

6. VEGETATION

6.1 BASELINE VEGETATION SURVEY

A baseline vegetation survey of Bradshaw Station was conducted by ERA Environmental Services Pty Ltd during June 1997. Their report is contained in Volume 2 of this EIS and the major findings are summarised in this section.

6.1.1 Survey Objectives

The main objectives of the baseline vegetation survey were to:

- describe, classify and map the vegetation on Bradshaw Station
- describe the vegetation communities within mapping units
- record the occurrence of species of conservation significance
- record the occurrence of species that have not previously been recorded in the region
- record the occurrence of introduced species
- assess the potential impacts of Defence use on vegetation
- propose management strategies to preserve biological diversity, protect sensitive communities and rare species, and maintain and enhance sustainable ecosystems.

6.1.2 Survey Methodology

A total of 151 sites were surveyed over a two week period (refer Figure 6.1). Most sites on the Angalarri Plain (Sites 1 to 58) were accessed by vehicle while all other sites (Sites 59 to 151) were accessed by helicopter.

Species that were not identified in the field were sampled and identified by staff of the Northern Territory Herbarium. For some specimens, especially sedges and grasses, identification to family or genus level only was possible due to a lack of fertile material.

Data collected by PWCNT in 1993 and by the MGI Unit of the Australian Army in 1995 at a number of additional sites were included for the purposes of improving the accuracy of the mapping unit classification and to increase the collective knowledge of vegetation in the area. These sites are numbered 152 to 208 on Figure 6.1.

At each plot, observations were made of the landform pattern, slope, aspect, geology, % rock outcrop, % gravel, % bare ground, and surface soil. Species abundance was estimated as the percentage cover of each species in the upper, middle and lower strata. Lifeform data was collected for 12 plant groups and the projected foliage cover (PFC) of each estimated. The overall percentage cover and average height of the upper, middle and lower strata was estimated and, based on the cover of the dominant stratum, a structural classification of the community was given.

6.1.3 Survey Results

Habitats and Communities

The three broad habitats that are commonly found in the Top End of the Northern Territory, namely sandstone habitats, lowland habitats and coastal habitats, all occur on Bradshaw Station. These can be further divided into vegetation communities (plant assemblages) based on dominant species and foliage cover. A total of 70 communities were identified from the survey data collected and are described in the full report contained in Volume 2.

The 70 vegetation communities were grouped under eight broad structural classes. Within these structural classes,

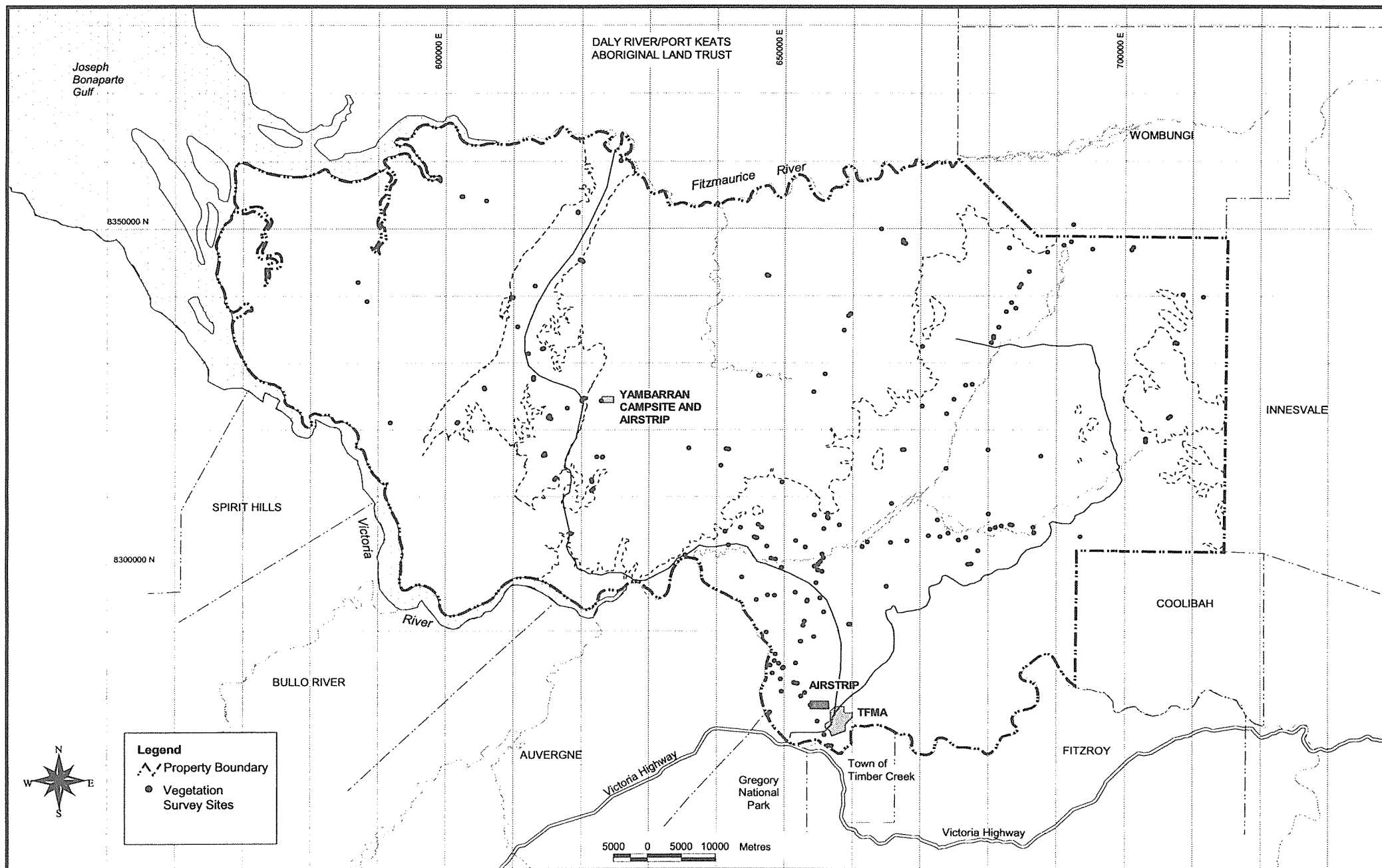


Figure 6.1 :
VEGETATION SURVEY SITES

communities were combined into a total of 51 vegetation classes (mapping units) for the purposes of mapping. The eight structural classes (refer Figure 6.2) and number of vegetation mapping units contained in each are as follows:

1. Monsoon Forest – 1 mapping unit
2. Riparian Forest, Open Forest – 3 mapping units
3. Eucalypt Open Forest, Woodland – 18 mapping units
4. Low Open Forest, Woodland – 6 mapping units
5. Eucalypt Open Woodland – 5 mapping units
6. Other Open Woodland - 7 mapping units
7. Shrubland – 1 mapping unit
8. Grassland – 5 mapping units

Figure 6.3 shows the distribution of each mapping unit. A description of the mapping units within each of the eight habitats is provided in the full report contained in Volume 2.

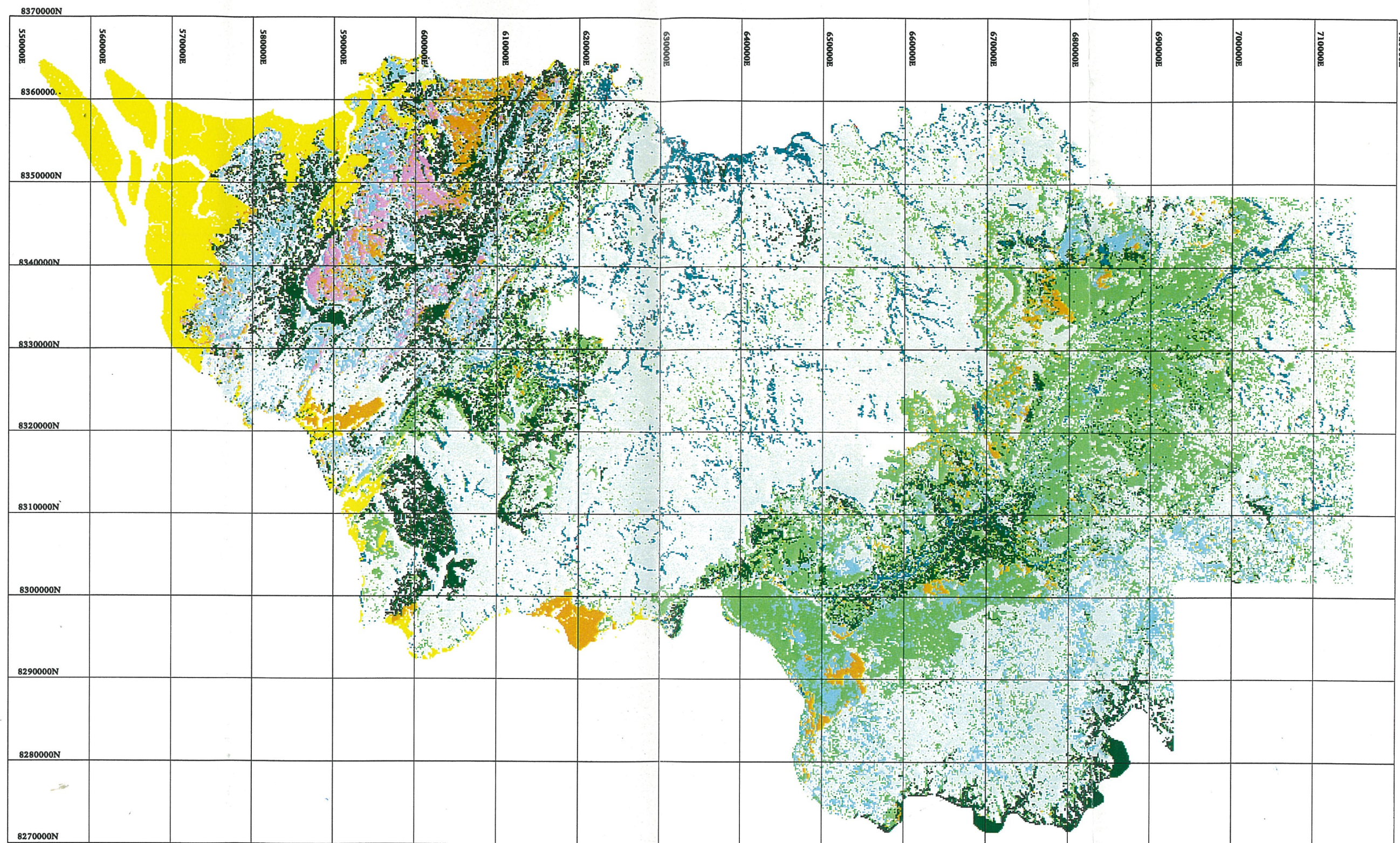
The dominant mapping class in sandstone habitats is *Eucalyptus miniata* and *E.phoenicea* open woodland, and in low habitats is *E.microtheca* and *Corymbia latifolia* open woodland.

