# Wet Tropics Vertebrate Pest Risk Assessment Scheme

Debra A. Harrison and
Bradley C. Congdon
School of Tropical Biology
James Cook University, Cairns

Consultants Report for the
WET TROPICS MANAGEMENT AUTHORITY

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# EXECUTIVE SUMMARY

## PART 1: THE WTVPRAS PROFORMA

### Research Objective 1: Establish a robust decision-making model for strategic mangement of vertebrate pests within the Wet Tropics region

#### *Key Findings*

This report outlines the Wet Tropics Vertebrate Pest Risk Assessment Scheme (WTVPRAS), a risk assessment process designed to establish the relative pest status and potential impact of exotic vertebrates within the Wet Tropics Bioregion.

- The WTVPRAS is an Excel-based spreadsheet program that assesses pest status relative to five generic pest species characteristics. These are i) previous pest history, ii) reproductive and dispersal potential, ability to iii) capitalise on variation in climatic and/or biological events, iv) vector diseases or parasites, or v) threaten existing species via predation, competition, and/or habitat degradation. Also, the WTVPRAS is designed to specifically gauge threats to the World Heritage and biodiversity values of the Wet Tropics region. It achieves this by assessing invasive species impacts relative to the Wet Tropics Biodiversity values identified by Goosem et al. (1999).

- The WTVPRAS assessment table uses published ecological data to generate four 'impact' indices (current impact, potential future impact, feasibility of control, and detrimental impacts of control) for each vertebrate pest. These four indices are then used to produce a combined assessment of overall pest status. The relative independence of each value also allows comparisons of 'impact types' to be undertaken in specific combinations for particular management purposes.

- The assessment table quickly cross references scores obtained from different impact sections and compiles this information into summary tables. The accompanying documentation provides detailed rationales (with appropriate references) for the assessment criteria used in each section of the table. Many assessment questions have quantitative terminology associated with them. Explanations of this terminology are given both in the report and as pull down menu options within the Excel spreadsheet.

- Provision has been made within the assessment table to document *in situ* all references used to obtain each risk assessment score. This allows data sources to be easily identified, and enables species-specific risk assessments to be updated as new information becomes available.

### Research Objective 2: Facilitate the collation of relevant reference materials

#### *Key Findings*

- The development of the WTVPRAS proforma has involved the compilation of a comprehensive list of references on generic risk assessment procedures, guidelines and protocols. Similarly, undertaking risk assessments on 28 exotic vertebrates within the Wet Tropics region has required the compilation of a substantial body of reference material on the general ecology and management of these species both in Australia and overseas. To extend the utility of this resource this material, combined with further references not directly cited in the text, has been complied into an annotated bibliography. This bibliography is available as Appendix (C) of the report.

# PART 2: VERTEBRATE PEST RISK ASSESSMENTS

## Research Objective 3: Focus on a manageable proportion of existing or potential vertebrate pests within the Wet Tropics Bioregion.

### *Key Findings*

- For the purpose of risk assessment the WTVPRAS considered species to be 'existing' pests of the Wet Tropics Bioregion if they were listed in Schedule two of the Wet Tropics Management Plan (1998) and/or had been previously reported as being present within the boundaries of the Wet Tropics Region (Long 1981; Herbert & Peeters 1995; Williams *et al.* 1996; Arthington *et al.* 1999). Other exotics were assessed as potential future pests (sleepers) if they were currently present within the Wet Tropics Bioregion or adjacent regions of Queensland. Although it was beyond the scope of this report to assess the pest potential of species that did not occur within these regions, such assessments are possible using the WTVPRAS. A list of the 28 species for which risk assessments were undertaken is given in Table 2 of the report. This list includes six fish, two amphibian/reptile, five bird and 15 mammal species.

## Research Objective 4: Provide direction for ecological vertebrate pest control research.

### *Key Findings*

- Currently, the major vertebrate pests of the Wet Tropics are identified as the pig, cat, cane toad, and dog/dingo. These species rank highly because of both their current impacts and their lack of controllability. Each of these species has a wide distribution and directly identifiable negative impacts on endangered and/or threatened species or habitats. Exotic fish (gambusia, tilapia x2, guppies, swordtails, platys) and rabbits, are also identified as significant pests. They have lower impact scores but are equally difficult to control. This is especially true for exotic fish, where it is extremely difficult to selectively target pest species using existing technology.

- Eradication of these major pest species from the region does not seem feasible in the short-term given current controls and costs. Identifying and costing specific management objectives to mediate impacts in sensitive areas will ultimately determine their future impacts. The effort required will depend on the management goals specified. For these species it will be necessary to establish goals on what are 'acceptable' levels of infestation and on the control impacts on native species that are acceptable to achieve these goals.

## Research Objective 5: Enhance the probability of early detection and response to 'sleeper' pest species and enable proactive contingency planning and swift response.

### *Key findings*

- The WTVPRAS clearly identified a group of 'sleeper' species with moderate current impacts but substantial future potential. These species in order of perceived threat are gambusia, the two tilapia species, and the fox. Other exotic fish posing only slightly less pest potential were the swordtail, guppy, and platy. Less significant but identifiable future threats were the black rat, indian myna and rabbit.
- In general, the WTVPRAS indicated that exotic fish may constitute the principal unrealised threat to the region. Once established these species dominate riverine communities and are extremely difficult to control. This is because of the intensity of control required and its highly negative impacts on non-target species. Impact scores for most exotic fish may also be underestimates reflecting a general lack of available information.
- Along with exotic fish, the WTVPRAS suggested that the fox is a major future threat to the Wet Tropics. The fox's relatively low current impact value was due only to its presently limited distribution.

- As a general trend, most pest species of the Wet Tropics were closely associated with human settlements or human disturbance. It is logical to conclude that any increase in human disturbance or expansion will bring with it increases in both high and low risk pest species.

**Research objective 6: Assist in identifying the Wet Tropics Management Authority's immediate to medium-term vertebrate management priorities and funding needs.**

***Key findings***

- The WTVPRAS has highlighted a number of generic problems associated with assessing the current and future impacts of vertebrate pests in the Wet Tropics. These are:
  a) the lack of baseline data on historic or current native species distributions and abundance against which to gauge exotic species impacts. This is a general problem but is particularly relevant to native fish and other freshwater taxa.
  b) A lack of quantified exotic impacts on native species. It is difficult to estimate the true extent of this problem and level of future work required. This is because many of these data may exist but are currently inaccessible in unpublished reports.
  c) The lack of basic data on pest population demography, including population sizes, ranges, and levels of interconnectedness. This stands out as being a major deficiency. Our current inability to adequately census most pest species within the Wet Tropics means that the efficacy of control methods cannot be accurately assessed. Data on control effectiveness, where they exist, do not provide information on the proportion of each pest population being removed per control ‘event’, or the relative impact of control on reproductive individuals. It is these data, combined with accurate post-control censusing that is needed to establish control effectiveness.

# PART 1 - THE WET TROPICS VERTEBRATE PEST RISK ASSESSMENT SCHEME

## 1.1 INTRODUCTION

The invasion of 'natural' ecosystems by exotic species is considered one of the major processes threatening global biodiversity (Species Survival Commission 2000). The establishment of self-sustaining non-native populations consistently results in substantial large-scale degradation of existing 'natural' ecosystems (Stone & Stone 1989; Lodge 1993; Davis *et al*. 2000; Species Survival Commission 2000; Mack *et al.* 2000). Disruptions to ecosystem function and changes to patterns of native species richness and abundance are common forms of degradation attributable to exotic or 'pest' species invasions (Species Survival Commission 2000; Sax & Brown 2000).

By removing natural barriers to dispersal, globalisation and the expansion of trade and tourism have facilitated many exotic species invasions (Mooney & Drake 1989; Species Survival Commission 2000; Mack *et al.* 2000). Similarly, human induced habitat modification continues to allow invasive species into previously 'immune' environments (Levin 1989; Mooney & Drake 1989). To date, all continents have been negatively affected by the introduction of exotic species. However, islands and other isolated habitats have been significantly more susceptible to biodiversity loss (Species Survival Commission 2000; Mack *et al.* 2000; Sax & Brown 2000). This susceptibility is attributed to higher levels of endemism in these isolated regions (Species Survival Commission 2000).

Thus, the development of effective management strategies aimed at preserving biodiversity, particularly in isolated areas of high endemism, must give a high priority to identifying and assessing the possible impacts of invasive 'pest' species (Lodge 1993).

### Identifying exotic 'pest' species

Once established, exotic 'pest' species are defined as "*locally or regionally abundant taxa that have the potential to induce significant deleterious effects*" (Braysher 1993). However, identifying life-history attributes that adequately define pest potential prior to establishment is a much more difficult task. This problem is the subject of considerable debate in the ecological literature (Ehrlich 1989; Davis *et al.*; 2000, Mack *et al.* 2000). This debate identifies a number of potential 'pest' characteristics. These characteristics, summarised in Ehrlich (1989), include; broad ecological requirements and/or tolerances, high relative abundances within original ranges, r-selected and polyphagous life-histories, associations with disturbed or anthropogenic habitats, short generation times, and extensive genetic variability. Also, many invasive species have the potential for a single fertilised female to colonise alone and have large body size relative to congeneric species (Sax & Brown 2000).

Despite these life-history similarities providing some measure of pest potential, it still remains difficult to identify pests prior to invasion. This is because the characteristics described above do not adequately define all pest species. For example, invasive species may develop from small but reproductively successful populations that originally have restricted distributions. The apparent non-detrimental effects attributable to these species while population numbers are low, means that they are often not recognised as potential pests. However, these 'sleeper' species can cause severe ecosystem degradation and native species losses when climatic and/or resources fluctuations allow population expansion (Davis *et al.* 2000). Similarly, while some established exotic species may not display 'pest' characteristics, and appear benign in their direct impact, they may vector other exotic organisms with devastating consequences on ecosystem integrity (Choquenot *et al.* 1996; Stone 1989; Pavlov 1992).

For invasive species to be successful they must also be able to adjust to the physical and biological characteristics of the habitat being invaded. Therefore, the characteristics of the target ecosystem will greatly influence the potential pest status of any invader (Ehrlich 1989; Davis *et al.* 2000; Lodge 2000). Some general habitat characteristics appear to make ecosystems more susceptible, these include relative isolation, the prolonged absence of predators, and previous human disturbance (Ehrlich 1989; Lodge 2000). However, the direct relationship between target ecosystem character and pest status makes identifying pest potential difficult without direct reference to the ecosystem under threat, and where possible, the impact of the potential pest in similar environments elsewhere (Pimm 1989).

Historically, only one in ten invasive species have been successful (Fox & Adamson 1985; Ehrlich 1989; Ricciardi & Rasmussen 1998; Mack *et al.* 2000;), with multiple introductions often being required before permanent establishment occurs (Ehrlich 1989; Lodge 1993). Of significance is that many invasions have succeeded only because of their association or dependence on human modified environments (Sax & Brown 2000). The implications of this phenomenon are obvious. Isolated areas of high endemism that have been, or are being fragmented by human disturbance, must be viewed as highly susceptible to the threat of exotic species invasion. The Wet Tropics Bioregion of northern Australia is one such region.

In summary, the ecological complexity of species-environment interactions make it difficult to generalise about the pest potential of invasive species based solely on broad life-history characteristics. Because of this, the possible impacts of invasive species in areas such as the Australian Wet Tropics can only be estimated through studies that also assess pest potential relative to defined habitat criteria, and consider the history of the potential pest in similar environments elsewhere.

## Wet Tropics Bioregion of Northern Australia

The Wet Tropics Bioregion of Northern Australia is a World Heritage listed area of identified global significance (Wet Tropics Management Authority 1998). The region extends along the northeast coast of Queensland from south of Cooktown to north of Townsville (15°39'-19°17'S, 144°58'-146°27'E). Its area is 894,420ha (1% of Queensland) and it borders on the Great Barrier Reef World Heritage Area. Altitudes range from sea level to high tablelands at 800m, with isolated peaks up to 1,622m. Approximately 3000 plant species from 210 families occur in the Wet Tropics, with more than 700 species being endemic to the region. Of the 3000 plant species listed more than 350 are considered rare or threatened with 14 presumed extinct and 65 endangered or vulnerable. Approximately 70 vertebrate species are endemic to the region with eleven being classified as vulnerable. The Wet Tropics also contains large numbers of species that have broader distributions (Table 1). Further details of the flora of the Wet Tropic region and the conservation status and distribution of rare and threatened plants are given in Rainforest Conservation Society Queensland (1986).

