trap

10 m Contour interval

0 100 200 300 400 m

SCALE 1:8000

N

FLORAVILLE RIDGE TRAPPING & SPOTLIGHTING SITES

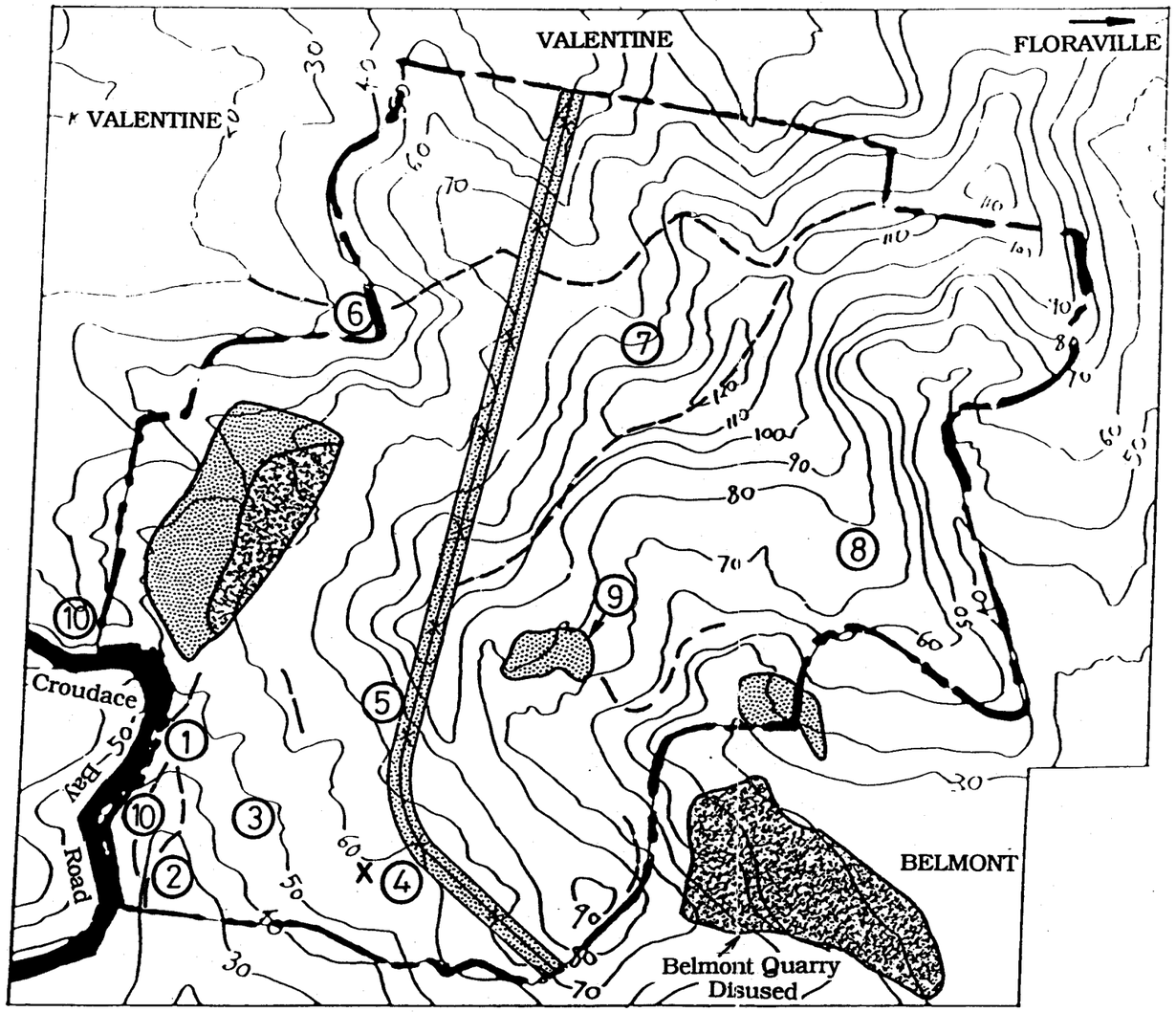


Figure 5

LEGEND

- No vegetation cover
- Grassland
- X Pitfall trap
- Spotlighting transect
- ⑤ Ground mammal trapsite

