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**The perceived environmental and socio-economic impacts of feral pigs
(*Sus scrofa*): A re-examination of their perceived pest status, and
management implications**

Thesis submitted by:

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January, 2012

In fulfilment of the requirements for the research degree of
Master of Science (Environmental Management)
in the School of Earth and Environmental Sciences
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Invasive Animals CRC



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Abstract

Feral pigs (*Sus scrofa*) are declared as a major vertebrate pest in the Wet Tropics World Heritage Area (WTWHA) of North Queensland, Australia. However, stakeholders' perceptions of their effects did not necessarily match their reported pest status. Almost unanimously, the environmental costs of pigs were considered to be significant because most stakeholders believed that pigs diminished the values that they attached to the rainforest. Nonetheless, those public 'values' which pigs damaged, did not match the experts' or scientific perspectives on 'values' of the WTWHA.

The socio-economic impacts of pigs had greatest perceptive variation among stakeholder groups, particularly among the local agriculture and tourism industries; and local residents. This was because feral pigs were valued either both as a resource and a pest, or neither a resource nor a pest. The main perceived costs associated with feral pigs were environmental, thus occurring in rainforest-dominant national parks. This resulted in feral pig management being seen as the responsibility of the government. Moreover, many stakeholders perceived that there was a lack of government action within national parks, and therefore, they were dissatisfied with the current management of feral pigs.

Management plays a crucial role in reducing the conflicts between stakeholders and feral pigs, and the methods used to control the animal need to be socially acceptable and cost-effective. Most stakeholders preferred trapping, compared to fencing, hunting and poisoning, because it entailed socio-economic benefits, and was perceived to be humane and target specific. Poisoning (1080) was the least favoured method mainly owing to its perceived lack of target specificity. Levels of social acceptability of the methods, however, varied considerably with social factors such as the type of stakeholder group and their socio-demographics, as well as cognitive factors such as perceptions of the severity of the problems associated with feral pigs.

Cost-effectiveness of the methods also varied, and trapping appeared to be the most cost-effective; however, simple reduction in numbers of pigs did not necessarily correspond to damage reduction; thus, cost-effectiveness based on population reduction was not an effective decision making tool in management. Feral pig management faces challenges in optimising socially acceptable and cost-effective control while accommodating various values of pigs held by different stakeholder groups.

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Chapter 1: Feral Pigs as an ‘Exotic’ Pest

1.1. Introduction

Throughout much of their global range, feral pigs (*Sus scrofa*) are considered an alien, invasive and pest animal which causes environmental and economic impacts (Lowe et al., 2000, Pimentel et al., 2005). ‘Alien’ or ‘introduced’ species refer to any species that has been established after introduction to new areas by humans. Subsequently, they become ‘invasive’ if regarded as a threat to ‘native’ biological diversity (Sandlund et al., 1999) or impact on human wellbeing or livelihoods. Feral pigs are believed to have originally been introduced to Australia by early European settlers in the 1700s (McLeod, 2004). Their ‘invasiveness’ is presented as a ‘*Key Threatening Process*’ to endangered species and ecological communities in Australia under *the Environment Protection and Biodiversity Conservation (EPBC) Act 1999* and as a ‘*Pest Animal*’ in Queensland under *the Land Protection (Pest and Stock Route Management) Act 2002*. Pigs also cause loss in agricultural production through physical attacks on crops and/or livestock predation, amounting to more than AUS\$100 million loss to the Australian economy per annum (McLeod, 2004). Owing to such negative environmental and economic effects, pigs are also reported as a major vertebrate pest in the Wet Tropics World Heritage Area (WTWHA), North Queensland. For biodiversity conservation and agricultural protection, management interventions have been attempted such as trapping, hunting (with dogs or rifles), fencing and poisoning (sodium fluoroacetate, known as 1080).

Conventionally, pig management had been based on the underlying assumption that negative effects of pigs are reduced as the animals are removed from the environment. This is problematic, because the costs and benefits of having pigs present in an environment can vary with individual perceptions. By definition, the word ‘pest’ describes an animal that causes damage to *valued resources* such as biodiversity and agricultural commodities, or conflicts with *human interests* such as biodiversity conservation (Olsen, 1998). Pest status, therefore, depends on perceptions and can vary with time and location. Consequently, conflicts in pest management often result not from the actual effects of the pest animal but rather from stakeholders’ perceptions of the effects of the pest and perceptions of a lack of control over addressing the ‘pest

problem' (Decker et al., 1996). Thus, managing pigs without understanding the perceived costs and benefits of the animal is questionable. The term 'stakeholders' refers to individuals and groups who may affect, or be affected by, pest management decisions and programs (Decker et al., 1996). Because human perceptions ultimately determine courses of action in such conservation management (Reaser, 2001), there is a need to understand how stakeholders perceive the impacts of pigs (White and Ward, 2010).

In assessing the perceived environmental implications of pigs for stakeholders, it is important to first understand values that stakeholders attach to an environment because values describe factors that contribute to their sense of wellbeing (Wallace, 2007). Pest management aims to maintain or improve those values or human wellbeing by reducing damage that pest animals cause to valued environmental resources. By definition, values are "standards of the desirable" (Bentrupperbaumer et al., 2006, p.725) and "criteria for guiding action and for developing and maintaining attitudes toward relevant objects and situations" (Stern and Dietz, 1994, p.3). People attach different values to an environment with cultural ideas that are shared and taken for granted and that symbolically represent their perceptions about the environment and relationships with it (Greider and Garkovich, 1994, Gifford, 1996). Thus, values attached to an environment depend on the views and needs of the people benefiting from it (Bateman, 2007, Hein et al., 2006).

As a result of different values attached to the environment by different social groups, conflicts often arise in conservation of the environment (O'Neill et al., 2008). One commonly known response to the value conflict is to measure value with a common denominator, often in dollar terms, so that the gains and losses in different values can be traded off one with another (O'Neill et al., 2008). This position is associated with welfare, environmental economics, or utilitarianism, and has dominated much public policy in environmental management (O'Neill et al., 2008). In environmental and ecological economics, values on which such economic valuation of the environment is based are identified and classified by two major value frameworks: the Total Economic Value (TEV); and the Millennium Ecosystem Assessment (MA) (Millennium Ecosystem Assessment, 2005, Turner et al., 2003). Under the MA, invasive species such as feral pigs are regarded as a 'direct driver of change' that diminishes the values of an environment or human wellbeing, to which management

interventions are attempted as a response (Millennium Ecosystem Assessment, 2005). Although invasive species are not contextualised within the TEV, it is the first kind of, and most common, economics framework used to assign value to ecosystems, including the range of impacts that invasive species can have on environmental values (Turner et al., 1994, Born et al., 2005). Thus, these existing frameworks can help understand the kinds of values that stakeholders attach to an environment, which can be affected by feral pigs.

It is uncertain, however, whether such ‘expert’ conceptual frameworks fit public construction of values. The classified values of the environment in the TEV, for example, were found to not be meaningful to lay respondents or the public (Barkmann et al., 2008). That is, the value frameworks may fail to reflect values associated with some aspects of the environment that the general public is not informed about, or does not have experience with, and neglect the benefits of the environment that they perceive (Nunes and van den Bergh, 2001). Value-Beliefs-Norms (VBN) theory suggests that values guide people’s general beliefs about the consequences of environmental change on things they value (Dietz et al., 2005, Schultz et al., 2005). Therefore, without understanding the values of an environment from the public’s perspectives, the perceived impacts of environmental change, such as feral pigs, cannot be fully appreciated. The public’s values are also key to environmental decision making processes because they identify the management consequences that require more careful attention and the tradeoffs that matter most (Gregory, 2000). Thus, in environmental decision making, a clear distinction between information on the values held by the public and ‘factual’ information from science or lay experts is important for informed judgements (Gregory, 2000).

For successful management of feral pigs with public support, it is also important to control the animal to an ‘acceptable’ level by socially acceptable and cost-effective methods. To minimise the impacts of pigs and their conflicts with stakeholders, management aims to reduce pig populations to an ‘acceptable’ or ‘desired’ level. The ‘right’ level, however, depends on subjective perceptions of pig populations rather than actual population levels; that is, an ‘acceptable’ level of control depends on “Wildlife Stakeholder Acceptance Capacity” (WSAC) (Zinn et al., 2000). WSAC is a relatively new concept, adopting components from the terms ‘cultural carrying capacity’ and ‘wildlife acceptance capacity’, and reflects the idea that different kinds of stakeholders

can have different tolerance or acceptance capacities to cohabit with wildlife of the same species, in the same place and at the same time (Carpenter et al., 2000). Such capacity, for instance, can vary with stakeholders' knowledge, beliefs and attitudes about wildlife, for example, the perceived impacts of wildlife. This then determines the desirable population level for those particular stakeholders (Gigliotti et al., 2000, Zinn et al., 2000). To manage pigs at an 'acceptable' level and reduce conflicts between stakeholders and pigs, stakeholders' perceptions about whether current management is 'sufficient' needs to be explored fully (Gigliotti et al., 2000). Understanding attitudes of both stakeholders and management authorities toward management also allows for identifying gaps in expectations of management outcomes.

Successful pig management is not only about how many pigs should exist, but also about how they are managed: social acceptance of management actions is also a key element in such wildlife management (Gigliotti et al., 2000, Zinn et al., 2000). What are considered to be 'acceptable' management interventions can also vary among stakeholders, especially when lethal methods are employed (Fraser, 2006, Miller, 2009, Stokes et al., 2006, Veitch and Clout, 2001, Zeng and Edwards, 2010). Problematically, lethal control is often justified as conflict prevention by decision makers, based on the underlying assumption that conflicts between humans and pest animals, that is, human-wildlife conflicts, decline as the problem animal is removed (Woodroffe et al., 2005). To reduce controversies around management and to lead to successful and sustainable management (Fitzgerald et al., 2007, Nimmo and Miller, 2007), control methods need to be socially acceptable or culturally adoptable, with understanding and support from the community, while being ecologically responsible and physically possible (Stankey, 1997, Firey, 1960, Shindler et al., 2004). Acceptability is defined as "judgment or decision regarding the 'appropriateness' of a particular action or policy" (Bruskotter et al., 2009, p. 121). Appropriateness is a subjective norm, depending on individuals' judgment via available information filtered through social networks of interpersonal affiliations, or on the perceived judgments of reference groups, that is, the groups to which a person belongs or aspires to belong (Brunson, 1997). Thus, acceptability of pig control methods can vary, depending on how stakeholders perceive each method.

Because resources for dealing with pest animals are limited, it is essential that methods used to control pigs are cost-effective while being socially acceptable (Moberly et al., 2004, Perrings, 2001, Izac and O'Brien, 1991, Hone, 1994, Tisdell,

1982). Cost-effectiveness analysis is used to examine the feasibility of the methods particularly when the benefits cannot be easily estimated in dollar terms, but the costs and outcomes, for example, the number of feral pigs killed, can be estimated (Hone, 1994, Hone 2004). Conventionally, effectiveness was measured by the level of population reduction, or the number of pests killed; however, Braysher (1993) and Engeman (2000) argue that effectiveness of control practices should be measured based on damage reduction rather than population reduction. Damage reduction should be the focus because management should aim to reduce the conflicts, that is, damage, that pigs cause. Moreover, the numbers of pigs killed should not be an indicator of the corresponding reduction in damage because of the uncertain and often non-linear relationship between the size of the pest population and the damage they cause. Hence, when assessing the cost-effectiveness of control methods based on 'costs per pig', it is important to examine the relationship between the population and resulting damage.

In summary, for the delivery of successful pest management, it is important to understand stakeholders' perceptions of the impacts of pigs and management actions as well as a range of psychological, social, economic, political and cultural factors that come into play (Olsen, 1998, Riley et al., 2002, Decker and Chase, 1997). This 'human dimension' of wildlife management is about how stakeholders value wildlife, how they want wildlife to be managed; and how they affect and are affected by wildlife and management decisions (Miller, 2003). The reliance on ecological knowledge such as the actual effects of feral pigs on the environment has resulted in treating the animal as the problem, and left unresolved value-based conflicts or unanswerable 'trans-science' problems in their management (English and Chapple, 2002, McNeely, 2001, Miller, 2009, Stankey, 1997). Thus, the human dimension in the management of pest animals is a critical conservation challenge that wildlife managers are facing today (Madden, 2004).

Problematically, little primary research has been conducted on public attitudes toward invasive animals in Australia (Fitzgerald et al., 2007, Wallis et al., 2009). Due to this lack of knowledge, current policies fail to adequately incorporate relevant social issues surrounding pest management (McLeod, 2004). Such issues include the environmental implications of feral pigs for values that stakeholders attach to the environment as well as their socio-economic implications such as agricultural loss incurred by damage caused by feral pigs and/or social benefits created by hunting

opportunities. In the WTWHA, multiple stakeholder groups are involved in the management of pigs, including main users of the rainforests and/or national parks such as the tourism industry and local Aboriginal communities. Despite tourists being primary users of the WTWHA, no study has examined how they perceive the presence of pigs within the national park rainforests, that is, perceived socio-economic costs and benefits of pigs for the tourism industry. How the local Aboriginal groups in the WTWHA perceive the costs and benefits of pigs in relation to their livelihoods is also unknown. This is problematic because Aboriginal perceptions are likely to be different from non-Aboriginal perceptions, and there may also be potential cultural variation in perceptions of feral pigs within and between Aboriginal groups in the WTWHA (McDonald and Lane, 2000). Furthermore, a management response results in different ramifications for different stakeholder groups who define the dimension of the problems in a different way (McNeely, 2001). Thus, it is important to understand potentially distinctive perceptions held by different stakeholders. There is also a general lack of assessment of the cost-effectiveness of control methods (Moberly et al., 2004). Social acceptance of control methods and stakeholders' attitudes toward current management also need to be assessed because it tends to be situation specific and varies with spatial, temporal, political and social contexts (Decker et al., 2002, Shindler et al., 2004, Woodroffe et al., 2005).

Importantly, despite the importance of definitions and classification of environmental values in policy making, little research has assessed the utility of value conceptual frameworks such as the TEV and MA (Beaumont et al., 2007). Problematically, government policies tend to rely on unproven assumptions and limited information about the values of an environment that are of importance to people's wellbeing (Carpenter et al., 2009); that is, conservation and management policies tend to be based on the scientific conceptual frameworks without knowing whether the values classified under the frameworks correspond to those perceived by stakeholders. Because the success of an environmental policy largely depends on how the public relate their needs to their environment, i.e. perceived environmental values by the public (Eden, 1996), it is also important to assess the utility of the frameworks in environmental management in addition to the kinds of values that the public ascribe to an environment.

This thesis aims to fill in some of the gaps in the knowledge as identified above, by examining the perceptions that different stakeholders have of the environmental and socio-economic impacts of feral pigs. The research also aims to investigate stakeholders' attitudes toward current management interventions, that is, their satisfaction with current pig management and attitudes toward different methods used to control pigs; and cost-effectiveness of the control methods. This chapter presents known environmental, economic and social effects reported in the literature; and management options available to control pigs in the WTWHA. Finally, it outlines the conceptual frameworks for this research, followed by aims and objectives and thesis structure.

1.2. Background information: feral pigs (*Sus scrofa*)

Feral pigs (*Sus scrofa*) are reported as a major vertebrate 'pest' worldwide, including Australia, the United States and New Zealand. In Australia, they are an abundant and widespread feral ungulate and have invaded all mainland States (Wilson et al., 1992), particularly New South Wales and Queensland where many agricultural and pastoral commodities are produced (Tisdell, 1982). In Queensland, the pig population is estimated to be approximately four to six million, 75% of which is considered to inhabit tropical North Queensland (McGaw and Mitchell, 1998) where rainforests with high rainfall and dense foliage provide a refuge habitat for pigs. Background information on their biology, ecology and population dynamics is provided in Appendix 1.

1.3. Wildlife damage management; 'effects' versus 'impacts' of feral pigs

1.3.1. Definition of key terms

Feral pigs cause many environmental and socio-economic 'effects', such as physical damage to agricultural commodities, natural landscape, native flora and fauna; and threats to human health and safety, and ecotourism. Some 'effects', however, may not be recognised by people; other 'effects' may be perceived as important 'impacts'. By definition, 'effects' refer to actual, known or scientific positive and negative outcomes of interactions among wildlife, people and wildlife habitat; 'impacts' are 'effects' that people recognise and regard as important (Decker et al., 2002). While scientists or government managers may explain 'effects', it is people who perceive the effects of wildlife based on their values and determine relative importance (Decker et al., 2002).

Accordingly, the fundamental objective of wildlife damage management is to minimise or maximise the ‘impacts’ that people associate with wildlife (Decker et al., 2002).

1.3.2. Environmental effects of feral pigs as invasive species

Because their diets are mostly subterranean, feral pigs are responsible for destruction of flora through rooting, especially on moist fertile soils such as rainforest areas (Wilson et al. 1992, Ickes et al., 2001). Rooting also results in: disruption of soil and leaf litter (Singer et al., 1984); alteration of physical properties of the soil and changes in nutrient dynamics (Lacki and Lancia, 1983); weed and exotic fungi dispersal (Aplet et al., 1991, Cushman et al., 2004, McGaw and Mitchell, 1998); habitat degradation (DEH, 2005, Rainforest CRC, 2003); increases in soil erosion and the turbidity of watercourses (Choquenot et al., 1996); and alteration of native plant and animal species distribution (Challies, 1975). A literature review of the environmental effects of pigs known worldwide is provided in Appendix 2.

The invasion of natural ecosystems by ‘alien’ or ‘exotic’ species is generally viewed as a major threat to biodiversity and disruption to ecosystem functions that lead to changes in ‘native’ species’ richness and abundance (Harrison and Congdon, 2002) (Table 1.1). Particularly in tropical rainforests, such as the WTWHA, negative environmental effects of feral pigs are a significant concern for conservation because the rainforests host diverse terrestrial flora and fauna (Grainger, 1980, Johnson and Stork, 2001). Pigs are reported to prey on the eggs of cassowaries (*Casuarius casuarius*), a species of conservation significance in the WTWHA (Pavlov et al., 1992). The range of potential prey species of feral pigs is wide including Boyds forest dragons (*Hypsilurus boydii*), northern barred frog (*Mixophyes schevilli*) and Fry’s litter frog (*Sphenophryne fryi*), all of which forage on the rainforest floor or around it (Choquenot et al., 1996, Heise-Pavlov, 2009, Tisdell, 1984). Pigs also compete for food with various species such as cassowaries, the broilga (*Grus rubicunda*), magpie geese (*Anseranas semipalmata*), scrub fowl (*Megapodius reinwardt*) and brush turkey (*Alectura lathami*) (Tisdell, 1984). Negative environmental effects of pigs can be the most severe when they competitively exclude those native species, such as cassowaries, during periods of limited resource availability (Harrison and Congdon, 2002).

Table 1.1. Flora and fauna species in Australia threatened by feral pigs (McLeod, 2004, pp. 27-28).

	Known Threat	Perceived Threat
Fauna	<ul style="list-style-type: none"> ▪ Carpentarian Rock Rat (<i>Zyomys palatalis</i>), ▪ Southern Cassowary (<i>Casuarius casuarius johnsonii</i>) ▪ Eastern Bristlebird (<i>Dasyornis brachypterus</i>) ▪ White-bellied Frog, Creek Frog (<i>Geocrinia alba</i>), ▪ Orange-bellied Frog (<i>Geocrinia vitellina</i>), ▪ Fleay's Frog (<i>Mixophyes fleayi</i>), ▪ Southern Barred Frog (<i>Mixophyes iteratus</i>), ▪ Gastric-brooding Frog (<i>Rheobatrachus silus</i>), ▪ Loggerhead Turtle (<i>Caretta caretta</i>), ▪ Flatback Turtle (<i>Natator depressus</i>), ▪ Hawksbill Turtle (<i>Eretmochelys imbricata</i>), ▪ Red-finned Blue-eye (<i>Scaturiginichthys vermeilipinnis</i>) 	<ul style="list-style-type: none"> ▪ Northern Hairy-nosed Wombat (<i>Lasiorhinus krefftii</i>), ▪ Long-footed Potoroo (<i>Potorous longipes</i>), ▪ Northern Bettong (<i>Bettongia tropica</i>), ▪ Black-breasted Button-quail (<i>Turnix melanogaster</i>), ▪ Armoured Mistfrog (<i>Litoria lorica</i>), ▪ Waterfall Frog (<i>Litoria nannotis</i>), ▪ Mountain Mistfrog (<i>Litoria nyakalensis</i>), ▪ Common Mistfrog (<i>Litoria rheocola</i>), ▪ Lace-eyed Tree Frog (<i>Nyctimystes dayi</i>), ▪ Sunset Frog (<i>Spicospina flammocaerulea</i>), ▪ Sharp-snouted Day Frog (<i>Taudactylus acutirostris</i>), ▪ Southern Corroboree Frog (<i>Pseudophryne corroboree</i>), ▪ Furneaux burrowing crayfish (<i>Engaeus martigener</i>)
Flora	<ul style="list-style-type: none"> ▪ Southern Shepherd's Purse (<i>Ballantinia antipoda</i>), ▪ Elegant Spider Orchid (<i>Calonemorchis elegans</i>) ▪ Majestic Spider Orchid (<i>Caladenia winfieldii</i>) ▪ Lesser Swamp-orchid (<i>Phaius australis</i>) ▪ Swamp Lily, Greater Swamp-orchid (<i>Phaius tancarvilleae</i>), ▪ Cinnamon Sun Orchid (<i>Thelymitra manginii</i>), ▪ White-flowered Wax plant (<i>Cynanchum elegans</i>), ▪ Palm (<i>Ptychosperma bleeseri</i>) 	<ul style="list-style-type: none"> ▪ Small Scurf-pea (<i>Cullen parvum</i>)

The extent of diggings caused by pigs can be the greatest in wet environments such as the WTWHA (Seward et al., 2004). There was a significant relationship between pig diggings and rainfall; when the soil dried up at the cessation of the wet season, rooting of microhabitats was common (Mitchell et al., 2007a). Nevertheless, damage was patchy as only around 4% of the ground surface in the WTWHA was rooted up (Choquenot et al., 1996, Mitchell and Mayer, 1997). Such spatial variation in damage is known as 'negative exponential frequency distributions' i.e. many sites with little or no damage and a few sites with a higher level of damage (Hone, 1994). Overall, the majority of diggings in the WTWHA were concentrated near roads, tracks, surface water, or drainage lines as well as along watercourses and table drains (Choquenot et al., 1996). The degree of damage was also different between lowland and highland areas in the WTWHA, with lowlands being more affected by pigs rooting than highlands

(Choquenot et al., 1996). Mitchell et al. (2007b) argued that intense, localised diggings could have an important ramification if those habitats are refuges for rare/endangered flora and fauna. Recent studies, such as Taylor et al. (2011), found that the key environmental effects of pigs included the decline in leaf litter, soil invertebrates and seedling densities, and that such effects could be translated into the decline of trees and other keystone species or decline in ecological processes in the future. Mitchell et al. (2007b) indicated that in the process of recovery from diggings, exotic taxa were able to rapidly colonise and persist in diggings whereas native taxa were slow to recolonise. The environmental effects of pigs, however, may depend on ecosystem types (Doupe et al., 2010); for example, the most recent studies such as Mitchell et al. (2007a) and Elledge (2011) detected that pigs had no significant effect on rainforest dynamics of the WTWHA. The most noticeable effect of pigs on the ecosystem is disturbed soil caused by their rooting behaviour when foraging, which can impact on rainforest dynamics such as invertebrate (e.g. earthworm) populations, nutrient cycles and plant regeneration. Elledge (2011) found, based on 14 years of plot comparisons, that seasons had a greater impact on such rainforest dynamics than pigs. Nonetheless, based on the current and potential negative environmental effects of pigs, the difficulty of controlling them and negative effects of some control methods, their current status is listed as a major vertebrate pest of the WTWHA (Figure 1.1).

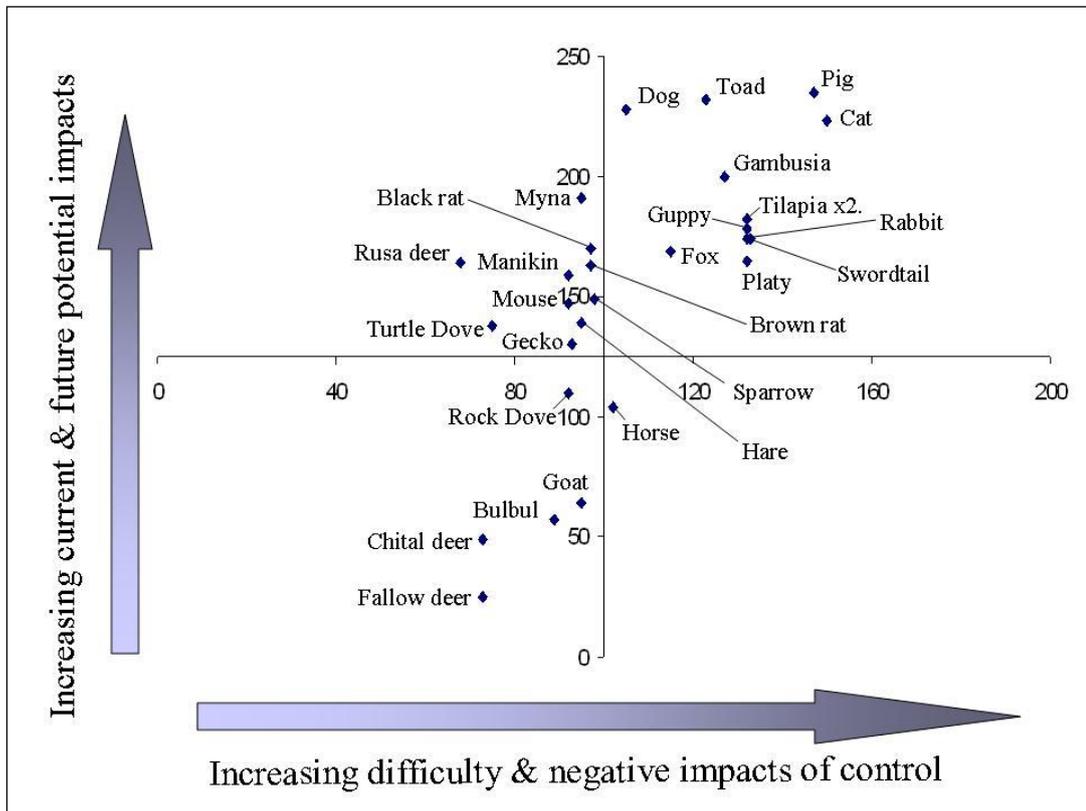


Figure 1.1. Assessment of current and potential effects (Impact Score: y axis) versus control difficulty and negative control effects (Control Score: x axis) of vertebrate pests in the WTWHA; relative pest status that increases towards the upper right hand corner of the graph (Congdon and Harrison, 2008, p. 325).

1.3.3. Socio-economic effects of pigs in Australia

The pest status of pigs also refers to its socio-economic effects. Their potential to become hosts or vectors for several endemic and exotic diseases can cause severe damage to the Australian economy (Table 1.2). For instance, Foot-and-Mouth Disease (FMD) could severely damage an estimated AUS\$14 billion worth of Australian agricultural industries (Choquenot et al., 1996, McGaw and Mitchell, 1998). The risk is high because it would be extremely difficult to eradicate FMD if it were to establish in a feral population, particularly in inaccessible terrain such as the WTWHA (Rainforest CRC, 2003). Other diseases such as leptospirosis, an endemic bacterial disease, can infect cattle and humans through contaminated water by pigs' urine (Alexander, 2003). Japanese Encephalitis, a mosquito-borne disease, is another disease of concern (Shield, 2001).

Table 1.2. Endemic and exotic diseases carried by feral pigs (McGaw and Mitchell, 1998, p.7)

ENDEMIC	EXOTIC
Brucellosis (<i>Brucella suis</i>)	Foot and Mouth Disease (FMD)
Tuberculosis (<i>Mycobacterium spp.</i>)	Classical Swine Fever
Porcine Parvovirus (PPV)	Aujeszky's Disease
Leptospirosis (<i>Leptospira spp</i>)	Japanese Encephalitis
Melioidosis (<i>Pseudomonas pseudomallei</i>)	Swine Vesicular Disease
Sparganosis (<i>Spirometra erinacei</i>)	African Swine Fever
Murray Valley Encephalitis (MVE)	Trichinosis
	Rabies
	Screw-worm Fly infestations

Agricultural loss caused by pigs is a more tangible cost to the economy. Owing to their close proximity to pig habitats in the rainforests, main agricultural commodities in the WTWHA, such as sugar cane and tropical fruit, including bananas, are subject to pig damage such as trampling of young cane and physical destruction of paddocks. Damage caused by pigs costs farmers, on average, \$300 for every 1,000 cartons of bananas and \$813 for every 1,000 tonnes of harvested sugar cane in the WTWHA annually (Rainforest CRC, 2003). Consequently, damage by pigs was ranked as the third most significant after damage caused by cane grubs and rats (Rainforest CRC, 2003). Economic costs and the extent of pig damage, however, most strongly depended on different factors such as changing value of production due to market pressure, seasonality, moisture content of farms and pig density. The value of bananas often changed with the seasons and so did the costs of damage; the extent of cane damage tended to be at its peak prior to harvest when the cane was most enriched with sugar (Mitchell and Dorney, 2002). Levels of damage also varied with types and conditions of farm: soft and uncompacted irrigated soils were subject to greater damage because they contained more earthworms or green forage than dry-farm soils (Mitchell and Dorney, 2002). Pig density can also determine the extent and costs of damage because the higher the density, the more damage a farm is likely to receive (Olsen, 1998).

The presence of pigs, however, also brings socio-economic benefits for sectors such as commercial harvesting and recreational hunting; thus, their pest status may be arbitrary and ambiguous. Feral pigs are regarded as the most important game animal in Australia, and approximately 120,000 pigs were annually exported and sold as wild pig meat to mainly European markets (Choquenot et al., 1996, Wilson et al., 1992). In 1995, Australia met around 20 to 30% of Europe's wild pig consumption, and the total value of the meat exports varied between \$10 million and \$20 million per annum, to which

Queensland contributed \$6 to 12 million worth of feral pigs per annum (1994 values) (McGaw and Mitchell, 1998). The main overseas markets in 2002 included Germany (47%), France (36%) and the Netherlands (11%) (AEC group, 2003). Recreational hunting also provides flow-on benefits from the hunters' expenditures that inject money into local economies where they hunt: on average, each hunter in Australia spent \$447 per annum, amounting to a total expenditure of \$45 million annually (1982 values) (Tisdell, 1982).

The presence of pigs may also benefit other stakeholder groups such as Aboriginal communities, who may use pigs as a food source and/or as an outlet for the maintenance of some aspects of traditional culture (Roberts et al., 2001). As a result, some Aboriginal people often do not agree with the mainstream view that feral animal populations need to be reduced or eradicated (Bradshaw et al., 2007). Nonetheless, their attitudes and beliefs toward feral animals vary between tribal groups, depending on time, place and circumstance (DEH, 2005, Roberts et al., 2001, Wilson et al., 1992, Aslin and Bennet, 2000, Altman et al., 1996).

In summary, pigs can entail benefits as an export commodity, recreational source, or food source, rather than merely represent costs as an environmental liability, disease hazard, or agricultural pest (Izac and O'Brien, 1991, Choquenot et al., 1996). The benefits attributed to pigs indicate that cultural values and economic concerns can determine the status of an animal as a pest or a resource in addition to the ecological or scientific factors (Zivin et al., 2000, Robinson et al., 2004). Thus, those perceived costs and benefits need to be explored to re-define the pest status of feral pigs, specific to the context of the WTWHA, where multiple stakeholders are involved and are likely to attribute different values to the animal. To identify the perceived costs/benefits of pigs in such rainforest environments, conceptual frameworks on values attributed to an environment can be useful, such as the Total Economic Value (TEV) and Millennium Ecosystem Assessment (MA).

1.4. Conceptual frameworks for understanding values attached to an environment

Although the classified values of an environment under the Total Economic Value (TEV) and Millennium Ecosystem Assessment (MA) are named differently from each

other, both identify similar types of values (Stoeckl et al., 2011, Charles and Dukes, 2007, Hein et al., 2006). The TEV reflects a pure utilitarian approach of economics, referring to instrumental/use and non-instrumental/non-use values of the environment. Similarly, the MA focuses on the kinds of ‘ecosystem services’ that benefit humans. The MA has attempted to elaborate on the values identified by the TEV with those expressed by different disciplines, cultural conceptions, philosophical views and schools of thought (Millennium Ecosystem Assessment, 2005). The concurrent use of the two frameworks is useful to evaluate the ‘significance’ of the impacts of invasive species in terms of their effects on ‘services’ and ‘values’ (Charles and Dukes, 2007). The combined model proposed by Hein et al. (2006) was particularly useful because it avoided the double counting of ecosystem services.

1.4.1. Total Economic Value (TEV)

Conventionally, the conceptual framework known as Total Economic Value (TEV) identifies the four value types that people can attribute to ecosystem services: *direct use*, *indirect use*, *option*, and *non-use* values. Direct use, or ‘utilitarian’ values, especially ‘consumptive’ or ‘market priced’ values, correspond to production services of the MA as well as some cultural services that are ‘non-consumptive’ or ‘non-market priced’, for example, tourism (Bateman, 2007). Indirect use values are similar to regulation services of the MA (Hein et al., 2006, Bateman, 2007). Option values stem from the individual’s willingness to keep open the option of using a resource in the future and can be similar to cultural services of the MA. Direct use, indirect use and option values are categorised as ‘use values’. Conversely, ‘non-use’ values are non-instrumental but anthropocentric values that reflect the individual’s concern for, sympathy with and respect for the rights or welfare of non-human beings and recognise the ‘existence’ values of certain species or whole ecosystems (Turner et al., 1994). Existence values are based on ‘stewardship motivation’, reflecting human responsibilities for resource conservation, for example, leaving non-human resources ‘undisturbed’ as far as possible, on behalf of all nature (Turner et al., 2003). Some literatures add *bequest* values, as another non-use value that an individual derives by preserving the environment for the benefit of future generations (Hein et al., 2006, Bateman, 2007). Bequest values represent ‘inter-generational altruism’ based on the ‘warm glow’ effect and purchased moral satisfaction (Turner et al., 2003). There are also ‘intrinsic’ values that reside ‘in’

environmental assets; however, the TEV only depicts anthropocentric and instrumental values (Turner et al., 1994). Bateman (2007) regarded intrinsic values as values of the resource in its own right, or non-human values, and separated them from anthropocentric existence values.

1.4.2. *Millennium Ecosystem Assessment (MA)*

Ecosystems such as rainforests are dynamic complexes of communities of plants, animals and micro-organisms; and the non-living environment, interacting as functional units (Pagiola et al., 2004). Ecosystems provide a wide variety of useful *services* known as ecosystem services. Ecosystem services arise from, and depend on, ecological *components, processes* and *functions*. Ecosystem *components* include resources such as species, vegetation types and oceans; ecosystem *processes* and *functions* refer to the biological, chemical and physical interactions in the ecosystem (Boyd, 2007). Ultimately, ecosystem services enhance human welfare; the aspects of ecosystems are utilised actively or passively to produce human wellbeing (Fisher et al., 2009) and are valued by people (Boyd, 2007).

The Millennium Ecosystem Assessment (MA) is a conceptual value framework that emphasises connections among ecosystem services and aspects of human wellbeing (Carpenter et al., 2006). MA identifies four different ecosystem services: production, regulation and cultural services that directly influence the wellbeing of people and supporting services that produce benefits that are either indirect or occur over a long period of time. Production services are the products people obtain from ecosystems such as food and fresh water. Regulation services are the benefits from the regulation of ecosystem processes such as air quality maintenance, climate regulation, erosion control and water purification. Cultural services are non-material benefits from ecosystems through, for instance, education, recreation and aesthetic experiences. The benefits derived from cultural services are based on ‘non-use’ of ecosystems and depend on human perceptions and behaviour that vary with individuals and communities (Millennium Ecosystem Assessment, 2005). Supporting services include functions such as oxygen production and soil formation, supporting the production and maintenance of all the other three ecosystem services. Specific categories of each ecosystem services are described in Appendix 3.

The four ecosystem services ultimately contribute to the following human wellbeing components: security, basic material for good life, health, good social relations and freedom of choice and action (Millennium Ecosystem Assessment, 2005) (Figure 1.2). Wellbeing can be enhanced or reduced under conditions of ecosystem change, induced by direct drivers of change such as species introduction. Feral pigs are considered one such direct driver of change, and pig management is one form of strategies and interventions to mitigate their impacts on ecosystem services and human wellbeing (Millennium Ecosystem Assessment, 2005).

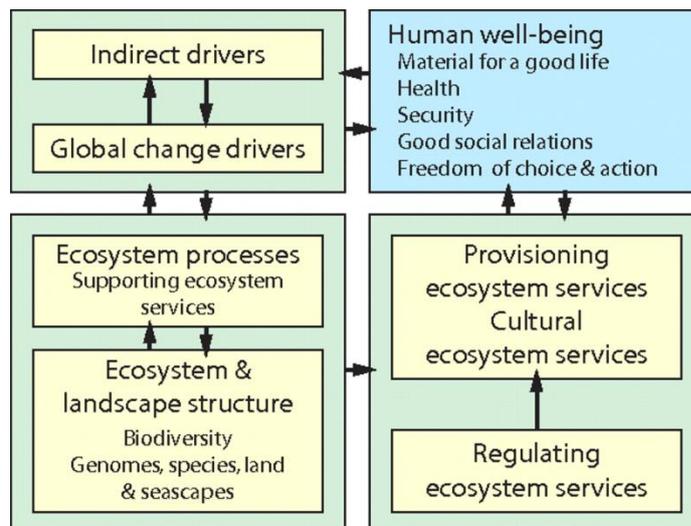


Figure 1.2. The overarching feedback loop considered by MA and the complex relationship among ecosystem services, human well-being, drivers of change, and supporting ecosystem processes and structure (Carpenter et al., 2009, p. 1308).

1.4.3. *Synthesis of the TEV and MA*

Given that the TEV and MA identify similar values, Hein et al. (2006) offered a holistic conceptual framework that combined the concepts introduced in both frameworks (Figure 1.3). Because supporting services of MA are the basis for all the other three services, their inclusion may result in ‘double counting’ (Hein et al., 2006). Thus, supporting services are omitted from the framework. Intrinsic values are also disregarded as they are not part of the TEV. Option values and existence values of TEV comprise all the three ecosystem services, that is, production, regulation and cultural services (Charles and Dukes, 2007). Existence values, or non-use values of TEV, are regarded as corresponding to cultural services of MA; however, the TEV views the mere existence of an ecosystem as being of value whereas the MA does not regard it as

an ecosystem service unless there are actual non-material benefits for humans, such as education and aesthetics (Appendix 3).

The combined conceptual frameworks were then applied to investigate the perceived environmental impacts of feral pigs to meet one of the main aims and objectives of the research.

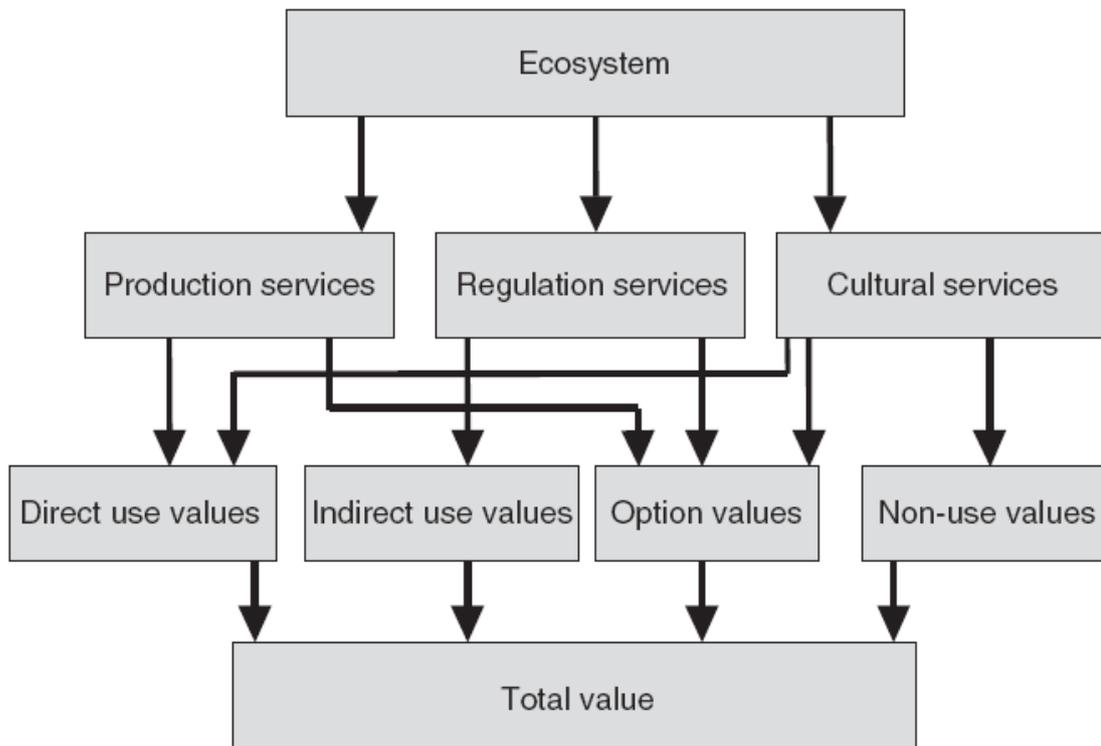


Figure 1.3. The ecosystem valuation framework based on MA and TEV (Hein et al., 2006, p. 211).