**Table 1. Percentage of Australian species from different taxomonic families represented in the Wet Tropics Bioregion of North Queensland (from Goosem *et al.* 1999)**

| Family | % of Australian spp |
|---|---|
| Ferns | 65 |
| Cycads | 21 |
| Conifer | 37 |
| Orchid | 30 |
| Mammal | 36 |
| Marsupials | 30 |
| Bat | 58 |
| Rodent | 25 |
| Bird | 50 |
| Frog | 25 |
| Reptile | 23 |
| Freshwater fish | 37 |
| Butterflies | 60 |

Goosem *et al.* (1999) divide the Wet Tropics bioregion into nine provinces based on Nix and Switzer's (1991) biogeographic units. These provinces identify differences in climate, geology and landform. Within these provinces 105 regional ecosystems have been identified using various floristic and geomorphic criteria (Goosem *et al.* 1999). Twenty-four of 105 ecosystems are considered endangered, with a further 17 listed as 'of concern'. Exotic species invasions (flora and fauna) have been identified as one of the most significant threats to these 41 ecosystems (Werren *et al.* 1995). Vertebrate pests constitute a substantial component of this threat (Wet Tropics Management Authority 1998). Thirteen mammals, one amphibian, two reptiles and at least six fish species are currently listed as undesirable in the Wet Tropics Bioregion (Wet Tropics Management Authority 1998). These vertebrates threaten the bioregions integrity via habitat destruction, predation and the competitive exclusion of native species (Wet Tropics Management Authority 1998).

The global significance of the Wet Tropics Bioregion and increasing tourism and travel between Northern Australia, New Guinea and areas of Southeast Asia with similar climate, means that an assessment of the current or potential pest status of invasive species within the region has become a priority. This report outlines a 'risk assessment scheme' designed to establish the relative pest status and potential impact of exotic vertebrates currently within the Wet Tropic Bioregion.

## 1.1.1 TERMS OF REFERENCE

The Wet Tropics Vertebrate Pest Risk Assessment Scheme (WTVPRAS) presented in this report was developed to undertake risk assessments of 'existing' and/or 'potential' vertebrate pest species within the Wet Tropics Bioregion.

Species were considered to be 'existing' pests if they were listed in schedule 2 of the Wet Tropics Management Plan (1998), and/or had been previously reported as being present within the boundaries of the Wet Tropics Region (Long 1981; Herbert & Peeters 1995; Williams *et al.* 1996; Arthington *et al.* 1999). Species were assessed as potential future pests (sleepers) if they were already present within the Wet Tropics Bioregion or adjacent regions of Queensland, Australia. It was beyond the scope of this report to assess the pest potential of species that did not already occur within these regions, although such assessments are possible using the WTVPRAS.
The emphasis of the WTVPRAS was on gauging the potential threat of vertebrate pests to the 'World

Heritage' values (as defined by the Wet Tropics Management Authority 1998) and biodiversity of the Wet Tropics Bioregion.  The WTVPRAS also aimed to help prioritise the eradication, containment, and control of vertebrate pests in the region.

### 1.1.2 SPECIFIC OBJECTIVES

Specific objectives to be met by the WTVPRAS were as follows:

- Focus on a manageable proportion of existing or potential vertebrate pests within the Wet Tropics Bioregion .
- Establish a robust decision-making model for strategic management of vertebrate pests within the region
- Facilitate the collation of relevant reference materials.
- Provide direction for ecological vertebrate pest control research.
- Enhance the probability of early detection and response to 'sleeper' pest species.
- Enable proactive contingency planning and swift response.
- Assist in identifying the Wet Tropics Management Authorities immediate to medium –term vertebrate management priorities and funding needs.
- Provide information to aid in the preparation of public awareness materials.

# 1.2 THE WTVPRAS PROFORMA

## 1.2.1 PROFORMA DESCRIPTION

A general review of pest and invasive species literature established five generic pest species characteristics upon which existing risk/impact assessment schemes are based. These were; i) previous pest history, ii) reproductive and dispersal potential, ability to iii) capitalise on variation in climatic and/or biological events, iv) vector diseases or parasites, or v) threaten existing species via predation, competition, and/or habitat degradation (e.g. Fox & Adamson 1979; Simberloff 1981; Groves & Burton 1986; Norton & Pech 1988; Brown 1989; Ehrlich 1989; Hobbs 1989; Levin 1989; Pimm 1989; Hiebert & Stubbendieck 1993; Lodge 1993; Hone 1994; Arthington *et al*. 1999; Cairns City Council 1999; Richardson *et al.* 2000; Sax & Brown 2000; also see annotated bibliography – Appendix C )

This same literature was used to design the WTVPRAS assessment table. This table comprises a series of questions that assess pest status relative to the above characteristics, specifically in the context of the Wet Tropic Bioregion.

The WTVPRAS assessment table uses published ecological data to generate four 'impact' indices for each vertebrate pest.

- Current impact within the Wet Tropics Bioregion.
- Potential future impact within the Wet Tropics Bioregion
- Feasibility of control specifically in the Wet Tropics Bioregion
- Detrimental impact of existing control measures on non-target species

These four independent 'impact' values are then used to produce a combined assessment of overall pest status. The relative independence of each value also allows comparisons of impacts to be undertaken in specific combinations for particular management purposes. For example, a management program aimed at minimising future degradation may wish to identify species with low current impact but high disturbance potential that are currently controllable, in preference to species with higher current impacts that have limited further pest potential and low feasibility of control. Obtaining only a single overall assessment for each species would not highlight these options.

The WTVPRAS assessment table is an Excel-based spreadsheets program that quickly cross-references scores obtained from different 'impact' sections and compiles the information into summary tables. A hard copy format of the assessment table is given below. The rational and justifications for the risk assessment criteria used in each section of the assessment table are given in Section 1.3 Risk Assessment Criteria. Many assessment questions have quantitative terminology associated with them. Explanations of this terminology are given in both Section 1.3.5 and as pull down menu options within the Excel spreadsheet. Provision has been made within the spreadsheet assessment table to document all references used to undertake a species-specific risk assessment. This allows data sources to be easily identified, and enables assessments to be updated as new information becomes available.

## 1.2.2 WTVP RISK ASSESSMENT TABLE

## Species Name ………………………………..

### SECTION 1. SPECIES CURRENT LEVEL OF IMPACT

***1.1 Distribution***

a. Distribution and abundance relative to Wet Tropics Bioregion.
(see Appendix A for provinces of the Wet Tropics Bioregion)

| | | **Species Score** |
|---|---|---|
| Established populations abut the Wet Tropics Bioregion | 2 | |
| Established populations exist within Wet Tropics Bioregion | 10 | |

b. Wet Tropics Bioregion Provinces in which species is present. Tick each occurrence or 'Present in all'.
(see Appendix A for provinces of the Wet Tropics Bioregion)

| | | |
|---|---|---|
| Kirrama-Hinchinbrook | 4 | |
| Paluma-Seaview | 4 | |
| Macalister | 4 | |
| Bellenden Ker | 4 | |
| Atherton | 4 | |
| Herbert | 4 | |
| Tully | 4 | |
| Innisfail | 4 | |
| Daintree-Bloomfield | 4 | |
| **Total** | | |
| Present in all | 40 | |

c. Most significant province of the Wet Tropics where species occurs. Tick one only.
(see Appendix A for provinces of the Wet Tropics Bioregion)

| | | |
|---|---|---|
| Kirrama-Hinchinbrook (1x2)+(5x1) | 7 | |
| Paluma-Seaview (1x2)+(7x1) | 9 | |
| Macalister (4x2)+(1x1) | 9 | |
| Bellenden Ker (4x2)+(2x1) | 10 | |
| Atherton (5x2)+(3x1) | 13 | |
| Herbert (8x2)+(5x1) | 21 | |
| Tully (11x2)+(5x1) | 27 | |
| Innisfail (11x2)+(7x1) | 29 | |
| Daintree-Bloomfield (12x2)+(6x1) | 30 | |

d. Distribution and Abundance

| | | |
|---|---|---|
| Small populations, patchy distribution | 5 | |
| Small populations, continuous distribution | 10 | |
| Large populations, patchy distribution | 10 | |
| Large populations, continuous distribution | 20 | |

| | | |
|---|---|---|
| **Total for Section 1.1** | **100** | |

***1.2 Direct effects on native species distributions and abundances***

| | | |
|---|---|---|
| Species has exhibited no detectable effect | 1 | |
| Minor modification to native species distributions and abundances | 10 | |
| Moderate modification to native species distributions and abundances | 20 | |
| Major modification to native species distributions and abundances | 30 | |
| Responsible for extinction of native species | 50 | |
| Impact Unknown | 25 | |

***1.3 Ecological interaction with vulnerable or endangered species***

| | | |
|---|---|---|
| Species has no or little ecological interaction with vulnerable or endangered species | 1 | |
| Species has minor interaction with vulnerable or endangered species | 20 | |
| Species has moderate interaction with vulnerable or endangered species | 30 | |
| Species has major interaction with vulnerable or endangered species | 50 | |
| Ecological interaction unknown | 25 | |

| | | |
|---|---|---|
| **Total for Section 1.1** | **100** | |
| **Total for Section 1.2 - 1.3** | **100** | |
| **TOTAL FOR SECTION 1 – CURRENT LEVEL OF IMPACT** | **200** | |

## SECTION 2. ASSESSMENT OF PEST POTENTIAL

***2.1 Known level of impact in other natural areas***

| | | |
|---|---|---|
| Not known to cause impacts in any other natural area | 1 | |
| Known to cause impacts in natural areas, but in different habitats and climate zones | 2 | |
| Known to cause low impact in natural areas in similar habitats and climate zones | 5 | |
| Known to cause moderate impact in natural areas in similar habitats and climate zones | 10 | |
| Known to cause high impact in natural areas in similar habitats and climate zones. | 15 | |

***2.2 Reproductive Potential***

a. Reproductive cycles

| | | |
|---|---|---|
| Reproduction reliant on specific a-seasonal environmental stimuli | 1 | |
| Seasonal | 2 | |
| Multiple reproductive events/season | 4 | |
| Continuous breeding | 5 | |
| Able to reproduce from one individual | 5 | |
| Unknown | 3 | |

b. Reproductive output

| | | |
|---|---|---|
| <3 offspring/cycle | 1 | |
| 3 – 10 offspring/cycle | 3 | |
| >10/cycle | 5 | |
| Unknown | 3 | |

c. Offspring viability

| | | |
|---|---|---|
| Low | 1 | |
| Moderate | 3 | |
| High | 5 | |
| Unknown | 3 | |

| | | |
|---|---|---|
| **Total for Section 2.2** | **15** | |

***2.3 Dispersal ability***

| | | |
|---|---|---|
| Low potential for dispersal | 5 | |
| Moderate potential for dispersal | 10 | |
| Dispersal associated with human movements | 15 | |
| High potential for dispersal | 20 | |
| Unknown potential | 10 | |
| | | |
| **Total for Sections 2.1 – 2.3** | **50** | |

***2.4 Mode of Impact***

| | | |
|---|---|---|
| Degradation/deprivation of habitat | 5 | |
| Competition for food and reproductive resources | 5 | |
| Transmission of disease/parasites/other pest species | 10 | |
| Direct predation of native animals | 15 | |
| More than one of the above modes | 20 | |

***2.5 Potential interactions with vulnerable or endangered species***

| | | |
|---|---|---|
| Species has little overlap with vulnerable or endangered species | 2 | |
| Species has minor overlap with vulnerable or endangered species | 10 | |
| Species has moderate overlap with vulnerable or endangered species | 20 | |
| Species has major overlap with vulnerable or endangered species | 30 | |
| Ecological overlap unknown | 15 | |

| | | |
|---|---|---|
| **Total for Sections 2.1 – 2.3** | **50** | |
| **Total for Sections 2.4 – 2.5** | **50** | |
| **TOTAL FOR SECTION 2 – POTENTIAL IMPACT** | **100** | |