Australia has been categorised into a number of biogeographic regions (bioregions) to assist in the assessment of conservation values, the current reservation of those values and land use planning. Bradshaw Station is within the Victoria-Bonaparte Bioregion of the Northern Territory. Most of the vegetation communities within this Bioregion are well represented in the Kimberley Region and in other parts of the Northern Territory. The exceptions are the *Xerochloa* grasslands on Mosquito Flat and in the south of the Western Hills, and *Melaleuca minutifolia* low woodland, both of which occur almost exclusively in the Victoria-Bonaparte Bioregion. These species occur mainly in this Bioregion but are poorly represented in reserves. They are likely to increase after destocking, particularly the *Xerochloa* grasslands.

Table 6.1 indicates the distribution of the mapping units within each of the nine proposed training sectors within BFTA.

Table 6.1 – Major Vegetation Mapping Units Within Training Sectors

Training Sector	Vegetation Mapping Unit	Approximate Cover (%)
Western Hills	Terminalia spp, Owenia vernicosa (with mixed species) over hummock grasses	19.30
	Corymbia latifolia over hummock grasses	17.50
	Corymbia phoenicea, Corymbia dichromophloia over hummock grasses	13.60
	Eucalyptus miniata over hummocks	6.60
	Plectrachne spp	5.90
	Acacia spp over hummock grasses	5.50
	Mangrove	5.10
	Xerochloa sp, Eleocharis sp	0.80
	Monsoon species	<0.05
	Melaleuca leucadendra with mixed species	<0.05
	Melaleuca minutifolia, M. sericea over annual and perennial grasses	<0.05
Lalngang	Eucalyptus miniata over hummocks	22.10
	E. tetradonta with mixed species	15.00
	Corymbia phoenicea over hummock grasses	11.70
	Terminalia canescens, Erythrophleum chlorostachys over annual grasses	8.80
	Corymbia polycarpa with mixed species	8.10
	Corymbia latifolia over annual and perennial grasses with sedges	6.10
	Corymbia dichromophloia over annuals and hummocks	3.70
	Melaleuca leucadendra with mixed species	3.60
	Xerochloa sp, Eleocharis sp	0.50
	M. minutifolia, M. sericea over annual and perennial grasses	0.20
	Monsoon species	0.10



Vegetation Structural Classes

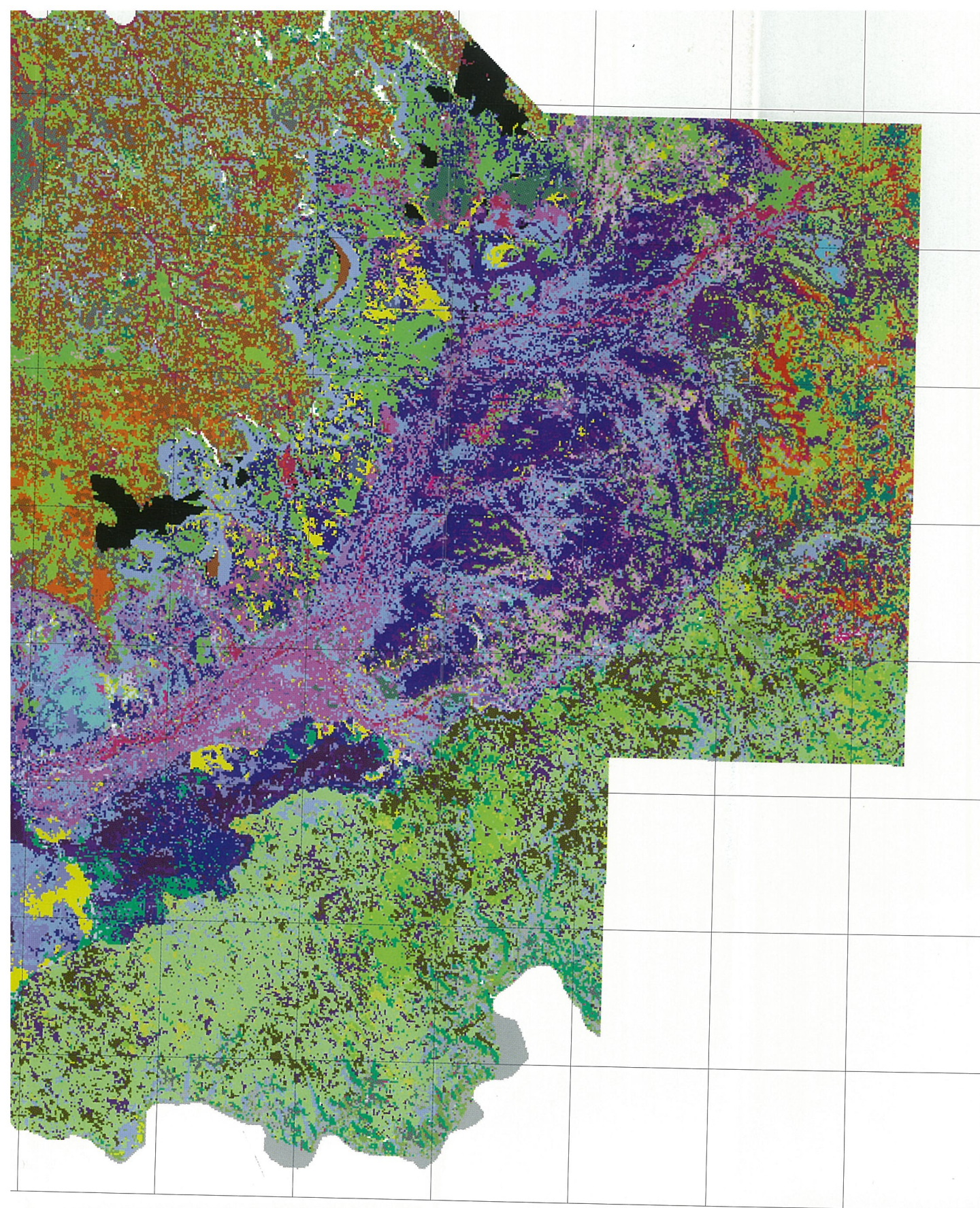
■ Monsoon Forest	■ Other Open-Woodland
■ Riparian Forest, Open-Forest	■ Shrubland
■ Eucalypt Open_Forest, Woodland	■ Grassland
■ Low Open_Forest, Low Woodland	■ Salt Flat, Mangrove
■ Eucalypt Open-Woodland	■ Water, Bare Areas, Fire Scars, Unclass

SCALE 1:500000

10 0 10 20 Kilometres

Grid lines are 10 000 metre intervals of the Universal Transverse Mercator Grid, Zone 52, Australian National Spheroid





10 metres

National Spheroid

SHRUBLAND

Acacia spp over hummock grasses

GRASSLAND

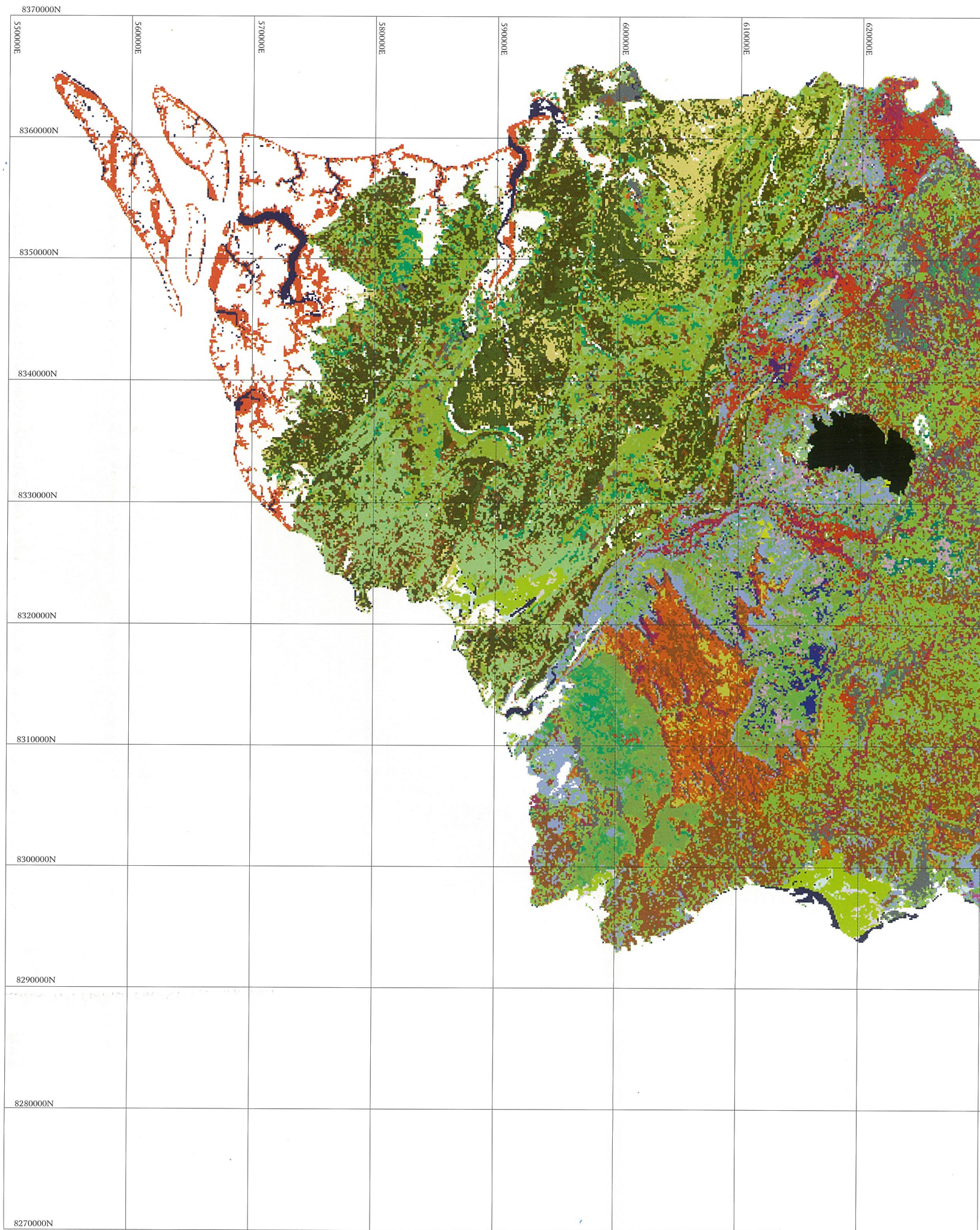
C. fallax, S. nervosum, S. plumosum, T. triandra
Xerochloa sp, Eleocharis sp.
S. stipoides, Eriachne spp, Aristida spp
Plectrachne spp
Sedge