1.5. Aims and objectives of this thesis

The aims of the research were to:

- i. Investigate the costs and benefits of feral pigs perceived by different stakeholders in the WTWHA.
- ii. Assess the cost-effectiveness and social acceptability of different control methods and stakeholders' perceptions of the management of pigs.

To achieve the aims, the objectives were to:

- a. Assess the perceived environmental costs and benefits of feral pigs by analysing values that stakeholders ascribe to the rainforest and the impacts of pigs on those values.
- b. Assess economic costs and benefits of pigs by examining the extent of agricultural damage and the implications of the presence of pigs for the tourism industry.
- c. Assess social costs and benefits of pigs by analysing the implications of pigs for local residents' livelihood.
- d. Assess social acceptability of trapping, fencing, hunting and poisoning to identify social costs of control practices.
- e. Conduct economic valuation of the cost-effectiveness of the different control measures.
- f. Assess stakeholders' attitudes toward the current management of pigs.
- g. Determine the utility of the chosen value frameworks (the MA and TEV) to reflect the public construction of values.

1.6. Thesis Structure

The thesis is divided into 10 chapters to address the aims and objectives.

Chapter 1: Introduction. As provided in the current chapter.

Chapter 2: Research Design and Methods introduces the research methods used to examine the perceptions of the stakeholders, including qualitative interviews, household surveys, participant observation and tourist surveys.

Chapter 3: Local Residents' Perspectives illustrates the results obtained from the household surveys of, and qualitative interviews with, the local residents in Mossman, Daintree, Cape Tribulation and South Cooktown (excluding farmers, pig hunters and tourism operators).

Chapter 4: Pig Hunters' Perspectives highlights pig hunters' perceptions identified from qualitative interviews and household surveys. In particular, the chapter examines the socio-economic importance of recreational hunting as benefits provided by the presence of feral pigs.

Chapter 5: Farmers' Perspectives focuses on farmers' perceptions of the costs and benefits of pigs, particularly the extent of pig damage to their farms, determined from qualitative interviews and household surveys.

Chapter 6: Government Officers' Perspectives closely examines government officers' perceptions of the costs and benefits of feral pigs and the role of government-funded feral pig trapping programs in Daintree through in-depth interviews.

Chapter 7: Tourism Perspectives presents the results from the tourist surveys conducted in Mossman and Daintree/Cape Tribulation. It also focuses on tourism operators' views about the implications of pigs for the tourism industry in the study area.

Chapter 8: Aboriginal Rangers' Perspectives focuses on Aboriginal rangers' views on feral pigs and aspirations in the management of the animal through qualitative interviews and/or participant observation.

Chapter 9: Cost-effectiveness of Different Control Methods presents the economic cost-effectiveness of trapping, dogging and shooting based on population reduction at a given pig density and the qualitative examinations of the effectiveness of fencing and poisoning. Various factors that determine cost-effectiveness are also discussed.

Chapter 10: Discussion and Conclusion summarises and discusses the findings from all the chapters on the perceived costs and benefits of feral pigs, the usefulness of each control method, including some management recommendations, and the utility of the MA and TEV frameworks for identifying public values.

Chapter 2: Research Methods and Design

2.1. Introduction

This research took a mixed-methods approach. Qualitative semi-structured interviews were first employed to inductively investigate stakeholders' perceptions in depth. Based on the perceptions identified in the interviews, the household survey (a quantitative method) was applied to deductively assess the extent to which those perceptions identified in the semi-structured interviews were applicable to a wider population. Because the household surveys systematically and randomly sampled the local population, it was possible to include some of the types of residents who might otherwise have been missed by convenience sampling used for the semi-structured interviews. The perceptions investigated in the semi-structured interviews with Aboriginal rangers were also corroborated by a participant observation method. A quantitative questionnaire-based survey method was applied to investigate the perceptions of tourists by systematic random sampling at a convenient location. The main advantage of a mixed methods approach is that the information derived from the different methods can be 'triangulated', and therefore, the validity of the results can be enhanced.

This chapter discusses the study area and research methodology. It addresses: (1) the ontology and epistemology of the research; (2) data collection methods; (3) sampling designs for each method; (4) details of the respondents; (5) data analysis; (6) biases inherent in the research; and (7) ethical considerations.

2.2. Study area: Mossman, Daintree, Cape Tribulation and south Cooktown in *the Wet Tropics World Heritage Area (WTWHA)*

The WTWHA extends along the north-east coast of Queensland, Australia, from south of Cooktown to north of Townsville (15°39'-19°17'S, 144°58'-146°37'E) (Figure 2.1). Covering 894,420 ha (1% of Queensland), it is the world's oldest tropical rainforests, containing numerous endangered flora and fauna, which account for a substantial part of Australia's biodiversity (Goosem et al., 1999). The WTWHA is Australia's most floristically rich area, embracing 3,000 plant species from 210 families, with more than

700 species being endemic and more than 350 species being considered rare or threatened (Harrison and Congdon, 2002). There are more plant taxa with primitive characteristics in the region than anywhere else on earth (Stork, 2005). The rainforests also serve as habitat for half of Australian bird species and one third of mammal species (Goosem et al., 1999, Stork, 2005). There are nine Bioregion Provinces within the WTWHA, and the Daintree Bioregion, where this research was based, is of the highest conservation significance because it has the highest numbers of endangered regional or 'of concern' ecosystems (Harrison and Congdon, 2002). Owing to its extraordinary nature and evolutionary history, the WTWHA is considered to have 'outstanding universal value' (Rossler, 2000). The Australian Government has had the obligation to preserve and conserve the WTWHA since its inscription on the World Heritage list in 1988.

Protecting the WTWHA is also important for other reasons. The economic value of nature-based tourism in the WTWHA increased after the World Heritage inscription. Annually, more than two million tourists visit the WTWHA (Bentrupperbaumer et al., 2006) and rainforest-based tourism generates more than AUS\$750 million per year for the regional economy (WTMA, 2000). Mossman Gorge, Daintree National Park, is a major tourist attraction in the study area and attracts more than 400,000 visitors annually (Bentrupperbaumer, 2002).

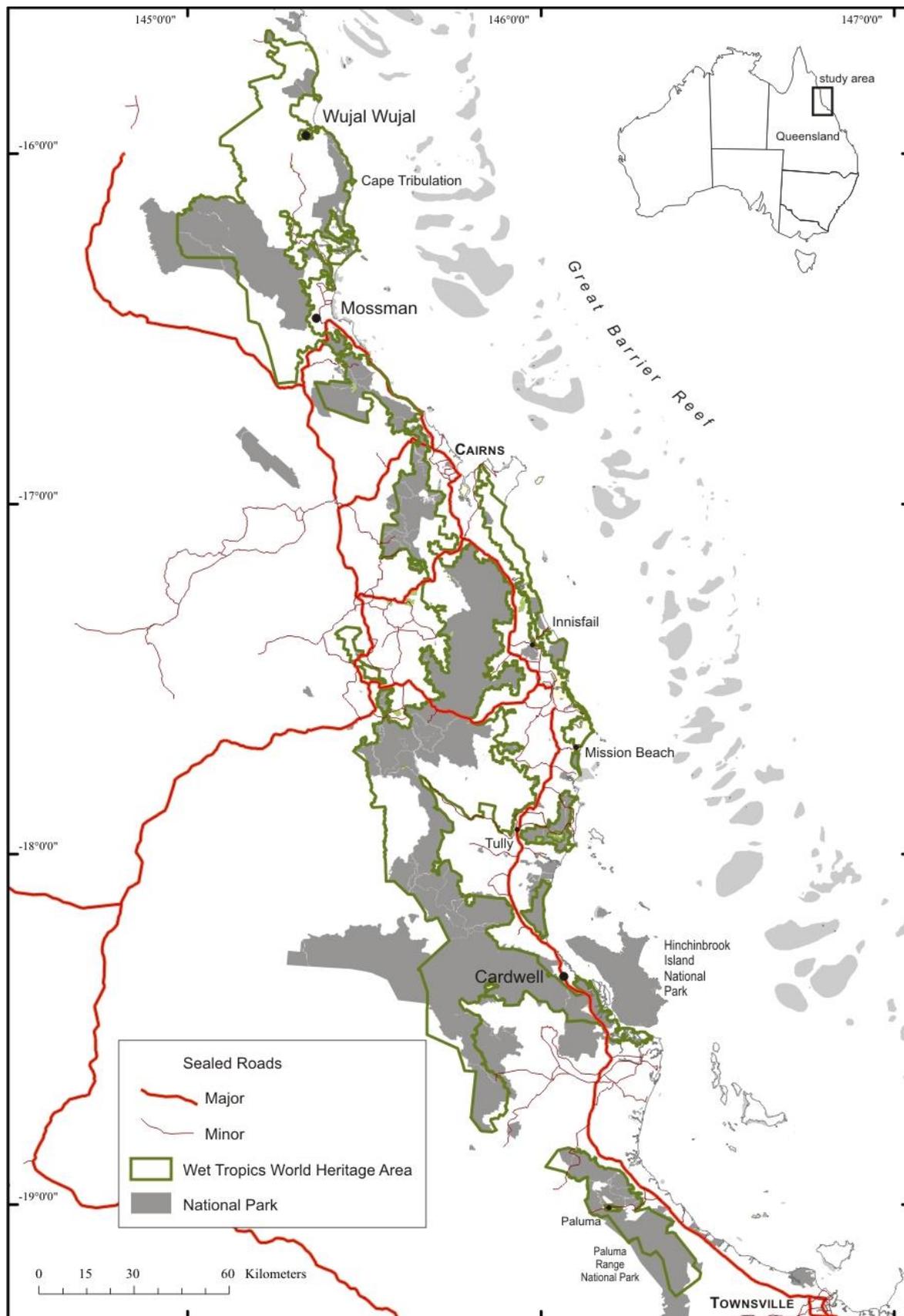


Figure 2.1. Location of the study area (© GeoScience Australia, 2010, Great Barrier Reef Marine Park Authority, 2006, Wet Tropics Management Authority, 2008).

2.3. Ontology and epistemology

Qualitative methods, particularly in-depth qualitative interviews, where an interviewee is encouraged to talk on a particular topic of interest, are the most appropriate techniques to investigate attitudes (Byrne, 2004) and generate data that are rich and meaningful (Hayes, 1997). Qualitative methods are normally based on a pluralist ontology and constructivist or phenomenological epistemology. Pluralist ontology values people's knowledge, values, and experiences as meaningful and worthy of exploration (Byrne, 2004). A constructivist epistemology focuses on how individuals develop, or *construct*, their subjective meanings of their experiences that are based on their historical and social contexts (Seale, 2004). Phenomenology identifies the human perceptions, or 'lived' experience, about a phenomenon as a sense of reality (Bernard, 2006, Creswell, 2009). The advantage of the phenomenological approach is that it adequately represents and analyses a 'voice' of the lived experiences of different people that the aggregated statistics of quantitative surveys cannot provide (Marks and Yardley, 2004). Based on the phenomenological paradigm, this research employed an inductive or Grounded Theory approach. Grounded Theory is a qualitative strategy of inquiry that emphasises the inductive and systematic discovery of theory from data obtained from the views of participants (Bernard, 2006, Creswell, 2009).

In contrast, quantitative methods, such as a questionnaire-based survey, are based on a positivist approach, which assumes that all phenomena can be measured using empirical indicators that represent the truth (Sale et al., 2002). Such methods are often based on written administered questionnaires with a limited range of predetermined responses to measure and analyse causal relationships between variables (Sale et al., 2002, Seale, 2004). Despite being ontologically and epistemologically different, quantitative and qualitative methods can be used together to explain the phenomenon of interest in a complementary manner. For instance, interviews could provide the lived experience of a phenomenon of individuals to inform a quantitative measure of the phenomenon (Sale et al., 2002). That is, qualitative measures can identify the range of values held, and quantitative measures can provide a view of the extent to which those values are held.

2.4. Research methods

2.4.1 Semi-structured qualitative interviews

Because of time constraints, this research used semi-structured, in-depth interviews, for which mostly open-ended questions were prepared in advance to examine subjects of interest. Before the interviews were conducted, the procedure was explained to each interviewee, emphasising that the data were to be used only for the research. Informed consent was obtained verbally. Interviewees were not referred to by names to protect their confidentiality. The interview conversation was taped if the interviewee agreed, or written down as field notes. The interviews were conducted based on an interview guide or basic open-ended questions with some closed-ended questions (Appendix 4). Types of questions differed across different stakeholders although there were some common questions. Flexible and open-ended questions receive a more considered response than closed-ended questions and provide better access to interviewees' views, interpretations, and understanding of topics, experiences, and opinions (Byrne, 2004). A conversation began with a simple and general question that interviewees could easily answer (e.g. "What do you think about feral pigs?"). Subsequently, they moved onto succeeding questions on the interview guide or sometimes jumped to a different question in a flexible order to follow the flow of the conversation. An interviewee's comments were linked with another question to determine the reliability of his/her perceptions. A new question could also be asked that arose during the interview as a result of a response from the interviewee to a particular topic. Therefore, the information generated was not limited to the original interview guide but evolved with new information provided by the interviewees. To inductively generate theory (i.e. Grounded Theory), qualitative interviews were conducted until theoretical saturation was reached. Theoretical saturation is the point at which sampling or data collection ceases when similar instances are found repeatedly and no new ideas are generated by empirical inquiry that may contradict, or help develop further, the emerging data themes which lead to theory development (Seale, 2004).

2.4.2. Triangulation of measures: household surveys and participant observation

Local residents, in particular, had diverse demographic backgrounds, and therefore, the data from the semi-structured interviews needed to be 'triangulated' by another method

to obtain convergent validity of the results and to expand the scope and extent of understanding. A ‘sequential’ mixed methods approach was decided upon, in which the findings from the interviews were elaborated and expanded with a quantitative method. Household surveys were used to assess the external validity or generalisability of the interviews, or to test whether the findings from the interviews were applicable to a wider population. Combining methods crosschecked the results for consistency and offset any bias of a single research method, thereby enhancing confidence in the overall conclusions drawn from the research (Spicer, 2004, Johnson and Onwuegbuzie, 2004). Thus, a high level of empirical rigor was maintained and a phenomenological ‘story’ of interviewees’ attitudes toward feral pigs was constructed (Mott-Stenerson, 2008).

Triangulation was also important within cross-cultural contexts. Face-to-face qualitative interviews were the most culturally appropriate method to give voice to Aboriginal rangers on behalf of their communities and allow them to express themselves freely and openly as possible (Tchacos and Vallance, 2004). A short-term participant observation method was selected to validate the results from the interviews with Aboriginal rangers. Participant observation was more suitable because meetings were more conversational in nature, and Aboriginal rangers tended to prefer an atmosphere of informality (Ngarritjan-Kessariss, 1997). Quantitative approaches such as written questionnaires based on closed-ended questions were considered culturally unsuitable and inappropriate; for instance, such surveys can create a perceived imbalance in power between the researcher and respondents, which creates an antagonistic reaction from the respondents because they perceive that interviewers are associated with officialdom (Edwards et al., 2005).

(a) Household survey

To incorporate a more representative and quantitative understanding of attitudes toward feral pigs and their management in the WTWHA, the categories or themes of the qualitative interviews were used to design survey questionnaires. Survey questionnaires relied more on closed-ended questions, such as multiple choices and 5 point Likert scales, to elicit specific information or facts that were considered significant by the emerging theory, or the categories identified in semi-structured interviews (see Table 2.1).

Table 2.1. Key sections of the household survey

	Key sections	Content
All local residents requested to answer	Perceptions of feral pig impacts	A range of impacts perceived by residents The severity of impacts in environmental, economic, social and overall dimensions
	Proximity to feral pig impacts	Damage and extent of damage to private properties Concerns about illegal hunting and its public safety issues Feral pig impacts on the quality of life in the Wet Tropics
	Social acceptability of control practices	Approval and disapproval of control practices Reasons for approval and disapproval Concerns for humaneness in control practices
	Current control management support	Extent of satisfaction with current control Reasons for satisfaction and dissatisfaction Extent of satisfaction with national park management
	The values they attach to the WTWHA rainforests	Elicitation of a range of values residents attach to the WTWHA rainforests and to what extent pigs affect these values
	Background information	Gender, age, the length of residence
Farmers	Socio-economic impacts of feral pigs on agricultural industry	Presence/absence, severity and seasonality of damage Types of crops Types, catch efforts and effectiveness of control practices Extent of social and economic burdens of control
Hunters	Implications of hunting practices for management	Importance of and reasons for engaging in hunting Opinions about conflicts with pig control efforts Preference of gender when hunting
Tourism operators	Feral pig impacts on the tourism industry	Perception of the impacts on their businesses, the industry and tourists' experience of the WTWHA rainforests Presence/absence of positive aspects to feral pigs in tourism Perceptions of risks involved in pigs' disease transmission potential

(b) Participant observation

Participant observation is a fieldwork method in which the researcher studies a social group, in this case Bana Yarralji rangers, while being a part of that group as “a participant and observer” in a social situation by maintaining sufficient critical distance to observe social dynamics and interaction (Seale, 2004). The researcher became closer to Aboriginal rangers through participant observation, making them comfortable with her presence and overcoming the problem of reactivity. The rangers expressed their views and aspirations about pigs and pig management more freely and comfortably during daily conversations. Field notes were compared with and added to the results from semi-structured interviews with the Aboriginal rangers. Inconsistency in their

opinions was addressed during debriefing sessions to determine the reliability of their opinions.

2.4.3. Tourist surveys

Because of the limited time availability during the tourists' visits in the study area, surveys based mostly on closed-ended questions were the most appropriate method to investigate tourists' perceptions. To enhance the response rate, the number of questions was limited to fit into one page. A few informal interviews were also conducted with some tourists if they had time and were willing to discuss and clarify their responses further.

2.5. Sampling design

2.5.1 Convenience and purposive sampling (qualitative interviews)

Local residents including farmers, pig hunters and tourism operators were approached via convenience sampling for semi-structured interviews. That is, people were sampled based on their being available locally when the researcher was in the field. Initially, flyers were placed on notice boards in the town centre of Mossman to seek participation from those interested in expressing their views, but there was a lack of interest using this approach. Therefore, convenience sampling was selected to seek their participation directly. Although the sample does not reflect the wider population, convenience sampling is a time and cost efficient way to investigate perceptions (Rubin and Babbie, 2008). Farmers and pig hunters were likely to be around farms, such as sugarcane paddocks or fruit farms, and therefore, the researcher drove along streets and roads neighbouring farms to recruit them. Tourism operators, particularly tour guides, were approached during tourist surveys when they were available. Other operators such as accommodation and tourist attraction managers were approached via email or on the phone with contact details provided in brochures at the Tourist Information Centre in Port Douglas. Because of the relatively small number of local tourism operators, all the operators based in Mossman, Daintree and Cape Tribulation were contacted through the brochures.

Government officers and Aboriginal rangers were 'purposively' selected for semi-structured interviews. Purposive sampling is a non-probability sample in which

the participants are selected based on who are considered to be the most appropriate, useful or representative for the study (Rubin and Babbie, 2008). This sampling method is useful in the study of hard-to-find populations (Bernard, 2006). Via purposive sampling, the approximate representation of the government officers and rangers was guaranteed (Carey and Gountas, 1997). There were only a few local and State government officers who were in charge of feral pig management. Four Aboriginal corporations (Girringun, Jabalbina Yalanji, Burungu Bubu and Bana Yarralji Bubu) were contacted through ranger coordinators to seek Aboriginal rangers' participation in interviews. Because of their experience and knowledge about feral pig issues and existing links with the broader public domain, Aboriginal rangers were invited to participate instead of members of the Aboriginal communities, which enabled the research with Aboriginal people to be conducted in a culturally sensitive and appropriate way. This also made the approach and interview process easier and overcame the time constraints of this study. The perceptions identified in the study, therefore, are indicative of different Aboriginal perceptions and attitudes concerning feral pigs, which may be idiosyncratic to the rangers interviewed. Some rangers who were recruited initially were not available to participate in the interviews at the scheduled time due to funerals, conflicting meetings and other competing demands. Interviews with Aboriginal rangers were not audio-recorded. The Girringun and Bana Yarralji rangers were revisited to confirm their perceptions to enhance validity of the study.

2.5.2. Systematic random sampling (household surveys)

Systematic random sampling was utilised in the household survey to estimate population parameters. Pilot surveys were conducted to refine the survey instrument and questions. The final household surveys (Appendix 5) were distributed by the drop-and-collect technique (Bentrupperbaumer and Reser, 2006). Residents were approached with face-to-face contact on Saturdays. Surveys were dropped to those who lived at every odd numbered house in every third street in Mossman and the second street in Daintree, Cape Tribulation and Cooktown with the starting point being the most southern street of the township. Personal distribution was chosen over a postal method to allow the researcher the opportunity to explain the purpose of the research and thereby increase the rate of return and obtain sufficient responses from the small

number of households¹ in the region. Those who agreed to participate were advised that the researcher would return on the following day to collect the survey; if residents were to be absent on the following day, they were requested to leave the survey in their mailbox or at the door for collection. The questionnaire was put in the mailbox or at the door for those absent during the distribution. Each questionnaire package contained a note asking the resident to complete the survey by the following day (Appendix 6). Any adult in the household was asked to respond to the survey regardless of the gender. If questionnaires were uncompleted or not placed for collection, a reply-paid envelope was left with a note requesting that the survey be completed and returned. If residents left the survey outside for collection during their absence, a thank-you note was left at the door or in the mailbox. During the face-to-face survey distribution, the researcher asked and noted the reasons for non-response if the residents refused to participate. Those already interviewed earlier were advised to return the survey unanswered to the researcher, if received, to reduce the potential of surveying a resident who had previously been interviewed.

2.5.3. Systematic random sampling (tourist surveys)

Tourists were located through the convenience of the walking tracks at Mossman Gorge in the Daintree rainforest. Subsequently, they were systematically and randomly approached at the two entry/exit points of the walks. The next-to-pass method (Lynn and Brown, 2003) was the most efficient way to sample a substantial number of tourists while reducing the bias in the choice of respondents. The first tourist that exited the walking tracks was approached and asked to voluntarily complete the questionnaire. After the respondent completed the questionnaire, the next tourist to pass was approached and asked to do the same. The questionnaires were administered on-site both on weekdays and weekends to reduce day-based bias. The bias of seasonality was eliminated by conducting surveys during the low, medium and high tourist seasons² - 4 days in February and March 2010, 2 days in November 2009, and 4 days in July 2010, respectively. Site biases were reduced by conducting surveys at a boardwalk in Cape Tribulation called Marrdja Botanical Walk in addition to Mossman Gorge during the

¹ According to Australian Bureau Statistics 2006 Census data, Mossman has a population of 1,740, Daintree 78, Cape Tribulation 101, and Cooktown 1,336 (ABS, 2007a).

² The information on the low, medium, and high tourist seasons was derived from the local tourism operators interviewed for this research.

high season³ so that similarities and differences between the two sites could be examined. Age (approximated by the researcher) and gender of the respondents were recorded immediately after collecting questionnaires.

2.6. Respondents

The following respondents were successfully interviewed or surveyed (Table 2.2). Interviews with some respondents, especially farmers who experienced only negligible damage from pigs, however, were relatively short because of their lack of interest in feral pig issues. Conversely, because of their concerns and complaints about feral pigs and associated management practices, several respondents expressed their views in depth.

Table 2.2. The total number of stakeholders interviewed or surveyed to investigate their perceptions of feral pigs and pig management (*local residents interviewed were not farmers, pig hunters, or tourism operators).

Stakeholders	Interviews	Household surveys	Tourist surveys	TOTAL
Local residents	8*	162		170
Pig hunters	10	20		30
Farmers	15	14		29
Government officers	5			5
Tourists			276	276
Tourism operators	11	19		30
Aboriginal rangers	15			15
TOTAL	64	215	276	555

2.7. Data analysis

2.7.1. Data organisation

The interview data were converted into Microsoft Word documents and were fully transcribed if tape-recorded. Then the data were inductively coded, or sorted according to research questions and main ideas, or ‘nodes’ that emerged from the preliminary categorisation of themes. In this ‘open coding’, the researcher read through the documents sentence by sentence and reduced the data into segments, or general

³ Because of the relatively low levels of visitation to the Boardwalk during the low and medium season (Bentrupperbaumer, 2002), the survey was conducted only in the high season.

concepts, that addressed research questions and were identified by several interviewees. After open coding, the categories that addressed the objectives of the research were selected for further analysis and irrelevant ones were retained for later use.

The quantitative data from the household surveys and tourist surveys were entered in Microsoft Excel to be converted into SPSS (PASW Statistics GradPack 18) for data analysis.

2.7.2. Thematic analysis

Thematic analysis was employed to qualitatively analyse the coded semi-structured interview results. The focus was on description of verbal patterns; nuances of the higher frequency themes were investigated in depth (Marks and Yardley, 2004). When analysing data from the interviews at the early stages of data collection, patterns and themes emerge from the categories found in the interviews. The similarities and differences between interviewees' responses were also considered. Theoretical categories and their properties found in the data were developed and redefined through constant comparison (Bernard, 2006, Creswell, 2009). The researcher determined whether the emerging theory from the categorised data was related to the themes from the literature review. The aim of thematic analysis was to describe how thematic content was elaborated by stakeholders in each group (Marks and Yardley, 2004).

2.7.3. Descriptive statistics

The quantitative data were analysed, using SPSS, to numerically or statistically describe the characteristics of the sample and the relationship among variables in the sample. The descriptive statistics tools used included univariate (frequency distributions) and bivariate (cross-tabulation) analyses. Statistical significance was tested, using Chi-square p values to determine the likelihood of the observed relationship in a sample.

2.7.4. Economic analysis of cost-effectiveness of the different control methods

Longitudinal collection of data on control efforts and the economic magnitude of pig damage was impractical due to the time constraints of the research. Instead, the raw data used for Mitchell and Dorney (2002) were used with their permission to compare the cost-effectiveness of control measures, specifically trapping, dogging and shooting.

In this region, hunters used dogs to locate pigs so that they could kill them with knives or rifles, known as dogging, or simply used rifles to kill pigs, known as shooting. The data comprised numbers of pigs caught, physical effort used to catch pigs, such as trap nights for trapping, and hours spent for dogging and ground shooting, with associated costs and estimates of economic loss. The data were collected by Mitchell and Dorney (2002) from seven different localities (Malbon Thomson Range, Eubenangee, Wopen Creek, Basilisk, Walter Hill, Tully and Hawkins Creek) within the WTWHA, stretching from Innisfail in the north to Cardwell in the south. Localities were either sugarcane or banana farm and all were close to rainforests. These characteristics of the areas being in the lowland rainforest and the existence of sugarcane and banana farms were similar to the study area of this research, i.e. Mossman, Daintree, and Cape Tribulation.

Data from Mitchell and Dorney (2002) were used to calculate the *Catch Per Unit Effort* (CPUE) of recorded trapping, dogging and shooting activities. These CPUE values were then used as indices of prevailing feral pig population densities in a specific location because true densities are generally unknown and difficult to assess. CPUE has been commonly used to estimate natural fish abundance in marine fisheries (Barnes and Hughes, 1999, Ye and Dennis, 2009) and the method should be applicable to wild terrestrial animals, such as feral pigs. It has been shown, however, that proportionality between CPUE and fish abundance may not always be 1:1 (Harley et al., 2001). This study assumes that feral pig density is proportional to the CPUE and the relationship is used to compare the cost-effectiveness of different control methods.

CPUE for a particular event was calculated as the total number of pigs caught divided by the total physical effort used to catch them. Hunters, whether using dogs or not, did not always manage to kill all the pigs they saw, but some were more skilful than others. To allow for different levels of hunter skill, it was decided to count all pigs seen as caught or killed only for the estimation of CPUE. Dogging was the method most commonly used in all the localities, and many properties did not use trapping or shooting. Some farms practised more than one control method at the same time. However, the relatively small numbers being caught by one method would not significantly reduce the estimated CPUE of another method.

The control costs were calculated by Mitchell and Dorney (2002), based on labour and capital such as actual person-hours, kilometres travelled and associated effort and costs involved pursuing the control methods. Normally, free feeding of bait is

conducted to enhance trapping success, at sites where pigs are active, and this could take up to a number of days (Sharp and Saunders, 2005). However, the data on the costs associated with free feeding were not available, and therefore not included in the calculation of control costs for trapping.

There were 22 data points for trapping in five different localities, 74 data points for dogging in seven different localities, 18 data points for shooting in five different localities. In total, there were 114 data points over the seven localities. To obtain greater stability in the data, the costs per pig and CPUE values within a locality (e.g. Basilisk) were aggregated to represent an average cost per pig against an average CPUE of that locality; thus, when plotting costs per pig against CPUE values, each point reflects a locality value. This resulted in exponential patterns, and a standard regression equation (using GenStat) was used to fit the standard Mitscherlich curves to the various data sets.

Since all three control methods were being used simultaneously in the target region, it was reasonable to assume that the three sets of CPUE figures should reflect the same overall pig densities in terms of average and range. However, the CPUEs calculated for each method were based on different units of physical effort, for example, trap nights versus hours spent dogging or shooting. To be able to compare the cost-effectiveness of the three methods, CPUE values needed to be standardised. Standardising CPUE values for each method involved first subtracting the average CPUE value from each CPUE value and then dividing by the standard deviation of the values. This also enabled the dollar values for estimated damage to 49 farms during the two year period (2000-2002) to be plotted against standardised CPUE values.

To examine if weather factors enhanced cost-effectiveness, data on the number of pigs caught monthly through the Daintree Feral Pig Trapping Program between 2005 and 2009 were obtained from the Cairns Regional Council. Data on monthly rainfall were obtained from the Australian Bureau of Meteorology website during the four year period from September 2005 to August 2009.

There were some limitations with the raw data of Mitchell and Dorney (2002).

1. The costs were aggregated per unit so the seasonal variances within a farm could not be incorporated in any analysis.
2. The sex of pigs caught was not recorded so influences of sex on the extent of damage caused by pigs could not be incorporated in the analysis.

3. The size of the properties surveyed was not recorded so that influences of property size on the extent of damage could not be incorporated in the analysis.”

Since the cost-effectiveness of fencing and poisoning was unassessed in the same manner as the other methods, this research used qualitative face-to-face interviews and household surveys with those who practised either of the methods.

2.8. Bias

Due to the exploratory nature of the research, this project had some limitations. Objectivity of the research was influenced to some extent by the researcher's subjectivity. Interviewing is a process of data generation, in which the researcher is a co-producer of the data; data were produced as a result of an interaction between researcher and interviewee. Differences between the researcher's and interviewees' demographic backgrounds such as age, gender, class, ethnicity and religion could all influence the possibilities of interaction and interpretation, thereby determining how the social world could be known (Byrne, 2004). The researcher being female and non-Australian may have changed the informant relations and ultimately the outcomes of interviews and analysis. To minimise the effect of researcher subjectivity and enhance external validity, research methods were intentionally triangulated through use of qualitative interviews and household surveys, and primary and secondary data sources were combined so that stakeholders' perceptions were more objectively represented and understood.

Because those who chose not to participate in the household survey tended to be unconcerned about pigs and management (Chapter 3), non-response bias is possible if respondents significantly differed from non-respondents in characteristics that influenced attitudes toward pigs and management. Hence, the results in this research should be regarded with caution when generalising from the sample to the population.

2.9. Ethical considerations

This research was conducted with due consideration, approval, and compliance with official university ethical guidelines (Human Ethics Approval Number H3490, James Cook University). The stakeholders' participation in the research process remained

completely voluntary and withdrawal from participation was accepted at any point if participants wished. Confidentiality about informant identity was also guaranteed. Before conducting interviews, verbal informed consent was obtained from research participants wherever possible to support the principle of individual autonomy and safeguard the rights of interviewees to participate knowingly and voluntarily in this research. Based on a principle of reciprocity and feedback (Smith, 2008), “reporting back” to the Aboriginal participants was made to disseminate research results and “share knowledge.” Feedback was also provided to those mainstream participants whose contact details were known.

Chapter 3: Local Residents' Perspectives

3.1. Introduction

The degree and extent of the environmental impacts of feral pigs in the WTWHA region have been investigated extensively in the scientific literature (Appendix 2); however, the general public's or local residents' perceptions on these impacts have not been examined fully. This chapter focuses on the perceptions of feral pigs and their impacts held by local residents. Factors addressed include: (1) different kinds of values that the residents ascribed to the rainforest and the impacts of pigs on those values; (2) the dimensions of the impacts (environmental, economic and social) of most concern to the residents; (3) levels of satisfaction with current pig management; and (4) social acceptability of different control methods. The data to address these matters were obtained from qualitative semi-structured interviews as well as quantitative household surveys; the survey questions were based on the themes identified from the qualitative interviews, known as a sequential mixed methods approach (Chapter 2). A total of 162 surveys were delivered by drop-and-collect method and eight local residents (non-farmer, non-hunter and non-tourism operator) were interviewed (Chapter 2). This chapter particularly focuses on the interview content and the first section of 19 closed-ended questions in the household survey that were applicable to all local residents, regardless of whether they were a member of special interest groups such as farmers, hunters and tourism operators. Some survey respondents did not answer every question, and thus, the number of responses varied with each question.

3.2. The results from the interviews and household survey

3.2.1. The household survey response rates and non-responses

The overall return rate of the household survey was 56.4% (Table 3.1), higher than those of equivalent community surveys conducted within the WTWHA in the past; 33.2% in 2002 (Bentrupperbaumer and Reser, 2006) and 20.6% in 2007 surveys (Carmody and Prideaux, 2008). The return rate was the highest in Daintree and Cape Tribulation (62.9%), possibly because of the residents' closer proximity to pig habitats (i.e. higher susceptibility to pig damage) in the rainforests of the region. When residents chose not to participate in the survey, the researcher asked them and noted the reasons

for rejection (Chapter 2). Initial non-response was stated to be as a consequence of lack of familiarity with, or concerns about, feral pigs (see Table 3.2). Nearly all of these non-responses occurred in urban areas including residential suburbs of Mossman and Cooktown. No language problems appeared to be relevant to non-responses.

Table 3.1. Total of responses to the household survey about community perceptions of the impacts of feral pigs in the WTWHA.

	Mossman (South)	Mossman (North)	Daintree & Cape Tribulation	Cooktown	TOTAL
<i>Total approach</i>	89	65	62	71	287
<i>Initial non-response</i>	19	13	8	12	52
<i>Total distribution</i>	70	52	54	59	235
<i>(with contact)</i>	48	37	39	42	166
<i>(without contact)</i>	22	15	15	17	69
<i>Total collection</i>	36	26	31	33	126
<i>Delivery by post</i>	15	5	8	8	28
<i>Rejection after survey</i>	6	0	1	4	11
<i>Total response</i>	51 (57.3%)	31 (47.7%)	39 (62.9%)	41(57.7%)	162 (56.4%)

Table 3.2. Reasons for initial non-responses to the household survey about community perceptions of the impacts of feral pigs in the WTWHA.

Reasons for initial non-response	Mossman (South)	Mossman (North)	Daintree & Cape Tribulation	Cooktown	Total	(%) non-response
<i>I don't have much to do with feral pigs.</i>	7	7	2	4	20	38.5
<i>I'm not interested.</i>	8	2	3	6	19	36.5
<i>I don't have time.</i>	4	4	2	2	12	23.1
<i>I don't care about pig management.</i>	0	0	1	0	1	1.9
Total non responses	19	13	8	12	52	

3.2.2. Profile of interviewees and survey respondents

In total, eight residents (seven males and one female) who did not belong to any of the stakeholder groups specifically targeted for this research were interviewed. Three more local residents were approached for interviews in Daintree, but they chose not to participate because they either did not care about feral pig issues or they had only recently moved to the area.

The majority of the survey respondents (60%) were male. Out of 162 survey respondents, 14 were farmers (13 male famers) and 20 hunters (14 male hunters). The majority of the respondents were aged between 30 and 59 years, accounting for 73% of the total respondents; 24% were over 60 years of age and only 3% were aged between 18 and 29 years. The demographic profile of the sample obtained was slightly different from that provided by Australian Bureau of Statistics (ABS); ABS (2007b) identified male as comprising 52% of the population and nearly half (47%) was aged 25 to 54 years, with 13% aged 55 – 64 years, 11% aged 15 – 24 years and 10% aged 65 years and over. Moreover, approximately 70% of the respondents were long-term (more than 10 years) residents of the study area (Figure 3.1); most respondents to the survey were likely to be familiar with feral pig issues.

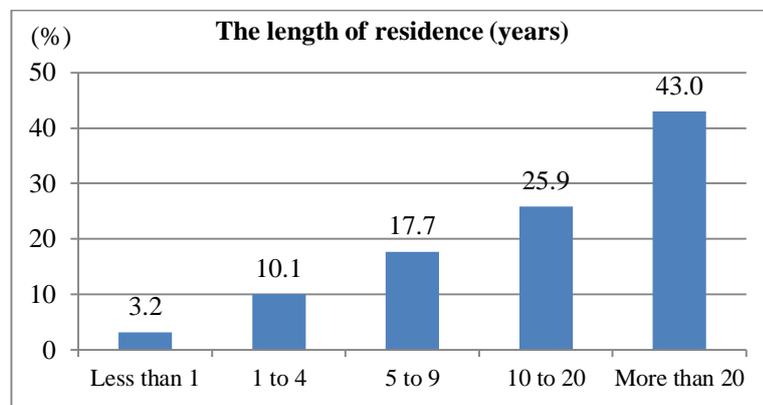


Figure 3.1. The number of years of residence of the local residents surveyed in the WTWHA (n=159).

3.2.3. *The perceived environmental, economic and social impacts of feral pigs*

(a) Perceived environmental impacts: values that the local residents ascribed to the WTWHA rainforest and the perceived effects of feral pigs on those values

The kinds of values that the local residents attached to the rainforest were explored by an open-ended question in both interviews and the survey. The interviewees and survey respondents were allowed to freely express values, and thus, more than one value was occasionally identified by an interviewed or surveyed respondent. In the household survey, the most common values included “provision of habitat for wildlife” (22%), “very important” (16%), and “the need for protection” (13%) (Table 3.3). There were some values that could not be categorised within the MA/TEV frameworks, amounting to 40% of the total responses. For instance, values such as “very important”, “the need

for protection”, and the concepts such as “nature” did not reflect any specific ecosystem service or economic use values. The values that reflected “very important” included:

“This is a very silly question! Rainforests are extremely important and mismanaged.”

“Per se, very important”

“Stupid question – very important”.

The values associated with “the need for protection” included:

“Very important – need to replace more rainforests areas we have destroyed.”

“Rainforests are becoming scarce. The more we protect, the better.”

“That it remains undisturbed and controlled.”

“Extremely important to leave rainforests alone”

“Sustainability with minimal human interaction as required.”

Table 3.3. Values ascribed to the WTWHA rainforest by the local residents surveyed in the order of frequency of responses (n= 113)

Rank	The values articulated	% of the respondents
1	Provision of habitat	22%
2	“Very important”	16%
3	“The need for protection”	13%
4	Biodiversity	10%
4	Ecological balance and stability	10%
4	Climate regulation	10%
4	Ecosystem/Environment/Ecology/ Nature/Natural/Trees/Life	10%
8	Air regulation	6%
8	Aesthetic values	6%
10	Recreation and tourism	5%
11	Erosion regulation	4%
12	Educational values	4%
<i>Other values:</i> None, Unsure, Far too many, Everything, It’s obvious		

Conversely, the remaining 60% of responses corresponded to the classified values of the MA/TEV frameworks (Table 3.4). Approximately 30% of the total responses were related to values such as “provision of habitats for native flora and fauna” and “biodiversity” that could be categorised within the MA as “ecosystem structures” that support ecosystem services, or as non-use values of the TEV and cultural services of the MA. Another 30% of the responses comprised values that could be categorised as regulation services in the MA, indirect use values in the TEV (e.g. specifically climate, erosion and air regulation); and cultural services in the MA, direct non-consumptive, option and existence values in the TEV (e.g. specifically aesthetic,

Table 3.4. Values identified in the household survey and interviews that can be categorised according to the MA and TEV frameworks (n= 40)

Total Economic Value		Millennium Ecosystem Assessment		Quotes (Examples)
Use Value	Direct Use (Consumptive)	Provisioning Services	Food Medicine Fresh Water	Traditional food sources Fishing industry (from barrier reef which rainforest supports) Traditional medicinal sources Reservoir and source for as yet unknown drugs Water catchment
	Indirect Use	Regulating Services	Air regulation Climate regulation Erosion regulation	It is the breathing lung of the country/ the world’s lung/ air quality The air filter factor worldwide Rain production/stabilisation of climate/ climate effects Carbon sink/fixing/sequestration Reduction of run off to the reef/ runoff filtration/ reduce or stops erosion
Use & Non-use Value	Direct use (non-consumptive) + Option + Existence	Cultural Services	Recreation & Ecotourism Aesthetic values Educational values Cultural heritage values Inspiration	A money spinner for tourism, brings tourists – economic growth and so forth As an economic value to tourism and people’s enjoyment of their rainforest experience The sheer beauty of it, Natural wonder/beauty, clean environment It is beautiful and sacred. Protection for the study of plant and animal life Scientific research, For the next generation to see what it is like Area of diverse ecosystem appreciated and used by several cultures of people The traditional medicinal and food sources to be passed down to the next generations to keep Aboriginal culture alive. It represents a 450 million year evolution of life and diversity Rainforest native to OZ/ Iconic natural wonder
N/A		Supporting Services	Nutrient cycling Production of oxygen Soil formation & retention Provision of habitat	Complex nutrient cycle Their production of Oxygen/ Oxygen producer Soil retention The only home of many native plants and animals World Heritage Refuge for endangered species To supply food and shelter for native species – not Anna Bligh’s pigs Protection of all rainforest animals – except pigs Breeding area for unique flora and fauna

“Biodiversity” & “Ecological integrity”

recreation, education, cultural heritage and inspiration values). A minority of the respondents articulated values that could be considered production services in the MA, or direct use values in the TEV, such as food, medicine and fresh water, as well as supporting services in the MA including nutrient cycling, soil retention and production of atmospheric oxygen.