## SECTION 3. FEASIBILITY OF CONTROL

***3.1 General susceptibility to control***

a. Dispersal/mobility

| | | |
|---|---|---|
| Individuals/populations are sedentary or have established tracks/movements | 5 | |
| Adults/juveniles are seasonally dispersive | 10 | |
| Adults/juveniles are continuously dispersive | 15 | |

b. Life history stage susceptible to control

| | | |
|---|---|---|
| all stages | 5 | |
| sub-group of stages | 7 | |
| single stage | 10 | |

c. Temporal availability to control

| | | |
|---|---|---|
| Continuously | 5 | |
| Seasonally | 7 | |
| Restricted | 10 | |

d. Recovery rate

| | | |
|---|---|---|
| Multiple reproductive events over an extended time period | 5 | |
| Multiple reproductive events over a short time period | 10 | |
| Single reproductive event | 15 | |
| Unknown | 7 | |

***3.2 Control Measures***

a. Present control measures

| | | |
|---|---|---|
| Control measures exist | 2 | |
| Control measures being developed | 5 | |
| Control measures do not exist | 50 | |

b. Effectiveness of current control measures

| | | |
|---|---|---|
| Highly effective | 2 | |
| Moderately effective | 5 | |
| Low effectiveness | 10 | |
| Unknown | 5 | |

c. Logistic difficulty of implementation

| | | |
|---|---|---|
| Low | 2 | |
| Moderate | 5 | |
| High | 10 | |

d. Potential to develop resistance to control measures

| | | |
|---|---|---|
| Low | 1 | |
| Moderate | 3 | |
| High | 5 | |
| Unknown | 3 | |

e. Cost

| | | |
|---|---|---|
| Low | 1 | |
| Moderate | 3 | |
| High | 5 | |
| Unknown | 3 | |

f. Level of control effort required

| | | |
|---|---|---|
| One application of one control measure is successful | 1 | |
| Multiple application of single control measure | 5 | |
| One application of multiple control measures required | 10 | |
| Multiple applications of multiple control measures required | 15 | |

| | | |
|---|---|---|
| **Total for Section 3.1** | **50** | |
| **Total for Section 3.2** | **50** | |
| **TOTAL FOR SECTION 3 – FEASIBILITY OF CONTROL** | **100** | |

## SECTION 4. NEGATIVE IMPACT OF CONTROL MEASURES

***4.1 Habitat impacts***

| | | |
|---|---|---|
| Minimal physical alteration to habitat | 5 | |
| Moderate physical alterations to habitat | 10 | |
| Major physical alterations to habitat | 25 | |
| Unknown | 12 | |

***4.2 Native Population Impacts***

| | | |
|---|---|---|
| Control measures affect few individuals of some species | 5 | |
| Control measures impact moderate numbers of individuals of several species | 10 | |
| Control measures impact large numbers of individuals of most species | 25 | |
| Unknown | 12 | |

**4.3 *Other pest species***

| | | |
|---|---|---|
| Control measures release other pest species with minor enhancement of impacts | 5 | |
| Control measures release other pest species with moderate enhancement of impacts | 10 | |
| Control measures release other pest species with major enhancement of impacts | 25 | |
| Unknown | 12 | |

**4.4 Length of Impact**

| | | |
|---|---|---|
| Short term (up to several weeks) | 5 | |
| Medium term (one season or reproductive cycle) | 10 | |
| Long term (more than one year or reproductive cycle/permanent) modification of habitat | 25 | |
| Unknown | 15 | |

| | | |
|---|---|---|
| **TOTAL FOR SECTION 4 – NEGATIVE IMPACT OF CONTROL MEASURES** | **100** | |

# 1.3 RISK ASSESSMENT CRITERIA

Section 1.3 of this report provides detailed explanations and rationales (with appropriate references) for the questions used in each section of the WTVPRAS assessment table. Specific terms used to quantify current or potential impacts are defined in section 1.3.5. Use of the WTVPRAS requires a sound biological knowledge of the potential pest species being assessed. As prevention is generally easier than control, where information on exotic species biology is limited, over estimation of potential impacts is advised (Daehler & Strong 1993: Species Survival Commission 2000). Therefore, if information is not currently available a precautionary principal (unknown impact = 'moderate' impact value) has been used in the WTVPRAS. This is to prevent missing information masking current or potential impacts. However, the need to apply a precautionary principal where information is limited may severely restrict the utility of some assessments. This is particularly relevant to exotic fish species within the Wet Tropics Bioregion.

## 1.3.1 CURRENT IMPACTS

The questions in Section 1 of the WTVPRAS assessment table are designed to assess the current level of impact of each pest species within the Wet Tropics Bioregion.

### *Question 1.1 Distribution and abundance of pest species*

Question 1.1a establishes whether populations of the species being assessed already occur within the boundaries of the Wet Tropics World Heritage area. Species established within these boundaries are considered more immediate risks and receive a higher ranking. If a species abuts the region it may be impacting fringing areas where it occurs. Such edge effects have been shown to have significant detrimental effect in fragmented landscapes and cannot be ignored. For this reason current impact assessments are made for fringing species.

Pest species distributions within the Wet Tropics have been recorded by numerous authors (e.g. Strahan 1993; Pusey & Kennard 1994; Williams *et al.* 1996; North Queensland Joint Board 1997; Wet Tropics Management Authority 1998; Arthington *et al.* 1999). Many pests occur in areas of high biological diversity and endemism. Questions 1.1b and 1.1c assess the total area of impact and the biological significance of that area respectively. Question 1.1b identifies the extent of regional infestation independent of the significance of the area occupied. A pest species that is present throughout the Wet Tropics region is given a higher impact value than one that occurs in only one or two provinces. This value is scaled for potential differences in the conservation value of each province occupied by question 1.1c.

Question 1.1c identifies the most significant province in which a pest species occurs, and so scales pest impacts relative to the Wet Tropics biodiversity values identified by Goosem *et al.* (1999). Using the number of endangered regional ecosystems and ecosystems 'of concern' that occur in each of the nine provinces, the Wet Tropics provinces are ranked. For example the Kirrama-Hinchinbrook province encompasses one endangered ecosystem and five ecosystems 'of concern'. It has the lowest ranking (1x2) + (5 x 1) of seven. In comparison, the Daintree (province 9) encompasses 12 (12 x 2) endangered ecosystems and 6 (6 x 1) ecosystems 'of concern' giving it total ranking of 30. This scaling enables an assessment of pest impact relative to the perceived conservation significance of each area. This ranking system assumes that the impact of invasive species is greater in provinces with higher numbers of endangered regional or 'of concern' ecosystems.

Question 1.1d assesses pest species population distribution. Species with large populations and continuous distributions will impose greater impacts than species having small discrete populations (Pimm 1989). This question mediates rankings from question 1.1a. A species may be present in all provinces (scoring 40 for question 1.1b) but if it occurs as small discrete populations confined to specific environments it will receive a only a further five points from this question. In comparison, a species, that occurs in only five of the nine provinces (scoring 20 from question 1.1b) but is distributed as a single continuous population will receive a further 20 points.

***Question 1.2 Direct effects on native species distributions and abundances***
The direct impact of pests on native species in the Wet Tropics is one of the most difficult components of the WTVPRAS to assess. This is due to a general lack of both i) historical data on native species past distributions and abundances and ii) the rigourous quantification of non-presence data for pest species. Quantifying current impacts is also hindered by an inability to access unpublished data. Pest species may impact on native species by direct predation of individuals, occupation or modification of habitat and/or competition for food and other resources. In question 1.2 direct effects are scored if a pest has been documented actively predating on native species, competing with natives for specific resources (e.g. nesting holes, specific foods, modifying specific habitats), or is considered to be exerting a major modification pressure on native species distributions and abundance. Pigs and cane toads are good examples of such species. Pests that do not exert these pressures (e.g. grazing mammals), or are confined to human settlements, are ranked more lowly.

***Question 1.3 Potential interactions with vulnerable or endangered species***
This question identifies pests that are likely to effect the biodiversity of the Wet Tropics region in the short-term by impacting directly on native species that are listed as endangered or vulnerable. Identifying these pest species may aid in establishing control priorities. The distributions and basic ecology of many vulnerable or endangered species within the Wet Tropics Bioregion has been documented (Strahan 1993; Williams *et al.* 1996). With few exceptions (e.g. pigs) the ecological overlap pest species have with endangered/vulnerable species is not well known. Any documented interaction between a pest species and an endangered or vulnerable native species (e.g. predation or competition for resources) ranks the pest as having a major negative effect. Wild dog harassment of tree kangaroos (Schmidt 2000) is such an example. If the general ecology of pests and endangered/vulnerable species suggest some overlap but no interaction has been documented, a precautionary principal is used. Species that have minimal identifiable ecological overlap with endangered/vulnerable species (e.g. sparrows, turtle doves) receive the lowest scores.

## 1.3.2 PEST POTENTIAL

No one set of life-history characters can be used to definitively assess pest potential (Ehrlich 1986, 1989). However, based on current ecological theory and information obtained from previous infestations, a number of generic characteristics have been identified that are common to many successful pests. These characteristics are used in section 2 of the assessment table to undertake an assessment of future risk potential.

***Question 2.1 Known level of impact in other areas***
Question 2.2 establishes previous pest history relative to climate and habitat requirements. Pest species originating from climatic zones similar to the Wet Tropics are more likely to cope with climatic stresses imposed during colonisation (Lodge 1993; Species Survival Commission 2000; Sax & Brown 2000) and so pose a potentially greater threat. Similarly, if a species has demonstrated pest potential in equivalent habitats elsewhere, this information can be used to quantify the potential threat posed to the Wet Tropics region (Lodge 1993; Species Survival Commission 2000; Sax & Brown 2000).

***Question 2.2 Reproductive Potential***
Questions 2.2a, b, and c assess reproductive potential. The frequency and magnitude of reproductive events, the ability to complete reproductive cycles and the viability of offspring all effect pest potential and thus impact. Species that reproduce less frequently or rely on specific environmental stimuli are less likely to impact than continuously breeding generalists (Ehrlich 1986, 1989; Pimm 1989). Accordingly, species that require a-seasonal specific stimuli or rare environmental events to trigger reproduction receive a lower score. Single female reproduction via parthenogenesis or multiple

insemination and sperm storage further increases colonisation potential (Ehrlich 1989; Pimm 1989; Lodge 1993). These reproductive modes enable pest species to more quickly establish viable populations and so receive a higher ranking.

The numbers of offspring produced during each reproductive event (2.2b) and offspring viability (2.2c) significantly influence a pest species ability to establish (Osborne 2000). Species that produce many young at an early age have greater population growth rates than species with longer reproductive cycles and fewer offspring (Ehrlich 1989). Consequently, the more fecund a species the more successful it will be at colonising new habitats (Fox & Adamson 1985). Thus, species that have few (<3) offspring are ranked lowest while those producing many (>10 for vertebrates) score more highly. If in-turn these offspring are highly viable establishment potential again increases.

### *Question 2.3 Dispersal ability*

A species dispersal potential is a major factor determining its ability to invade new areas (Levin 1989; Usher 1989). Potential pests will impact smaller areas if their capacity to disperse is limited (Usher 1989). Principal factors enhancing dispersal potential are mobility, tolerance to physiochemical variation and associations with human settlement (Ehrlich 1986, 1989; Lodge 1993). Therefore, these characteristics have been used to rank potential pest species. Species with mobile adults and/or young and a history of colonising new areas are ranked highly. Species closely associated with human disturbance (eg; cats, indian minors, rats, etc.) have aided mobility via human mediated transport. These species are ranked higher than moderately mobile species. This is because such species can establish stable source populations in favourable (human modified) environments prior to spreading into native habitats. Species with sedentary young that are not associated with humans, or have low tolerance to physiochemical variation, have much lower dispersal abilities and receive the lowest score.

### *Question 2.4 Mode of impact*

Introduced species may impact on native taxa in a number of ways. These include habitat degradation, the transmission of diseases and parasites, and/or direct predation, and competition. A pest species' mode of impact will significantly effect its ability to disrupt ecosystem integrity (Pimm 1989). The rank values for question 2.4 are based on the immediacy of perceived impacts. Reduction of native species numbers by direct predation results in more immediate and severe impacts (Pimm 1989; Usher 1989; Lodge 1993; Cowan 2000). Reviews of invasive species impacts consistently identify predation as as the principal cause of extinction (76% of 55 studies - Greenway (1967); 72% of 71 studies – Simberloff (1981)).