OTHER

Salt Flats
Mangrove
Water
Bare Areas
Firescar
Unclass



Figure 6.3:
BRADSHAW FIELD
TRAINING AREA
VEGETATION CLASSES



SCALE



Grid lines are 10 000 metre intervals of the Uni

MONSOON FOREST

mixed species

RIPARIAN FOREST, OPEN-FOREST

M.leucadendra with mixed species
E.microtheca, T.platyphylla
E.camaldulensis, E.microtheca

EUCALYPT OPEN-FOREST, WOODLAND

E.miniata, E.tetradonta over annual and perennial grasses
E.miniata (with E.tetradonta, E.bleeseri, E.dichromophloia) over hummock grasses
E.tetradonta with mixed species
E.bleeseri over hummock grasses
E.dichromophloia (with E.tetradonta, E.miniata) over annual and hummock grasses
E.tectifica over annual and perennial grasses
E.tectifica over hummock grasses
E.phoenicea over hummock (with annual) grasses
E.phoenicea, E.dichromophloia over hummock grasses
E.latifolia over annual and perennial grasses with sedges
E.latifolia over hummock grasses
E.pruinosa over perennial grasses
E.tintinnans over hummock grasses
E.policarpa with mixed species
E.alba, E.grandifolia over perennial grasses
E.microtheca (with Excoecaria parvifolia) over perennial grasses
E.microtheca over perennial grasses
E.microtheca over bare ground

LOW OPEN-FOREST, LOW WOODLAND

M.viridiflora over Eleocharis sp.
M.viridiflora over perennial grasses
M.minutifolia, M.sericea over annual and perennial grasses
Excoecaria parvifolia (with T.volucris) over perennial grasses
L.cunninghamii over perennial grasses
T.canescens, Erythrophleum chlorostachys over annual grasses

EUCALYPT OPEN-WOODLAND

E.latifolia over hummock grasses
E.latifolia over perennials
E.papuana, E.policarpa, E.bigalerita over perennial grasses
E.microtheca with mixed species over perennial grasses
E.tectifica over annual and perennial grasses

OTHER OPEN-WOODLAND

L.cunninghamii over perennial grasses
T.bursarina over annual grasses
A.valida over perennial grasses
M.minutifolia, M.sericea over bare ground
T.arostrata, T.volucris over perennial grasses
T.arostrata, Eucalyptus spp over perennial grasses
Terminalia spp, O.vernicosa (with mixed species) over hummock

Training Sector	Vegetation Mapping Unit	Approximate Cover (%)
Mount Thymanan	Melaleuca minutifolia, M. sericea over annual and perennial grasses	19.20
	Melaleuca viridiflora over perennial grasses	16.20
	Lysiphyllum cunninghamii over perennial grasses	8.50
	Corymbia phoenicea over hummock grasses	7.90
	Corymbia latifolia over annual and perennial grasses with sedges	6.50
	Eucalyptus tectifica over hummock grasses	4.90
	Eucalyptus microtheca with mixed species over perennial grasses	4.60
	Melaleuca leucadendra with mixed species	1.50
	Eucalyptus camaldulensis, E. microtheca	0.90
	Eucalyptus microtheca, Terminalia platyphylla	0.20
	Monsoon species	<0.05

Notes:

1. Bold indicates communities referred to in the text that are potentially more susceptible to impact, communities that are not reserved, or communities that have high conservation value.

Species

A total of 422 plant species were identified during the survey and they are listed in the full report contained in Volume 2. A further 132 species were not identified due to the absence of fertile material, many of which are likely to be duplicate species. Of the 422 species recorded, 139 had not been previously recorded in the area. These species are also listed in the full report in Volume 2. The large number of new species to the area is probably due to the relatively low collecting effort in the region to date. About 525 species that have been recorded in previous surveys were not recorded. The total number of species identified for Bradshaw Station therefore comprises about 950 species. One *Fimbristylis* species (*Cyperaceae*) is possibly a new species and has been sent to a relevant expert for verification. This species was collected from *Lysiphyllum cunninghamii* woodland in the southern area of the Angalarri Plain.

Within the Victoria-Bonaparte Bioregion, there are 39 species currently listed by the NT Herbarium as rare or threatened plant species. This mostly comprises species listed under the *Endangered Species Act*, 1992 in addition to a small number of species newly nominated by the NT Herbarium for future listing. It is likely that a significant number of these species are present on Bradshaw Station because each of the broad vegetation types of the Bioregion occur on the property. Three of the 422 species recorded on Bradshaw Station during the survey are currently classified by the NT Herbarium as rare in the Bioregion. In addition, previous surveys of Bradshaw Station have recorded a further eight species that are of conservation significance in the Bioregion as defined by the NT Herbarium. These species are described in Table 6.2.

Table 6.2 – Species of Conservation Significance

Species	Conservation Status	Lifeform	Habitat	Location
<i>Uraria</i> Litchfield	3RC-	Prostrate Forb	Open eucalypt forest on sandstone plateau	Site 103
<i>Grevillea myosodes</i>	3KC-	Shrub	Eucalypt woodland, plains or gentle slopes	Site 131
<i>Acacia kelleri</i>	3R	Shrub or small tree	Sandstone	Site 70
<i>Acacia setulifera</i>	3K	Shrub	Unknown	-
<i>Helicteres dentata</i>	3K	Shrub/Forb	Eucalypt woodland	-
<i>Marsdenia glandulifera</i>	3R	Forb or Shrub	Acacia thicket	-
<i>Polycarpaea staminodina</i>	3R	Forb	Eucalypt woodland	-
<i>Tacca maculata</i>	3RC-	Perennial Forb	Woodland	-
<i>Tephrosia macrocarpa</i>	3KC-	Shrub	Unknown	-
<i>Sesbania erubescens</i>	3R	Shrub	Riparian	-
<i>Utricularia hamiltonii</i>	3RC	Forb	Grassland	-

Notes:

1. The number 3 indicates the species has a range over 100 km in Australia but occurs only in small populations which are mainly restricted to highly specific and localised habitats.
2. K or k means the species is poorly known, may be endangered, rare and vulnerable, but current field information is inadequate.

3. C or c means the species is known to be represented in a National Park or reserve.
4. R or r means rare.
5. The use of capital letters indicates the status of the species is considered of national significance. Lower case letters are used where the status applies either to distribution of the species within the NT or to particular NT populations.
6. The use of "." indicates the species has been recorded in a reserve but the size of the population within the reserve is unknown.

Uria Litchfield was collected from *Eucalyptus* woodland on the sandstone plateau to the west of the Angalarri HEIA (Site 103). *Uria* is represented in Litchfield National Park and Nitmiluk National Park. The record on Bradshaw Station is a range extension for this species. *Grevillea myosodes* was collected from eucalypt mixed woodland on a sandstone rise where it was locally abundant (Site 131). The site is close to the proposed camp and airstrip east of the Koolendong Valley. This species has previously been collected from Litchfield and Kakadu National Parks and is not uncommon in the Kimberley Region. The record on Bradshaw Station is a link between the Arnhem Region and the Kimberley Region and represents a range extension for the species. *Acacia kelleri* was collected from a sandstone habitat (Site 70) in the Western Hills. It also occurs in sandstone areas in the Kimberley Region.

Grevillea myosodes and *Uria* Litchfield are currently listed as rare or threatened species by the NT Herbarium, however, recent survey by PWCNT indicate that these species are widely distributed in the Northern Territory and should be removed from the list.

Introduced Weed Species

During the survey, 14 introduced (weed) species were recorded as shown in Table 6.3.

Table 6.3 – Recorded Weed Species

Weed Species	Common Name	Growth Habit	Class of Noxious Weed	Habitat and Number of Sites
<i>Alternanthera pungens</i>	Khaki Weed	Annual forb	Class B, whole of NT	Riparian-2
<i>Bidens pilosa</i>		Annual forb	Not declared in the NT	Riparian-1
<i>Calotropis procera</i>	Rubber Bush	Shrub or small tree	Class B and C, south of 16°30'S latitude	Creek levee-1
<i>Cenchrus ciliaris</i>	Buffel Grass	Perennial grass	Not declared in the NT	Sandstone plateau-1
<i>Cynodon dactylon</i>	Couch	Perennial grass	Not declared in the NT	Creek levee-3
<i>Hyptis suaveolens</i>	Hyptis	Annual or Perennial Forb	Not declared in the NT	Woodland, riparian-1
<i>Parkinsonia aculeata</i>	Parkinsonia	Shrub or small tree	Class B and C, whole of NT	River levee-1
<i>Passiflora foetida</i>	Wild Passion Fruit	Herbaceous Vine	Not declared in the NT	Creek levee-2
<i>Pennisetum pedicellatum</i>	Annual Pennisetum	Annual grass	Not declared in the NT	River levee-1
<i>Senna occidentalis</i>	Coffee Senna	Annual or perennial shrub	Class B and C, whole of NT	River levee-2
<i>Sida acuta</i>	Spineyhead Sida	Annual or perennial shrub	Class B and C, whole of NT	River levee-1
<i>Sida cordifolia</i>	Flannel Weed	Annual or perennial shrub	Class B and C, whole of NT	River levee-3
<i>Sida rhombifolia</i>	Paddy's Lucerne	Annual or perennial shrub	Class B and C, whole of NT	River levee-1
Weed Species	Common Name	Growth Habit	Class of Noxious Weed	Habitat and Number of Sites
<i>Xanthium strumarium</i>	Noogoora Burr	Annual herb	Class B and C, whole of NT	River levee-2

Notes:

1. Class A – to be eradicated. These weeds represent a significant threat but occur over a relatively small area, and thus there is a reasonable chance of eradication.
2. Class B – growth and spread is to be controlled. These weeds occur more widely and are impractical to eradicate.
3. Class C – not to be introduced into the Northern Territory. Classifications in accordance with the Northern Territory Noxious Weeds Act 1980.
4. Classification on accordance with the Noxious Weeds Act 1980.