In the interviews with the residents, ambiguous values such as “very important” were uncommon because the interviewees tended to elaborate on the importance; however, those associated with ‘conservation’ or with the absence of human disturbance were also articulated by the general local residents interviewed:

“I’d like to see more farm areas revegetated because I think that detracts from the totality of the forest. There are feral sugarcane [in the rainforest].”

“I hate to see it [the rainforest] cleared.”

“[The rainforest is] important because city and society are away from the rainforest, and I like living with nature. [...] People in the city are the environmental destroyers.”

Nevertheless, the other residents interviewed articulated values that were related to the evolutionary history of the rainforest and the existence of threatened species, which could be categorised within the frameworks as “provision of habitat for wildlife” and “recreation and ecotourism” as well as “biodiversity”:

“Supporting the animals that live here, obviously a joy for tourists to come here.”

“Cassowary[habitat] although I’m living in the Cassowary’s environment.”

“[The rainforest is] important because this is where the life begins. This is the generation of all our oxygen and the rainforest here is hundreds of millions years old. It’s very special. 14 out of 19 original plants on earth, we got them here. I love the rainforest.”

“The best quality of the rainforest that this country has got – a patch of rainforest here has got a really rare and threatened species of plants. This is the result of early landslips in geological time. [It is] the best lowland rainforest with complex vine forest.”

These values articulated by the interviewees were perceived to be diminished by pigs owing to their ‘disturbance’ to the rainforest:

“I saw the sign in Mossman Gorge about the damage that pigs do to the regrowth [rainforests] 15 to 20 years ago.”

“Pig damage to the rainforest can be a bit of concern.”

Approximately 80% of the residents surveyed also believed that pigs diminished the values that they ascribed to the rainforest because of the negative environmental impacts of pigs on the rainforest (Figure 3.2).

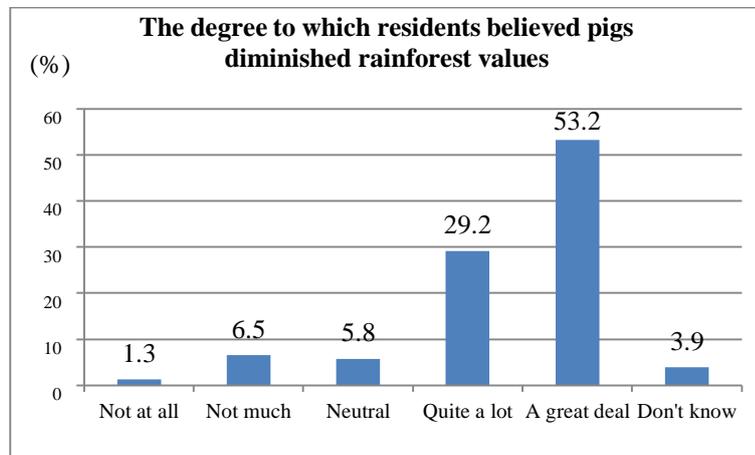


Figure 3.2. The degree to which the residents of the WTWHA surveyed believed that feral pigs diminished the values that they ascribed to the WTWHA rainforest (n=155).

Nevertheless, a minority (8%) of the local residents surveyed and one general local resident interviewed did not perceive that pigs diminished rainforest values (with 6% being neutral and 4% uncertain). The resident interviewed believed that the rainforest was capable of recovering from damage caused by pigs:

“[Pigs do] not at all [diminish rainforest values]. People think the rainforest is fragile, but it is not. Open areas adjacent to the rainforest return to the rainforest quickly. [...] What the rainforest will not recover from is subdivision when people keep it clear and live on it because people keep mowing to leave it open areas.”

The survey and interviews examined the types of perceived environmental impacts of pigs that were related to their implications for rainforest values. The interviewees referred particularly to physical damage to the rainforest, soil erosion, weed dispersal and predation of and/or competition with native species for food and habitat:

“They cause quite a lot of damage including a bit of erosion but the main impacts are on native animals on the ground including ground nesting birds such as cassowary, scrub turkeys, orange-footed scrub hens because pigs eat eggs.”

“Cow Bay is covered by invasive weeds like pond apples because it is swampy and close to the beach, which pond apples like the best, and pigs like pond apples and disperse their seeds.”

Based on the interviews, eight different kinds of perceived negative environmental impacts and one positive impact were listed in the household survey, and the survey respondents were asked whether they agreed with those perceived impacts and asked to articulate other impacts if any (Table 3.5). The respondents were also given an option to answer “no positive impact” or “no negative impact.” Nearly 60% of the survey respondents agreed that there were only negative environmental aspects to feral pigs in the rainforest. Only two of those surveyed believed that pigs had no negative environmental impacts. While perceiving negative environmental impacts of pigs, a minority (14%) agreed with the positive environmental impacts of pigs (i.e. seed dispersal). Out of the perceived negative impacts listed, those of greatest concern for those surveyed included damage to rainforest understorey plants (85%), competition with native species for food and habitat (81%) and deterioration of water quality of creeks (76%). Notably, the majority (53%) agreed with all the perceived negative environmental impacts listed in the questionnaire.

Table 3.5. The perceptions of residents of the WTWHA about the environmental impacts of feral pigs.

Environmental impacts	Count	# of total respondents	Percentage (%)
No positive environmental impacts	94	158	60
Positive environmental impacts	25	158	16
Seed dispersal	22	158	14
<i>Other</i>			
They eat rotten fruit in the rainforest	1		
They turn soil over	1		
They draw in the focus on the importance of preserving balance	1		
No negative environmental impacts	3	162	2
Negative environmental impacts			
Damage to the rainforest (undergrowth plants)	135	158	85
Disruption of rainforest nutrient cycling	84	158	53
Soil erosion into the reef	99	158	63
Deteriorated water quality of creeks	120	158	76
Predation on turtle eggs in Cape York	107	158	68
Predation on native species	110	158	70
Competition with native species (for habitat & food)	128	158	81
Weed dispersal	106	158	67
<i>Other</i>			
Damage to tidal areas	1		
Inshore, billabongs, reefs where fish stocks come from	1		
Damage to ground nesting birds' nests and predation on their eggs	2		
Damage to the wetlands/any wet areas	2		
Soil erosion in general (into rivers, streams and lakes)	2		
Predation on frog population	1		
Don't know (no opinion about environmental impacts)	4	162	2

(b) Perceived socio-economic impacts of feral pigs

Negative socio-economic impacts of pigs discussed in the interviews included damage to the gardens, safety issues with hunting and disease transmission potential:

“The impact I’m most concerned about is damage to my vegetable garden. I’m growing some vegetables including mangosteens and pigs are one of the reasons that I have put up a fence. I’m willing to maintain it.”

“I don’t like hunters hanging around the field. I don’t really mind pigs but hunters hunting near the property.”

“Pigs carry diseases.”

Although negative perceptions were predominant, some of the residents interviewed articulated the positive values of pigs as potential economic benefits, including a source of food and bait for fishing:

“We utilise them as a food source like Aboriginal people do. To be honest, if someone is going to have a party or wedding or something like that, we quite often go and catch pigs. Pig meat has a good wild taste.”

“They can be a source of food but I found them rather a nuisance than a positive.”

“I shoot them and use pig meat for mud crab bait.”

Similarly, the household survey listed the perceived economic impacts identified in the interviews and asked the survey respondents whether they agreed (Table 3.6). Around 20% disagreed with the positive economic values of pigs; the majority of those surveyed perceived negative economic impacts such as damage to agricultural crops (82%) and a Foot-and-Mouth Disease outbreak for the agricultural industry (55%). Only 3% disagreed with negative economic impacts. Conversely, nearly 40% agreed with their economic benefits in terms of job opportunities such as controlling and managing pigs. Another 30% agreed with other positive economic values such as the commercial value of the meat and the economic use of the meat for hunting dogs.

Table 3.6. The perceptions of residents of the WTWHA about the economic impacts of feral pigs.

Economic impacts	Count	# of total respondents	Percentage (%)
No positive economic impacts	35	158	22
Positive economic impacts			
Food source for humans	30	158	19
Food source for dogs	45	158	28
Meat used for bait	24	158	15
Commercial value of pig meat	46	158	29
Job opportunities	59	158	37
<i>Other</i>			
Pig hunting tourism, pig hunting economy	3		
No negative economic impacts	5	158	3
Negative economic impacts			
Damage to agricultural crops	130	158	82
Possible outbreak of Foot-and-Mouth Disease	87	158	55
<i>Other</i>			
Other pig-related (potential/new) viruses (Tuberculosis, rabies etc)	6		
Carry screw-worm fly larvae through Wet Desert areas of Cape York	1		
Killing of livestock	1		
Depletion of breeding area of crustaceans, mussels & ground birds	1		
Damage to fishing industry	1		
Costs of control	1		
Don't know (no opinion about economic impacts)	2	162	1

Feral pigs were also perceived to have negative social aspects; 22% of the residents surveyed disagreed that pigs had positive social impacts (Table 3.7). The most negative social impact was damage to private property, perceived by 80% of those surveyed. Other perceived negative social impacts included their disease transmission potential (73%) and safety issues such as car accidents (68%). Nonetheless, slightly more than half (54%) perceived that pigs had a positive social outcome such as recreational hunting opportunities.

Table 3.7. The perceptions of residents of the WTWHA about the social impacts of feral pigs.

Social impacts	Count	# of total respondents	Percentage (%)
No positive social impacts	34	157	22
Positive social impacts			
Recreational hunting opportunity	84	157	54
<i>Other</i>			
Education on feral species	2		
Bringing pig hunters – more the better	1		
No negative social impacts	3	157	2
Negative social impacts			
Disease transmission potential	114	157	73
Damage to the garden/property	126	157	80
Danger to pets	94	157	60
Safety issues (car accidents etc)	107	157	68
Bringing illegal hunters	69	157	44
<i>Other</i>			
Attacks on person, dangerous to encounter adult pigs in bush	2		
Don't know (no opinion about social impacts)	4	162	2

The household survey also examined the extent of the residents' exposure to pig damage to their properties other than farms. Almost 40% of those surveyed had experienced pig damage to their private properties (Figure 3.3a). All the residents who had suffered pig damage lived near/in the rainforest in Mossman and Daintree, near/in the woodland in Cooktown, or near sugarcane farms in Mossman. That is, their properties neighboured pig habitats. In Daintree and Cape Tribulation, 92% of those surveyed had experienced pig damage, compared with 32% in Cooktown and 17% in Mossman. As those interviewed suggested, the residents in Daintree and Cape Tribulation may have been more susceptible to pig damage because of their gardening practices within their rainforest-surrounded properties, where it was easier for pigs to dig for earthworms. The survey examined the kinds of damage targets in the residents' properties and found that targets were mainly gardens including lawns (84% of the residents), fruits (40%), vegetables (27%), and compost (27%). Those interviewed also indicated that targeted fruit seemed to be sweet products (e.g. rambutan, mangosteens and lychees). The interviewees in Daintree and Cape Tribulation mentioned that pigs especially targeted water sources such as creeks and drainages as well as areas easy for pigs to dig such as driveways on the edge of the rainforests:

“Destroyed six months of landscaping including pathways and steps in one night.”

Some residents interviewed reported pigs preferred certain species such as native *Licuala* palm trees and that damage was sporadic and/or seasonal, but intense:

“Pigs are around the house sometimes, but not often. They come close to water, where damage is concentrated. So I think they follow water. They dig up holes in the ground, making a lot of mess in the sides of the river.”

“They dig fruit trees and gardens. Damage to the property happens quite often but especially in October and November when mangoes are fruiting, pigs invade and pick up fallen fruits. These two months are pig damage season. They plough up to 20 acres of grass paddocks [out of 100 acres of the total property] very unevenly. I have to slash the area to even out the ground and it takes normally 4 hours of labour when the condition is right although country recovers from the damage quickly.”

The household survey also examined the severity of such property damage. Among the residents who received damage, 74% rated that damage as “bad” or “very bad”; nearly 20% rated it as “not very” severe (Figure 3.3b). Given that 40% of the residents surveyed received damage and 74% of them perceived the damage to be “bad” or “very bad”, this amounted to 29% of those surveyed who had experienced severe damage. The percentage of the total WTWHA residents who had experienced severe damage would be lower as the non-respondents were unlikely to have experienced such direct impacts of pigs (Table 3.2).

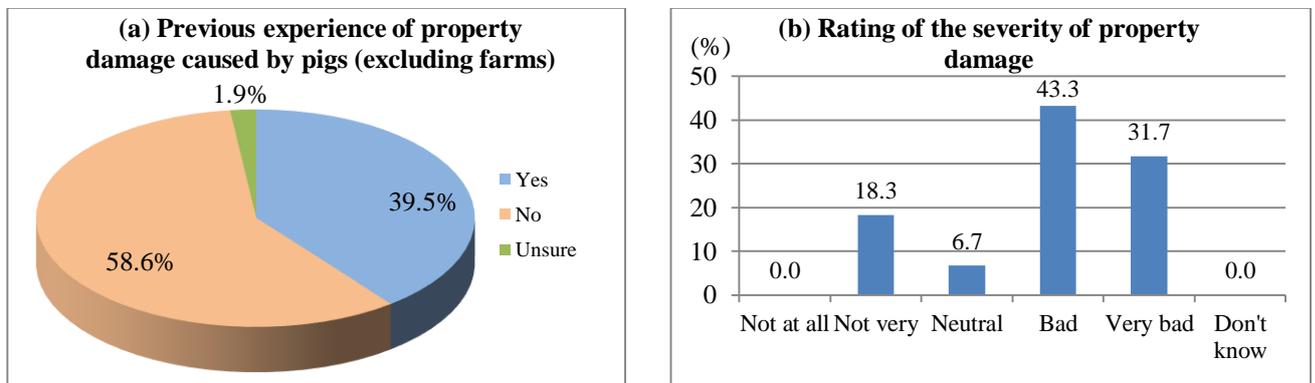


Figure 3.3. (a) The percentage of the residents surveyed in the WTWHA who had experienced feral pig damage to their properties (n=158) and (b) Rating of the perceived severity of the property damage (n= 61).

Illegal pig hunting (involving trespassing) and associated public safety issues were raised as another negative social impact of pigs during the interviews, and the household survey examined the extent of concern about this impact among the residents. Almost 30% of those surveyed had seen pig hunters illegally accessing private properties without permission (Figure 3.4a). Illegal hunting, however, was not

unanimously perceived to be of concern to public safety; 36% of the residents were unconcerned whereas nearly 40% were concerned (Figure 3.4b). One resident interviewed indicated that he never minded them as long as hunters helped control pigs:

“As long as they kill pigs, hunting is good even if hunters just walk into my property.”

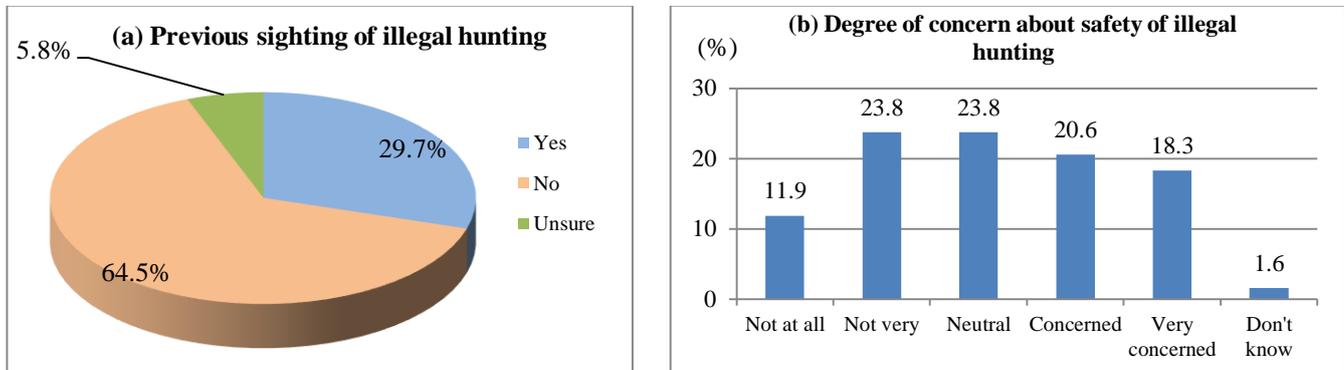


Figure 3.4. (a) The percentage of the residents surveyed in the WTWHA who had sighted illegal hunting before survey (n=156); (b) Rating of their degree of concern about illegal hunting of pigs (n=126).

Levels of concern about illegal hunting were related to actual sighting; those who saw illegal hunters tended to be concerned about safety whereas those who had never seen illegal practices were less likely to be concerned ($p < 0.01$). Gender and length of residence had no significant relationship with such residents' concerns.

The survey also investigated the impacts of pigs on the overall quality of the residents' life in and around the WTWHA as an index of social impacts of pigs. The majority of those surveyed (52%) perceived that the presence of pigs degraded the quality of life; 43% were neutral about their impacts (Figure 3.5). “Neutral” in this case indicated that pigs had no implications for 43% of the residents' quality of life as several respondents wrote down “Not at all” next to their answers. The impacts of pigs on the residents' quality of life had no significant relationship with their experience of pig damage to their properties, or their concerns about illegal hunting and/or about the perceived negative environmental impacts of pigs ($p > 0.05$). Nonetheless, some interviewees indicated that the negative environmental impacts of pigs could potentially degrade their quality of life:

“Pigs don't directly affect the quality of life but the quality of the rainforest, which affects the quality of my life.”

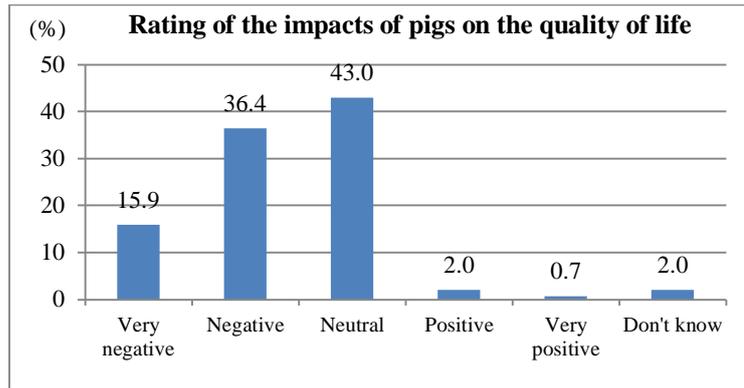


Figure 3.5. Rating by the residents surveyed in the WTWHA of the degree to which feral pigs affected the quality of their livelihood (n=151).

(c) Rating by the residents surveyed of the severity of the perceived environmental, economic and social impacts of feral pigs

These positive and negative environmental, economic, social and overall impacts were weighted numerically in the survey to determine the perceived extent of each impact; the value of -2 was assigned to 'very negative' -1 to 'negative', 0 to 'neutral', +1 to 'positive', and +2 to 'very positive' while the 'don't know' answers were excluded. Environmental impacts were the most negatively perceived compared to the economic and social impacts (Figure 3.6) (Table 3.8). The social impacts were the least negatively perceived. The overall impacts were more negatively perceived than economic and social impacts owing to the strong negative perceptions of the environmental impacts; 91% of those who negatively perceived environmental impacts negatively rated the overall impacts ($p < 0.001$). The numerically rated values of the overall and environmental impacts had smaller deviations whereas economic and social impacts had greater deviations; this indicates there was greater variation in the residents' perceptions of the socio-economic benefits and costs of pigs.

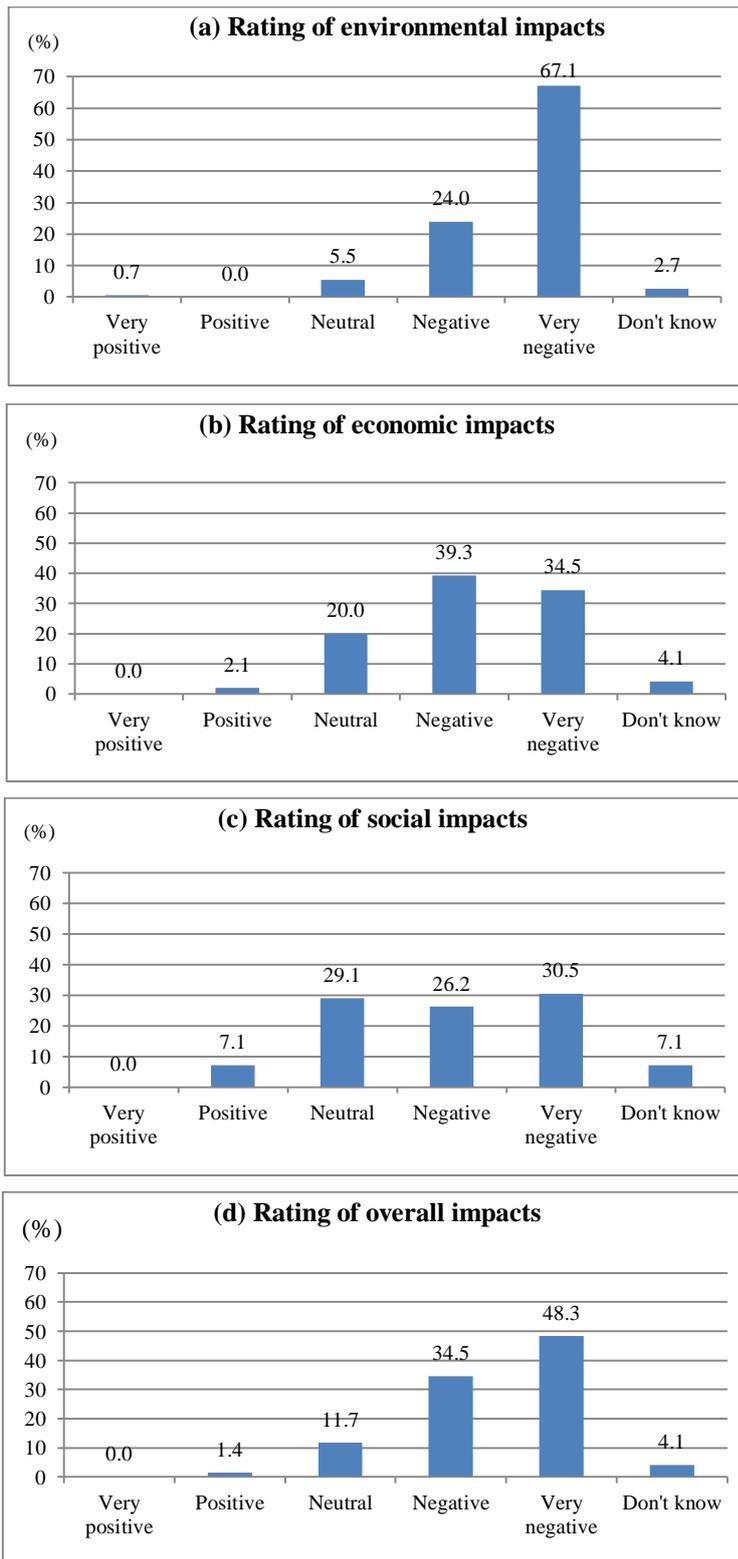


Figure 3.6. Rating by the residents surveyed in the WTWHA of the perceived impacts of feral pigs (a): the perceived environmental impacts (n=147); (b) the perceived economic impacts (n=146); (c) the perceived social impacts (n=142); and (d) the perceived overall impacts (n=145).

Table 3.8. Numerical rating by the residents surveyed in the WTWHA of the perceived environmental, economic, social, and overall impacts of feral pigs (-2: very negative; -1: negative, 0: neutral; +1: positive and +2: very positive).

Impacts	Mean
Environmental	-1.615 (± 0.66)
Economic	-1.114 (± 0.81)
Social	-0.871 (± 0.97)
Overall	-1.353 (± 0.75)

These perceived impacts, however, may not be important for those residents who are unfamiliar with, or unconcerned about pig issues. A newcomer resident interviewed articulated no impacts because of his lack of knowledge about pigs:

“I don’t actually know about them to be honest. Are there any impacts on the local species? I haven’t been here long enough to know. I just moved up last year and have never seen them in my property.”

The researcher asked non-respondents of the interviews and household surveys the reasons for refusing to participate, and lack of familiarity with, or concern with, pigs was a common reason; they recently moved to the study area so never had a problem with the animal (or did not hear about them) or did not care about pig issues. For those residents, pigs were neither positive nor negative. Pigs not causing significant financial costs also resulted in a lack of concern; a local resident in Daintree expressed that pigs were no problem despite the environmental impacts because they incurred no financial costs:

“Pigs around my place dig away all the dirt and get all the roots of the rainforest trees. That’s a bit of a problem because they are eventually killing the rainforest. But to me, they are no problem because I don’t make a living from the rainforest. The fruit that I grow (bananas) is for me and even if pigs knock down the banana tree, it doesn’t really bother me because I can’t eat so many bananas anyway. They don’t belong here so they are taking the places of something native that belongs here and I guess they are a pest but they are not a pest to me. They are not creating any problems for me.”

3.2.4. The residents’ attitudes towards the current management of feral pigs

To examine the degree of the residents’ acceptance capacity (see Chapter 1), the household survey investigated whether they perceived that the current control level was

sufficient or insufficient. The survey found that only 18% of the residents surveyed were content with the current level of control; 67% were dissatisfied (Figure 3.7).

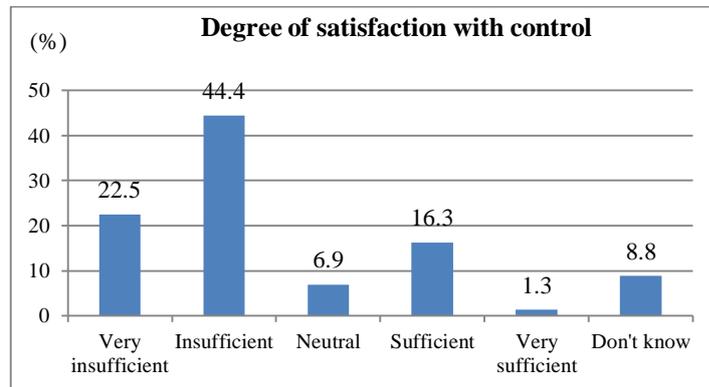


Figure 3.7. Rating by the residents surveyed in the WTWHA of the degree to which they thought that current control of feral pigs in the region was sufficient/insufficient (n=161).

Those interviewed perceived the level to be sufficient because they had not seen many pigs recently as a result of the trapping program in Daintree:

“Ten years ago, if you drove along at night, you would see pigs but nowadays it’s pretty hard to come across pigs although maybe there are not so many of them or pigs are becoming more wary. I’m not sure.”

Their perception of the effectiveness of the trapping program also contributed to a higher level of social acceptability of trapping (next section):

“A trapper (in Daintree and Cape Tribulation, employed by Cairns Regional Council) is doing a good job. The number of pigs is reduced a lot. I used to see pigs always between Forest Creek to Cape Tribulation and now there is only a few.”

During the interviews, another important factor for residents’ satisfaction with the management was that they understood or accepted that the aim of pig control was damage reduction or prevention rather than eradication:

“Weeds have broad tolerance to the environment and the ability to withstand the impacts once established. Pigs are the same; once established, it’s hard to get rid of them. Large scale is not going to happen and the community-based trapping program is all we can do.”

Conversely, those with a higher expectation of outcomes, that is, interpreted the aim of pig control as eradication, perceived that there were not enough people involved in control and/or that the control efforts had not caught up with pigs’ reproduction. Consequently, they were not satisfied with the current management:

“There are too many people in admin and not on the ground (to control pigs)”

“Pigs live in national parks and government trapping by one person is not enough.”

Furthermore, inconsistency in control efforts among residents themselves was regarded as resulting in a lack of control:

“The problem is that not many people are aware of the pig issue and too many people don’t care about this and don’t have any responsibility. They think ‘that’s somebody else’s problem’. We are never going to get rid of pigs but they could make the situation worse. If there is no humans to control, pigs become out of control through fast breeding.”

Dissatisfied interviewees often mentioned a lack of government action within national parks by restricting access to parks as well as hunting or use of guns as a major reason for a lack of pig control in the rainforests. This resulted in their views of national parks as “protecting” pigs and as a breeding ground:

“National parks and the World Heritage Area are ruining the rainforests. They own three quarters of the country (the Study Area) and pigs are in national parks and they are protected there. I used to hunt for 30 years to control pigs but can’t do it anymore because of all the restrictions in the national parks. They should be open to hunters. There are more big pigs than ever.”

The survey examined whether those surveyed also agreed with these reasons for their satisfaction or dissatisfaction with the current management. Not sighting signs of the presence of pigs was a major factor for their satisfaction with the current control level; conversely, a perceived lack of control against the high reproductive capacity of pigs, higher expectations of management outcomes (i.e. eradication) and national park management were major reasons for the residents’ dissatisfaction (Table 3.9).

Table 3.9. The reasons for satisfaction and dissatisfaction of the residents surveyed in the WTWHA with the current management of feral pigs in the region (the satisfied residents [n] = 31, dissatisfied [n] = 107).

	Reasons for satisfaction/dissatisfaction	# of respondents	% of respondents
Satisfied	I don’t see many pigs any more.	22	70.9%
	Total eradication is not an option so I’m more or less happy.	14	45.2%
	The government control program has been effective.	8	25.8%
	I don’t want too much control of the animal.	5	16.1%
Dissatisfied	Control is underfunded.	76	71.3%
	Pigs’ high reproduction is winning the control efforts.	74	69.2%
	It should be aimed at eradication, not just management.	71	66.4%
	The State government’s management of national parks.	67	62.6%
	Inconsistent control efforts amongst people.	53	49.5%
	The restrictions of the use of guns or dogs in national parks	47	43.9%

Around 60% of those surveyed perceived that the lack of government action and restrictions on the uses of guns and dogs in national parks inhibited the control of pigs (Figure 3.8). Furthermore, almost all of those who perceived the current control to be insufficient tended to strongly agree that national parks were a pig refuge; those who were content with current control disagreed with this view ($p < 0.01$). Dissatisfaction with national parks management was also linked to perceptions of negative impacts of pigs on the rainforests and duration of residence. Approximately 70% of those who perceived the negative environmental impacts of pigs and 85% of those who had lived in the WTWHA for more than 10 years believed that national parks were mismanaged. Newcomers who had lived in the area for less than five years, however, had mixed opinions.

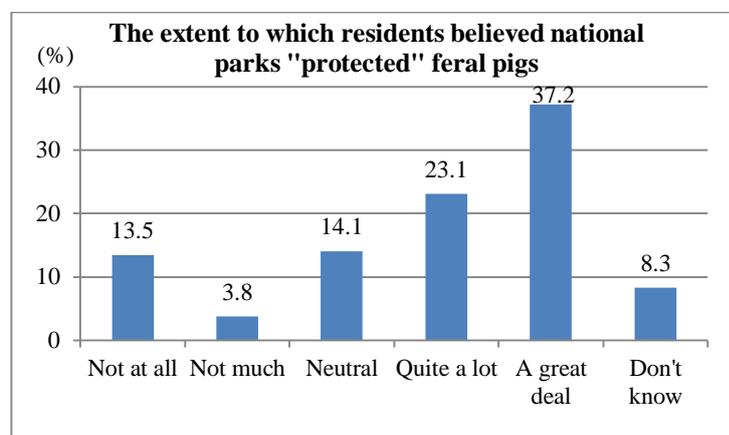


Figure 3.8. Rating by the residents surveyed in the WTWHA of the degree to which they believed that national parks protected feral pigs as their refuge habitat (n=157).

3.2.5. Levels of social acceptability of the different methods used to control feral pigs

Almost 90% of those surveyed supported trapping, the most favoured method (Figure 3.9). Given the value of 1 assigned to “strongly oppose (the method)” and 5 to “strongly support”, the mean value with standard deviations was 4.49 ± 0.80 for trapping, 3.75 ± 1.36 for hunting, 3.49 ± 1.40 for fencing, and 2.63 ± 1.56 for poisoning. Both in the interviews and surveys, the residents were allowed to freely express the reasons for supporting or opposing the methods (Table 3.10, Appendix 9 for quotes). The residents’ high support for trapping was because of their perceptions that it could provide job opportunities from selling the meat and that it was considered to be a humane, effective and safe method. Only 2% of the residents surveyed opposed trapping, but a minority of

those interviewed recognised the limitations of trapping such as a lack of effectiveness as a result of trap shyness of pigs and the labour intensiveness of the method. Perceptions that the government trapping program was expensive and ineffective for eradication also resulted in disfavour of the method. Approximately 70% of those surveyed supported hunting because of the perceived socio-economic benefits (e.g. opportunities for recreation, free food and potential income), effectiveness, humaneness and target specificity (with rifles). Despite fencing being non-lethal, its acceptability was lower than hunting; humaneness, or concerns about animal welfare had no significant relationship with acceptability of fencing ($p>0.05$). Disapproval of fencing was rather related to the residents' concerns that it could disrupt native wildlife corridors if used in the rainforests and that the maintenance was too costly. Overall, 40% of those surveyed expressed concern about humaneness in applying the control methods (Figure 3.10). Hunting and poisoning were opposed on this ground ($p<0.05$). The other 45% were unconcerned about humaneness in pig management and these residents tended to wish to control pigs by any means regardless of animal welfare ($p<0.01$). Those interviewed also argued that because pigs were a pest and hard to control, they supported any method to eradicate them:

“I support anything to help eradicate a destructive animal.”

“Pigs are a pest so I support all the methods.”

“The only way to eradicate pigs is genetic or sterile release; meantime, every possible solution should apply.”

The residents' opposition to poisoning was related to their concerns about target specificity, and the method was the least favoured among the residents surveyed and interviewed.

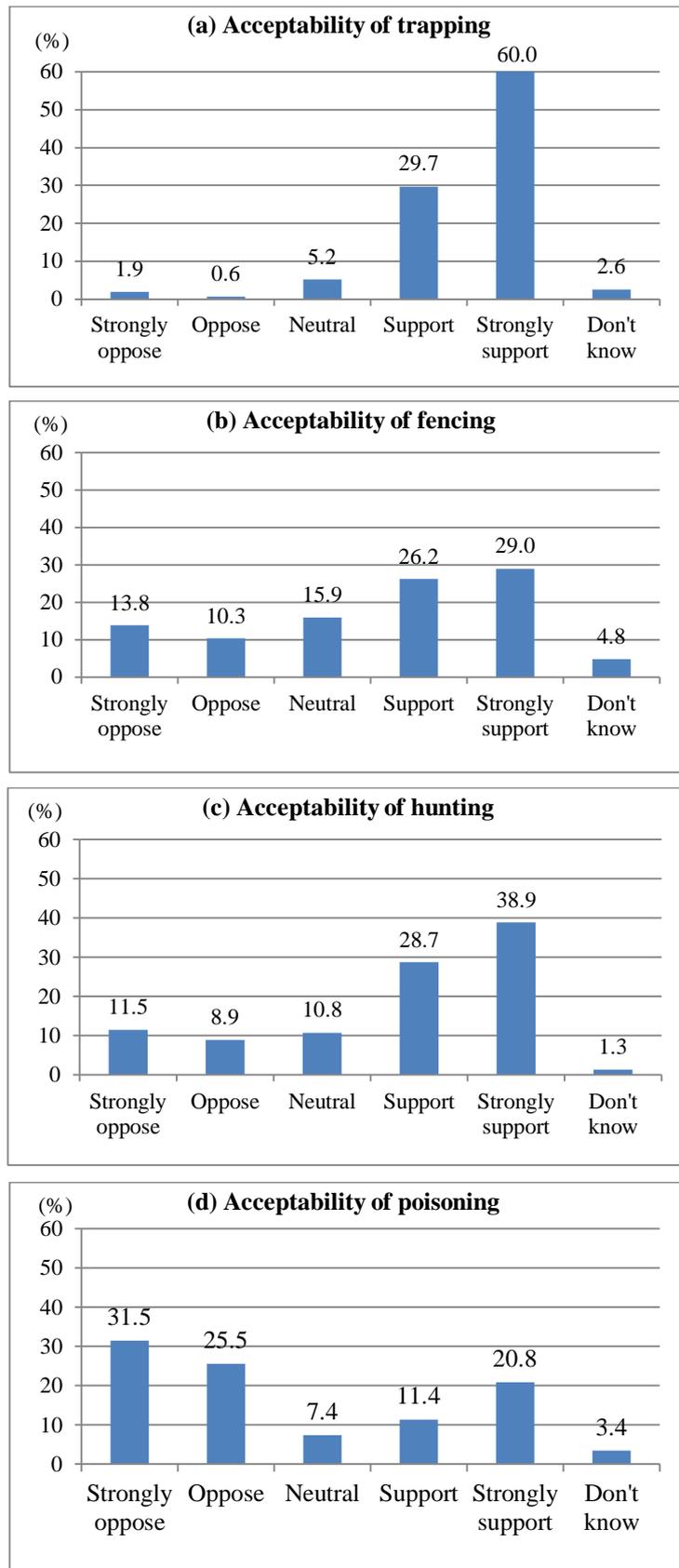


Figure 3.9. Rating by the residents surveyed in the WTWHA of levels of social acceptability of different methods used to control feral pigs in the region (a): trapping (n=155); (b): fencing (n=145); (c): hunting (n=158) and (d) poisoning (n=149).

Table 3.10. Specific reasons articulated by the residents surveyed in the WTWHA for supporting or opposing methods used to control feral pigs in the region

	Support		Opposition			
Trapping	n=28	Economic benefits	29%	N/A		
		Humaneness	21%			
		Safety	21%			
		Effectiveness	21%			
Fencing	n=10	Effectiveness	50%	n=16	Not environmentally friendly	63%
		Humaneness	20%		Lack of cost-effectiveness	37%
Hunting	n=18	Support only if regulated	39%	n=22	Lack of humaneness (with dogs)	55%
		Recreation (social benefits)	22%		Not environmentally friendly	32%
		Economic benefits	17%		Safety issues	14%
		Humaneness (with rifles)	17%			
		Effectiveness	11%			
Poisoning	n=4	Effectiveness	100%	n=7	Lack of target specificity	75%
					Lack of humaneness	13%

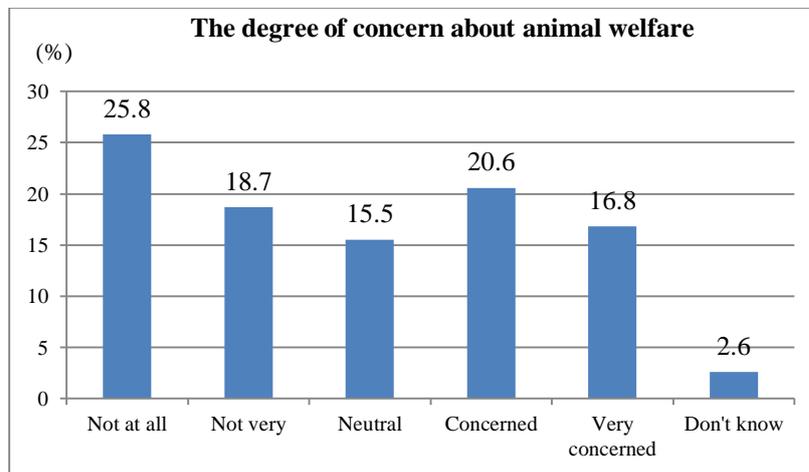


Figure 3.2. Rating by the residents surveyed in the WTWHA of the degree to which they were concerned about animal welfare in feral pig management (n=155).

Furthermore, acceptability, particularly of hunting and poisoning, had a significant relationship with social demographics of the residents surveyed, such as gender, age, and/or duration of residence ($p < 0.05$) (Table 3.11). Females were disinclined to support hunting and those who were aged between 30 and 59 years tended to disapprove of poisoning more than the other age groups. Duration of residence was a significant factor determining acceptability of fencing, hunting and poisoning; those who lived in the area for 10 to 19 years opposed these methods more than the other shorter- or longer-term residents. Similarly, poisoning was slightly correlated to gender and trapping to duration of residence ($p = 0.06$).