Many exotic pests harbour and/or provide point source introductions of parasites and viruses to native populations. Pigs provide a host for many diseases and parasites that are not endemic to Australia. Due to their wide distribution, pigs have the potential to transmit these diseases and parasites to native and human populations (Pavlov 1992; Pavlov *et al.* 1992; Department of Natural Resources 1996). Native Hawaiian bird species have been, and continue to be depleted by the introduction of avian malaria via exotic birds (Stone & Loope 1987). This mode of impact, once the parasite or disease is introduced, is likely to have immediate and serious effects on native species populations and is ranked highly.

Competition and habitat degradation have been ranked equally. While both these influences can produce substantial ecosystem degradation their impacts are generally perceived as occurring over the medium to long-term (Pimm 1989; Usher 1989; Cowan 2000). Competition may occur for a range of resources such as food, shelter and/or breeding sites. Impacts will be greatest where generalist exotics competitively exclude native species during periods of limited resource availability (Ehrlich 1989). Ecological overlap may also result in habitat degradation and the disruption of ecological processes. For example, pigs eating rainforest fruits may not reduce the availability of fruit to native animals in the short-term. But, as pigs do not distribute or 'process' fruit in the same way as native species they have the potential to produce longer-term changes in overall plant and animal species distribution and abundance (Choquenot 1984). Structural habitat alterations such as this have been shown to increase the threat of predation, and negatively effect foraging efficiency, and other behaviours associated with these activities (Petren & Case 1998). Previous studies have also shown that both habitat alteration and competitive exclusion contribute significantly to native species extinctions (Greenway 1967).

***Question 2.5 Potential interactions with vulnerable or endangered species***
Pests that may interact directly with native species listed as vulnerable or endangered have a greater potential to cause serious negative impacts on these taxa. The rankings for question 2.5 assume a direct relationship between level of potential interaction and magnitude of negative impact on vulnerable or endangered species. Interactions examined include any of the processes identified in question 2.4.

## 1.3.3 DIFFICULTY OF CONTROL

Section 3 of the WTVPR assessment table assesses three aspects of pest controllability. These are i) biological susceptibility, ii) cost effectiveness of current control technology, and iii) social acceptance of current controls from both cultural and ethical perspectives. A high ranking in this section indicates a current lack of effective control measures relative to one or more of the above criteria

***Question 3.1 Lack of susceptibility to control***
Five factors have been identified that influence a species susceptibility to control. These are:
a) *Dispersal/mobility*. If pest species are highly mobile or continuously dispersing then there is little chance that control measures will effectively reduce numbers or prevent further spread (Macdonald *et al.* 1989; Usher 1989). High dispersal rates also mean that new areas are continuously under threat and that containment or exclusion may be necessary to increase control efficacy (Usher 1989). Alternatively, if a species is sedentary, or habitually visits key sites, control measures are likely to be significantly more effective and have less impact on non-target organisms (Usher 1989).

b) *Life history stages susceptible to control.* The ability to use control measures on all or a number of life-history stages allows greater flexibility in their deployment and so may substantially increase control effectiveness. If few windows of opportunity exist to implement controls because only specific life history stages are susceptible, limited effectiveness of control events at these times could allow large increases in pest populations.

c) *Temporal availability.* As with question 3.1b the ability to deploy control measures throughout the year may substantially increase control effectiveness. Ephemeral species having boom bust cycles are often more difficult to control. This is because they are hard to detect during periods of low individual abundance and so less susceptible to control. Because of this, controls are often only effective if they can be implemented swiftly when monitoring detects species presence or increases in population size (Braysher 1993).

d). *Recovery Rate*. Pest species that can recovery to pre-control levels in only one or two reproductive cycles, or maintain small minimum viable population sizes, will require substantially more efficient control measures (Pimm 1989). Because of this they will be more difficult to control (Pimm 1989).

***Question 3.2 Current control measures***
Question 3.2 determines whether control measures currently exist for particular pest species and if so, examines the logistic difficulties and relative costs associated with their implementation. If no control measures exist the highest possible score is given, as the species is considered currently uncontrollable. Control methods that are either highly effective, implemented easily and at low cost, or require infrequent use will receive lower scores. Conversely methods that are ineffective, costly and /or logistically difficult to implement in the context of the Wet Tropics Bioregion will receive high scores indicating low feasibility of control.

Question 3.2d specifically examines the potential for resistance to controls to develop. Resistance can develop in either of two-ways. Firstly, if control measures remove only 'susceptible' individuals, and susceptibility is genetically controlled, then unless all individuals are susceptible resistance will develop. Over time the frequency of resistant genotypes in the population will increase and the effectiveness of the control will diminish (Usher 1989). A second form of resistance may involve individuals learning to avoid control measures through experience (e.g. trap and bait shyness etc.), and passing this avoidance behaviour on to other individuals via cultural associations (Usher 1989). Assessments of the potential for resistance to develop are based on the mode of operation of the control strategy and on previous results obtained using existing controls.

## 1.3.4 IMPACT OF CONTROL MEASURES

Section 4 of the WTVPRAS assesses the possible detrimental effects of control on both general habitat characteristics and non-target organisms.

### *Questions 4.1 Habitat impacts and 4.2 Native species impacts*

Control methods may involve physically altering habitats and/or adding substances to environment that detrimentally effect non-target species (Usher 1989). These impacts need to be assessed to determine whether they are justifiable relative to the current or potential level of pest impact and the degree of control that will be obtained. Special consideration must be given to this problem where controls may produce non-target impacts in one of the highly ranked areas of concern. Questions 4.1 and 4.2 assess the potential magnitude of these impacts on habitat physical characteristics and numbers of non-target species respectively.

### *Question 4.3 Other pest species impacts*

Consideration must also be given to the potential effect that controlling one pest species has on other pest species. Changes in the distribution of one pest may simply alter roles within an ecological system, or release other pests from a controlling agent. In some instances, removal of one pest can lead to substantial increases, rather than decreases, in predation of native animals (Usher 1989).

### *Question 4.4 Length impact of control measures*

The length of time a control measure is in place will also determine the effects it produces on non-target organisms (Newsome 2000). Loss of non-target individuals over short periods may be justified if the effectiveness of control will ultimately enable native populations to recover and remain viable in the longer-term (Usher 1989).

## 1.3.5 QUANTITATIVE TERMINOLOGY

### Section 1 - Current Impact Assessment

*1.2 - Direct effects on native species distribution and abundance*

**No detectable effect:** Species has been recorded i) only in fringing areas with no adverse effects being noted or ii) has been recorded in very low numbers in the Wet Tropics Bioregion for several years with no apparent increase in population size or adverse effects being noted.

**Minor**: Species has been recorded in the Wet Tropics Bioregion with small population increases being observed. Minimal impacts on habitats or native species have been noted and/or quantified.

**Moderate:** Species is indirectly impacting native fauna through quantifiable habitat alteration (e.g. creating microclimates, wallows etc) and competition for general resources (e.g. general food and roosting sites).

**Major:** Species is directly competing with/or preying upon native species, physical modifying endangered/'of concern' ecosystems, and/or transmitting detrimental organisms to native species.

**Unknown impact:** Species has no quantified history of detriment impacts, but possible effects are unknown. A precautionary principle is invoked so as to avoid non-detection of potential pest species.

*1.3 - Direct effects on vulnerable or endangered species distribution and abundance*

**No detectable effect:** Species has no documented or perceived ecological overlap with vulnerable or endangered species

**Minor**: Species has potential indirect effects on vulnerable or endangered species via quantifiable habitat alteration and/or competition for general resources due to an established presence in the region.

**Moderate:** Species has documented or expected direct overlap in habitat/resource utilisation with vulnerable or endangered species.

**Major:** Species is directly competing with/or preying upon vulnerable or endangered species, physical modifying endangered/'of concern' ecosystems, and/or transmitting detrimental organisms to vulnerable or endangered species.

**Unknown impact:** Species has no quantified history of detriment impacts, but possible effects are unknown. A precautionary principle is invoked so as to avoid non-detection of potential pest species.

**Section 2 - Pest Potential**

*2.1- Impacts in other natural areas*

**Low**: Species not recorded as a successful competitor/vector in similar habitats. Observed to establish small populations in urbanised areas.

**Moderate**: Species is known to cause habitat modification, compete for resources and/or transmit disease and/or parasites in similar ecosystems.

**High:** Species has a proven history of detrimental impacts via:

- monopolising limited resources (e.g. more successful at obtaining and defending nesting hollows)
- direct predation on endangered or threatened species,
- Successful competition for limited and specialised food resources,
- vectoring of diseases and/or parasites

*2.2c Offspring viability*

**Low:** Species offspring have documented low survival rates to maturity in the wild relative to numbers of offspring produced.

**Moderate:** Species offspring have documented intermediate levels of survival to maturity in the wild relative to numbers of offspring produced

**High:** Species offspring have documented high survival rates as young and through to maturity relative to numbers of offspring produced.

*2.3 Dispersal ability*

**Low:** Species requires specific and uncommon means of dispersal (e.g. an absent vector), and/or is sedentary.

**Moderate:** Species can disperse to a limited area of localised and ecologically suitable habitat.

**Human associated dispersal:** Species whose dispersal is reliant on, or aided by, human movement or habitation.

**High:** Highly mobile species whose dispersal is not impeded by geographic or climatically unfavorable conditions.

*2.5 Interactions with vulnerable or endangered species*

**No interaction:** Species are limited to human settlements or require agricultural resources to maintain populations and therefore have little interaction with vulnerable/endangered species.

**Minor:** Species whose wild populations are maintained by human settlements and have limited potential to predate on, or compete with, native species for limited resources (e.g. nesting and roosting sites, specific food types).

**Moderate:** Species with self perpetuating wild populations, but are generalist and not known to directly out compete native species for resources, or predate on native species.

**Major:** Species is know to prevent native species from utilising resources by modifying the environment, consuming food resources and/or nesting sites, predate on or attack native species.

## Section 3 - Feasibility of Control

*3.2b Effectiveness of current control measures.*

**Highly effective:** Control measures potentially effect a very high percentage (>85%) of the population controlled.

**Moderately effective:** Control measures potentially effect a majority (>50%) of the population or are highly effective against a specific life stage of a species.

**Low effectiveness:** Control measure is limited to acting on a specific life stage of a species with only moderate effectiveness (potentially <50%)

*3.2c Logistic difficulty of control measure implementation*

**Low:** Control measures are easily established (few man-hours and equipment required) in easily accessible control areas.

**Moderate:** Control measures either i) easily established in difficult or inaccessible areas or ii) require long establishment periods in easily accessible areas.

**High**: Control measures are difficult to establish due to establishment time, maintenance requirements, or inaccessible control areas.

*3.2d Potential to develop resistance to control measures*

**Low:** Species have no history of learned or genetic resistance to current control measures.

**Moderate:** Species have been documented to develop resistance to control measures but these may be circumvented by long-term presence of non-effective traps or manipulating exposure to chemical components.

**High:** Species learn to avoid traps and/or develop resistance to bait in the short term.

*3.2e Cost of implementation*

The cost of implementing of controls varies greatly between species, types of techniques, and population size. However, high costs of controlling a pest species will often determine the length and extent of control episodes. Costs of implementation are often determined by the availability of the control measures, the amount of training required to apply a technique and the ability to disburse the control measure against all members of the pest species.

**Low:** Control measures are freely available, with little training required and are easily disbursed against large populations of the target species.

**Moderate:** Control measures have limited availability, require specific application training and/or are difficult to distribute against large target populations.

**High:** Control measures require licensed availability, high level technical training in application and/or are difficult to distribute to target populations.

## Section 4 - Impact of Control Measures

*4.1 Habitat impacts*

**Minimal:** Control methods introduce small temporary trapping devices or application of substances with potency of less than one month.

**Moderate:** Large trapping devices, seasonal modification of landscapes or multiple application of short to medium potency (one to 6 months) toxic substances.

**Major:** Control measures which permanently alter the physical environment, (e.g. fences and permanent trapping areas), or toxic substances that remain active in the ecosystem for more than one season/year.