Twelve of the 14 weed species recorded were along watercourses, especially the Victoria River. Six of these are

declared noxious. Three of the noxious species, *Parkinsonia aculeata* (Parkinsonia), *Xanthium strumarium* (Noogoora Burr), and *Calotropis procera* (Rubber Bush), are serious weeds of threat to conservation and warrant priority control measures. Such weeds are detrimental to the conservation of natural resources through adverse effects on the integrity, conservation value or biodiversity of natural resources.

Parkinsonia is a shrub or small tree that is adapted to a wide range of soil types and can form dense thorny thickets along watercourses and around bores and dams. Dispersal of seed is via water, mud on animals and vehicles, and by bird and animal droppings. Control can be achieved by mechanical removal and follow-up herbicide treatment for small trees, or herbicide alone for large trees.

Rubber Bush is a shrub or small tree that is well adapted to poor soils. It invades roadsides, disturbed areas, watercourses, river flats and coastal dunes. Dispersal of seed is by wind and water and stands increase in size by producing suckers. Control is difficult because mechanised control and fire are ineffective due to vigorous regrowth from the tuberous root system. However, control may be achieved by regular cultivation and herbicide application.

Noogoora Burr is an annual woody herb that grows in a wide variety of habitats that are often disturbed, such as roadsides, bores and stockyards. It generally prefers unshaded positions in tropical climates but extends into semi-arid regions when water availability is adequate. Biological control agents are available for this species but, to date, appear to exert little control in the Northern Territory. Small infestations can be removed by hand while large infestations can be treated with herbicide. During the survey, Noogoora Burr was recorded along the Victoria River. It may be difficult to eliminate this species in this habitat because floating seeds are transported from upstream.

6.2 IMPACT ASSESSMENT AND MANAGEMENT

6.2.1 Construction Impacts and Management

Infrastructure development on Bradshaw Station has the potential to exert a range of impacts on vegetation. Short-term effects are unavoidable during the actual construction of camps and airfields, while longer term impacts resulting from concentrated human activity, altered drainage patterns and fire can be minimised by careful management as detailed in the Environmental Guidelines for Construction Activities in Volume 2.

The following guidelines would be followed for the final siting of infrastructure to reduce impacts on vegetation:

- Siting of the camp and airstrip east of the Koolendong Valley and access road should prevent potential adverse impacts on the riparian habitats in the area. Generally, the site is occupied by eucalypt woodland and open woodland, however, access to the Koolendong Valley from the proposed camp is likely to be through two gaps in the north-south ridge, both of which contain riparian habitats which may be sensitive to vehicular traffic. Careful consideration would be given to avoid the streamlines.
- Siting of the Yambarran Loop Road should avoid potential damage to the pockets of monsoon forest in the deeply dissected gorges in the headwaters of Lobby Creek and the southern tributaries of the Little Fitzmaurice River. It is likely that the road alignment would have to closely parallel the Little Fitzmaurice River headwaters to avoid steep cliffs and gorges, and this would necessitate the construction of crossings on major tributaries and probably the Little Fitzmaurice River itself. The riparian habitats along these streamlines are considered sensitive and where they cannot be avoided, careful attention to road siting and design will be important.
- Construction of primary access roads through woodland and open woodland should be undertaken with a minimum of clearing. Trees felled during road construction should be pushed to the centre of the cleared area and burnt rather than being pushed to the edge of the clearing.

6.2.2 Operational Impacts and Management

Training activity on BFTA would potentially impact on vegetation through damage by firing of weapons and vehicle manoeuvres. The degree of damage would depend on the intensity of use and type of vehicles and weapons being used. Those areas that are used most frequently and carry the heaviest traffic would suffer the more impact. The longer term damage sustained from military exercises would vary between vegetation communities and soil types.

Indirect impacts of training activities could include invasion of weed species, changes to the structure and composition of vegetation and loss of species. However, changes to the vegetation structure in impact areas may not always be detrimental in the context of land use.

Table 6.4 provides a general ranking from low to high of the sensitivity of the eight vegetation structural classes to a range of training activities on BFTA. The sensitivity ranking for each mapping unit within these habitats is provided in the full report contained in Volume 2. The ranking takes into account the conservation status of the vegetation and the resilience of vegetation to disturbance from military exercises and associated activities. Important assumptions of the ranking are that:

- areas are monitored and rested when appropriate so that vegetation can recover before further disturbance
- exercises are conducted during the dry season as none of these areas are suitable for wet season activity except for bare sandstone areas
- fire control strategies have been effectively implemented

Table 6.4 – Ranking of Habitat Sensitivity to Military Training

Habitat	Field Firing – High Explosives	Field Firing – No High Explosives	Dismounted Training	Manoeuvre Training
Monsoon forest ¹	High	High	High	High
Riparian ¹	High	High	High	High
Eucalypt open forest, woodland on sandstone ^{1,2}	High	High	Medium	High
Eucalypt open forest, woodland on clay plains	Medium	Low	Low	Medium
Eucalypt open forest, woodland on sandy loams	Medium	Low	Low	High
Melaleuca minutifolia low woodland ³	High	High	Medium	High
Low open forest, woodland	Medium	Low	Low	Medium
Eucalypt open woodland	Low	Low	Low	Low
Other open woodland	Low	Low	Low	Low
Shrubland on sandstone ^{1,2}	High	High	Medium	High
Xerochloa grasslands ³	High	High	Medium	High
Other grasslands	Low	Low	Low	Low

Notes:

1. Indicates that habitat is relatively sensitive to disturbance.
2. Indicates that the habitat contains rare species.
3. Indicates that the habitat is of conservation significance.

The vegetation communities that are likely to be the least affected by military activities are open woodlands and grasslands (except for *Xerochloa*) which comprise about 50% of Bradshaw Station. Open woodlands on BFTA generally occur on plains with clay soils which are relatively stable when dry. The foliage cover of trees in these communities is relatively low, at less than 10%, and thus damage from firing and ordnance would be low compared to forest and closed forest communities. Most tree and shrub species of tropical savanna woodlands have the ability to regenerate from lignotubers or epicormic buds following disturbance from fire. Provided trees are not killed, they are likely to regenerate after damage from ordnance or from vehicles. It is important that trees are given time to recover to the point where they can withstand further disturbance.

Sensitive Habitats

Habitats may be regarded as ecologically sensitive if they are adversely affected by, and have little resilience to, disturbance, either natural or human induced. Most of Bradshaw Station is suitable for the range of military activity proposed and irreversible impacts are unlikely provided that impacted areas are rested before damage occurs. However, four habitats within Bradshaw Station have been identified as being ecologically sensitive: sandstone habitats, monsoon forests, riparian habitats and coastal habitats.

Sandstone Habitats

Sandstone habitats are adversely affected by frequent fire and may be indirectly impacted by any military activities that pose a medium to high fire risk. Regeneration for many sandstone vegetation species is by seed only and they are unable to resprout after fire. Whilst most species are fertile by the third growth season after fire, some may take up to five years to produce seed. Thus, if fires are too frequent, the local survival of obligate seeding species would be threatened.

Sandstone areas occur in the Western Hills, Yambarran, Koolendong, Wombungi and Mount Thymanan Sectors (refer Figure 6.3 and Table 6.1). Sandstone habitats within these areas require a fire-free interval of at least five years so that obligate seeding species are able to mature, produce seed and sustain the population between fire events. In order to reduce the impact on these habitats, training could be restricted to training activities that do not pose a significant risk to fire. The use of these areas for activities which require active fire management in the form of fuel reduction burns prior to commencement would preferably be on a rotation basis so that substantial areas of this habitat remain undisturbed for several years at a time.

Monsoon Forests

Monsoon forests occupy a range of landforms, including perennial jungle springs, seasonally flooded lowland habitats and sandstone escarpments. Monsoon forests generally occur as relatively small isolated pockets within *Eucalyptus* and *Melaleuca* woodlands and occupy only about 330ha or considerably less than 0.05% of Bradshaw Station. Some of these areas are permanently wet and soils are highly organic peat. As such, they have no resistance to trampling and their structure is quickly destroyed.

Monsoon forests are highly sensitive habitats and require protection from fire, weeds, feral animals and human impacts. Monsoon forests are considered generally unsuitable for active training and the following management strategies would be adopted for these areas.

- delineation of appropriate management zones for protection these habitats
- fire management comprising back burning from the margins as early as possible in the dry season to provide protection from late dry season wild fires
- active feral animal and weed control

Riparian Habitats

Riparian habitats comprise approximately 3.5% of Bradshaw Station. These areas are particularly sensitive to disturbance due to generally sandy soils and flooding during the wet season. Removal of vegetation from river banks results in erosion, often in the form of deep rills and gullies. Erosion along river banks increases the sediment load in the water which results in siltation of shallow areas and a consequent reduction in water quality. This can have an adverse impact on aquatic flora and fauna. Riparian areas are also important as movement corridors for wildlife.

Riparian areas are highly susceptible to weed invasion due to water availability throughout most of the year and the seed transportation downstream causing weed propagation. This is demonstrated by 13 out of the 14 weed species recorded on Bradshaw Station occurring along the Victoria River. Weed infestations require active and regular management strategies proving to be costly and time consuming. Preventing introduction so that no active treatment is required is therefore the most effective means of weed management.