Contour interval 10m

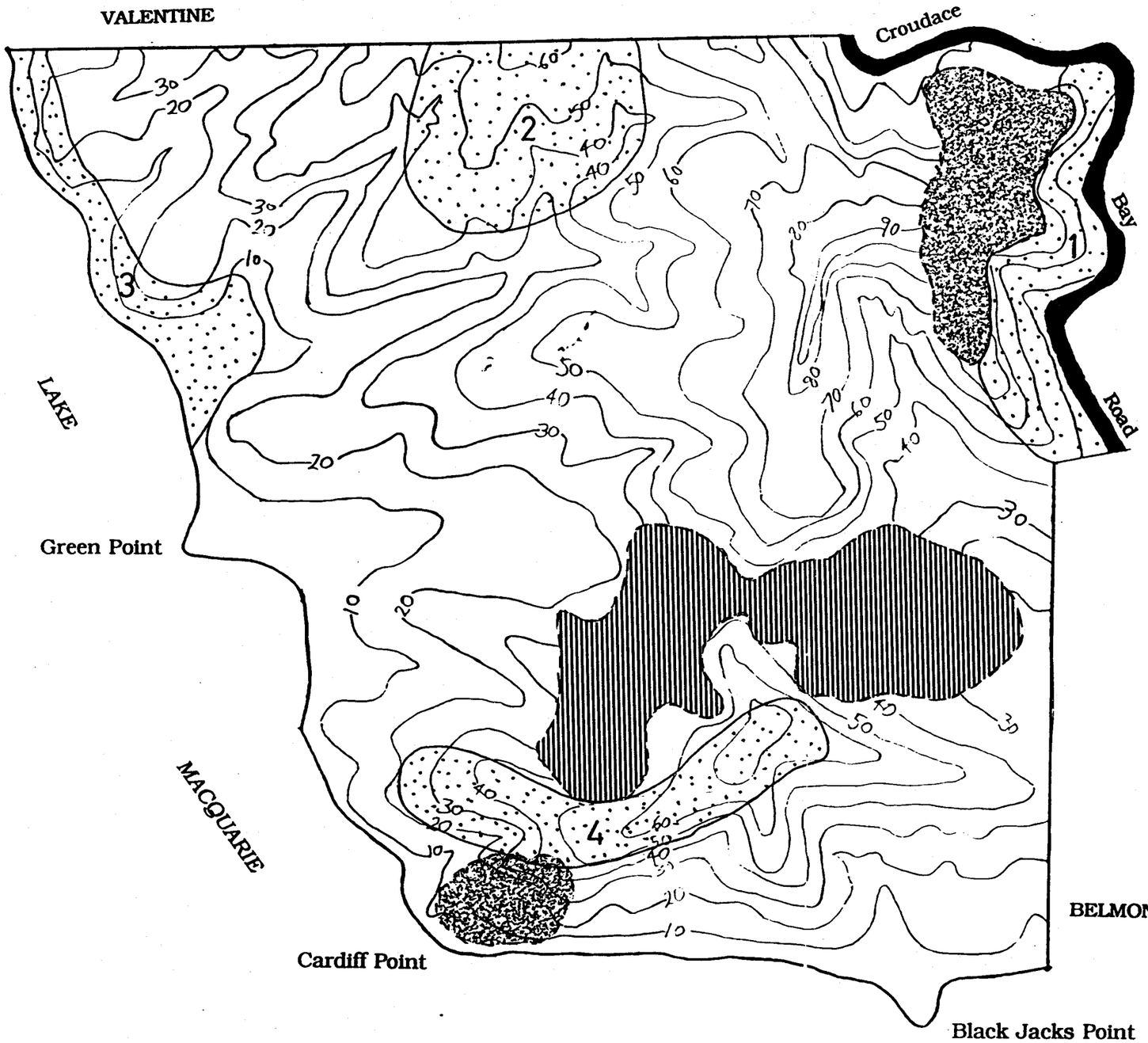
0 100 200 300 400m

SCALE 1:8000

N

GREEN POINT ESTATE BIRD SURVEY AREAS

Figure 6



LEGEND

- No vegetation cover
- Grassland
- 5 Bird survey areas

Contour interval 10m