Table 3.11. Statistical relationships between social demographics of the residents surveyed in the WTWHA and acceptability of the methods used to control feral pigs in the region.

	Gender	Age	Duration of residence
Trapping	$p > 0.05$	$p > 0.05$	$p = 0.06$
Fencing	$p > 0.05$	$p > 0.05$	$p < 0.05$
Hunting	$p < 0.05$	$p > 0.05$	$p < 0.05$
Poisoning	$p = 0.06$	$p < 0.05$	$p < 0.05$

Lastly, some residents had no opinions about the methods, or were unsure about them. Most of these residents were female and/or newcomers ($p < 0.05$). Those who responded “don’t know” to acceptability of trapping, hunting and poisoning were all female and most that had lived for less than five years in the WTWHA. A newcomer resident interviewed also referred to his unfamiliarity with the methods for not expressing his opinions:

“I don’t have an opinion about this because I don’t know much about it.”

3.3. Summary of the local residents’ perspectives

To assess the perceived environmental impacts of pigs, this research examined the kinds of values that the local residents ascribed to the Wet Tropics rainforests, North Queensland. Values that they articulated such as “very important” and “the need for protection” did not indicate a particular function or economic use of ecosystem services. Moreover, those values identified by the residents did not reflect utilitarian, altruistic or intrinsic value orientations, and it was unclear whether the respondents perceived the rainforest as important for their own wellbeing. Thus, these values were different from the categories of the MA or TEV. Similarly, values such as “nature”, “environment”, “balance of nature”, “ecology” and “ecosystem” were also ambiguous because they did not refer to any ecosystem services or economic use values identified within the MA/TEV frameworks. Other commonly perceived values were “biodiversity” and “provision of habitats for flora and fauna”. Based on these values attached to the rainforests, the vast majority of the residents believed that pigs diminished the values through their negative environmental impacts on the rainforest. Those impacts included “damage to rainforest understorey plants”, “competition with native species” and

“deterioration of water quality and soil erosion.” These aspects were the most negatively perceived impacts of pigs in the household survey.

In contrast to the strongly perceived environmental costs, the residents had mixed opinions about economic and social impacts of pigs. Some residents acknowledged positive economic and social impacts such as commercial opportunities from pig control and recreational activities for pig hunters. Nevertheless, the majority of the residents still perceived negative economic impacts on the agricultural industry as well as negative social impacts such as property damage, disease transmission potential and safety issues. The residents’ perceptions varied the most about pigs’ social impacts, possibly resulting from different degrees of their susceptibility to pig damage. Those who reside in areas close to pig habitats (e.g. Daintree) were more susceptible to pig damage. This may be why the response rate of the survey was the highest in those regions; they were more willing to have their say (especially about the negative impacts of pigs) in the survey. Concerns about the safety of illegal hunting as well as negative perceptions that pigs degraded quality of life were also identified as social costs of pigs.

Overall, the residents interviewed and surveyed were dissatisfied with the current level of pig control in the WTWHA. Long-term residents tended to have higher expectations of management outcomes, such as eradication, and were more likely to perceive that the current management was insufficient. Another major factor for dissatisfaction was perceived lack of funding for control to combat the fecundity of pigs especially within national parks, where access for control was restricted. Conversely, with no significant sign of the presence of pigs and acceptance of the infeasibility of eradication, a minority of the residents were satisfied with the management.

Social acceptability of the pig control methods varied. The residents found trapping the most acceptable because of the socio-economic benefits they could potentially derive from the method such as job opportunities in pig trapping control and use of pig meat for food industry after control. Hunting was more favoured than non-lethal fencing because of the socio-economic benefits that hunting entailed such as recreation and use of pig meat after control. Nonetheless, hunting as well as poisoning were opposed by some residents because of their concerns about animal welfare. Poisoning was the least supported owing to perceived lack of target specificity. Such variation in social acceptability of control methods had a significant relationship not only with animal welfare concerns but also with the residents’ familiarity with the

methods, residential stability and social demographics such as gender and age. In contrast to hunting and poisoning, acceptability of trapping and fencing was independent of animal welfare concerns. Newcomers seemed to be less familiar with pig management and the methods used to control pigs, thereby being indifferent about the management actions. A segment of the populations in the WTWHA (duration of residence of 10 to 19 years) were less inclined to support fencing, hunting and poisoning than those who had lived there shorter or longer. Female residents tended to oppose lethal methods such as hunting. Nonetheless, gender did not determine acceptability of poisoning but those aged between 30 and 59 years were disinclined to support the method.

These local perspectives held by residents are useful for understanding public or community perceptions of the impacts of feral pigs in the rainforest environment. There are, however, key stakeholder groups, for whom feral pigs have particular significance and implications. Pig hunters are regarded as a key stakeholder group in the management of pigs. Because they utilise pigs as a resource, their perceptions of the impacts and management of feral pigs are likely to be idiosyncratic. The next chapter, Chapter 4 will explore pig hunters' perceptions in detail.

Chapter 4: Pig Hunters' Perspectives

4.1. Introduction

Local residents in rural areas may have different perceptions of feral pigs depending on their occupation. The previous chapter focused on the general local residents' perceptions, but did not qualitatively investigate, in depth, distinctive perceptions of specific interest groups. These residents include pig hunters (for control and/or recreation), farmers (particularly sugarcane and tropical fruit) and tourism operators. This chapter focuses on pig hunters. Pig hunters' perspectives may be distinctive because the presence of pigs would seem to provide benefits for pig hunters in the form of hunting opportunities. Hunting, however, involves a variety of motivations, and therefore, it is important to understand how pig hunters' perceptions of the benefits of pigs relates to how they value pig hunting. Some hunters hunt pigs for control purposes to protect farms; others hunt for fun with family or friends, or for trophies. Commercial hunting, or hunting for monetary reasons (e.g. to obtain meat for sale, or to offer safari hunting opportunities with/without guiding) also exists. Particularly in Australia, hunting for animal control, or "integrated hunting" (commercial hunting that integrates animal control) is widespread. Nonetheless, the boundary between commercial, recreational and control aspects of hunting is indistinct (Bauer and Giles, 2002). Hunting can also be distinguished as skill hunting, group/individual hunting and trophy hunting (Bauer and Giles, 2002).

Factors addressed in this chapter include: (1) different kinds of values that pig hunters ascribed to the rainforest and the impacts of pigs on those values; (2) the dimension of the impacts (environmental, economic and social) of most concern to pig hunters; (3) perceived values of pig hunting; (4) levels of satisfaction with current pig management; and (4) social acceptability of different control methods. The data to address pig hunters' perspectives were obtained through qualitative semi-structured interviews as well as quantitative household surveys; the pig hunters' data from the household survey was disaggregated and analysed (see Chapter 2). A total of 10 male pig hunters were interviewed via convenience sampling and 20 surveyed via systematic random sampling (see Chapter 2). Determining the representativeness of the sample was not possible because data on the socio-demographics of pig hunters were

unavailable. Based on the interview results, the household survey contained a specific section for pig hunters (four questions) to understand the perceived values of pig hunting and/or implications of pig hunting for pig management (see Appendix 5): (1) rating the importance/value of pig hunting; (2) the reasons for pig hunting; (3) rating of perceived compatibility of pig control with pig hunting opportunities; and (4) rating the degree of selectivity or sex/size bias in pig hunting.

4.2. Results

4.2.1. Values that pig hunters ascribed to the WTWHA rainforest and the perceived effects of feral pigs on those values

The hunters ascribed definitive values such as “fresh water” (production services), “oxygen provision” (supporting services), “nutrient cycling” (supporting services) and “recreation and ecotourism values” (cultural services):

“The rainforest is very important because clean water comes from the rainforest and it provides oxygen and supports wildlife.”

“Surely the rainforest is important because this is where life begins. This is the generation of all our oxygen and it is very special because the rainforest here is hundreds of millions years old. We’ve got 14 out of 19 original plants on earth here.”

“The rainforest is important because of the regeneration. Its nutrient cycling gives you food, flows into ocean shores and is good for soil.”

“The rainforest is good for tourists. It is home in the best condition for animals including cassowaries. You need national parks for them.”

The majority of the hunters surveyed articulated rainforest values such as “air regulation” and their supporting roles for other ecosystems such as the Great Barrier Reef. Some hunters also held similar values to other local residents’ such as “biodiversity”, “provision of habitat for wildlife.”, “balance [of nature]” and “need for protection due to scarcity.”

Hunters had mixed opinions about the implications of pigs for rainforest values. Based on the perceived negative environmental impacts of pigs on the rainforest (see next section), some hunters argued that pigs would degrade those values. Conversely, others disagreed that pigs damaged the rainforest to a significant extent:

“Pig damage to the rainforest can be a bit of concern. But pigs don’t bother me around my property because tree kangaroos, cassowaries do also come around and they are all in harmony.”

“[The rainforest is important] but pigs are not affecting the [rainforest] values at all. They eat eggs but they have been doing for hundreds of years. Less pigs are the better though.”

4.2.2. Pig hunters’ perceptions of the impacts of feral pigs

(a) Perceived environmental impacts

Given their values ascribed to the rainforest, most hunters negatively perceived the effects of pigs on the rainforest environment and articulated their negative environmental impacts such as destruction of vegetation, predation of native species, such as cassowaries (*Casuarius casuarius johnsonii*) and turtles, and soil erosion:

“They destroy vegetation, destroy habitat especially of the cassowary. I’ve seen goannas getting chased by pigs and seen pigs eating dead horses too. They are the most opportunistic animal in the world.”

“Hunters are very aware of the importance of the environment and we don’t want to see cassowaries disappear either. Pigs take food of native animals. For example, kingfishers from New Guinea come over here and live inside ant nests but pigs eat those nests. First, hunting was for fun in the past but gradually the more pigs we hunted, the more we realised how much damage they were doing to the environment and cane farms and you can’t believe it. Pigs can eat cassowary eggs and dig up waterholes, eventually killing cattle and other wild animals that rely on the water source. So hunting also became part of controlling pigs for me.”

“Biggest impacts are their digging in watercourses and creek banks, which cause soil erosion.”

(b) Perceived socio-economic impacts

Hunters acknowledged negative socio-economic impacts of pigs such as damage to agricultural crops (which they often saw when they hunted pigs on sugarcane farms), transmission of diseases such as Foot and Mouth Disease and those transmittable to their hunting dogs, and property damage to private landholders:

“There are lot of pigs around here. In Lakeland, I caught 20 pigs in one night and saw a herd of 400 pigs in one morning in a 60,000 acre peanut farm. Pigs feed on peanuts and corns. Boar also knocks down banana trees.”

“I’m concerned about spread of disease especially screw worm flies to dogs after hunting.”

“I get calls from people asking me to hunt pigs, not only farmers but also from the people who get their gardens and front lawns dug up by pigs.”

Nonetheless, most hunters expressed tangible and intangible socio-economic benefits of pigs such as safari-hunting⁴, hunting as a sport (pastime opportunities) and income, and use of its meat as food for dogs and humans:

“Professional commercial pig hunting brings money. Hunting is a huge market and pigs are always going to be there. I’ve spent \$150 for a dog protection jacket, \$150 for a head torch, \$370 for two GPS driven dog collars and \$1500 for the actual GPS tracker. A hunting knife (for stabbing pigs) can cost \$80 to \$200 and rifles around \$500 to \$800 (Figure 4.1).

“There used to be chiller boxes around here, which was an opportunity for hunters to get paid for meat.”

“Pig meat is used for dog and humans sometimes. Pigs are not really a pest at all, for they are a good food source. Why don’t they use pig meat for export?”

Other positive aspects of hunting included “flow-on” socio-economic benefits for Aboriginal communities in Mossman by giving away the meat to them:

“Every now and then Aboriginal people want pig meat for their ceremonial events. Some hunters give the meat to dogs but I just throw them away.”



Figure 4.1. Various gear and tools purchased and used for pig hunting. (a) Protection jacket and a GPS integrated collar for dogs; (b) hunting dogs wearing protection jackets for hunting; (c) A GPS antenna for locating dogs

⁴ Safari hunting is “a more organised form of recreational hunting in which hunters are assisted by a guide, with or without services of an outfitter, and there is a more complete touristic experience than just the hunt itself” (Dryden and Craig-Smith, 2004:2).

Nevertheless, those potential economic benefits of pigs, especially from commercialisation of hunting (e.g. safari hunting), could discourage the reduction of the pig population and become negative economic costs by compromising control efforts:

“Hunters who make money from pigs choose to close eyes to the environmental damage that pigs cause because of money. If there is money involved, there is no incentive to kill all pigs. But those who purely enjoy hunting without money are the ones who will control pigs and these people can help control pigs.”

“Those hunters (i.e. hunters who have a pig safari) select which pigs to shoot so there are certain pigs to shoot and not to shoot. It depends on the size – not too big, not too small – so that the population can increase again. Those ones are not controlling pigs because they want to make money out of it.”

4.2.3. Pig hunters' perspectives on the value of pig hunting

The perceived socio-economic benefits of pigs stemmed mainly from the hunting opportunities offered by their presence. The hunters interviewed expressed a variety of opinions about the values of pig hunting, for example, as a hobby, pastime and/or sport, family inheritance, and connection to the Australian bush:

“I grew up with hunting introduced species including rabbits and pigs. It's my passion to protect native wildlife. Normally hunters have passion for Australian bush and wildlife and want to look after them. Younger generations are disconnected to bush now. Radical but not smart environmentalists don't understand this issue.”

The vast majority of the 20 hunters surveyed (85%) agreed that pig hunting was of significant value for them. Hunting was valued as a pastime with family and friends (75% of the hunters surveyed) or as a recreation that “does the environment a favour” (i.e. a common excuse used for hunting) (75%), as well as a sport (65%) and passion to protect Australian wildlife (i.e. control) (55%) (Figure 4.2). A few hunters stated that hunting was for “food”. Overall, hunting was valued both for pleasure and conservation (control).

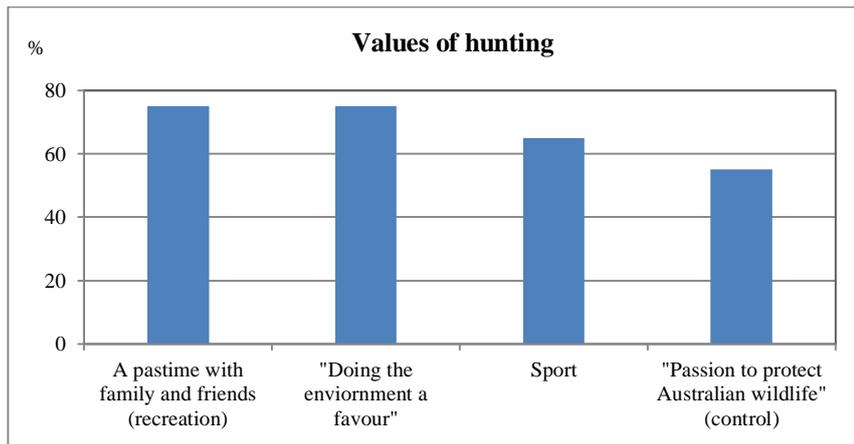


Figure 4.2. Different values attached to hunting by the pig hunters surveyed in the WTWHA: the reasons for their engaging in hunting

Based on the interviews with several hunters, hunting seemed to embrace cultural values regardless of whether it was recreational or control hunting. Hunting in cane paddocks involved a variety of methods including stalking (tracking a particular animal), still-hunting (searching by slow walking), waiting and hiding at a fixed position along a game trail, and “driving” by which a moving partner scared prey (i.e. pigs) with dogs toward a stationary hunter. Hunting requires practice with a gun, training of dogs and learning about prey’s habits, sensory capacities and foods. As most hunters interviewed described, pigs are cunning because they could detect hunters’ presence if hunters did not carefully approach the hunting field. Adopting careful behaviours was important such as staying stationary and quiet, avoiding things like slamming a car door, wearing perfume and driving too close to the field to prevent pigs from sensing the hunters’ presence:

“The best part of hunting is getting good results after putting all the efforts into hunting by checking out the fields, training dogs and teaming up with friends. When cane is tall during the harvest season, you need organised, strategic hunting. We need at least 4 hunters. Just before hunting, we check again and confirm their presence in paddocks. These paddocks were checked beforehand during the week to pinpoint a particular paddock to hunt. As soon as we confirmed it all the hunters go there and position themselves as planned in advance. They normally stand near the pads through which pigs come from the rainforest. For sugarcane hunting, you need good dogs to chase pigs out of the field so that shooters can shoot them when they come out. This way dogs don’t get hurt. Because of bad visibility, hunters need to detect pigs’ movements and whereabouts by hearing. You also need to work out the wind directions at the same time so that pigs don’t sense your smell. As soon as they smell us, they will not come out of the fields where hunters are waiting to

shoot. Strategic hunting also involves communicating with the other hunters with walkie talkies to check the pig movements like whether they are heading toward headlands or creeks. You also need to have really good dogs that know each other. The dogs need to have or get used to the company of other dogs to make hunting work. So it is very disappointing not to catch big pigs after putting in so much effort hunting and seeing dogs working so hard even if we shot two suckers.”

Secondly, the values of hunting were also social because hunters’ social status was contested and defined during hunting. Those who hunted without fail or kept the farms protected from pigs earned great trust from the other hunters as well as from farmers who asked them for control. On one hunting occasion, one of the hunters interviewed missed a big boar that came out of a cane paddock. He was angry and upset about the miss because he was afraid that “it was not good for his reputation”. If they miss a good target, other hunters in the same group may not trust his skills and not ask him to hunt with them again. That is, hunters engaged in testing of their social status through hunting and therefore, hunting was a social and cultural activity.

Social aspects of hunting were also observed from hunters’ territoriality. Hunters were territorial and loyal to their hunting ground (e.g. particular cane farms) and expressed concerns that hunters especially from the city came to their hunting grounds without permission, violating hunters’ social rule of territoriality and spoiling their hunting plans:

“There are a lot of people who want to hunt. If you hunt one area, it is your area of hunting and nobody else’s. Pig hunters are very territorial in this sense. The hunter who controls my property gets angry when somebody else comes to the property without permission on Friday night, the night before he planned to hunt, and that pushes pigs away and spoils his opportunity to hunt pigs the next day because pigs change their timing of coming to the property. He checks during the week about pigs’ timing of coming to the property and which paddock to be hunted and spends money on fuel so all the efforts are spoiled by other hunters without manners. Hunters don’t like other hunters hunting on their hunting ground without permission. So access is a huge issue and competitive for hunters. From the farmers’ perspective, it is not a problem that other hunters come around and control pigs so some farmers let any hunters hunt on their property. But that causes too much disturbance to pigs from dogs and messes up all hunting opportunities. From hunters’ perspective, it is quite upsetting. You need to let nothing happen on the ground at least for a day to cause no disturbance.”

Lastly, hunting may also hold socio-economic values especially when hunters (especially skilled, professional hunters) who control a farm can forge an

interdependent relationship with farmers who suffer pig damage, and ask the hunters to control them. Farmers practically gain economic benefits from hunters' willingness to hunt pigs on their properties because hunters mostly bear the hunting costs and may reduce pig damage through hunting pressure and efforts. Hunters also gain social benefits from being able to access the land for hunting and engage in recreational activities. Several hunters interviewed mentioned that some farmers even assist hunters financially to partially cover the costs of control for their mutual relationship:

"Farmers and hunters have close and tight relationship and they do help each other. Farmers need hunters to get rid of pigs and hunters need land to hunt. Hunters are very territorial so you cannot just hunt somewhere."

Although hunting embraces socio-cultural values and is acknowledged as a social benefit by the majority of the residents (Chapter 3), hunting, particularly trophy hunting, may conflict with pig management because a few trophy hunters were not supportive of control because it indicated "less pigs":

"Hunters get upset with control because pigs become less. It is a competition with control."

These trophy hunters tended to target wild boars to collect big tusks. Other hunters who controlled pigs argued that trophy hunting should not be valued as pig control:

"Another problem with recreational hunting is that hunters aim for wild boar only to collect big tusks. They need to shoot suckers and females too [for control]"

"We catch both boars and sows to stop them from damaging the environment. Otherwise you don't control pigs. Hunters hunting for chiller boxes hunt only for boars or sows without babies so that pigs can reproduce and they can continue making money."

'Hunters go for boars because they fight more and have big tusks. I collect them (Figure 5.2)'.

In the survey, 50% of the hunters surveyed disagreed that control was taking pigs away from hunting (these hunters were predominantly cane farm hunters). Similarly, 55% of the hunters surveyed denied that they selected boars over sows or young in hunting. Those who were neutral about selectivity (30%) may have implied that they did prefer bigger pigs as the cane hunters interviewed indicated. Conversely, 15% of the hunters agreed that control may diminish hunting opportunities and/or intentionally selected boars.



Figure 4.3. Trophies of pig hunting: hunters normally prefer boars for trophy hunting for tusk collections

Hunting also entailed social costs such as a negative social image of hunters and public concerns about illegal hunting:

“Hunting has become hard also because people in the city are afraid of guns and hunting dogs and dislike hunters, seeing them as ‘rednecks’. There are also hunters doing the wrong thing because of access issues, giving a bad image to hunters. There is a big difference between irresponsible hunters and serious, responsible hunters. Serious ones have dogs that are docile and those dogs get aggressive only against pigs. Because of the safety issues, those hunters never take alcohol for hunting. On the other hand, irresponsible ones are hunting just for a pastime with friends, taking alcohol, not considering about risks involved in shooting. Those hunters like hunting because of the social image of hunters being tough and bad. They shoot anything and are not professional. We don’t need this kind of posing hunters or posers.”

“The biggest problem with recreational hunting is illegal and poaching access. Many hunters illegally hunt on properties without permission.”

These social costs, particularly the public’s anti-hunting attitudes, were mentioned in Chapter 3, in which some local residents argued that hunting was inhumane and cruel and that hunters were “red necks”.

4.3.4. Hunters' attitudes toward the current management of pigs and the control methods

The vast majority of the hunters interviewed and surveyed argued that national parks lacked pig control because of the management being underfunded and/or because of the restrictions to control in national parks:

“The level of control is insufficient. More could be done if hunting with trained dogs is allowed in national parks.”

Most hunters surveyed then also perceived that national parks were protecting pigs by not investing enough into pig control. To combat this lack of control, they advocated regulated hunting or hunting by accredited hunters as a control method:

“[We need] access to breeding grounds in national parks as in VIC & NSW.”

Because they would hunt pigs for free as recreation if access was permitted, the hunters justified hunting as an economical control method:

“Control is not difficult at all because we enjoy it at the same time.”

“Government is protecting pigs in national parks and it is absolute stupidity. There are a lot of pigs in Australia and it is possible to let responsible and professional recreational hunters shoot in national parks because it costs taxpayers nothing and hunters would do it for free. Pigs are very smart and they know where is safe and where they are not hunted or there is not people, which is national parks. You are never going to get rid of pigs where people aren't allowed to go or see. You may get rid of pigs only where people are or where people see. But I'm not in favour of dogs in national parks because they can get lost. Nonetheless, the government should seek local knowledge and opinions.”

Because income could be derived from chiller boxes, some hunters interviewed supported hunting and advocated the reintroduction of the bounty system for pig control:

“Hunters are doing the environment a favour. We should get more subsidies or bounties for this like dingo bounties.”

In contrast to their great support for hunting, most hunters interviewed were disinclined to support trapping. One hunter interviewed was in favour of trapping only if the meat could be used:

“Trapping is good when pig meat can be commercialised but the problem is that pigs don't go there unless there is no food around and we can't process meat in this hot and humid

area. Because of the distance from the market and poor hygiene from high temperature, it makes no commercial sense so there is no chiller box around.”

A few hunters interviewed were suspicious about the effectiveness of trapping especially in cane farms, and this perceived ineffectiveness of trapping justified the use of shooting and dogging as more effective control methods on cane farms:

“Trapping does not work along the coast although Daintree is getting some good results with the trapping program. Tully, for example, has much more bananas growing than Mossman and pigs are used to eating bananas over there. But pigs in Mossman are used to eating cane so if you try to trap them with bananas it doesn’t work. There is so much food source around anyway in Mossman so trapping would not work.”

Not many hunters interviewed expressed views about fencing. This could be because of a disinterest in fencing. Nevertheless, one hunter mentioned that it could be useful for private use but not for a large-scale solution such as controlling sugarcane farms:

“For your own property, fencing may be good but pig proof fence is not effective because not everyone does it, especially sugarcane farms.”

Of all the methods available, the hunters supported poisoning the least not because of a lack of humaneness but because of a lack of target specificity:

“I don’t like poisoning because of negative effects on non-target species.”

Some hunters interviewed and surveyed supported all the methods to control pigs:

“Integrated approach is important for control. Try trapping and use rifles to get some pigs and use dogs and poisons to get the rest.”

4.3. Summary of the pig hunters’ perspectives

Hunters acknowledged the values of the rainforest based on its specific services such as fresh water, oxygen provision and nutrient cycling, or on its existence values stemming from its biodiversity or conservation significance. Compared to other local residents (Chapter 3), rainforest values that hunters articulated were more specific to ecosystem services that the rainforest delivers. The vast majority of the hunters perceived similar environmental impacts of pigs as did the residents; for example, destruction of vegetation, predation on native species and soil erosion. Nevertheless, although some hunters perceived that these impacts diminished the rainforest values, others did not.

Hunters typically emphasised the socio-economic benefits of pigs such as commercial and recreational opportunities. The benefits stemmed from safari hunting, hunting as a sport, recreation and food sources for dogs and humans. Most hunters were aware of the potential of safari hunting to be developed as rural tourism in areas such as Cooktown, a northern part of the WTWHA where there are few other economic opportunities. In addition to such tangible benefits, pig hunting itself also seemed to hold socio-cultural values. Despite different motivations, hunting required a myriad of skills that involved “learning about pig behaviours” and continual searching for pigs, and therefore, it is a cultural activity. Hunting was also social because it developed social status and relationships among hunters.

Because it entails socio-economic benefits, almost all hunters supported hunting the most as a control method. Hunters further justified hunting as a viable control option because of their reciprocal relationship with farmers. Their justification and promotion of hunting was also aided by a perceived lack of control within national parks. The hunters interviewed and surveyed advocated hunting as an economical method to control pigs. They considered that pig control in national parks was underfunded and restricted by regulations preventing the use of guns and dogs. Nonetheless, as indicated by some hunters, trophy hunting may compromise pig control because of their selectivity in only targeting boars. Trophy hunters were contradictory because they justified hunting as a conservation tool for national parks to mitigate the negative environmental impacts of pigs but perceived that pig control would diminish hunting opportunities and were disinclined to control pigs. Safari hunting as well as hunting through the bounty system (i.e. chiller/pig boxes) could also compromise pig control to an extent to maintain the population as an ongoing source of income. As a result, half of the hunters surveyed expressed that pig control indicated decreasing opportunities for them to hunt pigs.

Pig hunters’ perspectives, therefore, were distinctive: pigs were both a resource and a pest to pig hunters. The dual value of pigs may exert conflicting pressures on control efforts through pig hunting. Pig hunters closely collaborate with farmers (who may also be pig hunters) on pig control on farmers’ private properties, and this stakeholder group may also have particular perspectives because some farmers seem to control pigs as an agricultural pest to mitigate crop damage caused by pigs. Thus, in

contrast to pig hunters, farmers may have distinctively negative perceptions of pigs. The next chapter, Chapter 5 will explore farmers' perceptions in detail.

Chapter 5: Farmers' Perspectives

5.1. Introduction

Farmers are generally likely to hold negative perceptions of pigs especially when they suffer damage to their agricultural commodities as a result of pigs and/or exercise control to mitigate damage. Nevertheless, the economic effects of pigs may vary between farms, depending on types of commodities, farm locations, seasonality and effectiveness of control. Mitchell and Dorney (2002) found that pigs in the WTWHA were a major economic problem only to a minority of banana and cane farmers and that there was great variation in the extent of damage between individual farms, depending on the location. Variation in the extent of economic damage, therefore, suggests that not only may farmers hold different attitudes to pigs from the other stakeholder groups but may also vary in their perceptions or tolerance of the economic effects of pigs. Thus, this chapter focuses on farmers' perceptions of rainforest values and the impacts of pigs as well as their attitudes toward current pig management and control methods. Farmers' estimates of extent of damage to crops were also explored as perceived economic costs of pigs. Factors addressed in this chapter also include: farmers' use of pig meat after control and/or use of a bounty system to reward hunters as positive externalities or socio-economic benefits of pigs. Furthermore, the social impacts of pig control on farmers are also addressed in this chapter because they are likely to control pigs to protect their agricultural commodities. Social impacts of pig control include physical and psychological stress or pressure of having to deal with pigs, distress caused by constantly witnessing attacks on their crops, feelings of helplessness and lack of control and financial difficulty, lifestyle changes or unemployment (SCAFF, 2005). The data to address these matters were obtained in the same manner as for the general local residents: from qualitative semi-structured interviews via convenience sampling and quantitative household surveys via systematic random sampling (see Chapter 2). A total of 15 farmers were interviewed and 14 surveyed. Out of those interviewed, nine were sugarcane farmers (eight males and one female), five fruit farmers (four males and one female), and one tea tree farmer (female). As for those surveyed, eight farmers grew fruit and trees, one of whom also grew vegetables, and three sugarcane, two livestock (cattle) and one (unspecified). Apart from one female fruit farmer, all the other farmers surveyed were male. Based on the interview results, the household survey contained a

specific section for farmers and addressed the following questions to understand the perceived economic costs of pigs caused by agricultural loss and control practices (see Appendix 5): (1) the types of commodities damaged by pigs; (2) the extent of damage, (3) seasonal variation in damage; (4) control efforts and methods; and (5) social impacts of pig control.

5.2. Results

5.2.1 Values that farmers ascribed to the WTWHA rainforest and the perceived effects of feral pigs on those values

Most farmers interviewed spoke about the importance of the rainforest particularly referring to its ecological and evolutionary history, their personal engagement with the rainforest and regulation services:

“Half of our property is the rainforest, the World Heritage Area, and my life has been involved in wildlife.”

“The trees are too valuable. It’s the oldest rainforest in the world and it is absolutely spectacular as a place and trees attract rain.”

“Oxygen and good protection from fire.”

In contrast, although appreciating the importance of the rainforest as provision of oxygen and protection from fire, one farmer opposed to the expansion of the “protected” rainforests as he perceived it to be the loss of land to himself:

“We’ve got enough rainforest and I don’t want to lose our land.”

Most farmers surveyed articulated the value of rainforest derived from “provision of habitats for flora and fauna” or “biodiversity” and “air production”:

“To supply food and shelter for native species – not Anna Bligh’s [Queensland Premier’s] pigs”

“Lungs of earth”

Accordingly, almost all the farmers surveyed perceived that pigs degraded the values they ascribed to the rainforest (e.g. “provision of habitats for native species”) because of “disruption of habitat”.

5.2.2. Farmers' perceptions of the impacts of feral pigs

The majority of the farmers interviewed argued “there is nothing positive about feral pigs” for the rainforest and expressed their concern about the negative implications of pigs for the rainforest:

“They cause terrible havoc in the rainforest. Damage is everywhere including my property and the rainforest. Everyone wants to get rid of them. They are pests.”

The farmers articulated negative environmental impacts of pigs such as damage to the rainforest due to their foraging behaviours via rooting and predation of, and competition with, native wildlife:

“Damage the trees, soil, forests, wildlife.”

“Not only do pigs eat turtles and crabs in the beach, or cassowary eggs and all the wildlife eggs they can find to eat. [They] also [eat] snakes, lizards, pythons, frogs and goannas on my property. They eat everything! They also eat grass and dig up ground for grubs.”

“Any habitat with pigs is a disaster because they loosen up the rainforest and dig there, causing landslide and erosion and damaging black palms. Pigs eat young palms and cycads (roots) and succulents.”

“I don't see many frogs anymore.”

Of all those perceived impacts, almost all the farmers interviewed raised “soil erosion” as a major impact of concern:

“[Pigs are] digging up the creeks and rivers, resulting in soil washed. Anna Bligh [Queensland Premier] should have a look at this.”

Soil erosion was often discussed in reference to the Queensland Government's new Reef Rescue legislation, which took effect on 1 January, 2010. The legislation aimed to improve the quality of water entering the Great Barrier Reef (GBR) lagoon by reducing the amount of fertiliser and pesticides used on farms (especially cane farms in Northern Queensland) by 50% in four years (Ryan, 2009). Sugarcane farmers, for example, were then required to keep annual records on soil testing results and their use of chemicals and fertilisers. This legislative requirement indicated that the government blamed cane farmers for poor water quality that fed into the GBR, and in response, most farmers argued against the legislation, stating that it was not their fault but pigs':

“Anna Bligh [Queensland Premier] has recently made terrible impositions on the farming community, blaming them for all sorts of run-off and destroying the reef. The majority of the damage in North Queensland is actually caused by pigs.”

“Why is the government giving more attention to the reef rather than the rainforests? Soil erosion comes from pigs rather than canes. Anna Bligh is getting like a dictator as far as agriculture goes.”

One farmer, however, asserted that soil erosion caused by pigs was primarily because of farming practices; her neighbouring farmers created drainage, which became a favourable environment for pigs to dig up creeks:

“Pigs dig sugarcane drainage and trenches after farmers spray along it to kill vegetation so that water flows faster and attain better drainage. This creates an ideal spot for pigs to dig. It is all cleared once water flows because it is easier for pigs do dig. This causes more erosion.”

Another farmer argued that diggings caused by pigs on private properties could be attributed to humans because more land clearing proceeded and this would encourage pigs to come closer:

“As the area opens up, it becomes a more and more foraging area for pigs because people throw the rubbish out, have gardens and food waste. They all become the resource and encourage pigs to come around.”

By contrast, a minority of farmers (who did not receive any economic damage from pigs) disagreed that pigs caused significant damage to the rainforest; they even acknowledged positive aspects of pigs serving as an “entertainment” for tourists:

“If pigs come onto a beautiful property and dig it up, that would affect people. They come down to my property and dig up but I don’t fix the ground. And I don’t think pigs are doing much damage to the rainforest. They are only eating. They root a lot but that’s pigs. That’s part of their natural thing. They are looking for nutrient so the ground is part of their food. They are doing damage but they are not taking away the rainforest.”

“Pigs can be positive for tourism because it is interesting for tourists to see them.”

5.2.3. Economic impacts of feral pigs on agricultural industries

This study in Mossman and Daintree found that agricultural damage was localised and differed across space and time. The harvesting season when the cane matured seemed to be the peak time of pig damage for the majority of the cane farmers in Mossman and pigs tended to damage sweeter and softer canes. Out of 15 sugarcane and fruit farmers interviewed, only three sugarcane farmers claimed that they received considerable

damage in 2009. These three farmers owned paddocks that were adjacent to the rainforests/national parks:

“We have about 100 acres of cane paddocks and estimated harvest to be around 4,000 tonnes this year but we will be lucky if we get 3,000. So this year we lost about 30% of the profits and that’s worth \$30,000. We thought last year it was bad with pigs but this year is even worse. Rainforest farms have the same problems with pigs. The closer to the rainforest, the more damage you are going to get. You can’t believe the damage they do. We had beautiful proper cane and pigs just wiped it out when we came back after a month (Figure 5.1). By the end of August, they just wiped the place out. They can dig up easily during the wet season when soil is soft so they don’t eat the cane so much. They just make a mess and disturb the ground. When it’s dry, they really attack the cane. Pigs start chewing in June near the creeks and rainforest. The worst damage areas are near the ridges. We only got 10 out of 24 bins [10 tonnes per bin] from the paddock next to the ridge this year (Figures 5.2 and 5.3). It starts in July/August till November. September and October are the worst. Also, there are different kinds of cane and pigs prefer certain varieties like Q152 and Q138 but they normally target sweeter and more mature canes during the harvesting season. We are going to cut canes down earlier than usual to avoid damage this time. But this early cutting doesn’t come with enough sugar. Our cane fields further away from the ridge and close to the town have nearly no damage.” *(A sugarcane farmer in Mossman with some of his paddocks located adjacent to the forest)*



Figure 5.1. Pig damage to sugarcane, adjacent to the rainforest.



Figure 5.2. The close proximity of the damaged sugarcane to the rainforest.

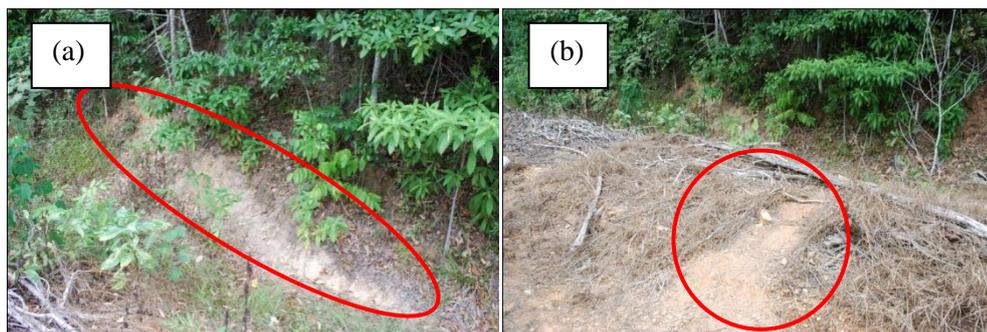


Figure 5.3 (a) & (b): Pig ‘pads’ (tracks) leading to the cane from the rainforest, through which pigs travelled to the cane and back to the rainforest for foraging.

Furthermore, extent of pig damage varied annually. The cane farmer who asserted that he had lost 1,000 tonnes of cane due to pig damage in 2009 confirmed that damage was negligible in 2010 because the wet weather without much sun reduced cane productivity more than pigs did:

“This year [2010] damage hasn’t been as bad as last year. I think it’s because there has been a fair bit of water in inland areas this year so pigs from those areas don’t come over to coastal areas here. [But] we haven’t got enough sugar. The wet season was good, we had enough rain, but we haven’t had enough sun.”

A hunter who controlled pigs for a farmer also confirmed that pig damage was intensive but localised and could vary in extent from year to year:

“Pig damage to sugarcane is mainly around the mountains. Farms not near the hills or creeks do not normally get damage. The nature of pig damage (to sugarcane) is that some areas are hit a lot harder than the other areas and. I have my own farms but I don’t get any damage on my property because it is not close to the hills or creeks or the rainforests.”

The majority of the farmers received negligible damage. One farmer suggested that the location of farms may have mattered because the closer a farm was to the ridge/rainforest, the more damage that farmers tended to suffer. Others argued that hunting pressure by skilled hunters had helped them mitigate damage even though their farms were located close to water sources or the rainforest:

“Pigs don’t cause a lot of damage to my farm. It’s less than 1% of my property which has 600 acres. Farmers on the hill may get a fair bit. My employee is a pig hunter so he hunts a couple of times a week. If there is no control, there will be a lot of damage to canes.” (*A sugarcane farmer in Mossman with his farms located near the main road*)

Additionally, one farmer stated that changes in crop varieties helped; because pigs tended to prefer sweeter canes, he planted ones that had less sugar content along the ridges where most pig damage occurred. As a result, he kept damage to a minimum:

“Pig damage is not really a big issue now because the farm has been controlled in the last 10 years by a hunting group. [Nowadays] only 100 acres or 5 paddocks out of 1000 acres [10% of the property] are subject to pig damage and pigs only get to 1/6 of the 100 acre paddocks. Pigs prefer softer and sweeter canes, which contain very good sugar. We normally get damage along the ridge. To avoid pig damage we plant the ones that produce good tonnage but less sugar so that pigs don’t come around so often to chew them. Pigs come around especially when cane is low, around August and September. That’s when the dry season kicks in and young cane has got moisture especially at the bottom of the stick because it has more sugar and it is a good energy source of pigs.” (*A sugarcane farmer in Mossman with his property facing the rainforest*)

One sugarcane farmer argued that crop damage did not amount to considerable costs because pigs targeted trash blanketing⁵ instead of chewing canes directly. Additionally,

⁵ The Queensland sugarcane industry had used fire to remove cane and cane trash from harvesting. However, in the past 20 years, the industry has adopted green cane harvesting; the green cane harvesting refers to keeping the leaves and tops of the cane on the ground as a “trash blanket” to protect the soil from erosion, increase soil moisture, provide weed control and reduce herbicide use, and does not involve the traditional burning. Almost 100% of the cane farmers in North Queensland have adopted this method (DPIF, 2008).

he added that most of the severe damage to cane was caused by native animals such as sulphur-crested cockatoos (*Cacatua galerita*), Agile wallabies (*Macropus agilis*), and Eastern Grey Kangaroos (*Macropus giganteus*). Wallabies and kangaroos targeted young green shoots when cane was just planted while cockatoos targeted the peripheral parts of cane fields during the harvest season in some cane farms. White-tailed rats (*Mystromys albicaudatus*) also chewed canes as pigs did:

“Pigs predominantly root up the trash blanketing after harvesting rather than chewing off the cane that is to be harvested. Trash blanketing is important for moisture retention, weed control and prevention of sediment [so pigs affect these environmental factors rather than economic factors]. Damage to trash blanketing happens all year around. But wallabies and kangaroos do more damage than pigs in my property. They eat small ratoons when canes are not tall, around 20 to 30 cm. Damage by cockatoos at the moment is worse than pigs. They come around July/August and target the cane especially at the periphery (Figures 5.4, 5.5 & 5.6). They are native wildlife so I can’t control them. I have complained to the government and suggested that we should trap them and possibly sell them but all they say is that they don’t want to exploit their native fauna. Cockatoos and wallabies move around so all you can do is frighten them off but they can come back (Figure 5.7).”