To protect sensitive riparian areas from disturbance that would inevitably result in erosion and weed problems, the following management strategies would apply:

- delineation of appropriate management zones along large watercourses on BFTA such as the Victoria, Angalarri, Ikymbon and Fitzmaurice Rivers, except at crossing points, within which vehicle and human disturbance should be minimised
- active management of existing environmental degradation within these areas to minimise further damage, including (as required) earthworks to prevent further loss of soil, weed treatment to prevent further spread and

revegetation using appropriate native species

Coastal Habitats

Coastal habitats were not assessed in this survey, however, these areas would be sensitive to high impact military exercises and vehicle movement. Training in these areas, if proposed in the future, would be limited to those activities that do not pose a significant impact on these habitats (eg dismounted training).

Habitats of Conservation Significance

Two vegetation types that are of conservation significance because they occur almost exclusively in the Victoria-Bonaparte Bioregion and are currently not protected in the reserve system of the Northern Territory are *Melaleuca minutifolia* low woodland and *Xerochloa* grassland. To assist in the management of these two vegetation types, disturbance from military activities would be minimised and burning regimes implemented that promote the maintenance of the habitat structure. For example, grasslands require occasional hot fires that suppress the growth and abundance of trees and shrubs, and early dry season fires in most other years.

Ground Cover

Military exercises, especially vehicle manoeuvres, are known to reduce the cover of understorey species by pulverisation. Damage would be increased by multiple tracking of wheeled and tracked vehicles over the same ground.

Some herbaceous species would be more susceptible to disturbance by military traffic than others. Annual species that rely on germination from seed for regeneration would be most vulnerable to disturbance, and their distribution is significantly affected by season and fire. The dominant herbaceous vegetation type in most areas of BFTA is perennial grass. Whilst above ground vegetative parts of these plants may be damaged or severed by sustained military activity, they would readily resprout from established root stock when relative humidity increases at the end of the dry season and with the first wet season rains. Areas where ground cover vegetation has been significantly depleted by activity would be rested prior to the wet season to allow time for re-establishment of foliage cover that would provide protection from erosion caused by early wet season storms.

Revegetation of heavily impacted areas may be necessary. Suitable species would be used as appropriate so that biodiversity is maintained and the integrity of natural systems is not compromised.

Weeds

Weed infestation is currently a significant problem within Bradshaw Station. Construction and operation of BFTA has the potential to introduce new weed species through vehicle movements into and out of the property and to cause the spread of infested areas by altering natural vegetation and creating disturbed areas which provide an environment conducive to weed invasion. However, it is likely that the removal of grazing, integrated with appropriate active management strategies would, in the longer term, reduce the abundance of most weed species.

Weed management strategies would be adopted to prevent introduction of new weed species, to prevent further spread of weeds already within Bradshaw Station, and to treat severely infested areas. These management strategies are detailed in the EMP (Part D) and include:

- utilise vehicle washdown facility on BFTA
- regular surveillance of susceptible areas to ensure early detection of weed outbreaks
- early intervention to treat small infestations as they are detected to reduce the likelihood of uncontrolled spread
- rotation of utilised areas to prevent serious land degradation
- feral animal control to prevent vegetation removal and disturbance to the soil surface

It is expected that weed management would involve an integrated approach using chemical, physical and fire treatments as appropriate for the weed species and infestation. A cooperative approach to weed management involving nearby land owners and relevant agencies is also recognised as being essential.

Monitoring

Monitoring the impacts of military land use on vegetation is crucial to achieving the objective of long-term sustainable use. Monitoring of impacts from military activities would be undertaken annually and at the same time of year to avoid seasonal variation in the presence and abundance of species. The monitoring program could include:

- monitoring the natural recovery of selected degraded sites in terms of vegetation cover and soil structure and the recovery rate of similarly disturbed areas actively rehabilitated to provide useful information for management of BFTA and other military training areas in the Northern Territory
- establishment of permanent sites for monitoring changes to species composition, abundance and cover within various vegetation units under a range of military activities to enable predictions to be made on the cumulative impact of specific activities in different vegetation communities and associated soil types



7. FAUNA

7.1 BASELINE FAUNA SURVEY

A baseline fauna survey of Bradshaw Station was conducted by ERA Environmental Services Pty Ltd between June and August 1997 with additional data gathered during October 1996. The report on the fauna survey is included in Volume 2 and the major findings are summarised in this section.

7.1.1 Survey Objectives

The main objectives of the baseline fauna survey were to:

- survey land and freshwater vertebrate fauna (excluding specific sampling for bats)
- compile checklists of freshwater fishes, frogs, reptiles, birds and mammals
- evaluate the conservation status of rare, vulnerable and endangered species from a NT, national and international perspective
- evaluate the use of Bradshaw Station by migratory birds that are listed under international conventions
- relate fauna habitats to land units (soil and vegetation classifications) as determined from collaborative studies
- indicate special diversity (core) fauna habitats
- evaluate the status of feral animals and propose measures for their management
- propose prescribed fire regimes for the conservation of fauna assemblages
- propose management strategies to avert or minimise military training impacts on native fauna and habitats
- propose monitoring strategies to assess the effect of military training and environmental management programs on fauna and habitat.

7.1.2 Survey Areas and Sampling Sites

The survey areas selected were the Angalarri Plain, Koolendong Valley, Victoria River frontage including Mosquito Flat, and the Yambarran Plateau. These were selected based on advice that these areas would be the priority areas for military training. Fauna habitats within these survey areas were categorised as follows: closed forest (including rainforest), open forest and woodland, rocky slopes and hills, streams and associated riparian strips, grasslands, and swamps (permanent and ephemeral). These fauna habitats were integrated with a land unit classification system based on soils, topography and vegetation determined in the soils and vegetation baseline surveys (refer Sections 5 and 6) as described in Volume 2.

Sampling sites within these survey areas were selected in representative vegetation and soil habitats, physical terrains, areas of relatively high and low cattle grazing pressure and areas where military activity is likely to be concentrated. A total of 62 sampling sites were established (refer Figure 7.1).

Major areas not surveyed during the baseline survey were the coastal flats, Western Hills, Little Fitzmaurice River frontage, northern regions of the Yambarran Plateau and hills to the north-east of the Angalarri Plain. Major habitats not included in the baseline survey were sandstone escarpment, brackish waters in the upper reaches of tidal streams, marine and coastal habitats.

The baseline survey was essentially conducted during one dry season (June-August). Temperatures were relatively cold throughout the day and night in July resulting in a low reptile activity. The species richness of reptiles would therefore potentially increase if surveys were conducted during warmer months. Similarly, surveys during the dry-wet transition period (October-December) and the wet season would provide the best opportunity to record migratory birds (many of international significance) and frogs.

The baseline survey has provided minimal coverage of designated survey areas and a minimum sampling frequency.

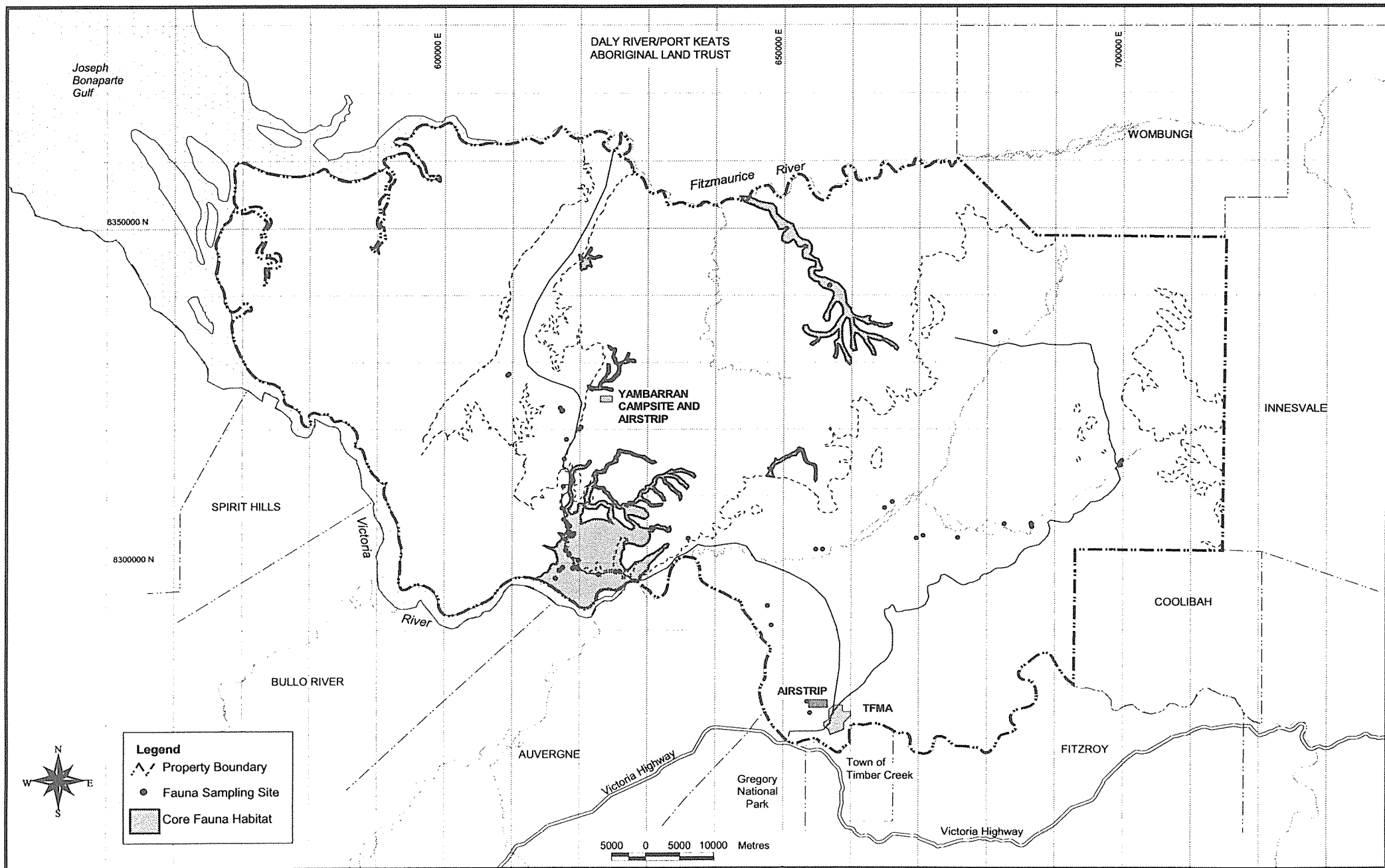


Figure 7.1 :
FAUNA SAMPLING SITES AND
CORE FAUNA HABITATS

Although data collected is useful as baseline information, a further survey would greatly improve information on the distribution and abundance of taxa, as well as providing monitoring data.