# PART 2 - VERTEBRATE PEST RISK ASSESSMENT

## 2.1 VERTEBRATE PESTS OF THE WET TROPICS BIOREGION

Table 2 lists vertebrate species identified as current or potential pests within the Wet Tropics Bioregion of North Queensland.

Table 2. Identified Vertebrate Pests of the Wet Tropics Bioregion (WTMA 1998)

| Family | Common Name | Scientific Name |
|---|---|---|
| Poeciliidae | Gambusia | *Gambuisa holbrooki* |
| Poeciliidae | Guppies | *Poecilia reticulata* |
| Poeciliidae | Swordtails | *Xiphorphorus hellerii* |
| Poeciliidae | Platys | *Xiphorphorus macularta* |
| Cichlidae | Tilapia | *Tilapia mariae* |
| Cichlidae | Tilapia | *Oreochromis mossambicus* |
| Bufonidae | Cane toad | *Bufo marinus* |
| Gekkonidae | Asian house gecko | *Hemidactylus frenatus* |
| Columbidae | Rock dove | *Columba livia* |
| Columbidae | Spotted turtle-dove | *Streptopelia chinensis* |
| Passeridae | Nutmeg manikin | *Lonchura punctulata* |
| Passeridae | House sparrow | *Passer domesticus* |
| Sturnidae | Common myna | *Acridotheres tristis* |
| Muridae | House mouse | *Mus musculus* |
| Muridae | Brown rat | *Rattus norvegicus* |
| Muridae | Black rat | *Rattus rattus* |
| Canidae | Dog | *Canis familiaris* |
| Canidae | Dingo | *Canis familiaris dingo* |
| Canidae | Red fox | *Vulpes vulpes* |
| Felidae | Cat | *Felis catus* |
| Leporidae | Rabbit | *Oryctolagus cuniculus* |
| Leporidae | Brown hare | *Lepus capensis* |
| Equidae | Horse | *Equus caballus* |
| Suidae | Pig | *Sus scrofa* |
| Cervidae | Rusa deer | *Cervus elaphus* |
| Cervidae | Fallow deer | *Dama dama* |
| Cervidae | Chital deer | *Cervus axis* |
| Bovidae | Goat | *Capra hircus* |

# 2.2 WTVP RISK ASSESSMENT SUMMARIES

Detailed risk assessments for all species in Table 2 are given in Appendix B. Each assessment contains individual scores for the questions in the WTVPRAS assessment table in Part 1 of this report. The references used to obtain the scores for each question are also provided.

Table 3 (over page) summaries the species-specific scores for the four principal sections of the assessment table i) Current Impacts, ii) Potential Impacts, iii) Control Difficulty, and iv) Control Impacts. Also provided are species-specific combined scores for 'Total Impacts'(current + potential), 'and 'Control Score' (difficulty + negative control effect). A summary of overall pest status is obtained from the 'Total Score' (Total Impacts + Control Score) for all categories combined. The pest species in Table 3 are ranked by 'Total Score'.

## 2.2.1 OVERALL PEST STATUS

Figure 1 provides a visual summary of the relative pest status of each species. The figure plots current and potential impacts combined (Impact score) against control difficulty plus negative control effect (Control Score). The 'pest space' described by these axis comprises four regions, each containing a cluster of species having similar pest status. Species in the upper right hand region of this figure are both difficult to control and have high overall impact. Species in the lower left region are significantly more controllable and have lower impacts. Relative pest status increases towards the upper right hand side of the figure.

Currently, the major vertebrate pests of the Wet Tropics are identified as the pig and cat closely followed by the cane toad, and dog/dingo. These species rank highly primarily because of their current impacts, but also because of their lack of controllability. These four species have wide distributions and directly quantifiable negative effects on endangered and/or threaten species and habitats (Pavlov *et al.* 1992; Werren 1993; Choquenot *et al.* 1996; Burnett 1997; Environment Australia 1999e; Schmidt *et al*. 2000). Exotic fish (gambusia, tilapia, guppies, swordtails, platys) and rabbits, are also identified as major pests. They have lower impact scores but are equally difficult to control. This is especially true for exotic fish, were it is extremely difficult to selectively target pest species using existing technology.

Impact scores for most exotic fish species may also be underestimates. This is because of a lack of studies quantifying their detrimental effects on native wildlife either in Australia or overseas. As with exotic fish, wild-dog control is also extremely difficult. However, if many dog attacks are attributable to unsupervised domestic, rather than wild dogs, overall dog control may be more feasible. Establishing the relative frequency of domestic to wild-dog attacks on native species would more clearly establish the level and type of dog control required. The indian myna, black rat, brown rat, nutmeg manikin, house mouse, house sparrow, brown hare and spotted turtledove also have intermediate impact scores but these species appear to be easier to control. Many of these species are primarily associated with urban or disturbed habitats and may not yet have reached their full impact potential.

**Table 3. The four impact scores obtained for each species as well as combined scores for current plus potential impacts (Impact Score), and control difficulty plus negative control effects (Control Score). A summary of overall pest status is obtained from the Total Score for all categories combined. Species are ranks by Total Score.**

| Species | Current Impact | Potential Impact | Impact Score | Control Difficulty | Control Impacts | Control Score | TOTAL SCORE |
|---|---|---|---|---|---|---|---|
| Pig | 150 | 85 | 235 | 77 | 70 | 147 | **382** |
| Cat | 145 | 78 | 223 | 80 | 70 | 150 | **373** |
| Cane toad | 150 | 82 | 232 | 78 | 43 | 123 | **353** |
| Dog/Dingo | 160 | 68 | 228 | 65 | 40 | 105 | **333** |
| Gambusia | 115 | 85 | 200 | 70 | 57 | 127 | **327** |
| Tilapia *(O. mossambicus)* | 107 | 75 | 182 | 75 | 57 | 132 | **314** |
| Tilapia *(T. mariae)* | 102 | 80 | 182 | 75 | 57 | 132 | **314** |
| Guppy | 115 | 63 | 178 | 75 | 57 | 132 | **310** |
| Swordtail | 106 | 68 | 174 | 75 | 57 | 132 | **306** |
| Rabbit | 114 | 60 | 174 | 68 | 62 | 130 | **304** |
| Platy | 102 | 63 | 165 | 75 | 57 | 132 | **297** |
| Common myna | 131 | 60 | 191 | 58 | 37 | 95 | **286** |
| Red fox | 95 | 74 | 169 | 70 | 45 | 115 | **284** |
| Black rat | 103 | 62 | 170 | 53 | 44 | 97 | **267** |
| Brown rat | 106 | 57 | 163 | 53 | 44 | 97 | **260** |
| Nutmeg manikin | 103 | 56 | 159 | 60 | 32 | 92 | **251** |
| House sparrow | 116 | 33 | 149 | 73 | 25 | 98 | **247** |
| House mouse | 111 | 36 | 147 | 55 | 37 | 92 | **239** |
| Brown hare | 90 | 49 | 139 | 67 | 27 | 95 | **233** |
| House gecko | 94 | 36 | 130 | 73 | 20 | 93 | **223** |
| Spotted turtle-dove | 102 | 36 | 138 | 55 | 27 | 75 | **213** |
| Horse | 66 | 38 | 104 | 58 | 44 | 102 | **206** |
| Rock dove | 70 | 40 | 110 | 48 | 44 | 92 | **202** |
| Goat | 4 | 65 | 64 | 70 | 25 | 95 | **164** |
| Red-whiskered bulbul | 4 | 53 | 57 | 50 | 39 | 89 | **146** |
| Rusa deer | 4 | 56 | 60 | 43 | 25 | 68 | **128** |
| Chital deer | 4 | 45 | 49 | 48 | 25 | 73 | **122** |
| Fallow deer | 4 | 21 | 25 | 48 | 25 | 73 | **98** |

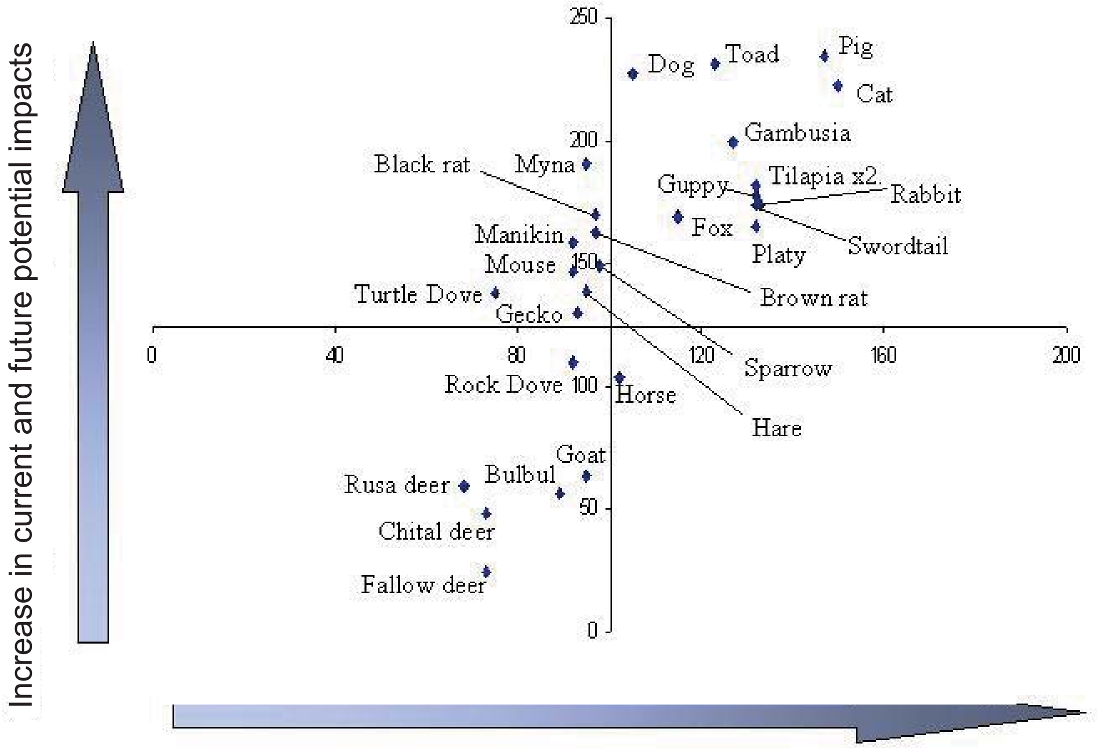


**Figure 1. Assessment of current impacts plus potential impacts (Impact Score) verses control difficulty plus negative impact of control (Control Score). The 'pest space' comprises four regions each containing species having similar pest status. Relative pest status increases towards the upper right hand corner of the graph.**

## 2.2.2 CURRENT VERSES POTENTIAL PEST STATUS

Figure 2 plotting current impacts against potential impacts can be used in a similar way. Species that occur in the upper right hand area of this plot have both high current and future potential impact (pigs, cane toads, cats, dogs). Also clearly identified on this graph is a group of 'sleeper' species (indicated by the boxed area) that have moderate current impacts but moderate to high potential future impacts. These species in order of perceived threat are gambusia, the two tilapia species, the fox, swordtail, guppy, platy, black rat, indian myna, rabbit, brown rat, and nutmeg manikin. Species that rank lower because of a lack of identified current impacts such as the red-whiskered bulbul, rusa deer and goats have considerable potential to cause problems should larger populations become established due to human error or translocation. Sparrows, house mice, brown rats and turtledoves currently impact only in urban and fringing areas and appear to have limited potential to spread to natural areas. The overall impact of these species will increase as development increases throughout the region. The house gecko, brown hare, rock dove, horse, fallow and chital deer have minimal impact and are unlikely to pose a serious threat in the foreseeable future.