Figure 5.4. Cockatoo damage to sugarcane



Figure 5.5. Cockatoo damage mainly to the periphery of the cane field



Figure 5.6. Difference between cockatoo and pig damage to sugarcane; cockatoos chew off the top part of the cane whereas pigs target the bottom part of it.



Figure 5.7. The cockatoos escaping after feeding around the cane field.

The extent of perceived damage caused by different animals to cane farms varied; another farmer argued that although pigs were the major cause of most cane damage in 2009 compared to kangaroos, wallabies and rats:

“90% of the damage is from pigs. The rest would be from rats and sometimes wallabies when the cane is young. Cockatoos don’t come to chew cane on my property. Pigs and rats chew off but in a different way. When pigs chew off they leave big chunks of chewed cane whereas rats have smaller bites and leave finer chunks (Figure 5.8).”



Figure 5.8. Rat damage to cane and its difference from pig damage; pigs chew off the cane at the bottom.

Similarly, tropical fruit and other crop (e.g. tea) farmers based in Daintree and Cape Tribulation perceived negligible economic impacts of pigs. Firstly, some farmers simply denied that pig damage amounted to significant financial concern:

“We grow 150 tropical exotic fruit species and pigs prefer certain trees. They push over the trees to get some soft part of the trees. We had a jack fruit damaged up to 1.5 metres. Pigs can stand to get them. Some trees are too high for pigs to reach but they are very efficient scavengers and they can take any food. [Economic] damage is there and it’s annoying but it’s not at a huge level and the damage is very seasonal. They come and disappear. They become most obvious during the dry season especially in October and November when there is still a bit of moisture around.” (*A tropical fruit farmer in Daintree*)

Other farmers believed that daily maintenance of the property either by human labour (e.g. picking up rotten fruits to prevent pigs from scavenging them) or hunting pressure was important for damage mitigation.

A banana farmer in Daintree argued that the types of bananas pigs targeted were of little economic value for the farm and that rats and guinea grass caused more financial costs than pigs did:

“Pigs target smaller and younger bunches especially near the river where ground is swampier. Especially the ones that are very close to getting picked [ripe] are targeted. Pigs are smart. Male boars or pigs in a team knock trees down before harvest. It is a loss before harvest so it is classified as ‘reject’ on the books and it is the same category as the loss from wind. So I’m not sure about the extent of damage but damage is there all year around. When the ground is weaker (softer) and bunches are heavy during the wet. But there is more damage from wind than from pigs. Younger and smaller plants that pigs target are B-grade so it is not a big issue for us. Extra large bananas from bigger plants are A-grade, which are sold in major supermarket stores and they are worth more, but pigs don’t target them. The severity of damage to bananas may get worse because now there are more younger plants replanted here and there are four or five paddocks of bananas with younger plants. The younger or smaller the plants are, the more severe the pig damage. Younger plantations are normally quiet so it is more suitable for pigs to come around. Rats are rather a problem because of lepto [leptospirosis] and they climb up the trees and make nests to avoid rain. On weekends pig hunters come around and banana farmers bring dogs for rat control. The smell of dogs is enough to deter pigs on farms. The more dogs is present, the better. This is an organic farm so we cannot use chemical. Guinea grass is in fact the biggest problem on this farm because it grows between bananas trees. It costs a lot of money labour-wise because of constant labour to get rid of them by hand. We’ve got two slashers working all week.” (*A banana farmer in Daintree*)

As for the farmers surveyed, 10 out of 14 claimed that they had experienced pig damage to their agricultural commodities or properties in 2009. Out of those 10 farmers who had suffered pig damage, four claimed that damage was negligible. In contrast, four other farmers surveyed perceived that the severity of the damage was significant. Two fruit and vegetable farmers surveyed perceived that they suffered ‘considerable’ economic impacts of pigs; one claimed an annual loss of \$2,000 or 1,800kg of fruit that accounted for 45% of the total property (1 hectare), and the other claimed an annual loss of \$1,000 or 100kg of fruit that accounted for 33% of the total property. Seven out of eight surveyed fruit farmers who had experienced pig damage claimed that damage concentrated during the wet season, which was also their harvest season. One claimed that damage was concentrated during the wet season because of the inaccessibility of pig hunters during that time. Another claimed that the presence of a dog within a property deterred pigs from damaging the property. Like those interviewed, one cane farmer surveyed asserted that pig damage to sugarcane was concentrated during the dry season (June to October), which was sugarcane harvest season. The two livestock farmers surveyed also claimed that the damage peaked during the dry season.

5.2.4. Perceived social impacts of pigs: pig control

As for the farmers surveyed, their opinions diverged as to whether pig control had physical and psychological pressure or stress; six out of 14 found dealing with pigs stressful whereas the other six did not (with two farmers being neutral), irrespective of whether they controlled pigs opportunistically or regularly. Rather, those who did not find control stressful were either pig hunters or those who had pig hunters control their properties. The farmers interviewed also expressed mixed opinions. A fruit farmer was concerned about the safety of her husband controlling pigs: “I don’t like my husband to hunt pigs because pigs are very incredibly dangerous.” One cane farmer interviewed argued that dealing with pigs was stressful because they regularly had to control pigs using more than one method (e.g. rifles, dogs, and fences) especially during the harvest season and it was difficult to control them. A couple of cane farmers argued that control was a job:

“Time is the burden. Control is a full-time job.”

“Just another job. We are not getting paid to catch pigs but we do it because we don’t want them to be on our property.”

Distress caused by witnessing attacks on their crops was also identified from a cane farmer: “You see beautiful green cane right here. We have put fertilisers on, done chemical work and cleaned and slashed headlands. And pigs are still there! It’s getting disheartening for farmers.” Another negative social implication of pigs was that change in the business: a cane farmer perceived that pigs changed the agricultural business “in the same manner as a thief walking into a grocery store stealing.” The farmers surveyed who perceived that dealing with pigs was stressful tended to perceive that pigs were causing a financial burden; the farmers surveyed with no negative psychological effect of pig control did not perceive that pigs had caused financial difficulty.

5.2.5. Farmers’ attitudes toward the current management of feral pigs

Only two out of 14 farmers surveyed were satisfied with the current management of feral pigs. One perceived that the government trapping program was effective given the impracticality of eradication. The other simply believed that the current management was sufficient because he had not seen many pigs anymore. The vast majority of the farmers surveyed and interviewed perceived the current management was insufficient because they believed that:

- The State government did not sufficiently control pigs in national parks and
- Control was underfunded (i.e. “more could be done”).

Their dissatisfaction was related to their perception that the Council was the one who was committing to the trapping program rather than the State government:

“The government (QPWS) don’t do proper jobs. I don’t understand why there are a lot of people researching about pigs for more than 30 years and nothing has been done. Locals know that there have been pigs for 30 years and the problem has been the same so we need to kill them. We don’t need research and we don’t need the State government. We only need local and federal, not something in between. The (State) government is doing absolutely nothing. In the World Heritage Area, the government is not protecting wildlife. It is used to build up pigs’ refuge. In Mossman, there’s too much water so pigs become abundant. They say that there are not many pigs in the rainforest but it’s not true. They are everywhere and the worst part is that we can’t control them for the simple reason that if you take the old shire (Douglas Shire), 85% of the shire is National Park and World Heritage Area and 15% is suburban sprawl, cane farms, cattle farms, orchards. So if you take this into account, 15% is not a big area. So when the rain comes here, pigs dig up the waterways and everywhere including wallows. The damage you can do in the cane

paddock and orchard is astronomical. We have the biggest feral piggery in the world because of the Australian government. They don't need to fix or check them out. There are diseases like brucellosis. It's not even funny. There are always pristine pigs running around in pristine rainforests."

The current control level was perceived to be insufficient mainly because of a lack of control by the government within public lands such as national parks:

"National parks are Anna Bligh's yard and nobody does anything in that yard."

"National parks are up to shit. The World Heritage has no person since 1998 [since its UNESCO World Heritage inscription] who is actually managing the rainforest on the ground because no hunters are allowed to go in. Where would pigs go when they escape from cane? National parks!"

The farmers' frustration with national parks management, apparent in the interviews and surveys, referred to the restrictions on access to parks (for pig control) and on the uses of guns and dogs for hunting, as expressed in their anti-government rhetoric:

"[The current control level is] not sufficient at all. Some of our neighbours have pigs walking through and they don't have gun licences. How are they going to kill them? They can't unless they've got traps. The only way we get our traps fixed is that some generous person from the Council comes in and helps us. We don't have anyone from the World Heritage coming and help us to put traps up. The guns are taken off the people in the bush. I can't manage pigs without guns. Pigs get the World Heritage protection. [...] I would never give away my property to the World Heritage. It is a disastrous organisation. There is absolutely no value whatsoever in what they've done. They haven't done anything for the area."

Some farmers interviewed mentioned that the current level of control had been effective solely because of the hunters' constant efforts to control pigs on farming land:

"[The current level of control is] good but if hunters lose interest, it will become a problem."

Due to the perceived lack of control in national parks and restrictions on the use of guns and dogs within the parks, almost all the farmers surveyed perceived that national parks served as a breeding ground for pigs.

As some farmers surveyed and interviewed articulated, inconsistent control efforts among people also led to their dissatisfaction with current management. Non-participating neighbours "free-rode" the farmers' control efforts, through which they received benefits (i.e. reduced damage) from the control:

“I am the only guy who controls pigs with my own expenses. No neighbour does. I’m doing the favour for these other farmers.”

One fruit farmer in Daintree mentioned that he relied on his neighbours to privately control pigs because he disliked disposing of the animal:

“I used to control them with traps but now we rely on neighbours to control pigs. They regularly monitor and control by themselves privately. We could do the same but I don’t like shooting and disposal by myself.”

5.2.6. Farmers’ attitudes toward the different control methods

In total, 13 out of 14 farmers surveyed practised control on their properties or had hunters control and based on their practical experience in pig control they supported or opposed the methods (i.e. focus on cost-effectiveness) rather than animal welfare. Five farmers indicated that control was opportunistic, no more than one day per month while another five asserted that they constantly and regularly controlled pigs throughout the year. Out of those 13 farmers who controlled pigs, six used more than one method to control pigs. In total, five farmers surveyed used traps, six used dogs, eight used rifles, two used poisons, one used fences. Firstly, all the farmers surveyed supported trapping and fruit farmers, in particular, tended to agree that trapping could be an effective control method:

“Trapping is the best to get rid of pigs. It had an important effect locally.”

Nevertheless, cane farmers tended to be uncertain about the effectiveness of trapping in cane fields. They believed the fruit baits used for trapping would hardly attract pigs because pigs were used to feeding on sugarcane in Mossman rather than fruit (i.e. there were few fruit farmers in Mossman):

“Trapping is alright but there is a big source of food around traps like fresh sugarcane. Pigs don’t bother to come to traps. So trapping wasn’t successful on cane farms. Also, free feeding has to be done before trapping them to get their confidence of coming into the traps and it was labour-intensive. In the last 20 years, I have found hunting the best control method.”

A cane farmer in Mossman also discussed the costs and difficulty of trapping especially in securing free bait; he had to pay for baits (e.g. bananas) when they were not available for free. Trapping could be time-consuming because of free baiting; he had to place bait

in traps to attract pigs and make them accustomed to the food source before trapping them:

“I trap pigs if there are free banana sources but nowadays people recycle bananas so it is harder to get them for free. Trapping takes a lot longer time in terms of feeding them in and actually capturing.”

Trapping, however, could be the only method available in areas such as rainforest-dominant Daintree. A fruit farmer in Cape Tribulation argued that trapping was labour intensive but had to use traps because it was the only method available.

One farmer opposed trapping not because of the labour intensive nature of the method but because of the potential that the non-native fruit baits may be dispersed by pigs into the rainforest:

“Trapping is useless because you need to check traps daily and they may catch other wildlife. A friend of mine used mangoes as baits for trapping and pigs ate them and carried their seeds, which was eventually dispersing them into the rainforest.”

For fencing, several sugarcane farmers interviewed and surveyed suggested that fencing would be useful if combined with hunting, especially for the cane farms that were adjacent to the rainforest. Even if pigs dug underneath the fences, those spots dug up would become the “pads” or “paths” through which pigs travelled from the rainforest to the cane paddocks and vice versa. Then, these pads would then become useful for hunters to target when shooting pigs; hunters use dogs to push pigs out of the cane field and pigs would escape following the pads (Figure 5.9). Or simply fences would be useful to guard the field by using dogs:

“We’ve tried electric fencing. Pigs still run through electric fences so it is only a deterrent and does not protect the property perfectly. But you can use electric fence in a more effective way. For example, create a gap in the fenced area so that pigs prefer to come to that gap and that way it is easier to control pigs by shooting because you know exactly where they are going to be. So hunting can be done more efficiently [by the presence of fences]. Electric fencing [that I put up in the past] was put away because pigs did not come to damage the area anymore.”



Figure 5.9. The utility of pig ‘pads’ in pig hunting, created by their digging underneath the pig proof fence; pig hunters marked this spot with the ribbon to be used for cane hunting at night, beside which hunters wait for pigs to come back to the forest from the cane when they are chased out of the nearby paddock.

Nevertheless, the farmers disagreed that fences were effective if solely used on their own because pigs could travel through the fences by digging underneath them or simply breaking through them. Some even opposed fencing if there was no coordination of the efforts to maintain fences with neighbours because otherwise it would create a gap in protection:

“While I farmed, I put up pig proof fences. Some farmers used electric fencing but maintenance of electric fencing was ongoing. You need to check it daily. With the pig netting, pigs try to go under and over it so we add another wire but they figure out another gap so we add another wire and eventually they have an asylum next door so they have a far better proposition. [The protection from pigs by fencing was] nowhere near 80%. It’s impossible to fence around. You’ve got roads running through and you can’t fence off so pigs are still free to travel. Protection is pretty minimal. You still need other assistance including hunting with dogs.”

Because fencing at a larger scale would be ineffective and expensive without coordination, one farmer suggested that the government should help farmers to share the costs for erecting pig fences as they did in the past so that fencing could be coordinated over a large geographical area:

“A full boundary fence – that’s what we need. We need pig fences put back up, which doesn’t involve chemicals or shootings. Fencing did work (when the government put up the old pig fences) – we had 20 bins out of it when fenced instead of 3, 4 bins a year like this year. But the thing is we need our neighbours to do it too. Fencing is expensive. The government could subsidise fencing and bear half of the costs and we can do the work, for example. We are happy to maintain fences if erected [by the government]. We just want some help from them but they don’t want to help us at all.”

A few cane farmers interviewed expressed their distaste for electric fencing compared to other types of fences such as mesh fencing because electric fences tended to require high maintenance such as keeping the grass underneath the fences low:

“[Electric] fencing helps but requires too much maintenance.”

“Mesh fencing is easier to look after than electric fencing.”

As the most effective control option, 13 out of 15 farmers interviewed and 11 out of 14 farmers surveyed (especially in Mossman) advocated hunting partly because it was the most commonly used method to control pigs. They supported hunting with a condition that it be regulated because of its safety issues and be organised for effective control:

“Strongly advocate shooting in particular but hunters need to be controlled. There were safety issues to backpackers. Once French tourists came to the property without permission at dusk and parked their car and put out their table and chairs on Friday when some pig hunters were already in the property for hunting. People from suburbs bring dogs but they shouldn’t come because dogs are used to the confined area and not near the rainforest. Illegal hunting is an absolute concern and hunters have to have licences.”

“This area [i.e. sugarcane fields in Mossman], hunting is the best control. But it needs to be done over a bigger area to be effective. We need more than one mob of hunters to do this if you are serious about controlling pigs.

Those interviewed who supported hunting as well as those who were opposed to recreational aspect of hunting as a control method particularly preferred “professional” hunting because it involves a regular check of hunting fields; analysing which cane paddock pigs feed on at a given time so that pig hunting could be organised accordingly:

“A hunter controlling this property comes around during the week to check which paddock is attacked and identify the active time by setting up a cross snatch that is meant to be triggered by pigs when they come across. He spends 20 to 30 dollars just for fuel every week for this. Every weekend they go pig hunting and catch a minimum of 50 to 60 pigs a year.”

Because hunting could be recreational, a few farmers interviewed opposed hunting as a control practice; they believed that some hunters who hunted pigs for pure recreational purposes would wish to maintain the population to some extent for their own social benefit:

“Hunting is recreational and done voluntarily and so is not professional. To some extent, they want to keep pigs for fun.”

Nonetheless, other farmers were supportive of hunting because pig hunting was a good recreational activity for hunters and a good opportunity to obtain food for dogs or for commercial sales:

“We control pigs through a neighbour hunter who uses dogs. It is recreational [for the hunters] and it is his hobby.”

“For hunters, pig meat is a great saving because they normally have 6 or 7 dogs and they need to feed them somehow.”

“We could have a chiller box and try to sell meat to tourists locally.”

A few fruit farmers interviewed also advocated hunting (especially with rifles) as a useful method when controlling pigs in an ad hoc way if they possessed gun licences:

“My wife and I have a gun licence so we used to hunt them around the property. I was going hunting with dogs 3 or 4 times a day everyday that includes throughout the night. I’m not joking and I’m very serious about this. Even when we went to the movies, we stopped at the bottom of the hill down there, put on a pair of shorts and searched around the farm. If the dogs saw pigs, we killed them.”

Moreover, hunting was supported because it used to be exercised for an organised community control measure in Daintree, using guns and/or dogs to locally help farmers:

“My husband used to be part of a pig gang around here who used to hunt them. Everyone helped out each other at a community level to kill pigs with guns and dogs.”

Despite the popularity of hunting, a minority of farmers interviewed were concerned about its animal welfare issues (especially hunting with dogs) and environmental costs arising from the use of dogs for native wildlife in the rainforest:

“Animal welfare concern when it comes to dogging – once 2 dogs got bashed by pigs and the hunter lost them after the pig attack.”

“It would be uneconomic to hunt pigs without dogs in the rainforests but I don’t support hunting with dogs in the national park because they can get lost and create another problem [in the rainforest].”

One farmer even blamed dogs (used for hunting) for the disappearance of cassowaries although it was uncertain whether dogs killed cassowaries to an extent that solely led to their population reduction:

“Dogs and rifles shouldn’t be allowed in national parks because some dogs are not trained enough. But hunters still go to the rainforest illegally. Australians have cow dogs including red heelers and bluies as pets and they can be dangerous and the owners need to know what to do with them. Here are cassowaries, wallabies and they are vulnerable to dogs. We’ve only seen one cassowary in 10 years and we think dogs have huge impacts – they push them away.”

The benefits of hunting were also perceived to be diminished because of illegal hunting or poaching. One cane farmer in Mossman was upset with illegal hunters as they destroyed the fences used for control:

“We do have hunters coming around here [without permission] (Figure 5.10). They have been a nuisance to us. They come in and cut the wires of fencing running through the property when they hunt. It’s a safety issue too.”



Figure 5.10. A warning signboard to keep illegal hunters off the private property (cane farms).

Lastly, despite their overall support for control in general, poisoning was the least popular method among the farmers interviewed and surveyed. As for the 14 farmers surveyed, four strongly opposed and two opposed, but five strongly supported poisoning. The main reason for the opposition was their concerns about lack of target specificity. Those who supported the method believed that poisoning was a cost-efficient way, or the only way to get rid of the problem, or pigs. For those interviewed, three out of 15 farmers clearly expressed that they opposed poisoning because of their concerns about lack of target specificity rather than humaneness:

“Poisoning is okay but you’ve got to be careful because domestic dogs and people walk around and the other animals may take up the bait. If you have a big problem in isolated areas like 5 miles away from the town, you may be able to bait. It would be a good idea.”

Conversely, several farmers interviewed were neutral toward the use of poisoning or were disinclined to support it because they were uncertain about the effectiveness of the method:

“We tried poisoning and another mob kept coming back and so it wasn’t really working. We had to spend a month on free feeding before baiting and lay new bananas every couple of days that we got from Daintree for free. It [baiting] does not work always. You see the ground dug up but bananas were not eaten. A good thing was to have DPI [Queensland Department of Primary Industries and Fisheries, Biosecurity Queensland] help baiting.”

“Pigs are smart and vomit. I’m not sure about its effectiveness.”

“Poisoning (1080) is biodegradable so if exposed to the rain, it doesn’t work. So when rain, no baiting.”

Nevertheless, one cane farmer who had used poisoning argued that the safety issue of poisoning arose because of people’s lack of attention and ignorance of the warning signboard rather than the poisoning itself (Figure 5.11):

“People don’t respect other properties even when poisoning. I put up the warning sign but there were still dogs and horses and kids running in and around the property.”



Figure 5.11. A warning sign of poisoning baits laid on a cane paddock; it did not prevent people and domestic animals from accessing the land.

Moreover, another farmer who had used poisoning argued that if poisoning was to be used the effort must be coordinated over a large geographical area to prevent a “gap” through which in-migration could occur and reduce the effectiveness of poisoning:

“Around Mt Garnet, I own a cattle station which lies to the west of Tully. Pigs eat dead cows and it was effective to bait on such a large area, although it was expensive both labour and poison wise. Baiting is only effective if it is done over a greater geographical area at the same time. Large scale and group approach is an important factor for poisoning to be effective. One concentrated area of baiting doesn’t work because it only creates a void and in-migration takes place straight away. Poisoning requires support of neighbours, almost all the Shire! A scattered approach doesn’t work.”

Of all the methods available, some farmers supported any type of control as long as pigs were controlled:

“I support all the methods. It doesn’t matter which one. We just need to keep doing it and don’t stop because there are more of them than us.”

5.2.7. The use of pig meat after control

A couple of farmers interviewed mentioned that after they controlled pigs either by trapping or hunting, they utilised the meat either for themselves or for other people including Aboriginal people in need of food:

“We used to eat them. I grew up in a rural and very poor family and the pig was a very good meat, good protein. Not many people eat them but I did.”

“I sometimes give meat to Aboriginal people from Wujal Wujal if they come down. That’s when they are hungry. If they’ve got a funeral or wedding, we will concentrate on catching pigs for them [by trapping]. But if they’ve got a dole and cheques coming through, they are not going to come down.”

The use of pig meat, however, may not be common among the farmers because only two out of 14 farmers surveyed indicated that they used pig meat for dog food after control; they disliked meat for human consumption because of the diseases that pigs were known to carry.

5.2.8. The use of bounty in pig control to reward pig hunters

Hunting provided a socio-economic benefit through a private bounty system between farmers and hunters. Out of those interviewed and surveyed, nine farmers interviewed and two surveyed relied on pig hunters for control. As discussed in Chapter 4, a few farmers interviewed affirmed that they provided hunters with cash for the number of pigs caught and/or with dog food, petrol, and bullets to help the hunters:

“We pay \$600 a year to pig shooters. So around \$30 per pig. Pig hunters hunt with dogs once a week and they check the paddock every second day. Without any shooters, damage would be more severe.”

“I pay \$30 per pig when hunters catch them. But I also pay for dog food and vet fees when their dogs get injured. Hunters constantly control my property, coming twice a week, on Monday and Thursday.”

5.3. Summary of the farmers’ perspectives

Most farmers interviewed and surveyed highlighted definite values of the rainforests. Like the majority of the local residents, pigs were perceived to diminish those values through diggings in the rainforest, soil erosion and predation of and competition with native animals (see Chapter 3). Nevertheless, some of the cane farmers interviewed seemed to be presenting pigs as a scapegoat using the argument of the perceived negative environmental impacts of pigs, particularly soil erosion so that they could counteract the legislative accusation of cane farmers for run-off into the reef. Pigs were also perceived as an economic cost by some farmers interviewed, but only a minority of

cane farmers actually claimed 'significant' financial costs; other cane and fruit farmers claimed no or negligible damage. The household survey also confirmed only a minority of those surveyed perceived 'significant' damage to their crops caused by pigs. Based on the interviews, those who had their properties adjacent to the rainforest/creeks/ridges seemed to suffer pig damage, particularly during the harvesting season. The survey also indicated that pig damage peaked during the harvest season of cane and fruit. Nonetheless, damage could be 'avoidable' to some extent by planting different types of cane and having good hunting pressure. Moreover, native animals such as wallabies, kangaroos, white-tailed rats and cockatoos were also considered responsible for damage. Similarly, a banana farmer suffered damage more from rats and guinea grass than pigs. Hence, the economic costs of pigs were unequally distributed in the study area across time and space and may be negligible compared to those from damage caused by other plants and animals.

To mitigate pig damage, almost all the farmers interviewed and surveyed controlled pigs or had hunters to control them. Pig control had negative social impacts on some farmers in terms of physical and psychological stress of dealing with pigs and distress from witnessing damage and financial difficulty from damage and control. For farmers, cost-effectiveness, or practicality, was the most important factor considered in supporting control methods. Trapping was perceived to be effective, especially on fruit farms in Daintree and Cape Tribulation, but not in cane fields. The use of fencing to aid hunting was supported for better effectiveness but not if used on its own. Poisoning was the least favoured because farmers perceived that it lacked in target specificity and therefore effectiveness, but was still supported as one of the means to control pigs. Hunting was perceived to be the most cost-effective although a minority showed concerns regarding its recreational aspects as well as environmental costs caused by the use of dogs. Regardless of cost-effectiveness, hunting may have been also supported for the mutually beneficial relationship between hunters and farmers and for the opportunities to gain meat for dogs and/or humans. Farmers' preference for hunting as a control method and their dissatisfaction with the current management of pigs both reflected their grievances against national park management. Unequal distribution of the costs and benefits of control was also another element of their dissatisfaction with the current level of control, related to unequal contributions of farmers to pig control. Different perceptions of the severity of the impacts of pigs among farmers as well as a

perceived lack of control conducted by the government, therefore, resulted in farmers' dissatisfaction with the management of pigs.

These farmers' perspectives are useful for understanding distinctive perceptions of feral pigs held by a special interest group. Pig hunters (Chapter 4) and farmers, in particular, emphasised the government's responsibility for pig control and expressed grievances against its lack of management within national parks, where access and use of dogs and rifles is restricted for these stakeholders. In contrast to these private landholders, it is important to understand how the government perceives the 'problems' and management issues associated with pigs so that potential conflicts between the public and management sides can be identified. The next chapter, Chapter 6 will explore government officers' perceptions in detail.

Chapter 6: Government Officers' Perspectives

6.1. Introduction

Different levels of government are involved in the management of pigs in the WTWHA. The current State legislation, the *Land Protection (Pest and Stock Route Management) Act 2002* (QLD) takes a tenure discrimination approach, which requires private landholders to keep their properties free of pest animals but does not explicitly articulate the State's responsibility to manage its own land. This policy is based on the user- or beneficiary-pays principle; the landholders are the principal beneficiary of the land and it is their interest and responsibility to reduce pest damage, regardless of any financial motives (Hassall and Associates, 1998). Historically, a federal government body the Wet Tropics Management Authority (WTMA) and the Queensland Parks and Wildlife Services (QPWS) conducted a Community-Based Feral Pig Trapping Program in the WTWHA, including Mossman and Daintree between 1995 and 2002. Subsequently, in Daintree and Cape Tribulation, Cairns Regional Council (the local Council) and QPWS (the State government) have pooled their funding to collaborate on the Community-based Daintree Feral Pig Trapping Program to help the local community control pigs on both private and public properties (i.e. national parks). A professional pig trapper has been contracted since 2005 for this trapping program.

This chapter focuses on the management agencies', or government officers', perspectives on the benefits and costs of pig management, particularly the trapping program in Daintree and Cape Tribulation. Factors addressed include (1) perceived rainforest values and the perceived impacts of pigs on those values as well as their perceived socio-economic impacts on the local communities; (2) perceived benefits of the trapping program in Daintree and Cape Tribulation; (3) levels of satisfaction with current pig management; and (4) social acceptability of the different control methods. The data to address these matters were obtained from qualitative semi-structured interviews with local and State government officers in charge of pig management (see Chapter 2) Five government officers who are primarily responsible for pig management were interviewed (see Chapter 2)."

6.2. Results

6.2.1. Government officers' perceptions of the impacts of feral pigs

As rainforest values, the government officers interviewed emphasised the 'high conservation values' of the Wet Tropics rainforests:

"The Wet Tropics is a tiny rainforest where there is a lot of endemic species found and nowhere else in the world and the only rainforest that exists in Australia."

To protect such values of the rainforest as a "valuable ecosystem", all the government officers interviewed strongly emphasised the need to control pigs because of the perceived negative environmental as well as economic impacts of feral pigs such as diggings in the rainforests, predation on native animals, deterioration of water quality, soil erosion, diseases and crop damage:

"Negatives are habitat damage, digging in the freshwater systems including creeks, predation on turtle eggs and causing erosion."

"They deteriorate water quality and ruin habitats of native wildlife and eat their eggs including Cassowaries' eggs although it hasn't been proven."

"The threat of spreading a disease would be the main problem. If Foot and Mouth Disease comes into the country, that can affect all our cattle and the whole country. This is the biggest negative, and crop damage [is also a negative aspect of pigs]. They are the main negatives. Last year and this year, cane prices have been very high [compared to the past low pricing] so it'd be upsetting if pigs come along and destroy the paddocks [which are more valued now]."

Additionally, a few officers expressed concern about the dispersal of noxious weeds by pigs such as pond apple (*Annona glabra*):

"There are more pigs in Cow Bay (in Daintree), where there's pond apple infestation. Pigs like swamps, where pond apple grows, and pigs like pond apples. There's approximately 50 to 60 hectares of pond apple infestation [in Cow Bay]."

Negative socio-economic impacts on the tourism industry were also raised as a cost of pigs to be mitigated, such as safety issues related to potential attacks to tourists and degradation of the "aesthetics" of the national park, part of the touchstone for presenting the environmental values:

"Safety issues for visitors [to the Daintree National Park]."

"Presentation issues for national parks. Ground-digging by feral animals in national parks can affect aesthetics and the tourism industry."

The officers noted, however, that safety complaints about pigs were mainly from the local residents near the national park rather than tourists.

Despite the environmental and economic costs, a few officers acknowledged benefits especially positive socio-economic impacts related to the hunting industry:

“For rural areas, recreational pig hunters are selling meat – employing a lot of people inland. Lots of money is tied up in pig hunting and shooting. From their perspective, there are positives on feral pigs.”

“Pigs bring money for hunters with dogs, rifles, bow and arrows because of all the gear and equipment as well as utes, fuel, food including tourism in local areas, chiller/pig boxes. Good export to Hungary, Russia and China. The Council could allocate a bounty to hunters, which brings money to the community.”

6.2.2. Government officers' attitudes toward the contributions of the Daintree feral pig trapping program to the local community and toward current pig management

Most local residents were supportive of trapping and of the government-funded pig trapping program in Daintree and Cape Tribulation (Chapter 3). Almost all the government officers also asserted that the program had positive contributions to both the government and the local community because it had reduced negative complaints about the government “not doing enough”:

“The control program in Daintree has drastically reduced the number of complaints from the public. I used to have to write a Ministerial letter once a month because of the public whinging about pigs but since the pig control has been in place, I haven't had to write any letter for a long time. Before the program started, people used to complain about national park management, saying the national park is a breeding ground, especially during the dry season when there were more visitors. Council gets more complaints to do with agricultural damage. We used to get complaints from Cow Bay especially around the two waterways Baileys Creek and New Hutcheson Creek. But not anymore because there are a few traps there.”

Another positive social outcome of the trapping program was that the trapper built good rapport with the local community and improved residents' satisfaction with the government. The trapper was also a local resident in Daintree and drove around the area daily to set up and check the traps located in and around the residential areas and in the rainforest. Because some of the government traps were set within private properties, the trapper had frequent personal and informal contact with the private local landholders.

Other landholders without traps could also see the trapper doing the work when he drove along in a Council car with trapped pigs hung at the back of the car. An officer interviewed argued that the trapper served as a “third party” who was perceived to be neutral (“not belonging” to the park) because he was a contractor, not a permanent QPWS employee:

“The pig trapper is very good with the public. He is a contract trapper and people see him differently from us [QPWS staff]. They love him and he has good rapport with them.”

Some officers, however, disagreed that the trapping program was sufficient because some residents expected eradication but the program was designed to control rather than eradicate pigs:

“It is a control program, not an eradication program. The main purpose of the government control is to preserve the conservation value of Daintree and to assist landholders in controlling pest animals for local reduction as part of community service.”

In response to the local residents’ perception of a lack of control (particularly in national parks), the officers argued that the achievable level of control depended on resource allocations and that the program could potentially control more pigs (i.e. therefore gaining better public satisfaction) if greater resources were allocated to the ground work:

“I think more could be done. We can definitely have more on-ground funding, more money put towards pig control, including trappers and traps. More could be done on that level. There’s always money set aside for pig control yet what’s actually been done? There’s only one trapper here in Daintree and there’s not a lot of on-ground work done. You could have ten times the amount of pig trappers, people on the ground actually working. There seems to be a lot of pig control funding but the thing is where does it go? There’s a lot of agencies but it seems like there’s not many people actually taking pigs out. It’s a resource allocation issue. It depends on how serious the government is on getting rid of pigs. Concentrate a lot of money on people on ground actually getting rid of pigs, it might make a difference.”

“Yes, they [national parks] can be the source of pigs but it all depends on money or funding. If the State government has lots of funding on its budget for control, more control can be done. For example, only the West coast of Cape York Peninsula was controlled to prevent pig predation on turtle eggs but now the control covers the East coast too because of more funding being available. With more funding, the government can coordinate control much better. Funding allocation or prioritisation plays a big role when it comes to control in national parks.”

From the government officers' perspectives, the trapping program was also successful in expanding the availability and quantity of funding because it was collaboratively run by the local and State governments as a joint contract to secure "sufficient" funding:

"QPWS used to burden one third of the costs but now it is half of the expenses [of the trapping program]. The most expensive part of control is disposal of pig carcasses and QPWS pays these disposal costs. The Council pays administration costs in kind."

Despite this joint delivery of the program, the State government normally concentrates their efforts on Class 1 pests (under the *Land Protection Act 2002*) while the Council focuses on Class 2 and 3 pests to ensure that landholders are controlling those pests. Therefore, the local Council is mostly responsible for controlling pigs because pigs are a Class 2 pest. The previous Douglas Shire Council (amalgamated into Cairns Regional Council in 2008) was successful in securing pest management staff, including for pig management, in addition to there being greater funding availability for the trapping program in the Daintree area since 2005.

Additionally, there was a perception of the high legislative or political commitment to control pigs, which also attracted greater funding for the program:

"Priority of government in resource allocation is a key too. If pigs do not have high priority, there will be less control thus more complaints as well."

To maximise the allocation of limited resources, funding for pig control was concentrated and prioritised in Daintree and Cape Tribulation owing to their conservation values:

"We prioritised the Daintree lowlands as it was an obvious hot spot, with many complaints from the community. It made sense to focus efforts there for conservation and environmental outcomes."

In other words, the amount of funding available was insufficient to control the entire protected areas in other parts of the WTWHA. This priority-driven approach of control created an unequal distribution of funding allocations for pig control within the same region, and the trapping program may be perceived to be insufficient in some areas, thereby generating the perception that the WTWHA lacked pig control and was serving as a pig habitat:

"Only a few little pockets of the Wet Tropics have been protected such as Daintree [by the government]. There's a lot of other areas where a lot more could be done. In [Atherton]

Tablelands [in the Wet Tropics], no funding allocation is there. They want to trap in the mountains but have no money.”

“We’ve had minimal effects at a local level. 80% of the Douglas Shire Council area is World Heritage Area, which is a refuge for feral pigs.”

Because of the limited funding and priority-driven management of pigs, two government officers interviewed stressed that the public should not rely solely on the trapping program but engage in “tenure blind” control of pigs:

“That [people complaining about national parks being a breeding ground for pigs] is why we’ve started doing this trapping program with the Council. Our approach is tenure blind. When it comes to pigs, tenure or who owns the property doesn’t matter. There is no boundary in pest management including weeds. This is a pointless complaint. You need to be tenure blind when it comes to control. As soon as pigs are in private properties, local residents are responsible for that.”

Nonetheless, the trapping program may still play an important role in the management of pigs because a “tenure-blind” approach would be impossible without residents’ interest in control, or willingness to rectify the perceived problems caused by pigs:

“In the past, there was a government fencing program but it was up to landholders to maintain the fences. As a result, some people didn’t take care of it and the program didn’t work out.”

“I know a lot of properties that don’t do any control work at all. They all like to have high pig numbers so that they can have recreational hunters come in for a fee, especially for Cape York, not so much for Daintree. In Cape York, there’s a lot of stations doing pig safaris. They like having feral pigs and that makes pig control hard. One station is trying to bait pigs and keep pigs out whereas some other stations try to keep as many pigs as they can. Control efforts are not consistent among people. Unless pigs are causing direct problems, it’s not a problem to a lot of people. A lot of people have pigs coming across their properties but it’s not a problem to them. So the whole community control won’t happen. [It is] more for landholders and the governments. It is more effective to directly government-fund particular landholders.”

6.2.3. Government officers’ attitudes toward the different control methods

The government officers’ opinions about the control methods reflected mainly practicality, acknowledging the strengths and weaknesses of each control option in a particular situation. Although agreeing that trapping had drawbacks in some locations

including sugarcane fields, most officers regarded it as the “only” option available in national parks because of the impracticality of the other methods:

“Trapping in the sugarcane is very difficult because they don’t need to necessarily go into the traps. In the canes, they use dogs and sometimes poison [as more effective control methods] but if the farm is too close to a township, it is hard to poison.”

“In remote areas, they can’t access traps so can’t do any control [in national parks].”

“We just need to keep trapping in national parks because of the demerits of the other methods.

Fencing was perceived to be useful if the area controlled was small or if it provided “peace of mind” for farmers; however, four out of the five officers interviewed perceived the method to be impractical in the study area because of the costs of erecting and maintaining fences:

“Fencing is definitely good for small rural properties of 2 to 5 acres, adjacent to the World Heritage Area but it only shifts the problem and is too costly.”

“If there is some fence for farmers, it will give them peace of mind.”

Three officers opposed hunting with dogs/rifles especially if used for national parks because of animal welfare, safety risks and environmental costs arising from the use of dogs:

“Animal welfare is very important when it comes to pest control. Even if the animal is feral, animal welfare considerations are applied. It becomes problematic when hunters don’t pay for expensive vet treatments when their dogs are severely injured, Animal welfare of those dogs is compromised. Also, training hunting dogs is important so that they attack pigs properly.”

“From the national park management point of view, hunting is no good because of too many safety issues involved with guns and dogs. Hunting would be okay in open country but not in this kind of environment like the Wet Tropics. You also need to think about humane destruction of pigs.”

“Dogs are a huge issue. The top 4 impacts that lead to fatality of cassowaries is pig dogs that have escaped or not trained properly and become wild dogs.”

Nonetheless, two officers argued that hunting could be useful in areas like sugarcane paddocks and even in national parks where there were limited numbers of park employees to manage pigs, although hunting within the parks was not without drawbacks:

“Some people think hunting with dogs is no good but in a lot of places like sugarcane, dogs are the only way to get pigs because you can’t trap pigs, you can’t bait because it’s close to town and it’s very hard to shoot them once they are in the cane because you can’t see them. So dogs have a handy use there.”

“Shooting can be a good management technique in national parks because there are only a few rangers to take care of a national park, but allowing dogs in national parks causes other management issues. Accreditation of hunters can be very controversial and they may whinge about the whole process being stringent. In New South Wales, there is a Game Council and they are managing access to the national parks well because there are only a few gates for entrance. But in Queensland it becomes a difficult issue; you cannot monitor access to the rainforest or open country, for instance.”

All the officers expressed concerns about the use of poisoning especially in the rainforest because of potential negative impacts on non-target species and its ineffectiveness (due to lower intake of bait by pigs), although they did not oppose poisoning as a potential control method:

“Baiting is not practised in the Wet Tropics [within national parks] at the moment because of off-target concerns. Trials haven’t proved that it could be safe in the Wet Tropics. But in the right circumstances, baiting would be okay if targeted. The Council has done some baiting on agricultural land. It was a targeted area with monitoring with cameras. Savannah or open country would be okay for baiting.”

“Pigs don’t eat manufactured baits [PIGOUT] and poisoning doesn’t work at all”.