Adequate sampling techniques were used in the baseline survey for all taxonomic groups except bats. Future surveys would need to use standard bat sampling techniques (including electronic bat recorders) at appropriate sampling sites.

7.1.3 Survey Results

Species Richness

A total of 310 species were recorded, comprising 24 species of fishes, 19 frogs, 56 reptiles, 171 birds and 40 mammals. The mammal species recorded comprised 23 non-flying native mammals, 11 bats and 6 ferals. In addition, several species of invertebrates were recorded during aquatic surveys.

Although relatively more species were recorded in the Koolendong Valley, overall differences between the survey areas were not significant, nor were there significant differences for each of the major taxa (fishes, frogs, reptiles, birds, non-flying native mammals, bats and feral mammals) between the survey areas. Riparian habitats had the greatest species richness for frogs, reptiles, birds, bats and feral mammals, and rocky slopes and hills had the greatest species richness for native mammals.

While not specifically recorded at Bradshaw Station, there are a number of other species which have been recorded in the general vicinity of the property and therefore possibly could occur on Bradshaw Station. These include 38 species of fishes, 12 frogs, 101 reptiles, 113 birds and 35 mammals, many of which are of conservation significance. A list of these species is provided in the full fauna survey report contained in Volume 2.

Species of International Importance

A number of species recorded within Bradshaw Station are listed under international agreements. However, it should be noted that there is substantial overlap between these international agreement listings, with a significant proportion of species being listed under more than one international agreement.

Defence can contribute to these international agreements by implementing appropriate environmental management strategies that maintain or enhance the quality of habitats for these species of international importance. These management strategies are outlined in Section 7.2 and addressed in detail in Part D of this EIS.

Convention on Wetlands of International Importance (Ramsar Convention)

There are no listed wetlands on Bradshaw Station or surrounding areas, the nearest being within Kakadu National Park.

Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention)

This convention lists endangered Australian migratory species. No listed species (turtles and whales) have been recorded on Bradshaw Station.

The convention also lists Australian migratory species which have an unfavourable conservation status and which require, or would benefit from, international agreements for their conservation and management. On Bradshaw Station, one of the seven listed reptiles and 51 of the 172 listed birds were recorded in this survey. A further four species of reptiles and 41 species of birds might occur on Bradshaw Station based on species distribution maps and further surveys in other areas of Bradshaw Station and in other seasons.

Agreement between the Government of Australia and the Government of Japan for the Protection of Migratory Birds in Danger of Extinction and their Environment (JAMBA)

This agreement provides for cooperation between the two Governments to protect birds that migrate between the two countries, to protect birds in danger of extinction and to protect their environment. Of the 76 species listed under this agreement, five were recorded at Bradshaw Station in this survey, but a further 42 listed species might

also occur based on species distribution maps and further surveys in other areas of Bradshaw Station and in other seasons.

Agreement between the Peoples Republic of China and the Government of Australia for the Protection of Migratory Birds and their Environment (CAMBA)

This agreement promotes cooperative measures that include controlling the taking and the trade or exchange of migratory birds and their eggs, establishing sanctuaries and other facilities for the management and protection of migratory birds and their habitats and undertaking joint research and exchanging information and publications on migratory birds. Of the 81 species listed under this agreement, six were recorded in this survey on Bradshaw Station and a further 40 might occur based on species distribution maps and further surveys in other areas of Bradshaw Station and in other seasons.

Convention on International Trade in Endangered Species of Wild Fauna and Plants (CITES)

This convention regulates the international trade in endangered species. The Saltwater Crocodile and Freshwater Crocodile, both relatively common on Bradshaw Station, are listed under this convention.

Wader (Shorebird) Flyways

Waders occur in both wetland and non-wetland areas across Australia. There are 15 species of waders that are resident in Australia (four recorded at Bradshaw Station), 36 species that are regular migrants (two recorded at Bradshaw Station), and 16 vagrants (none recorded at Bradshaw Station). Most waders that migrate to Australia are trans-equatorial migrants that breed in Asia in June and July. However, the Australian Pratincole is one exception that breeds in Australia and migrates to Asia between March and November.

The migration paths are termed flyways and birds concentrate in areas deemed to be of international or national importance. Within the Northern Territory, eight areas of international importance for waders and two areas of national importance for waders have been identified, but none are located on Bradshaw Station.

Species of National Conservation Significance

No species listed as critically endangered or endangered under the *Endangered Species Act 1992* were recorded. However, of those species recorded, one species (Dingo) is considered to be vulnerable and five species (Exquisite Rainbowfish, Copland's Rock Frog, Star Finch, Northern Quoll, Pygmy Long-eared Bat) are listed as near threatened (as defined in the baseline fauna report in Volume 2).

Prior to this baseline survey, five species of conservation significance (critically endangered, endangered, vulnerable or near threatened) were recorded within Bradshaw Station: Gouldian Finch (endangered), Kimberley Crested Shrike-tit (endangered), Purple-crowned Fairy-wren (vulnerable), Ghost Bat (vulnerable) and Grey Falcon (near threatened).

Defence can contribute to the protection of these species of national importance by implementing appropriate environmental management strategies that maintain or enhance the quality of habitats for these species. These management strategies are outlined in Section 7.2 and addressed in detail in the EMP (Part D).

Gouldian Finch (Erythrura gouldiae)

This species was previously recorded from the Angalarri Plain, including breeding records near Mount Thymanan and from the Koolendong Valley. Once widespread across northern Australia, this species is now found reliably only at a few sites between the west Kimberley Region and Katherine. Both the range and abundance of this species has decreased greatly over the past two decades. Populations that remain appear to be suffering excessively high mortality. The cause of the decline is unknown, but the most likely causes are inappropriate fire regimes affecting food supply and grazing by cattle. Other possible reasons include infection with an airsac mite (*Sternostoma tracheacolum*), a parasite in aviary birds that has escaped into the wild, a species-specific disease, burning of suitable nest trees, trapping for the bird trade, alteration of habitat and disturbance by mining.

Kimberley Crested Shrike-tit (Falcunculus frontatus)

The northern subspecies (*Falcunculus frontatus whitei*) occurs from the McArthur River (Gulf of Carpentaria) west to

the Kimberley and is classified as endangered. The other subspecies (*F.f.leucogaster*, *F.f.frontatus*) are considered to be rare and secure respectively. Although no decline has been recorded, there are only 24 records of this subspecies over the past 80 years or so. This subspecies may be naturally rare but the increased frequency of late dry season fires may have decreased the availability of invertebrate food under peeling bark. This species was not recorded on Bradshaw Station during this baseline survey.

Purple-crowned Fairy-wren (Malurus coronatus)

This species is not listed by the *Endangered Species Act*, however, the *Action Plan for Australian Birds* (Garnett, 1992) classifies the western subspecies (*Malurus coronatus coronatus*), found in north-west Western Australia and western Northern Territory, as vulnerable. Although not recorded on Bradshaw Station during the baseline survey, the Purple-crowned Fairy-wren was recorded in grassy embankments bordering the Victoria River about 100 km to the east of the property which suggests that this species could have been overlooked during the baseline survey. The favoured habitat is tall canegrass (*Mnesithea rottboellioides*) and screwpalm (*Pandanus* sp.) immediately adjacent to permanent rivers and associated swamps. Reasons for the decline of this species are overgrazing and trampling of habitat by stock and excessively frequent burning, which causes degradation and/or loss of habitat, and ultimately, abandonment of the habitat.

Dingo (Canis lupus dingo)

Although not evaluated by conservation authorities, recent research indicates that the dingo should be classified as vulnerable. The tropical form is common and subject to control in some areas, however, it is increasingly under threat of hybridisation with domestic dogs. On Bradshaw Station, dingoes were widespread in most habitats but numbers appeared to be low, possibly due to a consistent control campaign (poisoning and shooting) by local pastoralists.

Ghost Bat (Macroderma gigas)

This is Australia's only carnivorous bat which kills large insects, frogs, lizards, birds and small mammals, including other bats. The present patchy and widespread distribution of the Ghost Bat in northern Australia includes habitats as diverse as the arid Pilbara and lush north Queensland rainforests. One of the largest colonies known is near Pine Creek. Ghost Bats are sensitive to human disturbances which, in conjunction with their rarity and contraction in range, provide reasons for their vulnerable conservation status. Prior records on Bradshaw Station are from rocky habitats in the north-west of the Angalarri Plain.

Exquisite Rainbowfish (Melanotaenia exquisita)

Although found chiefly in upland habitats in the Katherine, Edith, Mary, South Alligator, Fergusson and Victoria Rivers of the Timor drainage, this species apparently has one of the most restricted distributions of Australia's rainbowfishes. On Bradshaw Station, this species was widespread and fairly abundant.

Copland's Rock Frog (Litoria coplandi)

This species is unusual because of its habit of living on rock faces near escarpments. On Bradshaw Station, this frog was fairly abundant but appeared restricted to rocky areas along the Victoria River frontage and the entrance to the Koolendong Valley.

Star Finch (Neochmia ruficauda)

The northern subspecies (*Neochmia ruficauda clarescens*) occurs across northern Australia from the Pilbara to north Queensland and is considered to be rare. However, this finch was fairly abundant and widespread on Bradshaw Station where it was recorded in pure and mixed flocks with other finch species. Within its range, it is mostly restricted to vegetation beside watercourses and swamps and grassy flats with few bushes and low trees.

Grey Falcon (Falco hypoleucos)

This species occurs throughout inland and drier coastal parts of all mainland states. Populations are small and the usual habitats are open grassy plains, timbered watercourses and pastoral lands. None were recorded on Bradshaw Station during the baseline survey.

Northern Quoll (Dasyurus hallucatus)

This species is now restricted to six regions within a former range that occurred across northern Australia from the Pilbara to south-eastern Queensland and is considered to be rare. On Bradshaw Station, the Northern Quoll was not uncommon (6 records) but appeared to be restricted to rocky and riparian habitats in the Koolendong Valley and woodland along the Victoria River frontage.

Pygmy Long-eared Bat (Nyctophilus walkeri)

On Bradshaw Station, 21 records were obtained in riparian and rocky habitats of the Koolendong Valley and Yambarran Plateau. This supports other evidence obtained in recent years that this bat is common and widespread.