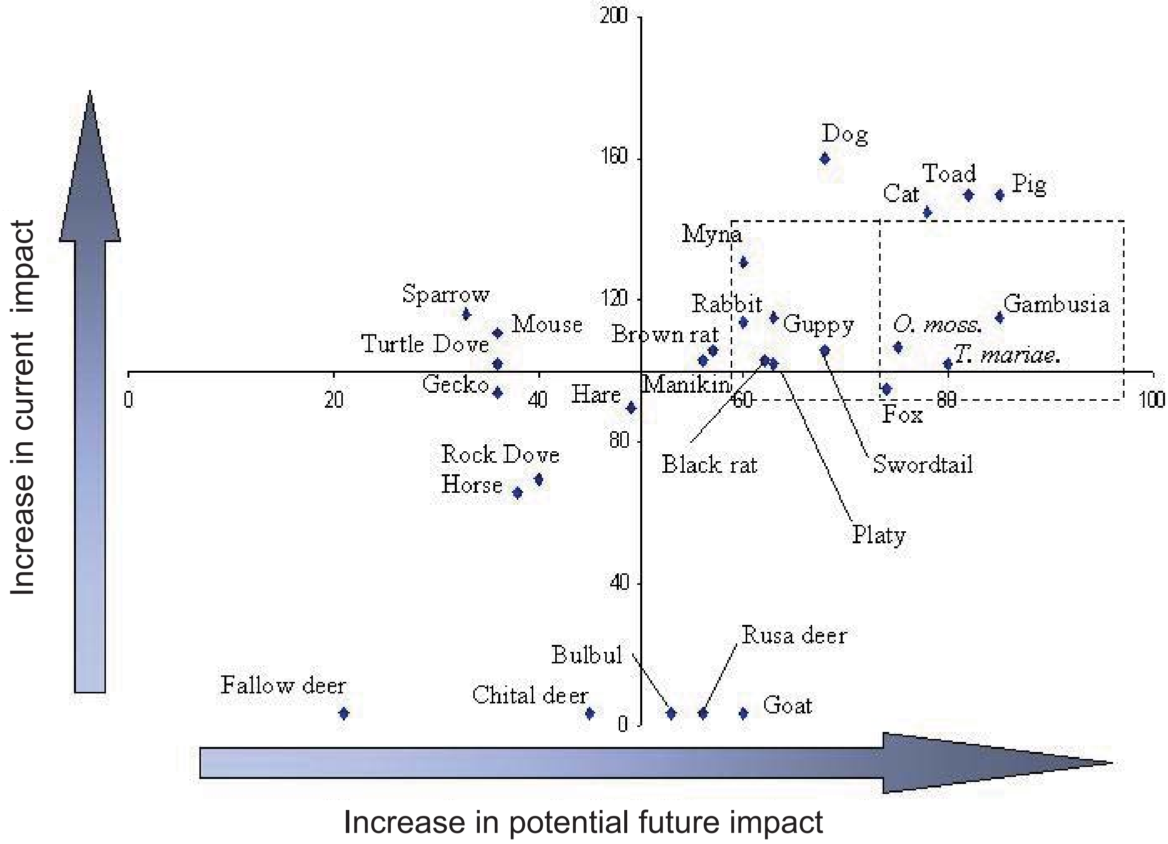


**Figure 2. Assessment of current verses potential future impact. This plot identifies pest species having both high current and high future potential impacts (pigs, cane toads, cats, dogs) and also identifies 'sleeper' species (indicated by the boxed area) with moderate current impacts but moderate to high future potential. Note also the goat and rusa deer which have no current impact but moderate potential future impacts.**

## 2.2.3 CONTROL IMPACTS

Figure 3 plots difficulty of control against the negative impact of control. Again, both the difficulty of control and the negative impacts of control increase towards the upper right hand corner of this figure. This figure clearly demonstrates that all control measures are perceived to impact native species to varying degrees. These effects can be significant. Figure 3 enables these effects to be examined in isolated for consideration during the development of future management objectives. Pig control poses the greatest perceived threat. This is because it is known to impact on high profile vulnerable species such as the cassowary, or requires incursions by domestic animals into otherwise pristine habitat with unknown consequences. Control methods for dogs, cats, cane toads, gambusia, tilapia, guppies, rabbits, swordtails, and platys also have the potential to exhibit significant detrimental effects on native fauna. This is because in general they are not taxa specific but affect any native species with similar ecological associations. This problem also gives these species their low controllability. For all other species, control measures have low impacts on non-target species. This is generally because of the tight associations between these pests and human settlements.

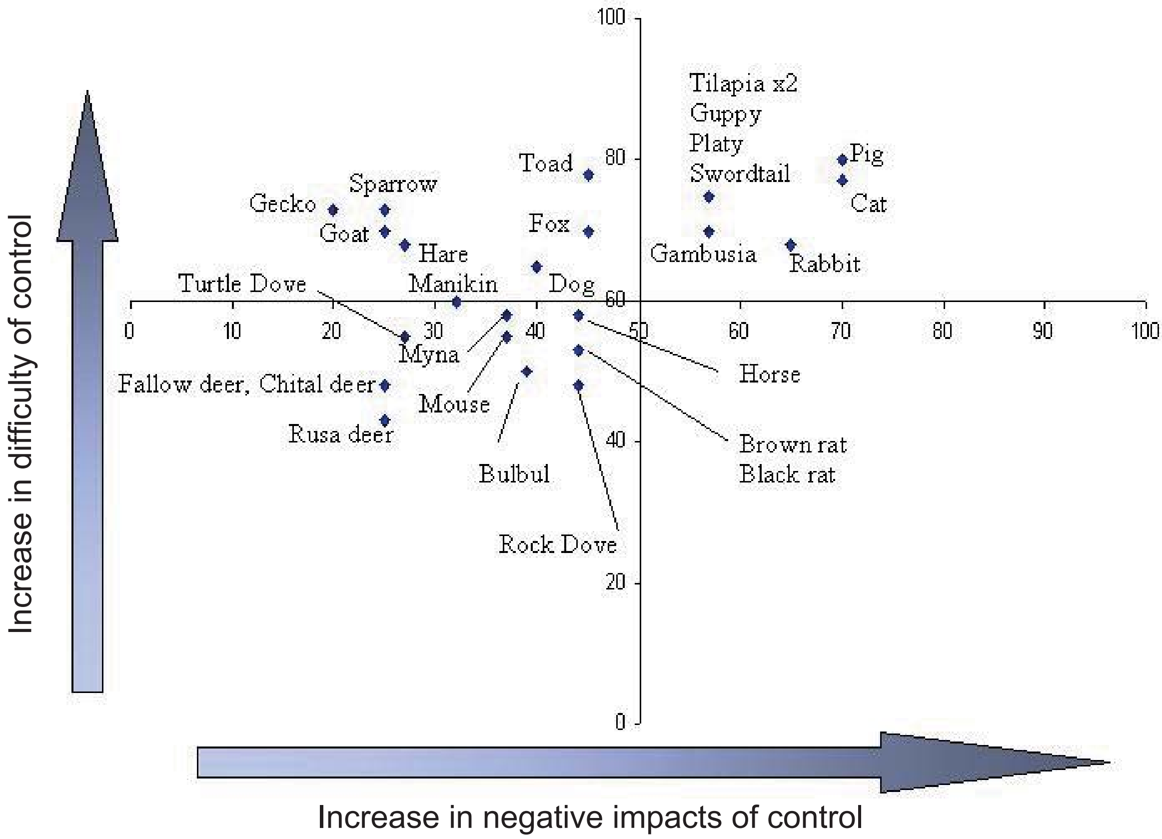


**Figure 3 Difficulty of control plotted against negative impacts of control on non-target species. Overall controllability decreases as you move towards the upper right corner of the graph. Note that all control measures are perceived to have some negative effects on non-target native species or habitats**

## 2.2.4 GENERAL DISCUSSION

### Generic problems of risk assessment

The development and use of the WTVPRAS has highlighted a number of generic problems associated with assessing the current and future potential impacts of vertebrate pests in the Wet Tropics. These are a) the lack of baseline data on historic or current native species distributions and abundance against which to gauge exotic species impacts. This is a general problem but is particularly relevant to native fish and other freshwater taxa. b) A lack of quantified exotic impacts on native species. It is difficult to estimate the true extent of information available on exotic species impacts and the level of future work that needs to be undertaken. This is because much of these data may exist but are currently inaccessible in unpublished reports. c) The lack of basic data on pest population demography, including population sizes, ranges, and levels of interconnectedness. Our current inability to adequately census most of the pest species within the Wet Tropics means that the effectiveness of control methods cannot be accurately assessed. Data on control effectiveness, where it exists, consists primarily of catch rates per technique per unit time. Unfortunately, these data do not provide information on the proportion of each pest population being removed per control 'event', or the relative impact of control on reproductive individuals. Obtaining these data requires accurate post-control censusing on known populations. It is these data that are needed to establish control effectiveness. Ultimately, the effort required to control individual pests will depend on the management goals specified. To facilitate the collection of appropriate information, particularly for pests that are difficult to control, it will be necessary to establish management critera on what are 'acceptable' levels of infestation for specific areas, and what control impacts on native species are acceptable to achieve these goals.

## Terrestrial Vertebrates

The WTVPRAS has confirmed the generally accepted belief that pigs, cats, dogs and toads are the high impact pest species within the bioregion. Eradication of these species from the region does not seem feasible in the short-term given current controls and costs. Identifying and costing specific management objectives to mediate impacts in sensitive areas will ultimately determine their future impacts. The effort and data required will depend on the management goals specified. The fox was identified as the principal terrestrial sleeper species of concern. The implications of this are discussed in the individual pest species descriptions.

As a general trend, most current and potential vertebrate pest species of the Wet Tropics are closely associated with human settlements or human disturbance. It is logical to conclude that an increase in human disturbance or expansion will bring with it increases in both high and low risk pest species. This finding must be considered during the development of any management aimed at containing vertebrate pests. This may be particularly important for high-diversity high-risk areas such as the Daintree-Bloomfield province, where many species with strong human associations (e.g. indian mynas, mice, sparrows, turtledoves) have not yet been recorded.

## Exotic Fish

Six species of exotic fish have been identified as major or potential pests of the Wet Tropics region. All species occur in degraded habitats and/or urban streams. Their current impacts are difficult to assess because of the limited historical knowledge of native stream fauna assemblages prior to introduction (Arthington & McKenzie 1997). Their present distributions probably still reflect human point source introductions and translocations (Arthington & Bluhdorn 1994; Pusey & Kennard 1994; Russel *et al.* 1996; North Queensland Joint Board 1997). Almost certainly, most of these species have not yet reached their full impact potential. While the WTVPRAS indicates a high pest potential for these species it may still under estimate their possible future effects. This is primarily because of the lack of information on native fish species distributions, and the uncertainty regarding taxonomic status and levels of local endemism in the bioregion (Arthington & McKenzie 1997). The two tilapia species pose the more immediate threat. This is because of their large body mass and ability to adjust metabolism and age/size at maturity to limited resources (Arthington *et al.* 1999). In comparison, the smaller poeciliids do not overwhelm and modify habitat as quickly as tilapia are known to do (Arthington & Bluhdorn 1994; Pusey & Kennard 1994). The limited thermal tolerances of tilapia (Cnaani *et al.* 2000) may offer limited protection to catchment headwaters in the region.

It should also be noted that populations of other exotic fish occur along the Central Queensland coast, principally in the Aplin Weir on the Ross River. These species include the green terror (*Aequidens rivulatus*), oscars (*Astronotus ocellatus*), red devils (*Amphilophus citrinellus*), banded cichlid (*Cichlasoma severum*), firemouth cichlid (*Cichlasoma meeki*), convict cichlid (*Cichlasoma nigrofasciatum*), and pearl cichlid (*Geophagus brasiliensis*) (Arthington *et al.* 1999). The jewel cichlid (*Hemichromis bimaculaus)* and oscars have also been reported, but not documented, in the Cairns area. These species exhibit very similar biology to the cichlid species already in the Wet Tropics Bioregion and their risk assessments would produce similar conclusions. All these species have the potential to become major pests of the region.

# 2.3 INDIVIDUAL PEST SPECIES DESCRIPTIONS

The individual pest species descriptions summarise the information contained within each risk assessment (Appendix B). Summary information is provided for: i) the most significant features of the species biology that determine it's pest status, ii) an general estimation of the accuracy of the assessment based on the information available and iii) an indication of the specific information required to improve the assessment. The individual pest species descriptions can be used to identify specific research priorities relative to pest status (Table 3). References used to provide the information contained in the individual pest species descriptions are provided with each risk assessment (Appendix B).