One officer suggested the usefulness of poisoning as an effective method if coordinated at a larger scale rather than only one or two properties poisoning:

“In-migration of feral pigs is a concern when poison baiting. Therefore, a large scale poisoning on a coordinated basis is necessary. It requires involvement of as many landholders as possible and timing is important” [see Figures 6.1 and 6.2]

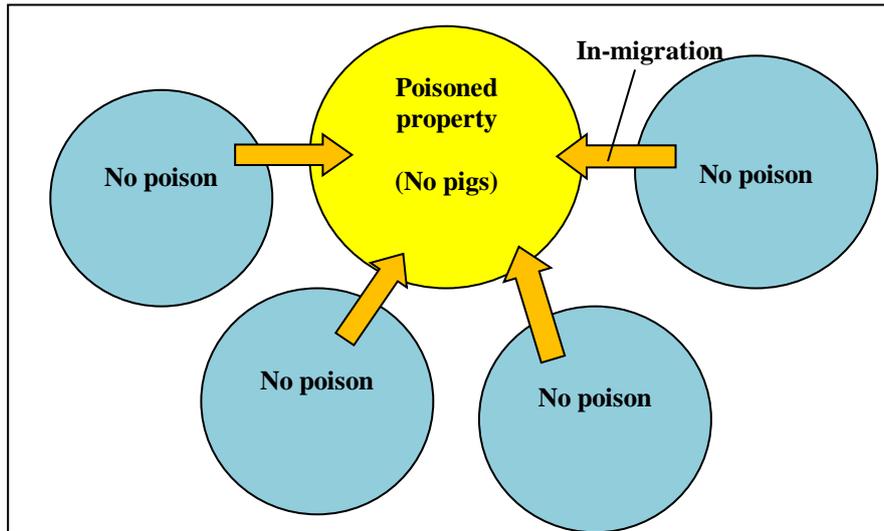


Figure 6.1. Compromised control efforts using poisons as a result of a lack of cooperation with adjacent landholders; this kind of poisoning on a small scale cannot prevent in-migration.

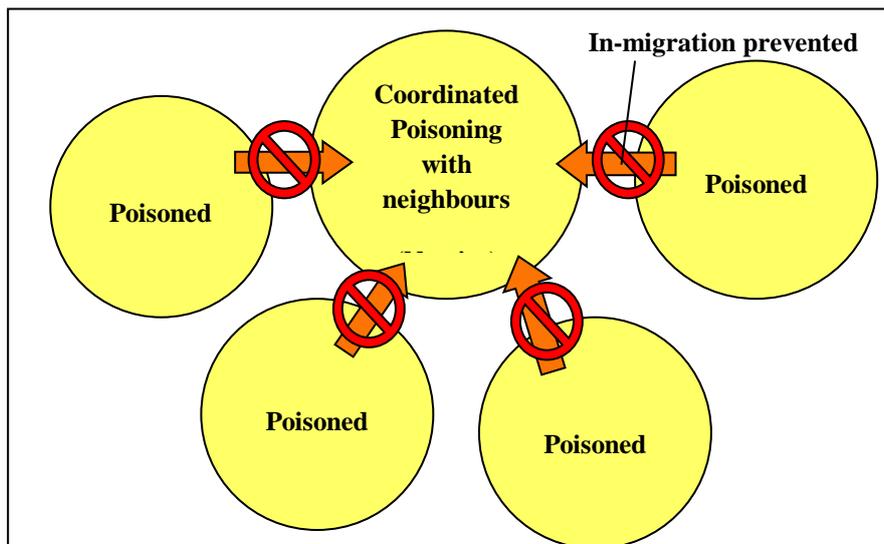


Figure 6.2. Prevention of in-migration of pigs by coordinated control efforts with adjacent landholders; the population will not recover, nor migrate quickly.

Regardless of the effectiveness or geographical scale, an officer acknowledged the difficulty of applying poisoning because of the public’s negative perceptions of “poisons”:

“1080 is political because the community perception of poisoning counteracts the use of poisoning bait. We still get complaints from environmental groups regarding 1080. So control doesn’t necessarily reduce the number of complaints.”

Based on the strengths and weaknesses of each method, most officers advocated the multiple-use of methods that were the most suitable to a particular situation or location:

“Integrated Pest Management is the key, taking into account the community aspects as well as the strengths and weaknesses of different control methods. Use the whole tool box and target pigs in different ways. For example, during the wet, pigs feed on vegetation and don’t eat anything else so trapping is not effective during this period of time so shooting can be employed during the wet outside the township. Near the township, you cannot hunt or poison so trapping is the only method. During the dry, when pigs start becoming skinny due to a lack of food sources and harder ground in addition to their chance of getting diseases, poisoning becomes more effective outside the township and after the baiting, shooting can be employed to get rid of the rest. Trapping can be [continuously] set up in the township.” [see Figure 6.3]

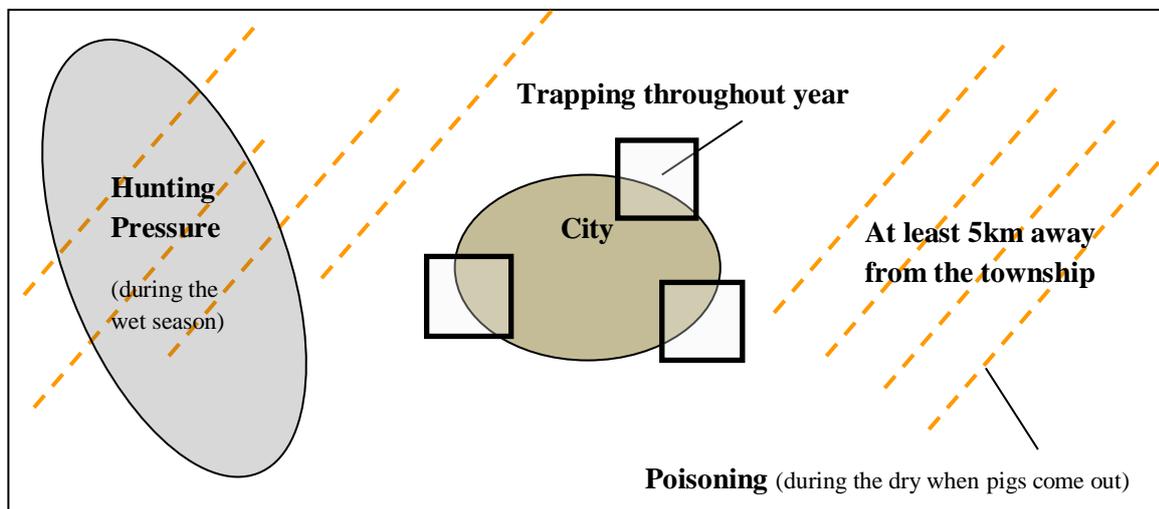


Figure 6.3. “Integrated Pest Management” using the whole tool-box given the applicability of each control method in a social context.

6.3. Summary of the government officers’ perspectives

The government officers’ strong belief that pigs should be “controlled” or “managed” was symbolic of their role in management, and reflected the current federal and State government proposition that feral pigs are a noxious pest to be controlled and managed but cannot be eradicated. Their emphasis on controlling pigs was based on their governments’ proposition that the ‘high conservation values’ of the WTWHA rainforest should be protected from the environmental impacts of pigs. Examples include predation on native animals, deterioration of water quality, and soil erosion. They also

perceived that as public servants for the local communities, they needed to mitigate the economic impacts of pigs, including transmission of diseases to livestock, such as Foot-and-Mouth Disease, and crop damage, particularly to sugarcane. The officers highlighted the dispersal of noxious weeds of national significance such as pond apple (*Annona glabra*) and the degradation of the “presentation” quality of national parks via pig digging and wallowing (i.e. negative impacts on the local tourism industry). These impacts were not considered to be important by the other stakeholders; this reflects the government officers’ knowledge of, and familiarity with, the broad environmental and socio-economic implications of pigs.

In protecting the “conservation values” of the rainforest (i.e. mitigate the perceived environmental costs of pigs), all the officers perceived that the Daintree pig trapping program had been “successful.” Firstly, the public’s complaints about pigs have been reduced. Secondly, the local presence of the professional trapper improved the image of the government and of the management by the local Council because of his positive interaction with the local residents. However, the perceived positive contributions of the trapping program may be offset by the public’s higher expectations of management outcomes (i.e. eradication) (Chapter 3). The officers argued that because of priority-driven and limited funding for pig control, control efforts through the trapping program were inconsistent throughout the study area and may be perceived to be insufficient overall. Instead of relying solely on the trapping program, some officers stressed the importance of controlling pigs with a “tenure-blind” approach. Nonetheless, the trapping program may still be the most effective way to deliver control because tenure-blind was often inappropriate where the pest problem was highly localised and landholders disagree with the severity of problems.

Lastly, the government officers focused mostly on technical or practical aspects of the methods available in supporting the control methods available. Based on the advantages and disadvantages of each control method, they advocated the use of a combination of methods depending on context: Integrated Pest Management or IPM.

These government agencies’ perspectives are useful for understanding the differences between local community and government perceptions of the impacts of pigs as well as their expectations of management outcomes. One of the main aims of the government trapping program is to ‘protect the conservation value of the Daintree rainforest’. Main economic users of the rainforest include not only local communities

but also the rainforest tourism sector. Thus, it is important to understand tourism perspectives on the impacts of pigs and the control methods so that the susceptibility of the industry to pig impacts and management can be examined. The next chapter, Chapter 7, will explore tourists' and tourism operators' perceptions in detail.

Chapter 7: Tourism perspectives

7.1. Introduction

Protected areas, such as national parks and World Heritage Areas, are considered the best examples of a nation's biological riches. IUCN Protected Area Category II also recognises protected areas as important tourist attractions as well as a foundation for biodiversity conservation. Hence, governments actively promote tourism in protected areas (Ceballos-Lascurain, 1996). In the WTWHA, ecotourism is the primary mode of tourism, which benefits from natural attractions of protected areas such as rainforests (Weaver and Lawton, 2007). For such nature-based tourism, a clean and undisturbed environment, or 'wild nature' is an important part of the tourism experience (Chan and Baum, 2007, Mowforth and Munt, 2003). Based on their 'natural' attractions, national parks and World Heritage Areas attract revenues from the tourism industry (Ceballos-Lascurain, 1996). That is, both tourism and World Heritage Areas can be in a mutually beneficial, symbiotic relationship where tourism depends on the quality of the World Heritage environment as a prime attraction for tourists, and in turn, tourism serves as a powerful incentive for conservation, and as a revenue generator for World Heritage Areas.

Invasive alien species, such as feral pigs, are one of the most serious threats to protected areas as they can lead to biodiversity decline (Tu, 2009). That is, feral pigs can have negative environmental and economic implications for the tourism industry. However, no study has investigated the implications of the presence of feral pigs in protected areas, including the sustainability of rainforest-based tourism in the WTWHA. As the government officers interviewed mentioned (Chapter 6), feral pigs may threaten the 'presentation' values of the WTWHA rainforest through their digging and wallowing. 'Presentation' of natural heritage of outstanding universal value such as the WTWHA is an important aspect of the UNESCO World Heritage Convention (Leask and Fyall, 2006). Identifying tourists' perceptions of feral pigs is also important to determine the susceptibility of the tourism industry to pigs (Smorfitt et al., 2005). Therefore, tourists are important stakeholders in the general context of World Heritage Areas (Bentrupperbaumer et al., 2006). Tourism operators are also an important

stakeholder group as providers of services to the tourism industry, and therefore, their perceptions should be incorporated.

This chapter aims to examine whether feral pigs are perceived to be a threat to ‘values’ of the WTWHA rainforest and tourists’ rainforest experience. Firstly, recreational benefits that tourists sought through the rainforest experience were investigated as components of their rainforest ‘experience’. Secondly, whether pigs influenced rainforest experience was measured based on a combination of two factors: tourists’ previous knowledge about the presence of feral pigs in the WTWHA and actual sighting of ‘disturbance’ or ‘damage’ caused by pigs on the rainforest during their visit. Tourists’ acknowledgement of pigs’ existence reflects their greater likelihood to notice ground damage and their ability to associate it with feral pigs, therefore, their susceptibility to a negative rainforest experience. Actual sighting of ‘damage’ itself alone could lead to a negative experience, depending on how tourists perceive it. Tourists’ attitudes toward the control methods were also investigated. The chapter also focuses on tourism operators’ perceptions of rainforest values, the impacts of pigs on those values and on tourists’ rainforest experience; and their attitudes toward the current management of pigs and control methods. The data to address tourists’ perceptions were obtained from quantitative tourist surveys and tourism operators’ perceptions from both qualitative semi-structured interviews and quantitative household surveys (Chapter 2). A total of 276 tourists were surveyed at Mossman Gorge and at Marrdja Botanical Walk, and 11 tourism operators were interviewed via convenience sampling and 19 tourism operators were surveyed via household surveys (Chapter 2). Some survey respondents did not answer every question, and thus, the number of responses varied with each question.

7.2. Results A: tourists’ perspectives

7.2.1. Visitor profile

A total of 276 tourists were surveyed, representing 70% of those approached to participate. Most of the tourists surveyed were self-driving with flexible time schedules. Tourists on buses could not be surveyed easily because of ‘tight schedules’ (Table 7.1), and this may have resulted in some bias.

Table 7.1. Reasons for non-response to the tourist surveys about the impacts of feral pigs on rainforest tourism in the WTWHA.

Reason for non-participation	Count	(%)
<i>I don't have time.</i>	36	30.8%
I'm not interested in surveys.	23	19.7%
<i>Busy with kids</i>	17	14.5%
<i>Bus tours 'tight schedules'</i>	13	11.1%
I'm a local, not a tourist.	9	7.7%
I don't speak English.	7	6.0%
I don't care about pigs.	5	4.3%
I don't have glasses with me.	4	3.4%
I just arrived in this area.	2	1.7%
I haven't seen the rainforest yet.	1	0.8%
TOTAL	117	

Gender of the respondents was almost equally distributed with 137 females and 138 males (with no record of age and gender of one respondent). Most tourists (40%) were young and aged between 18-29 years (Figure 7.1). The majority were either from overseas (46%) or domestic tourists from states other than Queensland (40%) (Figure 7.2). Local tourists from within the WTWHA were only 8% and Queensland tourists 6%. Overseas tourists were dominant during the low and medium tourism seasons (64%) and inter-domestic tourists during the peak season (49%). The high proportion of inter-state domestic tourists during the winter/high season was largely owing to the seasonal mobility of domestic tourists from the South to travel to areas with a warmer climate as well as coincidence with the school holiday season. The State of residence was described by 64% of the domestic inter-state visitors, and the majority were from New South Wales (44%), followed by Victoria (24%), South Australia (16%), Western Australia (9%), Australian Capital Territory (4%) and Tasmania (3%). Overseas tourists' countries of origin varied with season (Table 7.2). During the low and medium seasons, they were mainly from Germany (33%) and the U.K. (26%), and during the peak season from the U.S. (27%), France (18%) and New Zealand (13%).

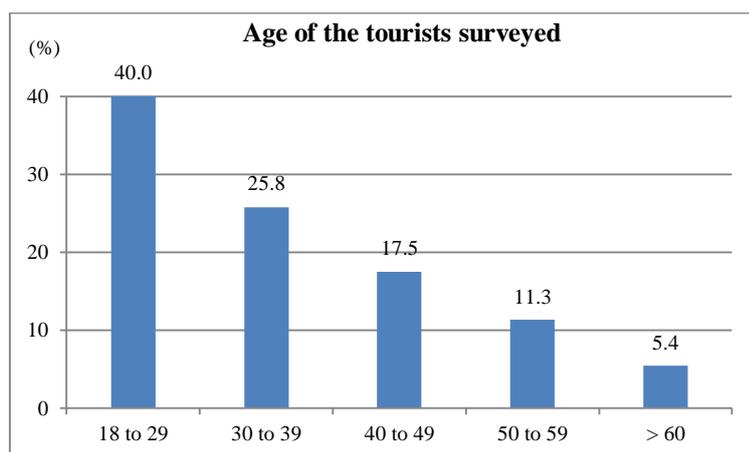


Figure 7.1. Age groups of the tourists surveyed in the WTWHA.

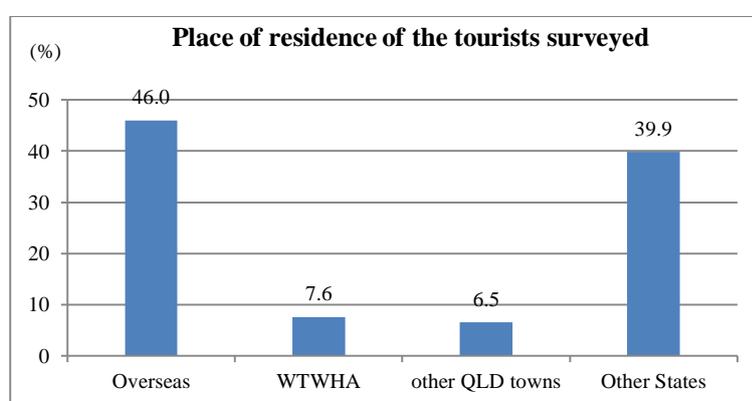


Figure 7.2. Place of residence of the tourists surveyed in the WTWHA.

Table 7.2. Origins of country of the overseas tourists surveyed in the WTWHA.

Country	Low/Medium Season (n)	High Season (n)	Total (n)	% of total overseas tourists
Germany	21	5	26	20.5
The U.S.	4	17	21	16.5
France	5	11	16	12.6
The U.K.	10	5	15	11.8
New Zealand	3	8	11	8.7
Ireland	5	3	8	6.3
Switzerland	4	2	6	4.7
Canada	1	4	5	3.9
Netherlands	0	4	4	3.1
Sweden	3	0	3	2.4
Spain	2	0	2	1.6
Austria	2	0	2	1.6
Norway	0	2	2	1.6
Philippines	1	0	1	0.8
Italy	1	0	1	0.8
Denmark	1	0	1	0.8
Belgium	1	0	1	0.8
Luxembourg	0	1	1	0.8
Hong Kong	0	1	1	0.8

The average number of days spent by the tourists surveyed in Mossman and Daintree varied (Table 7.3; Figure 7.3). Those from within the WTWHA had a relatively short-term visit possibly because of the short travel distance. Those from overseas and states other than Queensland stayed longer possibly because most of them were self-driving tourists (i.e. according to the tourism operators interviewed, tourists on buses would stay daily or for a few days). Domestic tourists from within Queensland tended to stay the longest. The average number of days spent by the tourists surveyed was six days. Those who did not specify the number of days were mostly locals who lived within the study area.

Table 7.3. The average number of days spent by the tourists surveyed in the WTWHA, distinguished by their places of residence

Place of residence	Mean	N (# of tourists)	Std. Deviation
Overseas	7.5	127	27.3
WTWHA	2.4	14	2.0
Other QLD towns	10.1	18	12.2
Other States	5.2	110	5.2
Total	6.4	269	19.3

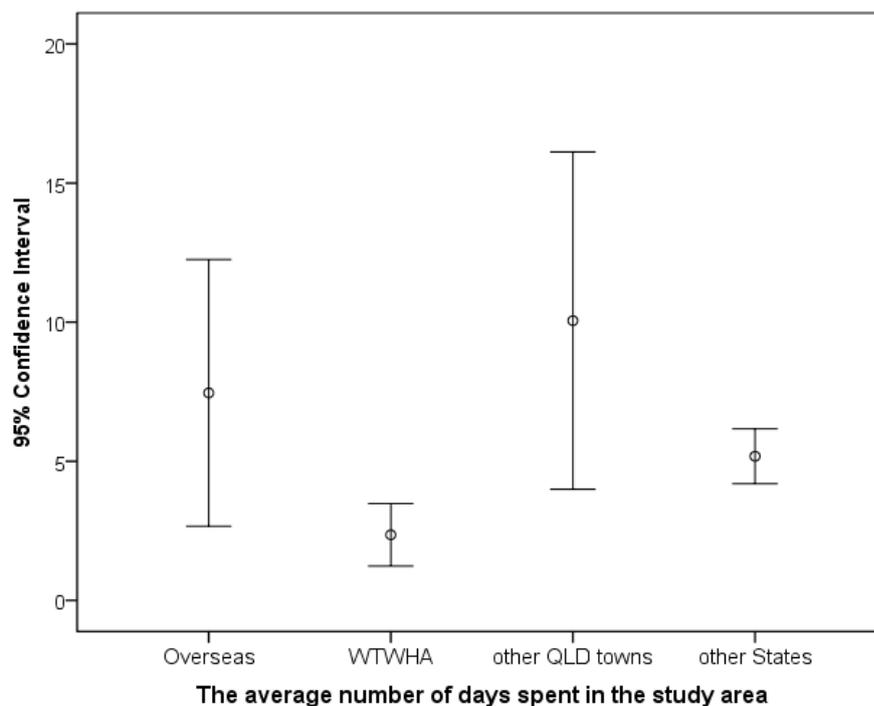


Figure 7.3. The average number of days spent by the tourists surveyed in the WTWHA, distinguished by their places of residence.

During the peak season, how visitors spent time in the rainforest was different between the two sites, Mossman Gorge and Murrinja Botanical Walk. Mossman Gorge experienced a high turnover of tourists with heavy traffic and crowds of self-driving tourists (Figure 7.4). Most of these tourists were families with children and/or bus tourists, quickly walking along the tracks, and some had been swimming in the nearby creek. By contrast, Murrinja Botanical Walk was uncrowded, and the visitors were in no rush (Figure 7.5). They took time to look around and paid attention to interpretation signage. The response rate was 85.1% (74 out of 87 tourists) at Murrinja Botanical Walk, higher than the 59.8% (101 out of 169 tourists) at Mossman Gorge.

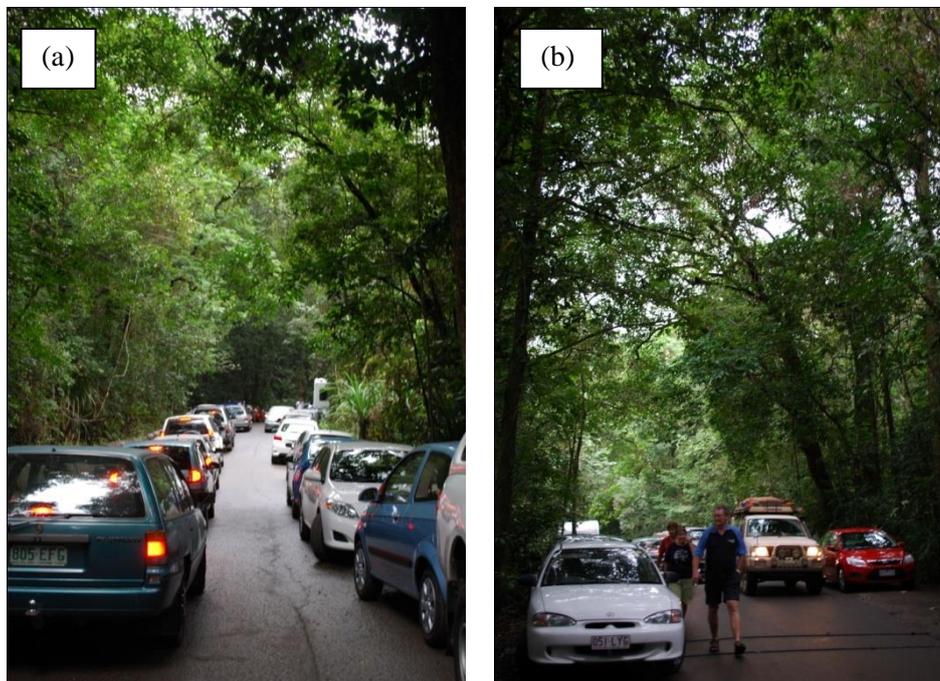


Figure 7.4. (a) & (b): Crowdedness of Mossman Gorge with self-driving tourists during the high season.



Figure 7.5. (a), (b):Marrdja Botanical Walk relatively free of tourists during the high season.

Previous tourist surveys in the Daintree rainforests (Bentrupperbaumer, 2002, Hill and Gough, 2009) offered similar results of visitor profile such as non-response reasons, dominance of self-driving tourists, non-local use of the rainforests, and age groups of the majority of visitors. Bentrupperbaumer (2002) found that 45% of the visitors in Daintree were with organised tours, but it was difficult to obtain their participation in the survey because of their “tight schedule”. Hill and Gough (2009) found that the Daintree rainforests were important for non-local use as the majority of those surveyed were young visitors from overseas and areas outside the WTWHA region, aged between 20 and 29 years who travelled in a hired car. Bentrupperbaumer (2002) also found that the majority of the overseas tourists were from the U.K. (33%) and the U.S. (16%). Although the current study did not investigate educational attainment of tourists, Bentrupperbaumer (2002) and Hill and Gough (2009) reported that most tourists were well educated with a tertiary level degree.

7.2.2. Values that tourists ascribed to the WTWHA rainforest

Approximately 90% of the tourists surveyed articulated a wide range of rainforest values and some of them articulated more than one value (Table 7.4).

Table 7.4. Values the tourists surveyed ascribed to of the WTWHA rainforest in the order of frequency (n= 244).

Rank	The values articulated	% of the respondents
1	Biodiversity	14%
2	Nature/Environment/the Wild	13%
2	Ecology/Ecological, Ecosystem	13%
4	Recreation and ecotourism (uniqueness, rarity, age, heritage)	12%
5	“Very important”	12%
6	Provision of habitat	11%
7	For species survival	8%
7	Air regulation	8%
9	The need for protection	7%
10	Climate regulation	6%
11	“Balance of nature”	3%
12	Aesthetic values	3%
13	Educational values	2%
<i>Other values:</i> Important for future (2.1%), climate change, medicine, fresh water, cultural heritage, not sure, everything		

Predominantly, most values failed to indicate a particular function or economic use value of ecosystem services. In total, 58% of the tourists articulated ambiguous values that failed to correspond to the classified values of the TEV and MA frameworks. In particular, the terms associated with ideas of the forest being untouched or undisturbed were the second most common values:

“Nice nature”

“We don’t live here.”

“It’s one of the few places untouched by humans.”

Similar concepts used to express rainforest values included “conservation” or “the need to preserve the rainforest”:

“Totally necessary. If you clear it, it’s going to be desert so it’s no good but I can’t put this in words, don’t know how to word it.”

“Protecting nature in general is important.”

A more ambiguous value was “very important”, implying that the tourists were unable to clearly articulate why the rainforest was important. Other ambiguous values reflected the concepts of “environment”, “ecosystem” and “ecology”:

“[The rainforest is] important for the ecosystem”

“Good things for the environment”

“Protection of ecology”

“It contributes to the ecosystem.”

Despite the ambiguous values, some tourists did express values manifested within the frameworks (Table 7.5). “Biodiversity” was the most popular value, which underpins all the ecosystem services. “Biodiversity” also indicates “provision of habitat for species”. Values associated with “recreation and ecotourism values” of cultural services in the MA (i.e. direct non-consumptive use values in the TEV) were also common. “Uniqueness,” “rarity,” “age,” and “heritage” were considered to fall under “recreation and ecotourism” values. “Aesthetic” and “educational” values were also related to “recreation and ecotourism” values. A minority articulated values associated with regulation services (i.e. indirect use values) or production services (i.e. direct consumptive use values). These values, such as biodiversity, habitat provision, and recreation, referred to non-use values or non-consumptive use values, or the life supporting and cultural aspects of the ecosystem services.

Table 7.5. Values the tourists surveyed ascribed to the WTWHA rainforest and that corresponded to the classified values of the MA and TEV frameworks (n= 144).

TEV		MA		Quotes (examples)	Ecosystem structure: Biodiversity (Provision of habitat for wildlife)
Use value	<i>Direct use (consumptive)</i>	Provisioning Services	<i>Medicine</i>	Medicine that we aren't aware of.	
			<i>Fresh water</i>	Water creation; The rain	
Use & Non-use value	<i>Indirect Use</i>	Regulating Services	<i>Clean air</i>	Providing clean air.	
			<i>Air regulation</i>	Allowing the planet to breathe; The lungs of the world/planet; The ecosystem for oxygen; Atmospheric interaction; Balance the atmosphere for the whole world; Absorption of carbon dioxide;	
			<i>Climate regulation</i>	Important for global climate; Climate control for earth; Climate balance	
	<i>Direct use (non-consumptive) + Option + Existence</i>	Cultural services	<i>Recreation & Ecotourism</i>	Important for tourism; Relatively easily accessible to experience; It's a great experience; Unique experience; Ancient; World Heritage Area; Rarity; Biodiversity	
			<i>Aesthetic values</i>	Natural beauty; Attractive; Serenity	
			<i>Educational values</i>	Lots of fauna & flora species to study; New discoveries for science	
			<i>Cultural heritage</i>	Cultural heritage	

7.2.3. Recreational benefits of the WTWHA rainforest: the significance and reasons for visiting the rainforest

The survey first examined the importance of the rainforest as a tourist attraction. Almost all the tourists surveyed (94%) rated the visit ‘important’ or ‘very important’ with no significant difference between the low/medium and high seasons (Figure 7.6).

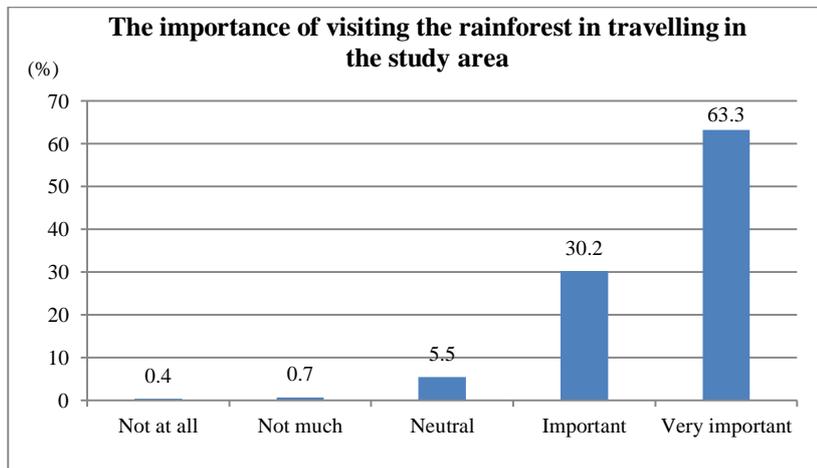


Figure 7.6. High significance attributed to visiting the WTWHA rainforest by the tourists surveyed (n = 275).

Those surveyed expressed a number of reasons for visiting the Daintree rainforests (Table 7.6). To enjoy the uniqueness of the rainforest environment and experience was the most popular motive: “being the major attraction of North Queensland” and “not having experienced a rainforest before”. To encounter scenic beauty or enjoy the aesthetics of the environment was the second most important recreational benefit. Thirdly, visiting the rainforest was “something to do for holiday/vacation”. Responses that reflected this motive included “tourism,” “tourist,” “sightseeing,” “vacation,” and “holiday,” all of which indicated that visiting the area was merely part of their vacation, holiday and sightseeing activities. The fourth most popular motive was “education,” such as opportunities to learn about the rainforest ecosystem and wildlife. Other recreational motives such as “seeing flora and fauna”, “curiosity and interest in the rainforest” and “world and national heritage status” could also be categorised as the uniqueness and experience of the rainforest environment.

Table 7.6. Reasons for visiting the WTWHA rainforest that the tourists surveyed provided (n= 260).

Benefits sought	Quotes	% of tourists
Unique environment and experience	Never been to a rainforest before. Unique mix of rainforest, agriculture and coast Interesting to see something only occurring in some/few parts of the world Experience something very special. See something rare and unique It's typical of this part of Australia. First time here.	34%
Aesthetics	To see serenity Spectacular For the enjoyment of unspoilt beauty. We like to see pure nature See natural beauty at its best See how beautiful it is. The beauty of untouched forest.	25%
Something to do for holiday	Because we are here. Cheap bust trip to accommodation Short weekend away Holiday/Vacation/Travelling/Pleasure Sightseeing/Tourist/Tour/Tourism It's a tourist suggested place. Something to do for the day.	16%
Education	Gives me more understanding about nature Education Studies (for ecology class) Learn about wildlife/nature/ecosystem Learn about the ecology and threats to remaining rainforest Teach children	10%
Seeing wildlife	To see native plants and animals Photographing exotic animals See different types of plants and animals	7%
Curiosity & interest	Curious Interest Heard about it at school from people.	5%
Recreational activities	Swimming at the gorge Bush walk – Cape Trib Beach Bridge in Mossman Gorge	4%
World and National Heritage Status	World Heritage Area National heritage/treasure	2%
Relaxation	Relax, Relaxation Rest	2%

7.2.4. *The perceived implications of the presence of feral pigs for tourists' rainforest experience*

- (a) Factors that would determine the impacts of pigs on rainforest benefits or values: tourists' previous knowledge about their existence and sighting of their damage in the rainforest

Whether or not feral pigs could enhance or degrade tourists' experience of the rainforest depended on two factors: tourists' previous knowledge of the presence of pigs in the rainforest; and direct sighting of diggings caused by the animal. Two thirds of those surveyed (67%) were unaware of the existence of pigs in the WTWHA. There was a significant relationship between tourists' place of residence and previous knowledge about pigs ($p < 0.001$). Around 83% of overseas tourists and 65% of inter-state domestic tourists were unaware of pigs' existence; visitors from within the WTWHA (91%) and other Queensland areas (67%) were aware of it. There was no significant seasonal variation in the tourists' knowledge. A few informal interviews during the survey suggested that tourists' participation in tours may help them gain knowledge about the presence of pigs. For example, some tour guides educated tourists about pigs and showed some damage if sighted during walking in the rainforest. Because few bus tour members were surveyed owing to their "tight schedules," the results shown here may be idiosyncratic to more independent, self-driving tourists who may be uninformed of the presence of pigs owing to, for example, the absence of guides or non-participation in tours.

Sighting of pig damage was also rare; only 22% of the tourists noticed ground disturbance in the rainforest (Figure 7.7). The rest of the tourists (78%) saw no sign of disturbance or presence of pigs or were unsure about it. Tourists' place of residence had a significant relationship with their likelihood to notice pig damage ($p < 0.01$); 43% of the local visitors from within the WTWHA saw damage, but only 15% of overseas and 35% of inter-state domestic tourists noticed it. There was also seasonal variation in whether tourists saw pig damage in the rainforest ($p < 0.05$); during the low and medium seasons, only 11% of the tourists sighted pig damage, but 28% noticed it during the peak season. Their greater likelihood of noticing damage during the peak season was possibly because of more frequent pig diggings during that time. This is because when soil becomes drier and harder in the forest, particularly the dry season which coincides with the peak tourism season, pigs need to travel to the lowland to dig softer ground to

feed on earthworms (Hillier, 2001). The researcher observed that there were more extensive diggings and wallowing along the walking tracks in the peak season than in the low and medium seasons. During the peak season, damage in the Marrdja Botanical Walk was more extensive than in Mossman Gorge (Figures 7.8 and 7.9).

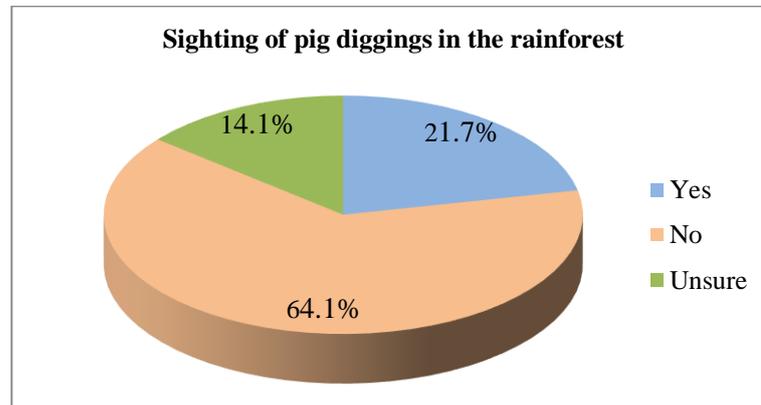


Figure 7.7. Proportions of the tourists surveyed who saw or did not see feral pig damage in the WTWHA during their visit (n= 276).



Figure 7.8. (a) & (b): pig wallowing and digging along the walking tracks in Mossman Gorge during the peak season.

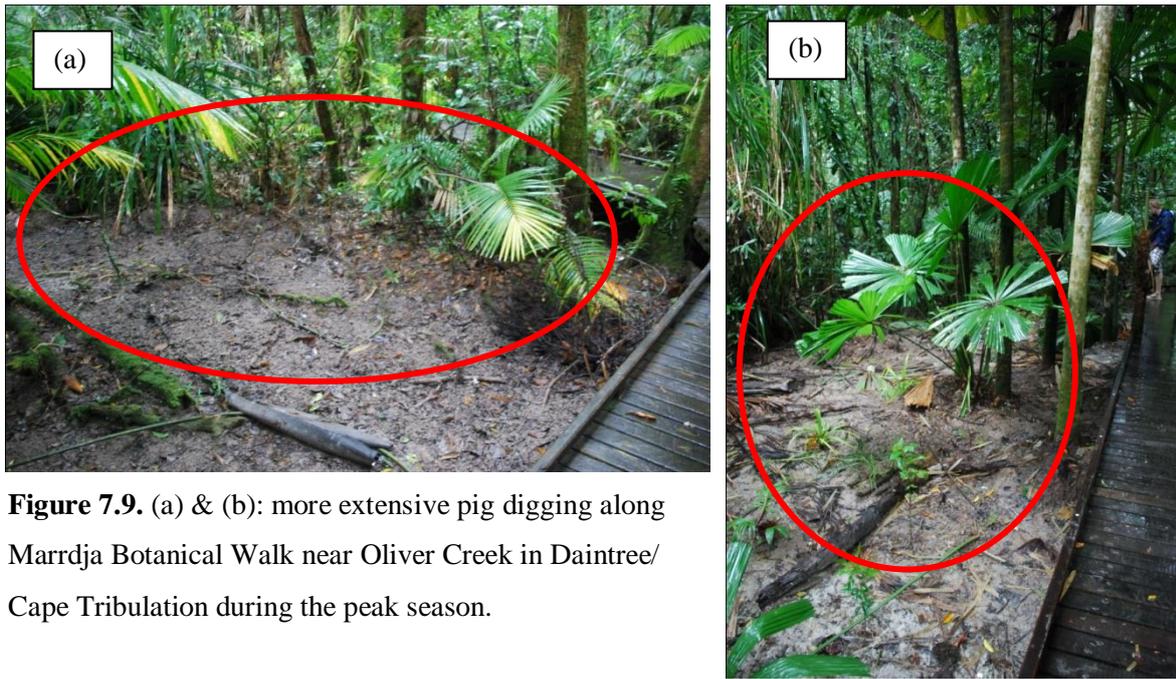


Figure 7.9. (a) & (b): more extensive pig digging along Marrdja Botanical Walk near Oliver Creek in Daintree/ Cape Tribulation during the peak season.

(b) The implications of tourists' previous knowledge about the presence of pigs and sighting of pig damage for their rainforest experience

Prior knowledge about the existence of pigs in the WTWHA had a significant relationship with tourists' likelihood of noticing damage ($p < 0.001$); those who knew about the presence of pigs were more likely to sight damage, whereas those who did not know about pigs were more likely to be uncertain whether they saw damage (Table 7.7). However, regardless of prior knowledge, the majority of the tourists surveyed (62 – 65%) were unlikely to notice pig damage (Table 7.7).

Table 7.7. Cross tabulation of tourists' previous knowledge of the presence of feral pigs in the WTWHA and sightings of pig damage in the rainforest during their visit ($n = 276$).

		Knowledge about pigs before survey		Total
		Yes	No	
Sighting of pig damage	Yes	31 (34%)	29 (16%)	60 (22%)
	No	57 (62%)	120 (65%)	177 (64%)
	Don't know	4 (4%)	35 (19%)	39 (14%)
Total		92 (100%)	184 (100%)	276 (100%)

Moreover, only 11% of the tourists (31 out of 276) surveyed could possibly have their rainforest experience influenced by the occurrence of feral pigs because they knew about their presence and then saw diggings in the rainforest (Table 7.7). In contrast, prior knowledge about the existence of pigs in the WTWHA could have no influence on rainforest experience for the majority of the tourists (57%, or 155 out of 276), who were unaware of the presence of pigs before survey and did not see or were unsure whether they saw damage (Table 7.7).

For those tourists who knew about the presence of pigs but did not see any damage (21%, or 57 out of 276), rainforest experience was unlikely to be affected; however, rainforest values may be diminished because they tended to be aware of the exotic status of pigs (next section). Those who saw damage but were unaware of pigs' presence (10%, or 29 out of 276) would not have their rainforest experience negatively affected. This is because these tourists seemed to have failed to associate the damage with the animal. Several tourists indicated they were unsure if diggings were caused by scrub turkeys (*Alectura lathami*) or pigs. Furthermore, even if they saw damage, the majority of those who saw it (55%) disagreed that it was a negative experience. Thus, a mere sighting of damage did not necessarily lead to negative rainforest experience no matter whether the tourists knew about the presence of pigs (Figure 7.10).

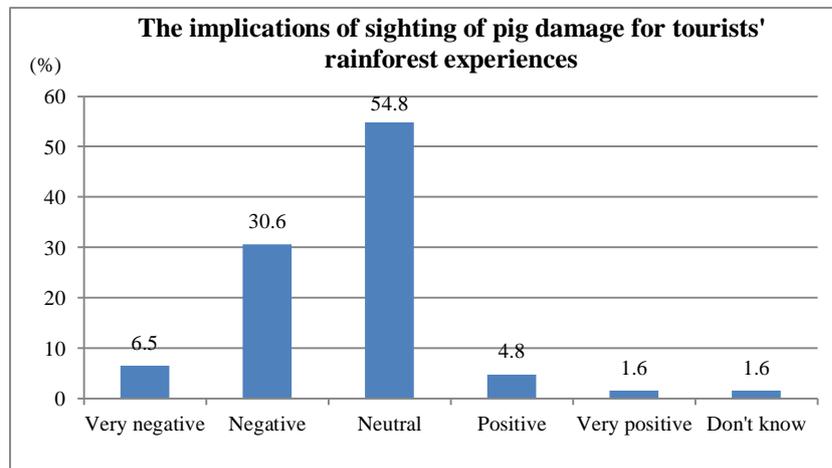


Figure 7.10. Rating of the extent to which sighting of feral pig digging in the WTWHA rainforest affected tourists' rainforest experience (n=62).