Notable Findings

A number of other notable findings were made during the survey and have also been considered in the formulation of environmental management strategies for fauna protection within Bradshaw Station. These management strategies are outlined in Section 7.2 and addressed in detail in the EMP (Part D).

The species recorded included an undescribed species of gecko (*Gehyra* aff. *australis*). The gecko was recorded on rocky slopes in three widely separated areas of the Yambarran Plateau, suggesting that this species may be widespread on Bradshaw Station in this habitat.

The Angalarri Grunter (*Scortum neilli*) was not recorded on Bradshaw Station in this survey despite targeted sampling. This species was previously known from nine specimens taken from a single location on the headwaters of the Angalarri River in 1981 and two specimens from the East Baines River immediately south of Bradshaw Station. On the basis of this, the Angalarri Grunter appears to be rare in a restricted range and virtually nothing is known of its biology and ecology.

Four specimens of the Whip Snake (*Demansia simplex*) were recorded from claypan/grassland habitats in Mosquito Flat. This species was previously known only from a few scattered localities west of Katherine to Pine Creek and the north-western Kimberley Region in open tropical woodland. These records represent an additional habitat for this species and suggest that this species is probably widely distributed but uncommon.

Records of the skink *Ctenotus tantillus* on Bradshaw Station represents a small easterly extension to its previously known range in the northern Kimberley Region. Similarly for the skink *Lerista griffini*, which is known from only two fairly small and isolated populations in Dampier Land, around the top end of the WA/NT border region, and in the vicinity of the Carpentaria Highway.

Records of the Pied Cormorant (*Phalacrocorax varius*), Great Cormorant (*Phalacrocorax carbo*), Blacked-eared Cockatoo (*Chrysococcyx osculans*), Masked Owl (*Tyto novaehollandiae*) and Clamorous Reed-warbler (*Acrocephalus stentoreus*) are useful records because, although within their known range, these species are infrequently recorded in the tropics or in habitats represented on Bradshaw Station.

Records of the Ningbing Pseudantechinus (*Pseudantechinus ningbing*), a marsupial mouse, from the Koolendong Valley and Yambarran Plateau represents an important easterly extension to its formerly known range in the Kimberley Region and from the vicinity of Keep River National Park.

Both the common form and the rarer rock form of the Long-tailed Planigale (*Planigale ingrami*) were recorded on Bradshaw Station.

The Kakadu Dunnart (*Sminthopsis bindi*), a small marsupial first recorded in Kakadu National Park in 1980, was recorded on rocky slopes in the Koolendong Valley. These records represent a major westward extension to its previously known range in the Top End.

Recent research by PWCNT suggests that the Lakeland Downs Mouse (*Leggadina lakedownensis*) is widespread and moderately common in southern regions of the Top End. This is supported by records from Bradshaw Station

where this species was fairly abundant in grassland and rocky habitats in Mosquito Flat.

The Rock Ringtail Possum (*Petropseudes dahli*) is fairly common in restricted habitats in the Kimberley Region, Alligator River Region and the Gulf District. The two records on the rocky slopes of the Yambarran Plateau escarpment within Bradshaw Station are the first from the intervening region between the Kimberley Region and Gulf District populations and represent an extension of range for this species.

The Spotted Grass Frog (*Limnodynastes tasmaniensis*) is a native Australian species that normally occurs over most of south-eastern Australia. It was first recorded in northern Australia (Kununurra) in 1978 where its presence is generally believed to be the result of an accidental introduction. This species was fairly abundant on Bradshaw Station, where it appeared to be restricted to grassland and wooded habitats bordering the Victoria River. Given their ability to exist in a wide range of habitats and their flexible breeding pattern, it is possible for this species to reach high population numbers and thus compete with local native species, possibly to the detriment of the latter.

Feral Animals

The following species of feral animals were recorded during the survey on Bradshaw Station:

Feral Cat (Felis cattus)

Feral cats are common throughout Australia. They are known to eat invertebrates, frogs, reptiles, birds and mammals and occupy a wide variety of habitats. At Bradshaw Station, feral cats were common and recorded in all major sampling areas and habitats, except closed forest, however, they are also likely to occur there.

Brumby (Equus caballus)

Feral horses are common and occur over about half of Australia in a variety of habitats associated with abundant pasture and drinking water. When present in large numbers, the brumby can be a pest, destroying fences, fouling watering points and consuming pasture. At Bradshaw Station, brumbies were recorded in fairly low numbers in riparian and grassland habitats in the Angalarri Plain and Victoria River frontage, however, they are also likely to occur in all other areas and habitats.

Feral Donkey (Equus asinus)

Feral donkeys have a similar distribution and habitat preferences as brumbies. Feral donkeys are agricultural and environmental pests because they compete with stock and native grazers for food and water and cause extensive erosion in rugged hill country. At Bradshaw Station, feral donkeys were common on the Angalarri Plain and Koolendong Valley in woodland, riparian and swamp habitats.

Feral Pig (Sus scrofa)

Feral pigs are widespread and common in northern and eastern Australia, with scattered populations in coastal regions of Western Australia. Feral pigs are opportunistic omnivores and compete with stock and native herbivores for ephemeral swamp vegetation, eat carrion and predate on small mammals, frogs, reptiles and ground-nesting birds. Digging activity has environmental effects such as disturbance to soil arthropod populations, altering soil nutrients and temperature, reducing plant cover, effecting soil erosion and altering plant species composition, including the introduction and spread of weeds. Feral pigs pose a threat to human health because they are commonly affected with viruses such as Murray Valley encephalitis and Ross River fever, meliodosis, brucellosis, leptospirosis and sparganosis. They also pose a huge threat to the pastoral industry in their potential role as an infection reservoir and/or transmitter of exotic disease, such as foot-and-mouth and rinderpest, should they enter Australia. At Bradshaw Station, feral pigs were fairly abundant in all areas and habitats except rocky hills and rocky slopes.

Feral Cattle (Bos spp.)

Feral cattle occur in small numbers throughout Australia, especially in northern Australia. They pose similar environmental threats as feral horses as well as being a potential reservoir of some exotic diseases. At Bradshaw Station, small numbers of feral cattle were recorded in all areas and habitats except rocky hills and slopes.

Swamp Buffalo (Bubalus bubalis)

This species is generally confined to the wet-dry tropical coastal regions of the Northern Territory. They have caused severe environmental damage, including accelerated soil erosion, channelling of flood waters, saltwater intrusion into freshwater habitats, loss of vegetative cover, reduction in the diversity and abundance of flora and fauna, and disfigurement of landscapes by their wallows, trails and dung pats. Swamp buffalo also spread diseases, particularly Tuberculosis. However, since the mid-1980s, feral swamp buffalo have been virtually eliminated from the northern wetlands by live capture (for domestication) and shooting. At Bradshaw Station, small numbers of swamp buffalo were recorded in the central and northern parts of the Koolendong Valley and Yambarran Plateau. They were seen in all major habitats except rocky slopes/hills and swamps, although they would be expected to occur in swamp habitats.

Fauna Habitats

Habitat Availability

The frequency of occurrence of fauna habitats within designated land units on Bradshaw Station is shown in tabular form in the full baseline report contained in Volume 2. Woodland habitats (41.1% of all habitats) were recorded most frequently, followed by rocky habitats (23.2%), riparian habitats (16.5%), swampy habitats (10.9%), grassland habitats (6.1%), and closed forest habitats (2.1%).

Species in Habitats

Excluding fishes, all major taxa were recorded in all major habitats except for bats in swamp habitats. However, species richness was not distributed equally across habitats, with significantly more non-flying native mammals recorded in rocky habitats.

Core Habitats

A number of habitats within Bradshaw Station are considered core habitats. A core habitat is a prime sanctuary for important species and may include representative groups of most taxa, high species diversity and abundance, high fidelity species (species restricted to single habitats), endemic species, and refugia for species that are of conservation significance. Refugia assist fauna to survive during adverse periods such as drought, severe wildfire, overgrazing or disturbance from development. Following severe perturbation, core habitats may provide the base to repopulate surrounding areas.

The baseline survey identified three core fauna habitats within Bradshaw Station that contain a high species diversity representative of Bradshaw Station. These were (refer Figure 7.1):

- Rocky habitats. Rocky habitats generally appear to be the most important habitat for mammals, reptiles, frogs and birds, and several species are restricted to this habitat. The most important rocky habitats are rocky slopes and gullies with closed forest (monsoon forest) and good examples are located at sampling sites 26, 27 and 5 km south-east of sampling site 31.
- Streams and riparian habitats associated with rocky hills. The best example is Lobby Creek and surrounding areas at the entrance to the Koolendong Valley (sampling sites 9, 10, 42-48, 51-55). Sampling sites 26, 29 and 30 are also good examples of this habitat.
- Grasslands with swamps. The best example is Mosquito Flat (sampling sites 7, 8, 56-62).

Mosquito Flat and the adjacent rocky hills (including riparian areas along Lobby Creek) represents a core fauna area because all types of core habitat are present. Also, habitat-restricted species and species that utilise several habitats occur in this area.

It should also be noted that other core habitats may be identified when other areas of Bradshaw Station are surveyed. Further, not all areas of the Angalarri Plain, Koolendong Valley and Yambarran Plateau were closely examined so it may be possible that other examples of core habitats may exist than those identified.

Regional Significance of Bradshaw Station

Within the Victoria-Bonaparte Bioregion within which Bradshaw Station lies (refer Section 6.1.3), 13 species of rare

and endangered vertebrates have been recorded and nine of these species occur on Bradshaw Station. Only one species, a skink, is restricted in the Northern Territory to this bioregion (with records from Bradshaw Station), and another four species (two on Bradshaw Station) have been mostly recorded from this bioregion. There are only two species (frogs, not recorded on Bradshaw Station) that have not been recorded in reserves in this bioregion.

There are two protected areas and one area of restricted access in this Bioregion: Gregory National Park, Keep River National Park and Daly River/Port Keats Aboriginal Land Trust. There is only one wetland site of national significance in this bioregion, being the Legune Wetlands, where 47 species of water birds (14 of them listed under treaties) and at least seven species of migratory waders have been recorded.