## 2.3.1 HIGH IMPACT/HIGH POTENTIAL - DIFFICULT TO CONTROL

**Pigs *(Sus scofa*)**

*Sus scofa* is the highest profile pest of the Wet Tropics Bioregion. Its WTVPRAS score would indicate this status is warranted. It is widely distributed and occurs in highly sensitive areas (Pavlov 1992; Pavlov *et al*. 1992; Olsen 1998). It modifies habitats, competes directly with endangered fauna for resources and transmits many diseases and parasites (Stone & Loope 1987; Pavlov 1992; Pavlov *et al*. 1992; Choquenot *et al*. 1996; Gadek 1999). It is a pervasive pest in similar environments elsewhere, has many generic pest species characteristics and is difficult control from both a technical and cultural perspective (Stone & Loope 1987; Pavlov 1992; Pavlov *et al*. 1992; Choquenot *et al*. 1996; Cape York Regional Advisory Group 1999). Sufficient information is available to comprehensively assess the current and future pest potential of this species. A current inability to accurately establish the effects of control on population size and demography is particular relevant to this species (see general discussion)

**Cats *(Felis cattus)***

Famous for their ability to decimate ground dwelling bird and small mammal populations especially on islands and in isolated areas, cats pose a significant threat to species in the Wet Tropics Bioregion. As with pigs, cats are widely distributed (Strahan 1993) and impact directly on vunerable species in highly sensitive areas (Environment Australia 1999e; Goosem *et al.*1999). They are highly dispersive and vector a range of other potential pests (Environment Australia 1999e). Currently populations are small but control methods are not very effective (Environment Australia 1999e). Where control is undertaken numbers are quickly replaced from stable populations in fringing urban areas (Environment Australia 1999e). Cats are closely associated with humans and can be expected to spread with increasing urbanisation. The extremely wet areas of the bioregion may offer some resistance to colonisation (Environment Australia 1999e). Assessment information is relatively complete although few studies have been undertaken specifically on feral cat impacts within the Wet Tropics. Also, the costs of control in heavily forested areas are unknown.

**Cane toad *(Bufo marinus)***

The cane toad has been present throughout the Wet Tropics region for many years (Department of Natural Resources 1997). The pest potential of this species is well known (Burnett 1997; Department of Natural Resources 1997) and is further confirmed by the WTVPRAS. Cane toads are thought to be significant threats to quoll, monitor and native frog populations (Burnett 1997), but the long-term potential impacts on these threatened species have not been quantified. Studies have shown that available controls have limited effect (Tyler 1996; Zupanovic *et al. 1998a;* Zupanovic *et al. 1998b).* Presently widespread control of toads seems unrealistic. This suggests toad research and control in the Wet Tropics may be best targeted at areas where they could be directly impacting vulnerable or endangered species.

**Dogs/Dingo *(Canis familiaris)***

In general, dingoes occur in drier habitats than the Wet Tropics, suggesting rainforest is not preferred habitat (Strahan 1993). Dingoes/dogs are known to take other pests such as rabbits, foxes and feral cats, as well as native species (Usher 1989; Olsen 1998; Environment Australia 1999e). Currently, they may limit numbers of these other vertebrate species (Usher 1989; Olsen 1998; Environment Australia 1999e). Any management strategy aimed at reducing dingo/dog numbers must consider the potential effects on these other pest species, particularly foxes. Identifying the principal perpetrators of 'dog' kills, particularly of tree kangaroos and cassowary, is required to focus management options. Attacks by unsupervised domestic dogs will require different control strategies to those used to reduce feral dog or dingo numbers.

## 2.3.2 SLEEPERS

Species with low to moderate current impact but high potential future impacts. This group of species constitutes the major unrealised potential future threat to the Wet Tropics region.

### Exotic Fish

The WTVPRAS rankings suggest that exotic fish may constitute the principal unrealised threat to the region. That similar potential impact scores were obtained for most exotic fish reflects a range of shared 'pest' life-history characteristics and a general lack of detailed information on impacts. Both these factors make species-specific descriptions difficult. A description is provided for two of the principal pest species that represent the two major life history strategies present in the Wet Tropics. Exotic fish in general are discussed in section 2.2.4.

### Tilapia *(O. mossambicus & Tilapia mariae)*

Tilapia populations are currently correlated with their release points (Arthington & Bluhdorn 1994; Pusey & Kennard 1994; Arthington *et al.* 1999). At these points they dominate riverine communities by utlising all resources and modifying habitat to their advantage (Arthington & Bluhdorn 1994; Froese & Pauly 2001). Human induced removal of riparian vegetation alters river ecology by removing native fish habitat and increasing water temperatures (Cnaani *et al.* 2000). These processes further aid tilapia expansion. The extensive control required and the highly negative impacts of control such as poisoning, suggests that control of tilapia species will be expensive (Arthington & McKenzie 1997). The exact limits of current distributions need to be established, as do the long-term effects of control measures on native fish. This is to determine if native populations are resilient against the broad-scale impacts associated with current controls. Tilapia populations in the Wet Tropics are also considered to be threatening the Gulf River Catchments (North Queensland Joint Board 1997). This issue further highlights the priortising of control for these species.

### *Gambusia holbrooki*

The distribution of gambusia within the bioregion is not well known. Various studies (Pusey & Kennard 1994; Herbert & Peeters 1995; Russell *et al.* 1996) and anecdotal evidence (Luxon *pers. com.*) suggest they occur in limited numbers in degraded areas, especially irrigation channels and drainages in most provinces of the Wet Tropics. The negative impacts of gambusia on native fish and frog species (Arthington & Mitchell 1986; Lund 1994a, 1994b; Goodsell & Kats 1999; Kittl 1999; Knapp & Matthews 2000), as well as on water quality in natural areas (Lund 1994b) are well documented. Given the difficulty in controlling fish numbers, the fecundity and dispersal capabilities of this species, and a reluctance to use current control methods because of negative impacts, it is expected that gambusia distributions will continue to expand.

### Fox *(Vulpes vulpes)*

Along with exotic fish, the WTVPRAS suggests that the fox is a major future threat to the Wet Tropics. The fox's relatively low current impact value is due only to its limited distribution in the Atherton and Kirrama-Hinchinbrook provinces (North Queensland Joint Board 1997; Queensland Museum 2000; Earthworks 2001). The fox is an intelligent predator that will take other pest species such as mice and rabbits in open areas (Strahan 1993). However, it prefers native prey in forested areas (Strahan

1993). Foxes are currently thought to threaten the tropical bettong (Environment Australia 1999d). If fox populations continue to spread through forested areas they are likely to threaten many other native species (Wet Tropics Management Authority 1995; Environment Australia 1999d). As with dingoes, foxes may currently contribute significantly to rabbit control along the edges of the bioregion (Environment Australia 1999d). The impact of fox control on other pest species needs be considered in any major control program. Fox risk assessments would be aided by detailed information on current distributions, including non-presence data, and native species interactions.

**Goats *(Capra hircus)***

Goats are not currently located within the Bioregion but given their pest history elsewhere there is concern that they may become established (Environment Australia 1999c). Of the no-current-impact species, goats have the greatest potential to cause serious future problems. The goat is a generalist herbivore that modifies its diet according to available foliage (Environment Australia 1999c). Predation by dingoes or dogs and increased mortality from higher parasite loads in wetter climates (Environment Australia 1999c) may restrict goats in some areas surrounding the Bioregion. Control of goat populations is labour intensive and is restricted to mustering, shooting and/or trapping. Baiting with1080 is not very successful. The extensive foliage cover offered in the Bioregion would also substantially decrease the effectiveness of control measures. The presence of goats needs to be closely monitored.

**Black Rat *(Rattus rattus)***

This species does not currently occur in uplands other than the Atherton Upland region (Williams *et al.* 1996; Queensland Museum 2000). Its presence in this region can be attributed to increased urbanisation. The black rat has not previously displaced native rats in intact forest areas (Stone & Loope 1987), but may place pressure on native species in degraded natural areas (Strahan 1993). The black rat may establish feral population independent of human settlements and will feed on a variety of food items (Strahan 1993). This species may require close attention, particularly given its high degree of adaptability, and the assistance increasing urbanisation will provide for further establishment.

**Indian Myna *(Acridotheres tristis)***

The impact of this species on native taxa within the Bioregion has not been accurately assessed. The myna is known to out compete and exclude parrots and small mammals from nesting hollows in woodlands and southern eucalypt forests (Pell & Tidemann 1997b). If myna impacts in the Wet Tropics are comparable then this species poses a major threat to the region. Long (1981) suggests that mynas maybe deterred by denser rainforest types. If so, this may restrict mynas to fringing zones and mediate impacts in some upland areas. This species is closely associated with human settlements and there seems little doubt that it impacts on native species with similar associations (Long 1981). Until information detailing myna impacts is available the effects of reducing myna numbers on biodiversity values in the Bioregion cannot be estimated.

**Rabbits *(Oryctolagus cunculus)***

*Oryctolagus cunculus* is a slowly advancing species. It appears to be a greater threat to the region than the brown hare because it occurs in upland sites (Williams *et al.* 1996) and has less selective feeding habitats (Strahan 1993). Rabbit spread may, in part, be contained by increased parasite load and mortality associated with high rainfall (Environment Australia 1999b). Similar mortality has been noted elsewhere (Strahan 1993; Environment Australia 1999b). The introduction of calcivirus may also significantly effect rabbit numbers (Environment Australia 1999b). The full impact of these potential controlling agents is not yet known. The impact of rabbits on the Bioregion is complicated by their relationship with other exotic pests. Rabbit predation may buffer native species from the impacts of a number of other exotic carnivores such as cats, foxes, and dogs/dingoes

## 2.3.3 THE MODERATES

### Brown Rat *(Rattus norvegicus)*
The Brown Rat is highly commensal with human settlements (Strahan 1993) and currently has a limited distribution within the Bioregion (Williams *et al.* 1996). It is expected that this species distribution will remain closely linked to human habitation. However, its very aggressive nature, and opportunistic feeding behaviour, where it will prey on small mammals, birds and bird's eggs, (Strahan 1993) would suggest that it may have significant impacts in fringing areas. Some surveillance or control strategy may be warranted.

### Nutmeg Manikin *(Lonchura punctulata)*
*Lonchura punctulata* is known for is close association with human agricultural and residential systems, where is has become a major pest (Long 1981). It is currently thought to compete with local finch species, Crimson Finch (vunerable species) and Chestnut breasted Finch (Werren *pers.comm.*). *L. punctualata'*s agility, ability to breed continuously, and its association with continuing human development will increase its impact on native species to some degree. Control of this species without impacting native bird populations may be very difficult (Yarrow 2000).

### Rusa Deer *(Cervus timorensis)*
Rusa deer are located on several of the Torres Strait and Gulf of Carpentaria Islands and are known to swim between islands and the mainland (Wilson *et al*. 1992; Cape York Regional Advisory Group 1999). It's preferred habitat is pasture or grasslands surrounded by woodlands. Current impacts are low. However, given its ability to diet switch from agricultural to native species (Moriarty 2000), and that control is limited to shooting, swift action should be taken if this species extends its current distribution.

### Brown hare *(Lupus capensis)*
*Lepus capensis* is a known agricultural pest that prefers drier habitats than the Wet Tropics (Strahan 1993). It currently occurs only in the Herbert province of the Bioregion (Williams *et al.* 1996). The hare's primary food sources are introduced pasture and grasses. Control measures are currently limited to shooting (Wilson *et al*. 1992) in open areas. If the brown hare were to become established over a wider area it would be difficult to control and may promote increases in exotic carnivore numbers. The hare has already caused significant problems at revegetation sites due to its preference for young seedlings and tree bark (Australian Nature Conservation Agency 2000).

### Red-whiskered Bulbul (*Pycnonotus jocosus*)
This species originates from the Indian subcontinent and is a recognised as a pest in other countries, as well as in other areas of Australia. This species is principally a pest of fruit growing and urban areas. It is included in this risk assessment due to its potential impacts to fruit bearing trees and its recent arrival in Mackay (Werren *pers com*). It is not currently known if this species will utilise rainforest fruits in native forest or agricultural areas. This species needs to be further monitored for northern dispersal.

## 2.3.4 LOW IMPACT/LOW TO MODERATE POTENTIAL

These species exhibit low current and low to moderate potential impacts in natural areas. They are principally associated with human activity. In general, control measures are not very effective but offer low impacts on native populations. However, in some cases control could impact significantly on native species with similar associations.