Those who were neutral or indifferent about the implications of sightings for their rainforest experience included both those who were and were not aware of pigs' presence. However, the reasons for their indifference toward damage sightings were

slightly different (Table 7.8). Those who were unaware of the presence of pigs failed to realise that the deep soil digging was caused by pigs, thereby having neutral or no negative experience. Conversely, those who knew about pigs' existence regarded diggings as being caused by pigs but as being "part of the environment".

Table 7.8. Reasons why sighting feral pig damage to the WTWHA rainforest did not lead to a negative experience, provided by the tourists surveyed (n=43).

Knew about pigs?	Reasons for indifference toward damage sighting	Quotes
Yes	<i>Pigs part of the forest</i>	They have been around so long – get used to them. Now part of the environment. I see this as a part of the forest.
	<i>No actual sighting of pigs</i>	I didn't see any pigs so it didn't affect me.
	<i>Not much damage</i>	There wasn't very many holes, may not be many pigs?
No	<i>Not much damage</i>	Not a lot
	<i>Nothing to compare to</i>	Didn't know any better
	<i>Uncertain about the effects</i>	I don't know if they cause much of a problem or not.
	<i>Did not realise it was due to pigs</i>	Didn't realise it was caused by the pigs. Didn't know what caused the digging.
		<i>[Thought it was natural or due to native animals]</i> I thought it was the bush turkeys that dug the soil. Didn't know what it was. Saw it as part of rainforest life. Didn't know what it was. I thought it was due to native animals so it didn't really affect me at all. Thought it was something else. Thought a native animal had dug the dirt. Thought it was native animals. I was assured that it was a native wild animal.

Nonetheless, 37% of those who saw pig diggings (i.e. but only 8% of the total number of tourists surveyed) perceived sighting as a negative rainforest experience (i.e. diminished recreational benefits) because most of these tourists knew about the existence of pigs and were aware of their environmental effects:

"Ecology is being damaged."

"Know what they do the environment, compete with native fauna, destroy flora, cause erosion and sedimentation."

Some tourists (particularly inter-state domestic tourists) negatively perceived the sighting of damage without knowing the presence of pigs because they were now confirmed by the survey that it was due to pigs and they knew its pest status in Australia:

“Because I thought it could be wild pigs”

“Now that I know what caused it – am very concerned.”

Most of those who negatively perceived sighting of diggings articulated the aesthetics and uniqueness of the rainforests, wildlife sighting and educational opportunities as recreational benefits of the rainforest (although not all the tourists who sought those aspects of the rainforests noticed and perceived damage sighting to be negative). Thus, these tourists were more likely to be interested in observing the rainforest (i.e. more likely to notice ground disturbance), compared to those who visited the rainforest for “something to do for their holiday”, “recreational activities” or “relaxation”.

(c) The perceived effects of the presence of pigs on rainforest values that tourists ascribed

In contrast to the negligible impacts of sighting of pig damage on tourists’ rainforest experience, over half of the tourists surveyed (57%) viewed pigs as “negatively” or “very negatively” affecting (i.e. depreciating) those rainforest values (Figure 7.11). Meanwhile, approximately 40% of the tourists (n=271) were neutral/indifferent or had no opinion about whether pigs enhanced/degraded the forest values they ascribed. The mean value was 2.06 ± 1.02 when “very negatively” was assigned a value of 1 and “very positively” a value of 5. “Don’t know” responses were omitted from the mean value.

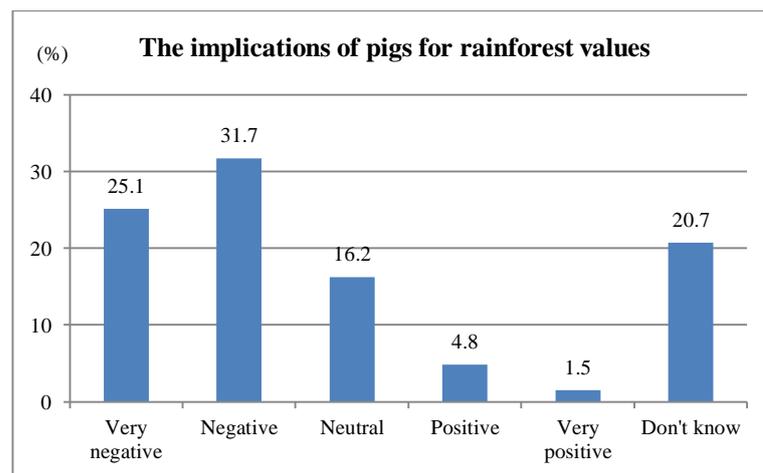


Figure 7.11. Rating of the degree to which the tourists surveyed believed feral pigs affected the values they ascribed to the WTWHA rainforest (n= 271).

Tourists' place of residence had a significant relationship with the perceived implications of pigs for rainforest values ($p < 0.001$). The majority of the overseas tourists (53%) were unconcerned and indifferent ("neutral") or had no opinion about this topic ("don't know"); only 37% of overseas tourists perceived pigs depreciated rainforest values. In contrast, domestic tourists were more likely to be concerned about the impacts of pigs on the forest values; only 23% of them were neutral or indifferent and 73% perceived pigs depreciated the values. Correspondingly, tourists' prior knowledge of the presence of pigs significantly related to the perceived implications of pigs for rainforest values ($p < 0.001$) (Figure 7.12). Those who were unaware of the presence of pigs in the WTWHA, such as overseas tourists, tended to be unconcerned or have no opinions about the impacts of pigs on rainforest values. Conversely, those who knew about pigs' existence, such as local and Queensland domestic tourists, tended to negatively perceive the impacts of pigs. Seasonality also had a significant influence; tourists perceived pigs *less* negatively during the low/medium seasons probably because there were more overseas tourists and/or because there were fewer sightings of diggings.

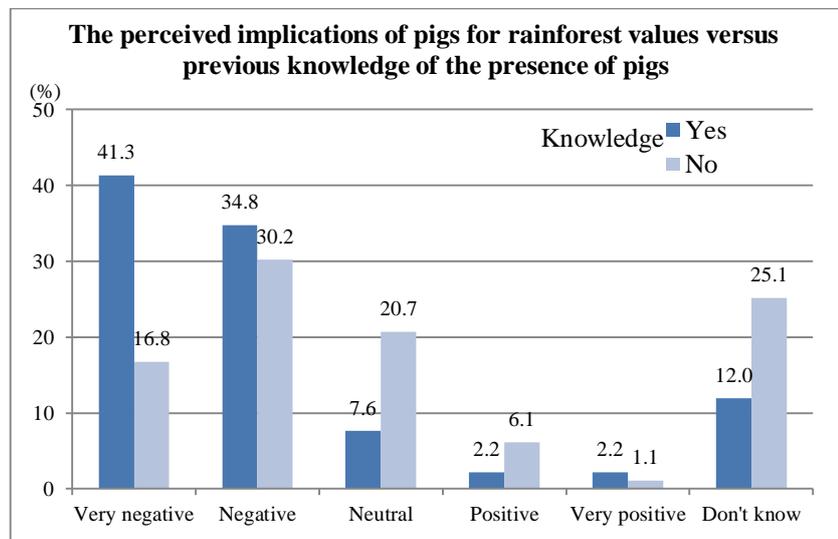


Figure 7.12. The relationship between tourists' prior knowledge of the presence of feral pigs and their perception of pigs' impacts on rainforest values (n= 271).

Nearly 50% of the tourists surveyed (n=132) articulated why they believed that pigs enhanced or degraded the rainforest values they ascribed. Those who believed that pigs enhanced or "very positively" affected the forest values were all overseas tourists; a minority of them even claimed that they knew about pigs' presence in the forest. They

argued that pigs “added to diversity”, “contributed to the variety” and “were an important part of the ecosystem”. The majority of those who believed that pigs “*positively*” affected the values were either overseas tourists or those who were unaware of the presence of pigs. These tourists would be unaware that pigs were “non-native” to the area. They argued that pigs had positive values for the rainforests such as:

“Diverse ecology I think.”

“Encourage fertilisation of plants”

“If this is their normal habitat, they may be important to maintain the balance in the forest.”

“Make it seem more alive and less manufactured.”

“They are fun for tourists to see.”

Those who were unconcerned about the implications of pigs for rainforest values were also unknowledgeable about feral pigs:

“Didn’t know they were there.”

“They live there. It’s their home.”

“Because I assume they are native to the environment.”

“If wild then all part of the experience.”

“Pigs usually don’t have positive associations.”

Nevertheless, some tourists may have had knowledge or at least guessed about the non-native status of feral pigs (“not green”, “not natural”, “feral”, “exotic”) even though they were unaware of the presence of pigs in the WTWHA before the survey. These tourists as well as those who knew about pigs’ existence tended to negatively evaluate the impacts of pigs on rainforest values:

“They are feral! Therefore shouldn’t be here (Evidence of human influence negatively).”

“I think people see pigs as domesticated animal so they think they don’t belong here.”

“Damage and create imbalance in ecosystem.”

“Disturbing the original nature.”

(d) Tourists’ desire to protect the WTWHA rainforest against feral pigs

If tourists believed that pigs had detrimental effects on the rainforest values, they would wish to protect the values through management/control. To validate the correlation, the survey measured the degree to which tourists wished to protect the rainforests against

pigs with a closed-ended question of a Likert scale. Those surveyed were asked to rate how much they thought pigs should be controlled on a scale from 1 (“not at all”) to 5 (“a great deal”) with an option of “don’t know” for those who held no opinion. Approximately 60% of the tourists believed that the rainforest should be protected from feral pigs (Figure 7.13). The mean value with standard deviations was 4.08 (± 1.09). Approximately 30% were indifferent or held no opinion about the topic.

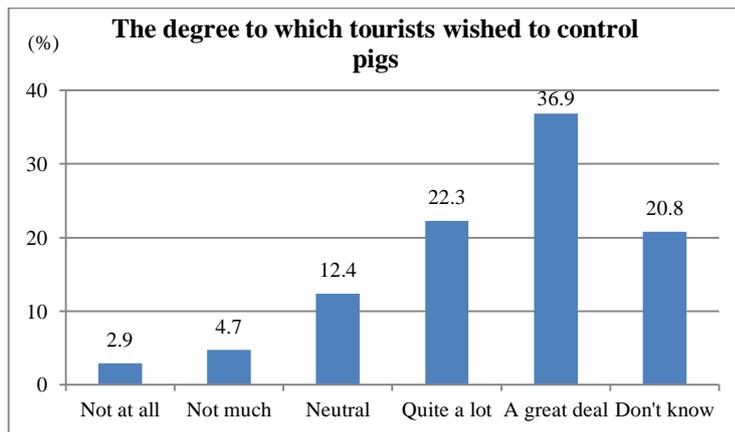


Figure 7.13. Rating of the degree to which the tourists surveyed wished to have feral pigs managed in the WTWHA rainforest (n= 274).

A significant correlation existed between the perceived negative impacts of pigs on rainforest values and the perceived need for pig control ($p < 0.001$). Accordingly, tourists’ previous knowledge about the presence of pigs as well as their place of residence also had a significant relationship with their attitude toward the need for pig control ($p < 0.001$). Most overseas tourists (50%) were indifferent or held no opinion; only 14% agreed that pigs needed to be controlled “a great deal”. Conversely, only 19% of domestic tourists were indifferent or held no opinion; 57% believed that pigs needed to be controlled “a great deal”.

7.2.5. Tourists’ attitudes toward the different control methods

Tourists’ attitudes toward the different control methods were investigated because of the potential implications of pig management on the tourism sector. The four different methods considerably varied in acceptability but with no seasonal variation (Figure 7.14). Tourists supported trapping and fencing and were disinclined to support hunting and poisoning.

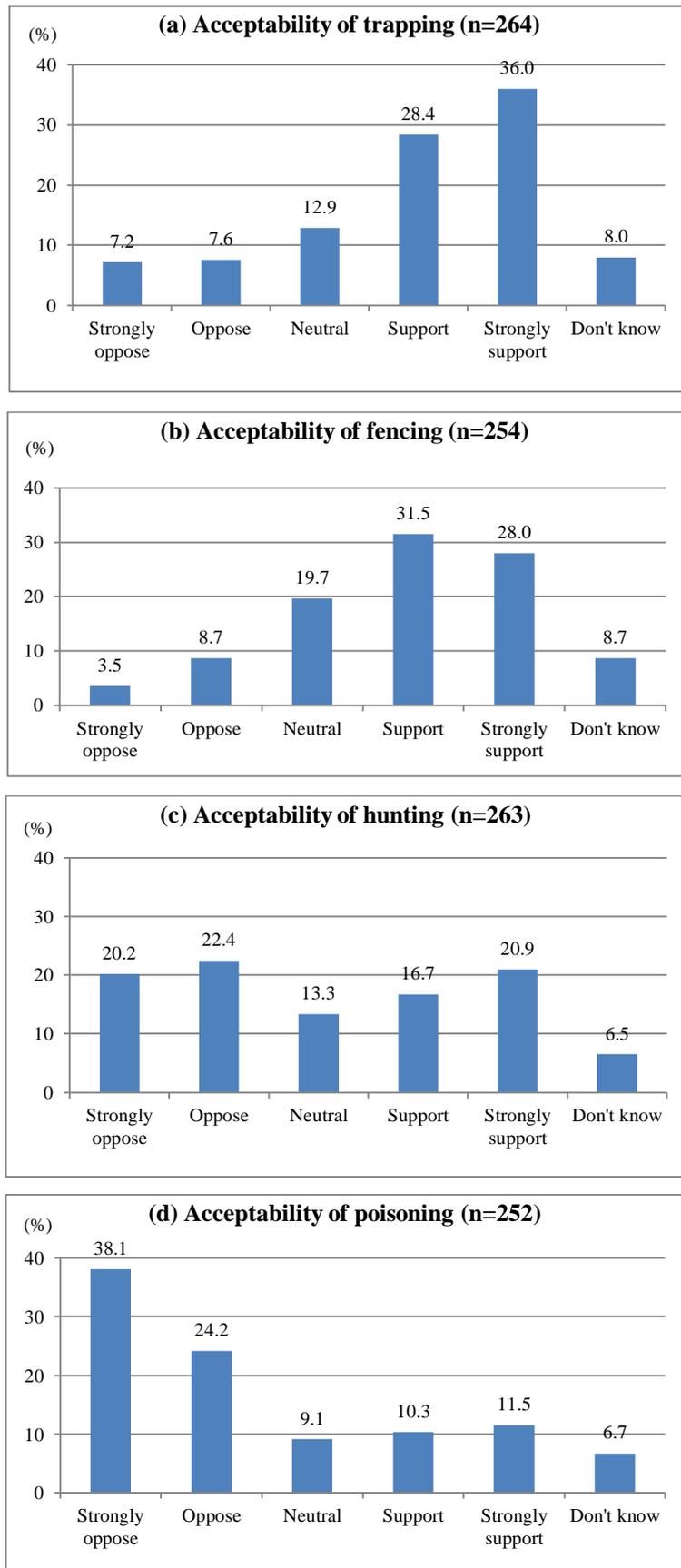


Figure 7.14. Rating of levels of social acceptability of the different pig control methods used in the WTWHA, from tourists' perspectives.

Numerical values that indicate levels of acceptability were based on the value of 1 assigned to “strongly oppose” and 5 to “strongly agree” with “don’t know” being excluded in the calculation. Trapping had the highest mean value (with standard deviations) of 3.9 (± 1.2), followed by 3.8 (± 1.5) for fencing, 3.0 (± 1.1) for hunting and 2.3 (± 1.4) for poisoning.

To understand the reasons why tourists supported/opposed the methods, the survey gave an open-ended question for them to articulate on their own terms. Approximately 60% of the tourists (n=165) articulated why they approved and/or disapproved of certain methods (Table 7.9).

Table 7.9. Specific reasons for supporting/opposing each pig control method used in the WTWHA, articulated by the tourists surveyed (*responses related to general opposition to lethal methods based on a perceived lack of humaneness were excluded)

	Support		Opposition			
Trapping	n=28	Humaneness	57%	N/A		
		Environmentally friendly	21%			
		Economic benefits	11%			
Fencing	n=14	Humaneness	79%	n=17	Not environmentally friendly	53%
					Lack of cost-effectiveness	47%
Hunting	n=11	Humaneness (with rifles)	46%	n=26	Lack of humaneness (with dogs)*	62%
		Socio-economic benefits	46%		Not environmentally friendly	27%
		Support only regulated	19%		Safety issues	11%
Poisoning	n=11	Support only if target specific	73%	n=49	Lack of target specificity	53%
					Lack of humaneness*	39%

Firstly, trapping was supported mostly for its humaneness:

“I support a quick and humane way of eradicating these introduced species – but in the most efficient way.”

“I support trapping if they could be disposed of humanely.”

The second most important justification for supporting trapping was that it incurred no environmental or aesthetic costs:

“Trapping does not destroy nature. All the other methods do destroy nature.”

A minority of tourists were in favour of trapping because of the ability and possibility to sell pig meat or utilise pigs caught after trapping:

“I support trapping if they could be used in the animal meat industry.”

Similarly, fencing was mostly supported for its relative humaneness compared to hunting and poisoning. Those who disapproved the nature of killing involved especially in hunting and poisoning tended to prefer fencing because it inflicted no killing.

“Killing the pigs seems inhumane. Maybe best to just keep them out by fencing.”

“Cruelty is why I disagree with trapping, hunting and poisoning.”

“I know they don’t belong here and destroy a lot but I just feel sorry for the animals too and don’t want to kill them.”

A minority of tourists opposed fencing, especially domestic tourists, because of the negative environmental implications (e.g. blocking wildlife corridors) if erected in the forest as well as its ineffectiveness and high maintenance costs:

“Fencing may affect other animals in the forest.”

“Fencing only diverts issue”

“Fencing is expensive and ineffective.”

Those who especially opposed hunting because of its lack of humaneness and negative environmental implications, particularly referred to the use of dogs:

“Dogs can get hurt.”

“Hunting – stress for pigs.”

“Hunting could affect native animals and disturb native populations.”

A minority of tourists were concerned about the safety of hunting with rifles and expressed their distaste for hunters:

“Hunting – some feral humans appear.”

“Don’t want bogans in rifles shooting.”

Nonetheless, some tourists, particularly domestic tourists, supported hunting mainly because of humaneness (if done with rifles) and the socio-economic benefits of hunting:

“Rifle – instant death.”

“It is humane and quick and killing is less expensive.”

“Some people will do it for FREE (sport).”

“Hunters have a chance to get rid of meat.”

Some of the tourists supportive of hunting indicated that their support was conditional as they would prefer hunting to be exercised by those who were trained or regulated to determine who could hunt:

“Hunting would be the best if people are trained.”

“Hunting I think should be done by a ranger, not everybody.”

Out of all the responses to the reasons why they supported/opposed the four methods, 24% were related to opposition to lethal methods in general, referring particularly to poisoning as well as hunting. If these responses were taken into account, humaneness was the most common reason to oppose poisoning (65%) and hunting (84%):

“Poisoning – slow death.”

“Poisoning seems too barbaric and cruel.”

Another common reason for opposing poisoning was the perceived lack of target specificity as well as negative environmental implications:

“I don’t like poisons – they have an impact on our native birds and animals.”

“Poisoning can affect waterways.”

Target specificity or the absence of environmental implications was also an important condition to support poisoning:

“Would only support poison if native species are immune or protected.”

“As long as no impact on environment.”

Last but not least, there were two extreme cases where tourists generally supported or opposed control regardless of the methods. Those who supported all the methods were mostly domestic tourists, the majority of whom were male. Conversely, those who opposed all the methods were all overseas tourists. The domestic tourists’ general support for control was based on their belief in the need to eradicate and control pigs as pests:

“All methods of value and urgent need.”

“Eradication – pests.”

“Get rid of them for future generations to enjoy rainforest.”

In contrast, those who opposed control in general argued that control could not be justified because animals including feral pigs had the right to live or that they were part of “the wild”:

“Animals should be respected.”

“Don’t kill poor pigs.”

“They should live where they want.”

“I love the wild.”

Statistically, four socio-demographic factors had a significant relationship with levels of acceptability; tourists’ gender, age, previous knowledge about the presence of pigs in the WTWHA and place of residence (Table 7.10).

Table 7.10. Four socio demographic factors affecting social acceptability of the methods used to control feral pigs in the WTWHA; tourists' gender, age, previous knowledge about the presence of pigs and place of residence.

Method	Gender	Age	Knowledge	Residence
Trapping	N/A (p>0.05)	N/A (p>0.05)	<i>With knowledge</i> Support 87% Oppose 7%	<i>Overseas</i> Support 44% Oppose 24%
			<i>No knowledge</i> Support: 53% Oppose 19%	<i>Domestic</i> Support 82% Oppose 6%
Fencing	N/A (p>0.05)	N/A (p>0.05)	N/A (p>0.05)	<i>Overseas</i> Support: 52% Oppose: 15%
				<i>Domestic</i> Support 66% Oppose 10%
Hunting	<i>Female</i> Support: 26% Oppose: 54%	<i>20-29 years</i> Support: 26% Oppose: 63%	<i>With knowledge</i> Support: 50% Oppose: 37%	<i>Overseas</i> Support: 24% Oppose 51%
		<i>30-39 years</i> Support: 41% Oppose: 36%		
		<i>40-49 years</i> Support: 51% Oppose 32%		
		<i>50 – years</i> Support: 48% Oppose 46%		
Poisoning	<i>Male</i> Support 49% Oppose: 32%	<i>20-29 years</i> Support: 9% Oppose: 76%	<i>No knowledge</i> Support: 31% Oppose 46%	<i>Domestic</i> Support 49% Oppose: 36%
		<i>30-39 years</i> Support: 27% Oppose: 54%		
		<i>40-49 years:</i> Support: 40% Oppose: 44%		
		<i>50 – years:</i> Support: 26% Oppose: 58%		
Poisoning	Support 15% Oppose 68%	<i>20-29 years</i> Support: 9% Oppose: 76%	<i>With knowledge</i> Support:32% Oppose: 55%	<i>Overseas</i> Support: 9% Oppose: 79%
		<i>30-39 years</i> Support: 27% Oppose: 54%		
		<i>40-49 years:</i> Support: 40% Oppose: 44%		
		<i>50 – years:</i> Support: 26% Oppose: 58%		
Poisoning	Support 29% Oppose 56%	<i>20-29 years</i> Support: 9% Oppose: 76%	<i>No knowledge</i> Support: 16% Oppose 66%	<i>Domestic</i> Support: 33% Oppose: 47%
		<i>30-39 years</i> Support: 27% Oppose: 54%		
		<i>40-49 years:</i> Support: 40% Oppose: 44%		
		<i>50 – years:</i> Support: 26% Oppose: 58%		

Firstly, female tourists were more disinclined to support hunting and poisoning compared to males. Secondly, younger tourists aged between 18-29 years tended to oppose hunting and poisoning; older tourists aged 30 years or more were more in favour of these methods. Thirdly, those who knew about the presence of pigs in the WTWHA before the survey tended to approve of trapping, hunting and poisoning; those without

the knowledge tended to disapprove of those lethal methods. Lastly, domestic tourists tended to more strongly support the four methods (i.e. more willing to control pigs) than overseas tourists.

7.3. Results B: tourism operators' perspectives

7.3.1. Values that tourism operators ascribed to the WTWHA rainforest and the perceived effects of feral pigs on those values

Tourism operators interviewed expressed various values of the rainforest (Table 7.11).

Table 7.11. Rainforest values ascribed by the tourism operators interviewed and surveyed in the WTWHA that corresponded to the classified values of the MA and TEV frameworks.

Total Economic Value		Millennium Ecosystem Assessment		Quotes	Biodiversity + "Balance" Ecological)
Use Value	Direct use (consumptive)	Provisioning services	Biochemicals	Reservoir and source of as yet known drugs Medicinal importance	
	Indirect use	Regulating Services	Air quality regulation Climate regulation Erosion regulation	The air filter factor worldwide Oxygen producer Carbon Sink Stabilising the climate Reduce erosion	
Use + Non-use Value	Direct use (non-consumptive) + Option + Existence	Cultural services	Cultural diversity	Area of diverse ecosystem appreciated and used by several cultures of people	
			Educational values	So much we can learn from the rainforest A living museum containing every stage in the evolution of plants and animals Evolutionary history and ecological link Educate tourists about the importance of the rainforest.	
			Aesthetic values	Clean environment Beauty a beautiful environment to be in.	
			Sense of place	World's oldest rainforest Cassowary habitats	
			Recreation & Ecotourism	World Heritage Refuge for endangered and extremely rare primitive species Only small % of rainforest left in OZ Lifeline of the tourism industry Cassowary habitats Plants and animals that people come and see	
			Miscellaneous (personal attachment)	My life has been involved in wildlife of the rainforest Passion for Australian bush and wildlife	
N/A (valued indirectly through their role in enabling the ecosystem to provide the other services)		Supporting services	Nutrient cycling Water cycling Provision of habitats for wildlife	Complex nutrient cycle Rainfall Habitats for animals Need areas for wildlife to live because of climate change	

Most values fell under the MA and TEV, particularly related to cultural services of the rainforest that benefit the tourism industry, such as the ecological and evolutionary history of the rainforest, its status as the world's oldest rainforest (with the presence of primitive and rare species) and its associated educational values. The existence value of fauna (endangered, primitive, rare), for which the rainforest provides habitats, was also valued. Nonetheless, the vast majority of the operators surveyed (12 out of 14) articulated ambiguous values such as "ecological," "hugely environmental importance," "extremely," or simply expressed that the rainforest should be protected.

Almost all the tourism operators interviewed and surveyed perceived that pigs degraded the rainforest values that they identified because of the negative environmental impacts of pigs (next section). One operator specifically mentioned that especially when walking into a big pig wallow in the middle of the forest, it smelt and degraded the aesthetics of the rainforest.

7.3.2. Tourism operators' perceptions of the impacts of feral pigs

All the operators interviewed (11) expressed concern particularly about the negative environmental impacts of pigs on the rainforest. The perceived environmental costs of pigs referred particularly to predation on, and competition with, native wildlife, damage to the rainforest and soil erosion:

- Predation of turtle eggs on the mainland
- Destruction of habitats and nests including cassowaries'
- Predation of native fauna such as Agamid/dragon lizards (e.g. Boyd's Forest Dragon) and/or their eggs including cassowaries' and megapodes'
- Damage to undergrowth rainforest through rooting/digging
- Prevention of the regeneration of the forest
- Destabilisation of the creek banks and beds by digging, causing soil erosion going into the reef (e.g. "all the run-off of soil dug up by pigs will destroy the reef.").

One reef-based tourism operator expressed his concern particularly about pig predation of turtle eggs on the mainland because of the iconic significance of turtles for reef tourism.

The operators surveyed also expressed similar concerns about negative environmental impacts of pigs such as damage to the rainforest and competition with native species for habitat and food (Table 7.12). Some operators expressed other

negative environmental impacts such as damage to wetlands and predation of cassowary eggs (referring to predation of native species). Conversely, a few operators acknowledged positive aspects of pigs, for example, as a rainforest seed disperser and as an educational opportunity for tourists to appreciate the importance of preserving “balance”.

Table 7.12. The surveyed tourism operators’ perceptions of the environmental costs of feral pigs in the WTWHA (n=19)

Perceived negative environmental impacts of feral pigs that are of concern	Number of operators who agreed with the statement
Damage to the rainforest (undergrowth plants)	18 (94.7%)
Competition with native species (for habitat & food)	18 (94.7%)
Deteriorated water quality of creeks	16 (84.2%)
Soil erosion into the reef	14 (73.7%)
Predation of turtle eggs in Cape York	14 (73.7%)
Predation of native species	14 (73.7%)
Weed dispersal	13 (68.4%)
Disruption of rainforest nutrient cycling	10 52.6%)

As a negative economic implication of pigs for rainforest tourism, some operators interviewed were concerned about the disease transmission potential of pigs. Those surveyed expressed mixed opinions; 47% agreed that the potential disease transmission from pigs could be a concern whereas the rest disagreed or were neutral or indifferent about this issue, possibly because of its perceived lower likelihood.

7.3.3. Tourism operators’ views on the implications of feral pigs for rainforest tourism

Although all the operators interviewed (11) perceived that pigs would degrade the rainforest values they ascribed, they had mixed opinions about the impacts of pigs on the sustainability of rainforest tourism in the WTWHA. A reef-based tourism operator was concerned about pigs’ negative effects on reef tourism in the long run through predation on turtle eggs because of the significant economic value of turtles to the industry. Other operators interviewed expressed other concerns about the impacts of pigs for rainforest tourism. A rainforest tour operator in Daintree was concerned that tourists were “not going to see very well-maintained natural environments” because even though sighting of pig damage was rare, tourists tended to ask about the damage

around the boardwalks if sighted. The operator believed that there would emerge a gap between their expectations and reality of the condition of the rainforest because undisturbed rainforest was of primary interest to tourists. Another rainforest tour operator perceived that pigs' predation of Agamid/dragon lizards such as Boyd's Forest Dragons (*Hypsilurus boydii*) was of concern for rainforest tourism because the lizards were iconic in Daintree and Cape Tribulation. Similarly, several operators argued that pigs had negative implications for the tourism industry because of their predation on, or competition with, iconic species such as southern cassowaries (*Casuarius casuarius johnsonii*) if their population level declined due to pigs. One rainforest tourism operator also expressed concerns about pigs' destruction of habitats because it would diminish the quality and quantity of the forest, implying there would be less forest for future generations to appreciate. Safety issues were raised as another concern for rainforest tourism, such as gun use by pig hunters around areas where tourists stayed. One operator was concerned about the potential safety threat posed by recreational bow-and-arrow pig hunters near Coconut Beach in Cape Tribulation where tourists often visited:

“One of the emerging concerns we have here is an organised hunt by groups of hunters in the night time, introducing prohibited animals like dogs into the World Heritage and discharging firearms. It is a public safety issue. Bullets are flying around and dogs running around; that doesn't help the economic health of tourism in Daintree.”

The same operator also showed concern about direct safety threats to tourists by pigs; at the same beach (Coconut Beach), tourists were once chased by pigs. He perceived pigs to be a major public danger and argued that a place like Daintree and Cape Tribulation needed a responsible type of tourism supported by the proper management of pigs. Almost half of the operators surveyed (9 out of 19) agreed that pigs had negative impacts on the tourism industry and/or their business. More than half (11 out of 19) also agreed that pigs degraded tourists' rainforest experience.

Nevertheless, some operators interviewed disagreed with the immediate negative implications of the environmental costs of pigs for the tourism industry. One of the tour guides was concerned about the destruction of cassowary habitats by pigs because it was his task to find cassowaries for tourists, but he perceived that pigs were no immediate threat to rainforest tourism although habitat destruction by pigs could reduce cassowary sighting opportunities in the long term. Another operator argued that pigs were no immediate threat because tourists rarely saw pigs or pig damage and

because the environmental costs of pigs were a concern not for the tourists but for the tour guides. A tour guide interviewed also mentioned that pigs would have no implications for tourists' rainforest experience because tourists would rarely associate the damage with pigs unless guides told them. An accommodation manager also argued that most tourists (especially tour participants) rarely saw pigs or their damage because they tended to have a relatively short stay in Daintree and Cape Tribulation, especially if they visited by bus from Cairns or Port Douglas.

On the contrary, some operators suggested that pigs had positive impacts on rainforest tourism as an "entertainment" factor. A fruit-farm accommodation manager argued that tourists perceived pigs to be a "wild animal" rather than a pest:

"Tourists don't recognise pigs as being dangerous, they are still excited to see one and thrilled by seeing them as a wild animal. So there is a thrill factor to the animal. I tell them about pigs and they get excited."

Another fruit-farm accommodation manager in Daintree also argued that it was "interesting for tourists to see pigs". A tour guide in Daintree argued that both domestic and international tourists became excited about seeing pigs because some Australian tourists were hunters while overseas tourists tended to see pigs as fauna or a wild animal without realising that pigs were introduced. A few operators interviewed argued that the presence of pigs provided a great educational opportunity to inform tourists of general environmental issues associated with introduced species in Australia. More than half of the operators (10 out of 19) surveyed also agreed that pigs were a positive entertainment factor for tourists. Some operators (7) surveyed disagreed with this positive value of pigs because pigs represent public safety issues and spoil the image of the rainforests with their existence and environmental impacts as an introduced species.

7.3.4. Tourism operators' attitudes toward current pig management

Some operators interviewed perceived current pig management to be reasonable and sufficient, recognising that the methods that could be used in rainforests were limited because of their potential disturbance to wildlife (e.g. hunting) and/or because of the impracticality of eradication:

"I don't think total eradication is an option at all. So I think that's going to be a permanent, constant pressure on the pig population to the low level to keep them undercover a lot

more.....I'm more or less happy with current control. I think it takes far more effort to get rid of the last 20% of the population left, for example, than justifying the return. There's got to be a balance and eradication is not possible. There are going to be reserves of pigs in the rainforests and you are not going to get them all."

A few operators interviewed believed that control by the government trapping program had been sufficient because they perceived that sighting of pigs have been reduced:

"It's sufficient as long as they keep somebody here coming over on a daily basis to set the traps and check them. It's great and they should definitely keep it going on. I haven't seen lots of pigs down here this year and I think the trapping program has been working."

Nonetheless, the majority of those interviewed and surveyed were dissatisfied with the current level of pig control. The operators interviewed who were dissatisfied with the current management tended to expect more than control (i.e. eradication) and/or perceive that control was underfunded or did not overcome pigs' fecundity. Those operators surveyed by the household survey also expressed similar reasons (Table 7.13):

"Queensland is now talking about 'pig management' but we don't 'manage' pests, we have to 'eradicate' them. Even the terminology is wrong. These animals don't belong here. Threat Abatement Plan by all the academic professionals says eradication is not an option from the beginning, 'all we can do is manage'. I thought that it was pathetic to be honest. Eradication is the only option."

"It's underfunded because it (the study area) is far away and the large percentage of conservation people are humane society type of people so any killing is bad. There is not always 100% support for that kind of thing."

"Usually, almost everything, when it comes to conservation, is not funded necessarily well enough to do the job. There's not enough money. Pigs are winning and we are not spending our money."

"There is only one (government employed) trapper in this area. There were two in the last contract before. If the current trapper had an extra hand, they would have caught more pigs. It's definitely underfunded."

The operators' dissatisfaction was also associated with the State government's management of national parks (by which pigs were "protected"), particularly referring to the restrictions on the access to, and gun use within, the parks:

"The government doesn't permit shooting in national parks, which is the rule to protect pigs. So pigs have the same level of protection as cassowaries. Pigs are a protected species,

even though they are a threat to this beautiful forest. People find it really hard to come to terms with that one.”

Table 7.13. Reasons for the surveyed tourism operators’ dissatisfaction with current pig management in the WTWHA (n=19).

Reasons for perceiving insufficiency of control	Number of those dissatisfied
The aim of control should be eradication, not management.	11 (73.3%)
Control is underfunded.	11 (73.3%)
Pigs’ high reproduction is winning the control	11 (73.3%)
State government management of national parks	7 (46.7%)
Inconsistent control efforts amongst people	6 (40.0%)
Restriction of use of guns or dogs in national parks	4 (26.7%)
Other: Only traps are used (in Daintree); they hardly capture any.	1 (6.7%)

7.3.5. Tourism operators’ attitudes toward the different control methods

Most operators interviewed and surveyed supported both trapping and fencing based on humaneness as well as cost-effectiveness. They strongly supported trapping because it was considered “safer” for other animals with “no painful outcome” and offering employment opportunities. They also believed that the government trapping program was successful, which may have further encouraged their support for trapping:

“The government pig trapping program has been very effective and has reduced the numbers of pigs and I would highly recommend that they keep doing that. It definitely made a big impact on the number of pigs”

“Trapping is humane so it is good. Even if pigs are not native, it is not their fault that they are here so it has to be humane.”

Some operators were uncertain about the effectiveness of trapping and fencing (but did not object to them) because those methods would be of limited use to eradicate pigs and would cost a lot if designed to control a larger area:

“Pig trapping by government agencies is expensive and does not work for eradication or long-term reduction of numbers. Research should continue into other potential means of control.”

“We are throwing money away by putting so much money a year into the community-based feral pig trapping program; pigs are breeding faster than trapping and we are buying the illusion that something is being done.”

Fencing was favoured overall because of its usefulness for environmentally or economically critical areas of relatively small size:

“Fencing should help farming.”

“Fencing is needed to keep pigs out of high value areas e.g. wetlands, until effective control is possible.”

The opposition to fencing was not articulated in the surveys or interviews.

The operators expressed mixed opinions about hunting and poisoning. They were disinclined to support hunting because of: the negative social image of hunting as a “red neck” activity; the perception of animal cruelty (to pigs and/or dogs) incurred by hunting with dogs; and negative impacts of dogs on native species:

“Hunting is for rednecks and they use dogs for hunting and the way of killing is cruel and not humane.”

“The rainforest is a very fragile ecosystem and so I don’t want it to be disturbed [by dogs].”

“Some pig hunters cut off ears of female pigs and release them illegally so that dogs can’t bring them down and pigs can repopulate. We’ve seen so many earless pigs in Daintree. People are trying to increase the concentration of pigs because it’s their interest. This area, an expression of Australia’s conservation performance, is actually a pig hunting venue.”

Conversely, some operators supported hunting because they perceived that it was a cost effective way to manage areas such as national parks and/or because they believed that hunting was part of recreational activity, through which pig hunters would be willing to control at their own costs. Nonetheless, most operators supported it only if it was responsible or regulated hunting:

“If hunters are trained with extra licences or dogs are trained, it would be a great idea to hunt in the national park to control pigs but not a free range thing. If you had a scheme to set up, it would definitely help.”

“There is not enough funding so we need to find ways that Indigenous people can go out and make money and hunt in national parks or get all overseas tourists who want to hunt pigs. There will be an employment opportunity and if Indigenous people get employed, they will get some meaning in their life because there is a lack of meaningful employment in Indigenous communities.”

“Pig hunters love hunting pigs with their dogs and I wouldn’t be against it at all as long as it’s done effectively and nothing suffers. It is an effective way of controlling.”

Most operators showed great opposition to poisoning largely because they perceived that it lacked in target specificity and humaneness:

“I wouldn’t like to see poisons put out here because of other rare creatures.”

Those who approved of poisoning were generally in favour of any control methods (“strongly support the eradication of feral pigs”), demonstrating no concern about welfare of pigs and/or dogs (used for hunting) as long as pigs were controlled.

7.4. Summary of the tourism perspectives

7.4.1. Tourists

Tourists articulated similar values to the local residents, most of which were ambiguous and reflected no specific use or services of the rainforest such as those that MA and TEV suggested (Chapter 3). The attributes of recreational benefits of the rainforest were related to motives such as a desire to encounter new environments and experiences and to enjoy scenery and nature. These results of this study were similar to those from the previous studies (Chan and Baum, 2007, Wight, 1996) and those attributes fitted into four of the six domains that led to positive ecotourism experiences: hedonic, novelty, comfort and stimulation (Table 7.14).

Table 7.14. Six construct domains of positive ecotourism experience (Chan and Baum, 2007, p. 582)

Domain	Explanations	Examples from survey
Hedonic	Excitement, enjoyment and memorable experiences related to wildlife, natural environment, experience of a jungle walk etc	Aesthetics Something to do for holiday Seeing wildlife Recreational activities
Novelty	Something new, unique and different experiences (never been before, first time to see wildlife in the wild, lifetime experiences, something that I could never do etc)	Unique environment and experience Curiosity and interest
Comfort	Physical relaxation in the natural environment, experiencing the peaceful tranquility of the natural environment	Relaxation
Stimulation	Learning experience and an understanding of the natural environment as valuable education	Education World and national heritage
Interactive	Opportunity to meet, and positive interactions between, guests, guides and group members Being part of the process to see and spot wildlife	N/A – no tourist articulated
Personal safety	Trip safety	N/A – no tourist articulated

In the present study, novelty and hedonic domains were the most important benefits they sought from the rainforest experience. The ‘novelty’ of the rainforest was likely to

be linked to the ‘quality’ of the environment that was expected of protected areas, such as the WTWHA, which was also related to existence values that the tourists ascribed to the WTWHA rainforest.

These recreational benefits were not significantly influenced by the occurrence of feral pigs because the majority of the tourists were unaware of the presence of pigs and were unlikely to see ground diggings caused by pigs. Overseas tourists, in particular, were less likely to be aware of the presence of, and damage by, pigs. Most tourists, however, perceived that rainforest values were diminished by pigs as soon as they were informed of their presence, for example, by the survey, despite the ambiguity of the values. Even though they were unaware of the presence of pigs, some tourists knew or guessed the “non-native” status of pigs; this acknowledgement was associated with their perception that pigs were deleterious for the environment (thus degrading rainforest values). Accordingly, the majority of the tourists expressed that they wished to protect the rainforest from pigs.