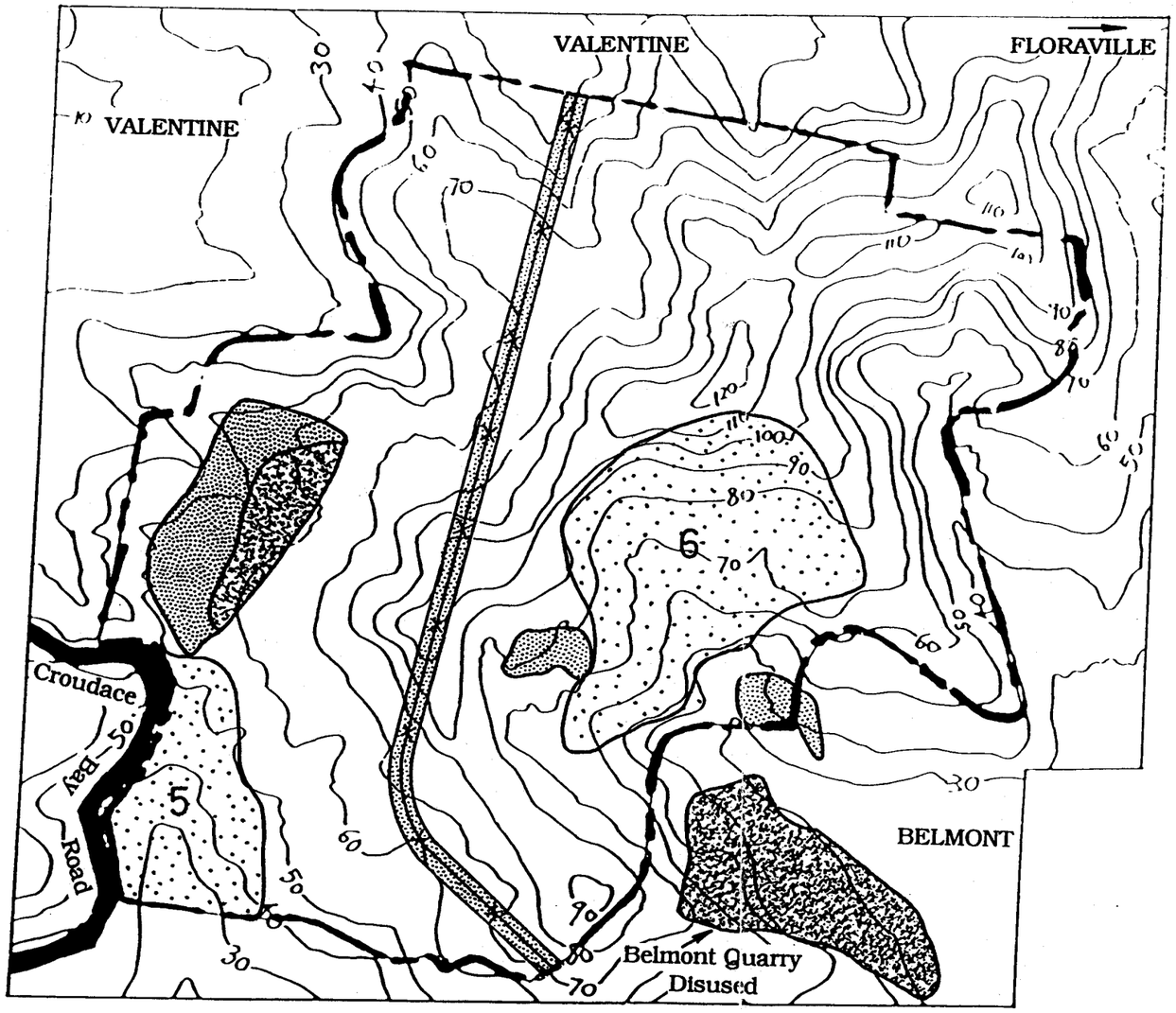
0 100 200 300 400 m

SCALE 1:8000

N

FLORAVILLE RIDGE BIRD SURVEY AREAS

Figure 7



LEGEND

- Transmission line
- No vegetation cover
- Grassland
- 5 Bird survey areas

Contour interval 10m

0 100 200 300 400m

SCALE 1: 8000

N