### House Mouse *(Mus musculus)*
The distribution of this species is still restricted to human settlements in the bioregion (Strachan 1993; Williams *et al*. 1996). It may be out competed by endemic *Rattus* and *Melomys* species (Strachan

1993). This competition and the lack of grain food sources may continue to inhibit the spread of mice into native habitats. However, given the ability of this species to rapidly increase population size to plague proportions if appropriate resources are available caution should be used. Very little is known about current mice impacts in fringing areas and whether these impacts would be significant if major outbreaks were to occur.

**Horse *(Equus caballus)***

The impact of this species within the bioregion is difficult to assess. Its distribution is limited but the species is well established in areas abutting the Wet Tropics. The horse prefers more open forests than those in the region. However, given its dispersal ability, disease vectoring potential (Environment Australia 1999a) and the controversy associated with control, an accurate assessment of its distribution, and possible effects on the bioregion's fauna and flora may be warranted.

**Rock Dove *(Columba livia)***

This species distribution is not well documented within the Bioregion. It has only become established outside the large cities where sources of grain exist (Long 1981). Pigeons have been observed to utilised native bird nesting sites on cliffs (Long 1981), but it is unknown if they can effectively compete for these sites. Their risk potential would appear to be low.

**Spotted Turtle Dove *(Streptopelia chinensis)***

This species overlaps ecologically with the native bar-shouldered dove and is known to displace it in other areas (Schodde & Tidemann 1983). *S. chinensis* prefers agricultural lands especially grain producing areas, scrub along creek lines and swamp margins. The extension of farmland and urban development in the Wet Tropic region may extend this species distribution and promote edge effects. These effects may be of concern in the future.

**Chital Deer *(*Cervus axis*)***

Populations of this species occur in the Charters Towers area (Maryvale Creek 130km NW of Charters Towers) and on islands near Ayr (Wilson et al. 1992). Their preference for pasture over tree foliage and the occurrence of dingoes in the area may limit it distribution. It should be noted that chital deer have a preference for chinese apple an extremely invasive weed (Werren pers com) and may be an agent for its dispersal. Current and potential impacts are low but given the only method of control is shooting swift action should be taken if this species extends its current distribution.

**Fallow Deer *(Dama dama)***

As with other deer species, fallow deer are primarily pasture grazers. However, this species is very gregarious and has a preference for forested areas for shelter, thus controlling fallow deer may difficult if a population was to become established in the bioregion.

**Asian House Gecko *(Hemidactylus frenatus)***

The Asian House Gecko is totally reliant on human dwellings for habitation (Cogger 2000). Presently they do not present a threat to the biodiversity values of the Wet Tropic region. *H. frenatus* is replacing *Lepidodactylus lugubris* on many pacific islands by being a superior competitor for resources around urban lights (Petren & Case 1998). As *L. lugubris* is currently thought to be an introduced species in the Wet Tropics this impact is not rated highly. The distribution and any potential impact of *H. frenatus* will increase with urban and rural development in the bioregion.

**House sparrows *(Passer domesticus)***

House sparrows have a worldwide distribution due to human aided dispersal (Long 1981). Throughout this range they are not known to have competitively replaced native species in undisturbed habitat, though some species displacement must have occurred (Long 1981). Given these findings, sparrows receive a moderate to low ranking for current and potential impacts. The close association of this species with human settlements, it difficulty of control, and the probable detrimental effects of control measures (poison) on urban native species, mean that the overall pest status of this species is unlikely to change. It should be noted that indian mynas are known to prey upon young sparrows, but that the ecological relationships between these two pests are unknown.

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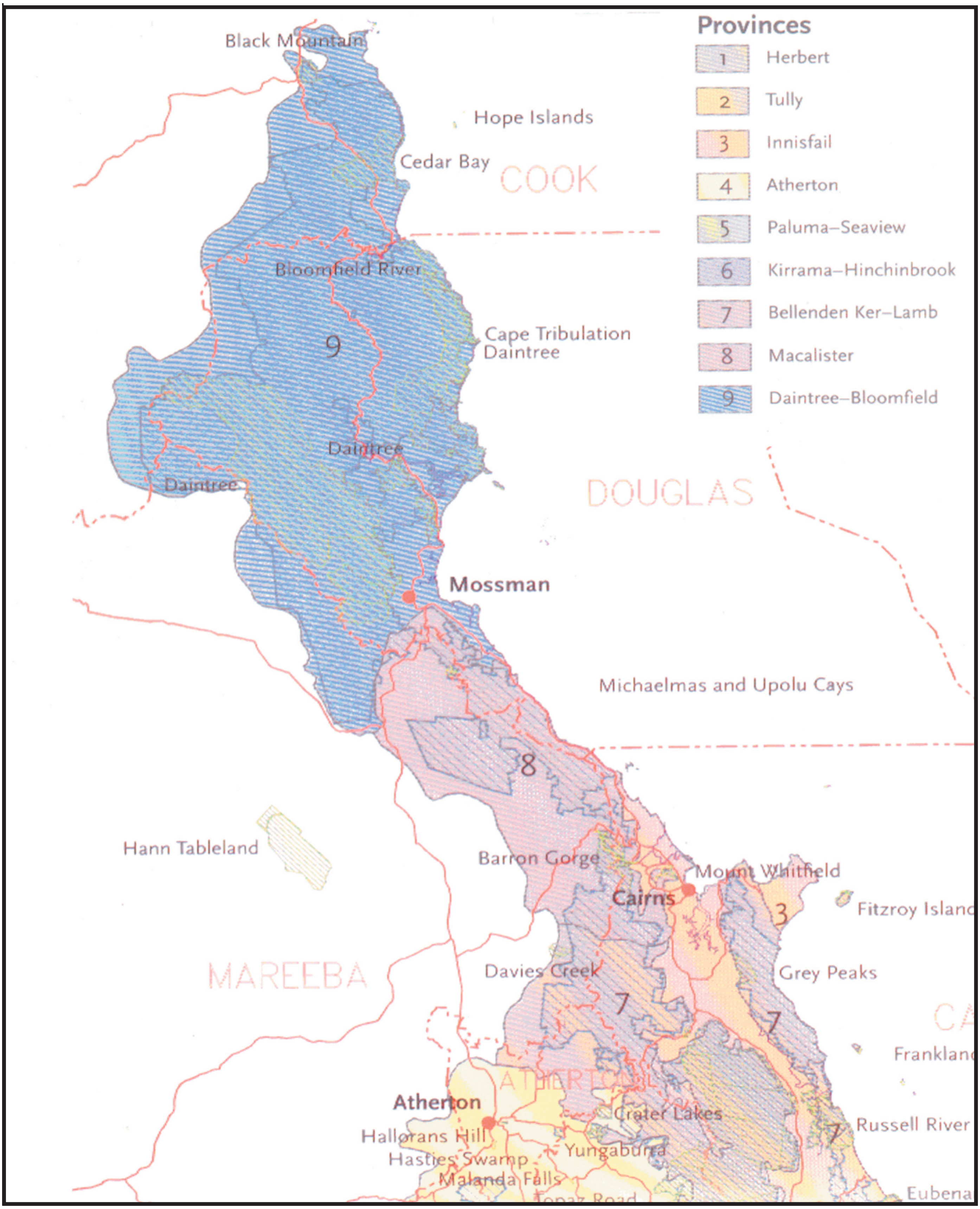
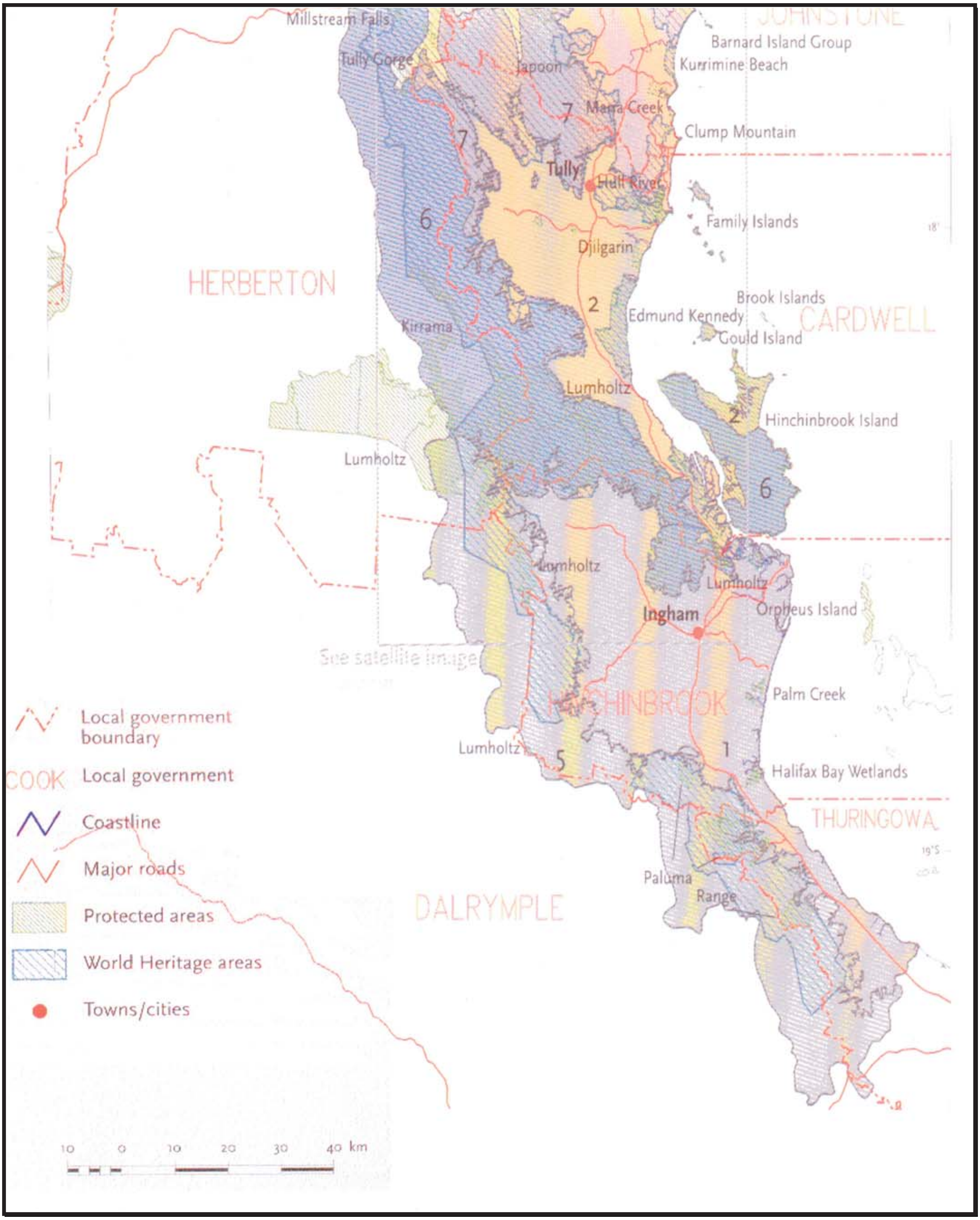
# APPENDICES

# APPENDIX A: MAP OF THE WET TROPICS

Modified from Goosem, S., Morgan, G., & Kemp, J.E. (1999). Chapter 7. Wet Tropics in Sattler, P.S. & Williams, R.D. (eds) *The Conservation Status of Queensland's Bioregional Ecosystems*. Environmental Protection Agency. Page 7/73.




Millstream Falls
Tully Gorge
Japoon
Barnard Island Group
Kurrimine Beach
Maria Creek
Clump Mountain
Tully
Hull River
Family Islands
Djilgarin
HERBERTON
Brook Islands
Edmund Kennedy
Gould Island
CARDWELL
Kirrama
Lumholtz
Hinchinbrook Island
Lumholtz
Lumholtz
Lumholtz
Orpheus Island
Ingham
Palm Creek
HINCHINBROOK
Lumholtz
Halifax Bay Wetlands
THURINGOWA
Paluma
Range
DALRYMPLE
Local government boundary
COOK Local government
Coastline
Major roads
Protected areas
World Heritage areas
Towns/cities
10 0 10 20 30 40 km