As noted in Section 6.1.3, the *Xerochloa* grassland habitat is likely to increase after destocking. This may result in a population increase of several species of conservation significance (including the Purple-crowned Fairy-wren, Star Finch and Gouldian Finch). This is probably the most regionally significant aspect of Bradshaw Station.

Overall, Bradshaw Station does have regionally significant environmental values. It has approximately 70% of rare and endangered species of the bioregion, all species that are restricted in the Northern Territory to this bioregion, and important vegetation types are well represented. At about 16% of the land area of this bioregion, and being virtually surrounded by two protected areas and one area of restricted access (Gregory National Park, Keep River National Park and Daly River/Port Keats Aboriginal Land Trust), Bradshaw Station is an important component of this conservation network.

7.2 IMPACT ASSESSMENT AND MANAGEMENT

7.2.1 Threatening Processes to Fauna and Habitats

The major cause of declining fish populations in Australia is habitat degradation and/or interactions with introduced fishes such as Mosquito Fish. Examples of habitat degradation include changes to natural flow regimes, clearing of catchment vegetation, increased sediment load, alteration of river beds and banks, desnagging, reducing water quality and creation of artificial barriers to fish movement. If riparian vegetation is removed, there is decreased bank stability, fewer snags and other aquatic microhabitats, and decreased food (leaves, insects). Water temperature also increases. The increased siltation load smothers riffle areas, invertebrate food sources and demersal fish eggs.

The major threatening processes to frogs, reptiles, birds and mammals are habitat clearance or modification, overgrazing by stock and feral animals, cropping, urban development and predation by introduced animals (principally foxes, cats and rats) and anthropogenic fires. Additional threats for birds are hunting and trapping for the bird trade.

At BFTA, Defence activities (both construction and operation) have the potential to impact in some of these ways. These potential impacts and possible management strategies to minimise such impacts are discussed below.

7.2.2 Construction Impacts

Construction activities and infrastructure development would result in a very small loss of habitat that is well represented elsewhere on BFTA. No threatened fauna are likely to be dependent on habitats in which infrastructure is proposed and common resident species are likely to either habituate to construction activities or move into the abundant and similar habitats nearby.

Roads are unlikely to be a major barrier to fauna movement and the use of causeways is unlikely to significantly interfere with fish migrations. Pylons associated with bridges may provide opportunities for ambush predators to attack migrating fishes but the overall effect on fish populations is likely to be negligible.

Non-native species and feral animals may be introduced to BFTA on vehicles and equipment and are likely to

predate upon or compete with native species. Regular inspection of vehicles at a wash facility before access into BFTA should be undertaken.

Barramundi Waterhole and Mussel Waterhole have been identified as potential water supply points for construction activities. These sites are located within core fauna habitats and extensive use of water from these natural waterholes may lower water tables and cause a decrease in species richness and/or species abundance. The following management strategies would be investigated and applied if alternative water supplies are not identified:

- limitations on the amount of water taken
- strict limitations on any required clearing of bank vegetation
- measures to minimise water turbidity

7.2.3 Operational Impacts

The change in land use on Bradshaw Station from pastoral to military use, and proposed environmental management program to be implemented by Defence, including weed and feral animal control, fire management and soil management, should assist the natural regeneration of presently degraded areas and enhance fauna habitat across the property.

Notwithstanding these broader management programs, military training has the potential to adversely impact on fauna and fauna habitat. Training activities have the potential to kill or displace individual animals through direct hits or habitat destruction. In particular, the effect of field live firing of heavy ordnance could damage fauna habitat. However, populations should not decline if habitats in which training occurs are allowed to recover after major exercises and core fauna habitats are excluded from training activities (except for transit).

Most of the nine proposed training sectors contain core fauna habitats (refer Figure 7.1). However, these core fauna habitats represent a small proportion of each of the training sectors. Training activities, except transit, would be excluded from core habitats where possible and specific management strategies would be adopted to protect these habitats. The core fauna habitats within each training sector are described below and management strategies for them are outlined in Section 7.2.4 and addressed in detail in the EMP (Part D).

Koolendong Sector

Two core habitat types were identified: rocky slopes with monsoon forest and streams and riparian habitats associated with rocky hills. These are generally located along the western edge of the Yambarran Plateau escarpment and in particular at sampling sites 26 and 27.

Ikymbon Sector

No core habitats were identified within this sector.

Yambarran Sector

Three core habitat types were identified. Rocky slopes with monsoon forest and streams and riparian habitats associated with rocky hills are generally located on the edge of the Yambarran Plateau escarpment and throughout the Yambarran Plateau, and in particular the Lobby Creek area at the entrance to the Koolendong Valley and sampling site 29. Core habitat grasslands with swamps are located at Mosquito Flat. Together, Mosquito Flat, the adjacent rocky hills and Lobby Creek constitute a core fauna area.

Fitzmaurice Sector

This sector contains rocky slopes with monsoon forest and streams and riparian habitats associated with rocky hills. They are generally located in gorges throughout the plateau, and in particular along an unnamed river at sampling site 30.

Angalarri Sector

This sector contains rocky slopes with monsoon forest generally located along the eastern edge of the Yambarran Plateau escarpment and in particular at a valley some 3 km south-east of sampling site 31.

Mount Thymanan Sector

No core fauna habitats were identified in this sector, however, two sensitive areas were identified which require attention. The first is the original collecting site of the Angalarri Grunter within the proposed Wombungi HEIA. This is a rare fish with restricted distribution and until scientific information is obtained about the ecology of this species for a management plan to be developed, minimal potentially disturbing training activities should be conducted in the vicinity of this tributary of the Angalarri River.

The second sensitive area relates to the conservation of the Gouldian Finch. This endangered species has been previously recorded in the Angalarri HEIA, including breeding records near Mount Thymanan. This is one of the few known breeding areas in northern Australia for this species. Until further field surveys confirm the presence or absence of the Gouldian Finch in this general area, restricted training activities would be undertaken. Given the current paucity of knowledge regarding the local distribution of this species, it is difficult to define how large this general area should be, however, an area of some 50 km² extending south-east from Mount Thymanan to the Ikymbon River has been suggested to provide coverage of previously recorded breeding areas and other suitable breeding habitat and watering points. Should the presence of breeding Gouldian Finches be confirmed, advice should be sought from PWCNT on an appropriate management plan to protect this species and its habitat and to determine appropriate long term training activity.

Western Hills Sector

This sector was not surveyed for fauna so it is not possible to indicate core habitats and potential impacts. However, this sector contains coastal flats and dissected sandstone habitats. Elsewhere in northern Australia, these habitats contain a high species richness of waders and endemic birds respectively, and it is highly likely that distinctive species also occur in this sector.

Lalngang Sector

This sector was not surveyed.

Little Fitzmaurice Sector

This sector was not surveyed.

7.2.4 Impact Management and Monitoring

Core Fauna Habitats

Training activities would be avoided within core fauna habitats and a management zone surrounding these habitats would be applied to manage fauna within these core habitats and manage those fauna species that utilise the perimeter of core habitats. Management zones would also provide a buffer against disturbance of the core habitat itself from military activities. Active management of core areas would entail monitoring of species richness and abundance, feral animal control, weed management and fire management as detailed in the EMP (Part D).

Fire management has important implications for fauna. Research in Kakadu National Park (Corbett *et al*, 1997) found that both late dry season fires and a "no fire" regime tended to be more detrimental than beneficial to fauna. Early dry season fires had the least impact on fauna which suggests that this regime is the most appropriate to maintain a status quo in fauna diversity. However, consideration should be given to more intense fires in the Angalarri Plain and Koolendong Valley every four to five years or so to stimulate habitat diversity. Core fauna areas with monsoon forest habitats would also need protection by backburning from the margins as early as possible in the dry season to protect them from late dry season wild fires that are potentially destructive to fire-sensitive habitats.

The baseline survey identified Mosquito Flat and adjacent rocky hills (including riparian areas along Lobby Creek) as a core fauna area. After stock are removed from BFTA, the grassland habitats in this area should be enhanced,

particularly stands of rice grass. As a result, it is possible that populations of rare and threatened species such as the Purple-crowned Fairy-wren, the Gouldian Finch and the Star Finch may increase. This area can be enhanced by maintaining effective feral animal control and conducting research to improve the fire management of grasslands. Training activities in this habitat could also be restricted to transit between the Angalarri Plain and Koolendong Valley via a single road located on the northern boundary of the grasslands.

Feral Animals

Feral animal control on BFTA would need to be incorporated within the broader control program for the Victoria River Region coordinated by the NT Government authorities. In addition, localised programs would be undertaken periodically by Defence on BFTA to maximise the effectiveness of broad scale programs.

The effective control of feral cats, feral pigs and feral stock would be undertaken following a planned management program. Although populations of feral cats are difficult to eradicate, numbers can be reduced by shooting over spotlights, particularly in open grassland habitats, and by trapping with baited cage traps in closed forests.

Populations of feral stock (donkeys, buffalo, horses and cattle) and feral pigs would be initially reduced by a large-scale shooting program from the ground and by helicopter. Subsequent regular management to eradicate or minimise populations would use the "Judas" technique where considered appropriate. This technique involves releasing radio-collared animals into a particular area and, after a sufficient period to allow them to join the herd, tracking them and culling the other individuals associated with them.

The Spotted Grass Frog is a conservation conundrum as it appears to be well established on Bradshaw Station and might be considered as an acclimatised native species. It is recommended that advice be sought from PWCNT as to whether this species needs to be managed specifically. Any management plan would need to be implemented on a regional basis.

Monitoring

Monitoring of ecosystems is important to provide data on which land managers base decisions. At BFTA, Defence should aim to assess the short-term and long-term changes associated with Defence use (both negative and positive), as well as assessing the effectiveness of management programs.

Permanent monitoring (sampling) sites should be established in control and treatment areas. Control sites represent relatively undisturbed areas that reflect natural changes to the environment and could include core habitats and other undisturbed areas in each of the training sectors. Treatment sites (areas of disturbance) should be established in each of the training sectors and in areas which reflect a range of training activities (field firing, dismounted training, manoeuvre training and so on).

Fauna sampling sites established in the baseline studies would be used as the basis for future monitoring programs to assist in assessing the effect of training activities and environmental management programs. Additional sites would also enhance the representativeness of the current network by including areas not previously surveyed in the baseline study and those areas close to military impact sites.