Lastly, feral pig management may face difficulty as lethal methods such as hunting and poisoning received lower levels of acceptability compared to less “cruel” methods such as trapping and fencing. Female and younger tourists were more likely to oppose lethal methods such as hunting and poisoning. Conversely, those who knew of the presence of pigs in the WTWHA were more likely to approve control methods in general to rectify the problems. Domestic tourists were also more in favour of exercising control methods possibly because they were more aware of feral animal issues in Australia than overseas tourists.

7.4.2. Tourism operators

Tourism operators articulated the existence values of the rainforest that benefited rainforest ecotourism, such as the evolutionary history of the rainforest and its educational values, and species diversity (or provision of habitats for flora and fauna). These existence values (of the TEV) are likely to be related to recreation and ecotourism values of the MA. Like other stakeholders, almost all the tourism operators surveyed articulated ambiguous values that only emphasised the importance of the rainforest per se without clearly explaining why the rainforest was important. The majority of the operators interviewed and surveyed agreed with the negative impacts of

pigs on rainforest values because of their environmental costs such as predation of, and competition with, native species, and damage to the rainforest.

Some operators perceived that the negative environmental impacts of pigs had negative implications for rainforest tourism, especially predation on, and competition with, iconic species for the tourism industry such as cassowaries (rainforest) as well as turtles (reef). Nonetheless, the majority of the operators surveyed and interviewed acknowledged that tourists positively valued pigs as an “entertainment” factor or a “wild animal”.

Lastly, tourism operators held similar attitudes to other stakeholders (e.g. Chapter 3) toward control methods and current management: they supported methods that are perceived to be humane such as trapping and fencing and were dissatisfied with the current management due to their higher expectations of management outcomes.

These tourism perspectives were important to understand the perceived implications of pigs on a special interest group that utilises the WTWHA differently from the local communities. Aboriginal communities, or groups, are another special interest group benefiting from the WTWHA. Understanding their perceptions is also important particularly because cross-cultural difference may be evident in the perceived benefits and costs of pigs for those groups. The next chapter, Chapter 8 will explore Aboriginal rangers’ perceptions in detail.

Chapter 8: Aboriginal rangers' perspectives

8.1. Introduction

People's perspectives on wildlife are inevitably bound to their worldviews, cultures, societies and social groupings within societies (Aslin and Bennet, 2000). Aboriginal people's worldview is essentially represented by the concept of 'country'; they relate and belong to a particular land, or 'country', and have *social obligations* of 'caring for country', responsibility to take care of the land including its flora and fauna (Aslin and Bennet, 2005). Such social obligations are passed onto younger generations through customary activities such as hunting, fishing, and harvesting or simply by elders' telling young ones stories when walking the country (Aslin and Bennet, 2000). This Aboriginal people's connection to a land via social obligations contrasts to non-Aboriginal Australians' interest in the land through personal preferences, and their different worldview may contribute to different attitudes and behaviours toward feral pigs.

The current western or scientific discourse of anti-"exotic" species treats "native" and "alien" as ecological absolutes, by which native species are favoured at the expense of alien species (Warren, 2007). As different groups of mainstream stakeholders held different views (Chapters 3, 4, 5, 6 and 7), Aboriginal people may not necessarily disfavour exotic animals. They may also see such animals as an important resource for food, employment and recreation and may even wish to establish feral animal harvesting programs, rather than simply try to eradicate them (Aslin and Bennet, 2000, Trigger, 2008). In Alice Springs, most feral animals such as camels (*Camelus dromedaries*) are perceived as being "-arenye", or *belong to the country*, as opposed to "ulerenye", or *a stranger to the country*, although they were perceived to have once been "ulerenye" (Rose, 1995). In Aurukun Cape York of northern Queensland, pigs have become an important source of protein and replaced native prey in the diet because many native prey have become scarce or extinct (Bomford and Caughley, 1996). Because feral animals may become "culturally native" through cultural acceptance and adoption, their merits should also be considered based on their values to humans regardless of ecological absolutes of "exotics" (Warren, 2007).

Aboriginal people's attitudes and beliefs towards feral animals, however, also vary between tribal groups and across time and space (Aslin and Bennet, 2000, Altman

et al., 1996, Roberts et al., 2001). Although most groups agree that feral pigs cause ecological damage to their country, attitudes differ whether they should be controlled, utilised, or left alone (Wilson et al., 1992). In central Arnhem Land, the Northern Territory, traditional Aboriginal people support pig control because pigs damage bush tucker that they rely on (Wilson et al., 1992). In north-western Arnhem Land, the Northern Territory, pigs are valued as a resource to be used for game meat and safari activities because few commercial opportunities exist; such ventures are regarded as being worth exploiting (Wilson et al., 1992). Because attitudes vary and change with time and space, it is important to identify the cultural variability in perceptions of feral pigs within and between Aboriginal groups (Roberts et al., 2001).

To take into account the cross-cultural variation in the perceptions of pigs, this chapter investigates the views of Aboriginal rangers from the four different tribal groups within the WTWHA (Girringun, Jabalbina Yarralji, Burungu, and Bana Yarralji) as follows:

1. Basic socio-economic backgrounds of the area where each Aboriginal group resides.
2. Their perspectives on the impacts of feral pigs.
3. Their perspectives on feral pig management.

A total of 15 Aboriginal rangers were contacted and interviewed via purposive sampling (through ranger coordinators) (see Chapter 2). Rangers were invited instead of members of the Aboriginal communities because of their experience and knowledge about feral pig issues and existing links with the broader public domain (see Chapter 2). The sampling may have biased toward Aboriginal people whose views have been influenced by their higher degree of exposure to general community views on pigs.

8.2. Aboriginal rangers' views on feral pigs

8.2.1. Girringun (Cardwell)

(a) Basic socio-economic background of Cardwell

Girringun Aboriginal Corporation is situated in Cardwell of the WTWHA and represents the interests of traditional owners from nine tribal groups. Around 63% of the previous Cardwell Shire is gazetted as national parks, State Forest or WTWHA (CSC, 2010). Despite the small population of roughly 9,500 people (ABS, 2008a), the

regional economy in the Shire is equipped with main transport infrastructure such as the Bruce Highway (part of the National Highway) and is relatively diversified, including agricultural, light manufacturing, and tourism sectors. Other primary production sectors include aquaculture, beef, and other fruit and vegetable crops.

(b) Giringun perspectives on the impacts of feral pigs

The rangers interviewed expressed concern about the negative environmental impacts of pigs that resulted from their rooting behaviours in foraging in the rainforests such as:

- Destruction of vegetation
- Run-off and erosion
- Predation on and damage to bush tucker
(e.g. native ginger, native wildlife including turtle eggs and scrub turkeys' nests and eggs)
- Dispersal of introduced plant seeds including lantana through excretion and germination.

Pigs' foraging of bush tucker, in particular, was also perceived to have negative socio-economic implications because bush tucker was a culturally preferred food source for Aboriginal people.

The rangers also acknowledged other negative socio-cultural implications of pigs including: safety issues to people (because pigs can be aggressive and attack people); and damage and disturbance to cultural heritage or Aboriginal sacred sites such as cave painting or rock art (especially when pigs rub up against the historical and cultural artwork) as well as shell middens:

“Shell middens are subject to pig damage. Discarded shells have accumulated since thousands of years ago by Aboriginal ancestors and shell middens are a cultural heritage site and connection to country. They are very important sites and we think pigs disturb middens as well as rock art within the same site. This is an enormous social impact of pigs to us.”

Shell middens are places where the debris from eating shellfish and other food is disposed. These places are an important link for Aboriginal people to their culture and their past, providing valuable information about Aboriginal use of coastal resources (DPCD, 2008). Since Aboriginal shell middens are among the most fragile cultural sites, they can be easily degraded by animal interference including feral pigs, and can rapidly deteriorate once degraded (DPCD, 2008). One of the rangers argued that disturbance to

shell middens by pigs was of great concern because many shell middens were located in inaccessible and hilly terrain in the region, making it difficult to protect the midden sites from pigs.

The rangers' negative perception of pigs was also highlighted by rejecting the view that the animal was an important source of food for the Aboriginal people in the region; there was no need to rely on pigs because of the absence of a subsistence economy:

“Indigenous people in this Girringun area don't eat feral pigs so often and there is not much hunting happening, either.”

“Pigs are rather a pest than a source of food. We do sometimes eat pigs when hungry and pig meat is good. In Cape York, pigs eat dead animals including horses and cows, but pigs in the Wet Tropics have different diets including fruit and vegetation so they are a quality meat. But pig meat is not so important for us because we are mainstream Australians and have stores just around the corner. Our situation is different from the one in remote areas. Groceries in remote areas are three times as expensive as those here so Aboriginal people in remote communities rely more on wildlife or wild animals, which become their supplementary income.”

One of the rangers summarised their perceptions of the negative impacts of pigs on Aboriginal people in the region:

“The rainforest means everything to traditional owners including land ownership, spiritual, cultural, social and economic values, and pigs affect those values a great deal.”

(c) Girringun perspectives on feral pig management

The rangers supported pig control in general because they perceived that pigs were an environmental pest with no socio-economic benefits to the communities. They approved of trapping the most because of the negative consequences of the other methods. Poisoning was opposed because they were concerned about a lack of humaneness and potential risks for other animals. Hunting, especially with dogs, was also opposed because dogs could be lost and become wild or feral, which potentially would have negative impacts on other native wildlife (e.g. predation) and become another problem in national parks. Trapping was perceived to have no such environmental costs. An animal waste issue as a result of control was also investigated because some Aboriginal people were uncomfortable with killing animals and wasting

the meat (Vaarzon-Morel, 2008). The rangers in Cardwell were unconcerned about animal waste because:

- pigs were not considered suitable for eating due to the diseases they carried;
- local Aboriginal people did not depend on pigs for food (so not concerned about “killing to waste”); and
- using pig meat after control was regarded as incurring financial costs:

“Pigs carry too many diseases. Some Aboriginal people sell pig meat to supply food for croc farms in Innisfail, but no one has the facility to process and eat pigs around here, and you need a licence for chiller boxes. I’m not into making money out of it.”

Despite their general support for control, the rangers were dissatisfied with the current level of control because they perceived that there were not enough people (including Aboriginal people) on the ground to control pigs as a result of the restrictions of access and control in national parks and licence procedures and costs for hunting (outside the rainforests). The restrictions in national parks, in particular, implied that there was a need for more accredited rangers to be involved in trapping in the parks (i.e. more money/funding was needed):

“Control is underfunded. Where there are not many people, there are lots of pigs. There used to be traps [here in Cardwell] but we ran out of money and funding.”

Moreover, the perceived lack of control was also due to the perceived difficulty of control in closed-canopy rainforests where control methods were limited:

“We will never get rid of pigs, they are like cane toads. It is easy to control in open country, you can do aerial shooting and use dogs on pastoral land but not in the rainforest.”

8.2.2. *Jabalbina Yalanji (Mossman)*

(a) Basic socio-economic background of Mossman

Mossman is a small town of roughly 1,700 people (ABS, 2008b) but has been a rural centre for the sugar cane industry as well as a service centre for tourists travelling north including Daintree and Cape Tribulation. Mossman Gorge is located in the southern part of the Daintree National Park and also is a main tourist attraction in Mossman because it is one of the most accessible places to experience the rainforest. The traditional Aboriginal land owners play a part in the tourism industry by conducting tours from their base adjacent to the Gorge, in which visitors learn about traditional use

of the rainforest, known as Kuku Yalanji Dreamtime Walks. The Indigenous Land Corporation (ILC) is currently investing in further infrastructure development including an interpretation centre and car and bus parking to cater for more visitors (with an estimated increase up to 780,000 people per annum by 2010) and to create more jobs for local Aboriginal people (ILC, 2010).

(b) Jabalbina Yalanji perspectives on the impacts of feral pigs

Jabalbina Yalanji rangers had conflicting views about the values of pigs and articulated both positive and negative values, not necessarily perceiving them merely as a pest:

“Pigs are both good and bad because they are a natural animal.”

Positive aspects encompassed the use of the animal as a meat and food although they ate pig meat “once in a blue moon” or “occasionally” when private landholders provided them the meat after control. This was also confirmed by non-Aboriginal local residents (hunters and farmers) who were also interviewed for this research. Although the rangers stated that pigs could be a food source, the overall economic value of pig meat was not perceived to be important and the rangers stated that local Aboriginal people rarely engaged in hunting pigs:

“Pigs are not bush tucker. We eat bush tucker. The meat is not as important as turtles because pigs are introduced.”

The rangers also perceived positive environmental implications of pigs as an agent to disperse some seeds of rainforest trees by eating their fruit. Nevertheless, most of the rangers agreed that pigs were predominantly an environmental pest:

“Pigs are a pest and very destructive in the rainforest. I wish pigs were not here. I just don’t like pigs. Captain Cook brought pigs in the Endeavour, and before that we didn’t have pigs in the rainforest. They are the same as the worst pest: cane toads.”

The rangers listed the following negative environmental impacts of pigs:

- Damage to bush tucker through rooting/digging
- Predation on bush tucker including tubers (potatoes/yams) and their roots
- Damage to native plants, ‘ripping apart the rainforest’
- Predation on native animals that Aboriginal people eat including goannas, snakes and turtles (their eggs)
- Possible predation on cassowary eggs.
- Predation on wildlife in creeks and waterways, affecting the sea as a ‘chain reaction’

- Wallowing in the rainforest, polluting waterways
- Soil erosion
- Carrying parasites and diseases

As the rangers described the rainforests as “the oldest culture”, the rainforests held cultural significance and therefore, some of these negative environmental costs had socio-economic and cultural ramifications, especially damage to bush tucker. The rangers argued that Aboriginal people tried to regenerate or replant tubers (their bush tucker) after being destroyed by pigs but those replanted tubers were often damaged as well.

In addition to such direct economic costs, the rangers also expressed sympathy for farmers in Mossman who suffered damage caused by pigs especially to sugarcane. As for cultural implications of pigs, no Jabalbina Yalanji rangers mentioned pig damage to their cultural or sacred sites. Nonetheless, they were concerned about the potential predation on eggs of cassowaries (*Casuarius casuarius*) as the animal was sacred for the Jabalbina Yalanji people.

(c) Jabalbina Yalanji perspectives on feral pig management

The rangers supported pig control in general because Aboriginal people in Mossman were not heavily dependent on pigs for food and negative environmental implications of pigs were of great concern. Trapping, hunting, and fencing were supported and poisoning opposed because the rangers were concerned about the negative environmental consequences of poisoning such as pollution of waterways and risks to other animals including cassowaries as a result of a lack of target specificity. They argued that the use of chemicals including poisons and pesticides was generally not socially or culturally accepted by Aboriginal people. Local Aboriginal people ceased to eat native animals such as Northern Brown Bandicoot (*Isodon macrourus*) owing to the perceived health risks posed by the use of pesticide in sugarcane.

Irrespective of the current level of control, the rangers emphasised the management process itself because of their dissatisfaction with the current government policies in the management of pigs that pose restrictions of access for Aboriginal people

in national parks. They aspired to collaborative or joint management⁶ instead of a top-down approach by the government so that local Aboriginal people could participate in the management:

“The government is the problem when it comes to control. We are not allowed to control in national parks but we should be able to do it. Introduced weeds are also a concern to Yalanji people, at the same level as pigs, including chiney apples and guavas. Yalanji people want overall management and to manage on our own terms.”

8.2.3. *Burungu (Wujal Wujal)*

(a) Basic socio-economic background of Wujal Wujal

Wujal Wujal is a relatively small Aboriginal community, located in the north of Cape Tribulation, with the Aboriginal population accounting for 95% of the total population of 361 (ABS, 2008c). A large proportion of the population (over 25%) is a dependent population under 15 years of age (ABS, 2008c). Access to the town is relatively difficult, via an unsurfaced track road only suitable for four-wheel drive vehicles due to the gradient of the terrain and the streams and rivers with high water flow during the wet. Its remoteness is also reflected by there being only one Community Store in the town. Wujal Wujal is the ninth most socio-economically disadvantaged of all the Queensland Local Government Areas and the 20th of a total of 1,395 Australian Statistical Local Areas (ABS, 2008d). Many Aboriginal people in Wujal Wujal (including the rangers interviewed) work for the equivalent of welfare payments through Community Development Employment Projects (CDEP), which often incorporates “Caring for Country” programs that are related to customary activities for biodiversity conservation, pest reduction and weed control (Altman et al., 2005). People employed under the CDEP earn on average \$277 per week, a higher income than those under Indigenous employment (\$162) or not in the labour force (\$193), but much lower than mainstream employment (\$609 per week) (Altman et al., 2005). In remote areas like Wujal Wujal, there are not enough private sector jobs and there is an urgent need to create an economic base (Altman et al., 2005).

⁶ Co-management, or joint/collaborative management, refers to co-operative management of protected areas, a mechanism that recognises and respects knowledge and rights of Indigenous people over parts of Country that have been declared as a protected area (Ross et al., 2009). Co-management is about “power and responsibility sharing” between government and resource users (i.e. Indigenous people), based on equitable partnership (Nurse-Bray and Rist, 2009).

(b) Burungu perspectives on the impacts of feral pigs

The Burungu ranger strongly emphasised positive values of feral pigs rather than negative ones, arguing that although there were “too many” pigs, they were “just another animal” and were “wanted” as a source of food for humans and dogs because of a lack of traditional food available:

“Pigs don’t become a problem, but there are too many pigs in national parks. We want pigs, but not too many, as long as they are in low numbers. [...] People can hunt and eat pigs, which contributes to controlling feral pigs. Even if the meat is not suitable for people, we can still use it for dogs. [...] For Aboriginal communities, pigs are becoming their traditional food and supplementary ceremonial food because other traditional food is becoming scarce. We would hunt wallabies but there are not many around anymore because of dingoes.”

According to the ranger, at ceremonies such as birthdays, funerals and weddings, feral pig meat was normally served with turtle meat, illustrating the importance of pigs as a supplementary “traditional” food. Yet, the use of pigs for food seemed to be opportunistic and adaptive:

“If pigs had not been here, we wouldn’t have needed them, but now they are here so we can use them as meat.”

A pig trapper contracted for the Daintree pig trapping program also confirmed during the interview that Aboriginal people in Wujal Wujal used pigs that he had trapped mainly for home consumption (see Appendix 9 for the quote). The ranger indicated that local Aboriginal people’s reliance on pigs to supplement money and traditional food was due to the underlying economic circumstances of the Aboriginal communities in remote areas:

“Feral pig meat is very important for Aboriginal communities. Considering the average weekly household income of Aboriginal communities, they cannot afford enough food and so pigs serve as a supplement of money. Kids cannot go to school because there is not enough food. Nowadays, the rent price went up, which put more financial burden onto those Aboriginal communities. Pigs are now part of our native animals as traditional food like wallabies and bandicoots.”

Despite these positive economic contributions of pigs to the Aboriginal communities, their environmental and socio-economic costs were also acknowledged, including their predation on and damage to bush tucker such as yams and water lilies. In particular, the ranger was concerned for the neighbouring Aboriginal communities

further north (i.e. Cape York) where pigs ate water lilies, an important source of traditional food. Nonetheless, the ranger was unconcerned about pig damage to his communities' cultural sites or animals such as cassowaries:

“There are no impacts on cassowary. Rather, it is people who are impacting cassowaries by knocking forests down, leaving no food for cassowaries.”

(c) Burungu perspectives of feral pig management

Despite the importance of pigs as a food source, the ranger indicated that pig control was important to maintain pig populations at an “acceptable” level because both local consumption of pigs and management of pigs were considered necessary. Nonetheless, poisoning was opposed because of the risks to the Aboriginal people who ate pig meat. The ranger asserted that prior consultation was extremely important if poisoning was to be implemented. Trapping was supported as long as “the meat is not wasted.” Waste of meat after control was criticised especially when the meat was good quality (i.e. during the wet season). Hunting was the most approved not only because it provided the opportunity for the Aboriginal people to gain meat but also because it allowed young people to regain connection to country through a customary activity:

“The rainforests are very important for us because of our connection to land and people. Now I am concerned about young generations having no tie to country because of ‘no living on country’. Young people are now grown up in urban areas and this is how society is losing connection to country. Their tie to country is lost. If there are pig hunting opportunities for them, we can get them back here. Pigs will provide traditional hunting opportunities and it’s good for the people because hunting is an active sport, keeping people active, and because they provide people food so people can eat meat. They can also connect to country and learn about country, simply by walking out during hunting. Weeds can be spotted and we can deal with those weeds too while hunting, which pigs may have spread. By hunting and looking in country, we can manage country. Ultimately, young people become connected to country. Hunting also means employment so young people would come back and we could train them to manage and keep country open. So hunting can give lots of benefits.”

Because of this socio-cultural significance of hunting, the ranger expressed grievances against the restrictions of hunting in national parks and opposed a top-down approach of national park management:

“National parks mean management and protection, but they are not managed properly. Pigs in national parks are a ‘protected’ species because people can’t hunt there. So national parks are the place where pigs damage and where people can’t control them and the governments are starving the Aboriginal people because of the restrictions and legislation of national parks.”

Moreover, the ranger showed frustration with the current management of pigs because it employed ineffective government-initiated control methods instead of employing local Aboriginal people. As an alternative to the conventional national park management, the ranger aspired to collaborative/joint management of national parks by Aboriginal communities and the government.

8.2.4. *Bana Yarralji (Shipton Flat/ Wujal Wujal)*

(a) Basic socio-economic background of Shipton Flat

Shipton Flat, the outstation at which the rangers from Bana Yarralji Bubu Corporation are based, is located in the north of Wujal Wujal, near the Annan River Catchment on the lower western slopes of Trevethan Range where the tropical rainforests of the Wet Tropics World Heritage Area meet drier savanna woodlands near Cooktown. It is the ancestral home of the Kunawarra, a clan group of the Kuku Nyungkal people of the northern Daintree people (Aurecon, 2010). However, most of the Bana Yarralji rangers were originally from the Wujal Wujal community. The socio-economic background of Bana Yarralji people is similar to that of Burungu from Wujal Wujal. The Shipton Flat base is a centre for natural resource management and drug and alcohol recovery for the people from Wujal Wujal to attain cultural reconnection and identity, and a potential ecotourism base in the future.

(b) Bana Yarralji perspectives on the impacts of feral pigs

The rangers held mixed views about the values of pigs for Aboriginal people and were in a dilemma between eradication of pigs as an environmental pest and leaving enough pigs to be a good source of food:

“Pigs are a pest, living and nesting under lantanas, and they chew and spread the seeds. But they are good to eat. The Aboriginal people in Wujal Wujal live off the land and pigs are their main meat. [...] Pig meat from the rainforest is good and very important for the people. Pigs that eat dead animals in drier country are no good but pigs in the rainforest eat fruit including mangoes, wild figs and vegetation.”

“Pigs are good and bad. They are good because we hunt them and eat them for free but they are bad for the landscape because they dig up the riverbanks and damage the root system of the rainforest.”

Although they believed that pigs had a positive environmental aspect as a seed disperser of native fig trees after consumption, most rangers mainly regarded the animal as a pest due to the perceived environmental costs such as:

- Plant damage by pigs wallowing, which is ‘destroying the ecosystem’
- Predation on wildlife including turkeys, their eggs and turtle eggs
- Damage to bush tucker that Aboriginal people eat (quandongs, syzygium fruits and wild native ginger) and native medicinal plants.
- Wallowing causing soil erosion and run-off to the reef, which is ‘destroying the reef’
- Weed dispersal including lantana, guinea grass, mangoes and sicklepod.

The rangers also articulated negative social and economic aspects of pigs such as:

- Disease transmission potential of pigs because people eat pig meat and can get sick from the consumption; “in the eye of health, it is a worry”.
- Destruction of people’s gardens.

The diseases that pigs carry were of great concern for the rangers because they ate pigs, and they aspired to learn about autopsies, or monitor pigs to identify the food sources that cause diseases.

Despite the negative aspects of pigs, the rangers emphasised positive values during the period the participant observation was conducted, when they went hunting and cooked the meat with native bush tucker such as lemon grass using their traditional underground oven called Kurrma. A ranger who had showed great concern about pig damage to the country showed gratitude to pigs as a food source during cooking:

“Damage in the rainforest by pigs is a worry, but they are not a nuisance around here and pig meat is good here because of their diet in the rainforest. If there are no diseases, they are good to eat. Eating them is also a good way of controlling.”

The rangers also indicated that pigs provided other flow-on economic, social and cultural benefits through traditional hunting as well as trapping practices. For example, hunted pigs (“free meat”) can be served as a feast on special occasions including birthdays and sorry business. Pig hunting served as “walking in country” and provided socio-cultural benefits such as:

- *An educational opportunity for Aboriginal people.* They can learn about the environment and may get more interested in education in general. Hunting can be ‘learning outside school’; kids can learn about the Bama (Aboriginal) law system instead of LAW (i.e. the conventional Australian laws), sacred sites, medicinal plants and Aboriginal languages, which can subsequently give them ‘connection to land’ and ‘sense of identity’.
- *The importance to their social structure.* Hunting gets people together.
- *Prevention of boredom and deviant behaviours.* It is a good exercise and provides something to do for Aboriginal people instead of drinking alcohol or taking drugs.
- *Re-establishment of connection to country.* Hunting pigs gives the people the time to connect to land and makes them familiar with the area. It can be ‘initiation’ or ‘walkabout’ (i.e. as a traditional practice where boys go and learn from their grandfathers about how to hunt when they reach a certain age, generally at 10 years of age).
- *‘Recuperating’ or ‘recovering’ from city life.* There is an emerging concern about the younger Aboriginal generation’s detachment from their country due to a lack of cultural activities or ‘no living in country’:

“Not many people hunt nowadays. During the 1970s and 80s, people used to hunt every afternoon, but today we’ve got TVs, fast food, KFCs, pubs and alcohol for social outings. Those things took over hunting. There are not many cultural activities any more. Kids don’t learn about wildlife or bush tucker. They just don’t go out. Younger people are not in the country. [...] We are getting more diabetic because of the changed diet. There are more shops available and we’ve got everything in store and easier access to food. They all took over [hunting].”

The importance of feral pig meat, however, was mainly economic and not necessarily cultural because many people relied on pig meat out of necessity rather than choice because of the deficiency of native animals that are their food sources:

“Pigs took over traditional Aboriginal food including wallabies and kangaroos as a meat nowadays. Aboriginal people are at the poverty line and they have no choice but to eat pigs. [...] Pigs are not our culture. Pigs mean only meat. Ancestors used bush tucker and medicine before, and pigs are not bush tucker. Pigs are a modern generation. Every other animal is getting scarce and so pigs are getting supplementary because they are breeding faster than other native animals. We eat pigs but it is not our meat.”

Although the rangers downplayed cultural significance of pigs, their consumption of pig meat was integrated into their seasonal patterns of consumption of traditional food:

“We hunt and gather, and eat and live by seasons, and there is a particular season for us to eat pigs. During the wet days after mangoes mature, pigs are normally fat and good to eat. During the dry season, pigs become skinny and are not ready for us to eat; so instead we

eat seafood. We still catch pigs during the dry but we will give meat to dogs. We hunt all year around and it keeps dogs occupied and gives them some exercise.”

The rangers stated that pig meat was also normally served on special occasions such as Christmas and Easter. They liked pig meat because they preferred meat from the “bush”. The wet season was the preferable season for the consumption of pig meat when pigs were fatter and meaty.

Pig hunting was enjoyed often by young Aboriginal males “for fun” (as a sport) and “for supper”:

“Hunting is men’s business and it is like a race or adventure with adrenalin rush. It is a cultural activity too and keeps people active by walking in country.”

A few rangers also mentioned that they usually caught and kept piglets as “pets” instead of killing and raised them with milk until they became mature to sell them to the people in Wujal Wujal or release them so that they could hunt and catch them again.

The rangers’ mixed views about the costs and benefits of pigs in the rainforests (as an environmental pest as well as socio-economic and cultural resource) represented their social obligations for “caring for country” and their reliance on the rainforests as a rich source of food:

“The rainforest is like a cupboard, my store, and a season calendar. It provides us air and oxygen, freshwater, bush tucker and bush medicine; it is a food source and a resource. Everything is supplied in the rainforest. It is too valuable to us.”

“Everything in the rainforest is here for us and they are resources. We make life out of it.”

“Rainforest people protect land and sea and rangers are keepers and protectors of the rainforest. The rainforest is our garden and it is common sense to look after the land.”

“Pig damage is very severe ecologically. Pigs are affecting the rainforest as well as the communities. It is upsetting to see introduced species like pigs in our country because we protect the land, the rainforest. It is the main aim of the caring for country project. There are a lot of declared plants and animals and we need to clean the country – it is the biggest clean-up and country needs it. Pest animals like pigs and cattle need to be destroyed. Pigs are destroying beautiful areas in the rainforest. The rainforest carries beautiful plants and animals and pigs step over them or kill and eat them.”

(c) Bana Yarralji perspectives on feral pig management

Although pigs provided socio-economic benefits as a food source and as an opportunity for Aboriginal people to engage in customary activities, the rangers stressed the importance of controlling the animal because of damage to the rainforest, which was considered to be “bad for the country”:

“Pig meat is important indeed. They are one of our cultural resources and are good food sources but we want pigs to disappear because pigs are a pest and bad for the country. They are also a disease carrier. We need to keep them under control; otherwise they would cause more damage to gardens, vegies, taros and pollute river ways.”

Their willingness to manage pigs, however, implied reduced food sources for their people and in response, some rangers advocated a “piggery” to raise pigs from those caught by control so that they could supply themselves enough meat as well as commercialise it for the regional economy and provide related job opportunities:

“It’s better to breed pigs and butcher them to sell them (than just controlling); it gives people jobs. We can put up fences in an area so that we can put pigs into the fenced area after trapping or hunting them. Things are expensive up here and supplying pig meat at a local level is a healthy thing. We need money to look after country and want to provide young people with better jobs. We really want to help young people so need to create something to develop and keep their enthusiasm.”

The rangers’ aspirations for employment and commercialisation opportunities were strongly related to their desire to be self-sufficient in the long term and to look after country, independent of government funding:

“We need to keep the value in the environment; the value of country and people. Good management means healthy country and management is for all of us. An ideal situation will be our people working hard and self sufficiently for healthy country. Self sufficiency is important because money dries up. We want to meet our aspirations when looking after country because there is too much government dictatorship. We want to keep ownership of management and do not want to be distracted by what the government wants.”

To be able to utilise or harvest pigs as a source of food, the rangers supported trapping because it would not damage pigs. Poisoning was disapproved of due to the risk to those who ate the meat. Wastage of animals as a result of control, therefore, was considered undesirable because of the alternative use of the meat for food although the rangers tolerated animal waste to some degree because of the health risks from the diseases that pigs carried:

“I don’t like killing for nothing, it is cruel and I don’t want to waste meat, but we have concerns about diseases.”

The rangers supported hunting with dogs because of its positive contribution to the maintenance of customary activities. Some rangers downplayed the benefits of hunting with dogs to some extent because of:

- the costs of food for dogs;
- the costs associated with treatment of injured dogs and with the time consumed for training dogs and retraining new ones to replace those lost; and
- damage dogs could cause to pigs (i.e. inability to sell the meat if commercialised).

Provided the limitations of poisoning and hunting with dogs as well as the lower costs of trapping, the rangers preferred trapping in general and wished to continue their engagement in trapping.

Nonetheless, despite the demerits of hunting with dogs, the rangers emphasised their wish to incorporate their “cultural” practices (i.e. hunting and traditional trapping) into pig management:

“We want more traps for control, but want to get pigs in a cultural way, too. Trapping (used currently by the government) is not cultural. Our ancestors used cultural traps so we need to educate non-Indigenous people about how we trap animals. It is a new way of modern tactics: cross-cultural trapping of pigs. We want a cultural way of trapping. It is about HOW to manage them. We don’t need guns to shoot pigs. Our ancestors never used to. Modern generations use guns as a weapon to destroy pigs but we want to use cultural ways at the same time.”

Using “traditional” or “cultural” methods in pig control in this case also meant managing pigs using “traditional” knowledge about their food sources and about hunting methods and cooperation with other friends:

“We know what kinds of fruits pigs eat like berries and other food sources like bulbs and ginger. And we know where they are and when the seasons are for these food sources. These are our traditional knowledge and with this we know when and where pigs are likely to be around. When we hunt pigs, we work with other friends as a team to catch them. One of us can scare pigs off to a certain direction using fire and wind so that the other ones can wait for pigs to come toward where they are.”

To encourage the far-reaching potential socio-cultural benefits of customary activities as a control method, the rangers wished for collaborative/joint management and for

more funding to engage in the cross-cultural integration of control methods via trapping and hunting and opposed a top-down approach in pig control by the government.

8.3. Summary of the Aboriginal rangers' perspectives

There were similarities and differences in perceptions about feral pigs among the rangers from different Aboriginal groups within the WTWHA (Table 8.1). The similarities were that most of the rangers agreed that pigs had negative environmental consequences in the rainforests. Giringun and Bana Yarralji rangers also articulated socio-cultural costs of pigs such as damage to cultural sites that contained shell middens and/or cave or rock art. Pig predation on bush tucker was perceived not only as an environmental concern but also as a socio-economic cost by most rangers from all the Aboriginal Corporations because it was a cultural source of food. Conversely, their attitudes toward pigs varied, particularly regarding their importance as a source of food. Giringun and Jabalbina Yalanji rangers were based in areas that were relatively socio-economically advantaged, and therefore, pigs had no value as an important food source. Burungu and Bana Yarralji rangers were based around Wujal Wujal, areas that were socio-economically disadvantaged, and therefore valued pigs as a supplementary food source. The reliance on pigs as a food source in remote areas such as Wujal Wujal, therefore, was related to socio-economic factors such as remoteness, few economic opportunities, low incomes and a subsistence economy. The consumption of pig meat was rationalised in those areas because of the scarcity of native animals. The Burungu and Bana Yarralji rangers also valued pig hunting as a customary activity because of its far-reaching social and cultural benefits such as: improved social relations among Aboriginal people, re-establishment of connection to land, further educational opportunities to learn about traditional systems, and prevention of socially deviant behaviours such as alcohol and drug abuse (Figure 8.2). Thus, pig hunting was perceived as having the potential to alleviate the economic predicament of remote areas as well as promoting cultural practices while contributing to the management of pigs (Appendix 8). Hence, pigs were both a pest *and* a resource to the rangers in remote areas, whereas the rangers in urban areas perceived them mainly as an environmental pest due to their lack of reliance on pigs for food.

Table 8.1. The similarities and differences in Aboriginal rangers' perceptions about feral pigs and their management in the WTWHA (✓ : Agreement; ▲ : Neutral; ✗ : Disagreement).

Tribal groups	Location	Similar perceptions			Different perceptions			
		Environmental pest	Favour of trapping	Desire for joint management	Resource (food source)	Opposition to poisoning	Concern for animal waste	Support for customary activities in control
Girringun	Relatively in urban areas	✓	✓	Not mentioned ⁷	▲	Due to the risks to other animals	✗	Not mentioned
Jabalbina Yalanji		✓	✓	✓	▲		✗	Not mentioned
Burungu	Relatively in remote areas	▲	✓	✓	✓	Due to the risks to people who eat pigs	✓	✓
Bana Yarralji		✓	✓	✓	✓		✓	✓

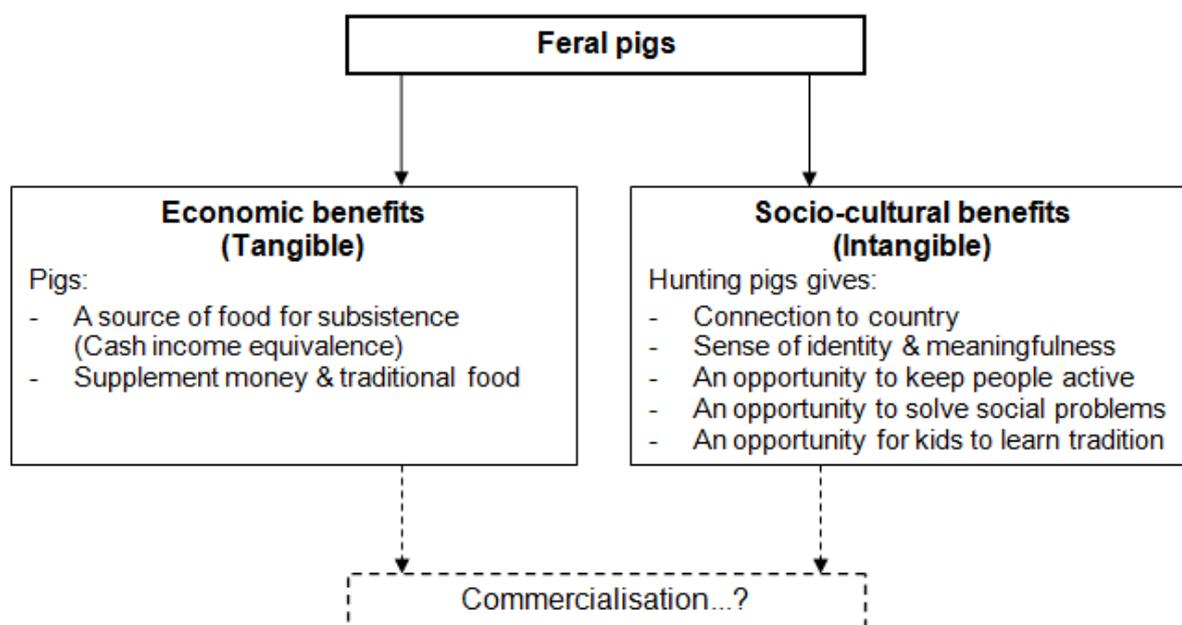


Figure 8.1. Perceived benefits of feral pigs to the Aboriginal communities in remote areas within the WTWHA.

There were also similarities and differences in the rangers' attitudes toward the management of pigs. Trapping was the most favoured method by all the rangers interviewed. Their preference for trapping was mainly due to the perceived negative

⁷ Girringun traditional owners and the Great Barrier Reef Marine Park Authority (GBRMPA) developed a co-management agreement in 2002 for their sea country management (Nurse-Bray and Rist, 2009); the rangers did not explicitly discuss co-management probably because they have made progress with the government body.

environmental consequences of the other methods such as hunting and poisoning. The rangers from all the groups interviewed reflected dissatisfaction with the current national park management.

Nevertheless, the rangers' attitudes toward management varied particularly regarding poisoning and hunting. Giringun and Jabalbina Yalanji rangers, who were based in relatively urban areas, opposed poisoning because of the risks to "other animals"; Burungu and Bana Yarralji rangers, who were based in remote areas, opposed it because of the risks to "the people" who ate pigs. That is, the reasons for opposing poisoning varied because of different degrees of reliance on pigs as a food source. Accordingly, those rangers in remote areas supported hunting as a control method because of its convenience of catching pigs. The degree to which the rangers wished to control pigs varied because those in remote areas were unclear how much they wished to control pigs and leave them "enough" for future consumption as food. The socio-economic and cultural contexts of Aboriginal communities, therefore, were important considerations in incorporating their needs and aspirations in the management of pigs so that decision-making could be contextualised.

Lastly, all the rangers valued the rainforests because of their cultural significance such as "connection to country." The rainforests were also valued as a rich source of food especially by the rangers in remote areas. The benefits and costs of pigs were discussed in this context, and pigs had different implications for the socio-economic and cultural aspects of Aboriginal people's livelihood in the rainforests (Table 8.2). Pigs positively contributed to the remote Aboriginal communities as a source of food, and hunting practices also enhanced cultural services of the rainforest.

These Aboriginal perspectives are useful for appreciating cross-cultural difference and needs in the perceived benefits and costs of feral pigs. Social acceptability of control methods also reflected the values of pigs attached by the Aboriginal rangers. Management implications of the positive values of feral pig in remote areas in the WTWHA are discussed in Appendix 8. While it is important to take into account socio-economic benefits and costs of control methods, cost-effectiveness is one of the key factors to be considered in adopting the methods available (see Chapter 1). The next chapter, Chapter 9 will explore the cost-effectiveness of the control methods in detail.

Table 8.2. The perceived impacts of feral pigs on rainforest values from the Aboriginal rangers' perspectives, categorised by the MA and TEV frameworks.

Total Economic Value		Millennium Ecosystem Assessment		Negative values	Positive Values
Use value	Direct Use Values (Consumptive)	Provisioning services	Food Biochemicals Fresh water	Pigs damage bush tucker. Pigs damage bush medicine. Pigs pollute the waterways	Pigs serve as a source of food for Aboriginal people, especially in remote areas.
	Indirect Use Values	Regulating services	Erosion regulation Disease regulation Pest regulation	Pigs cause soil erosion Pigs carry and spread diseases Pigs disperse introduced plant species	
Use + Non-use value	Direct use (non-consumptive) + Option + Existence	Cultural services	Spiritual & religious values Knowledge systems Educational values Aesthetic values Social relations Sense of place Cultural heritage values	Pigs damage cultural heritage sites and animals. Pigs deteriorate 'beautiful' rainforests Damage to cultural heritage sites, art crafts and animals.	Hunting pigs may give the people an opportunity to learn about the traditional knowledge. Pigs may serve as an educational opportunity for the Aboriginal people to learn about their country when controlling/hunting pigs Controlling & hunting for food unites the Aboriginal people Hunting for food or controlling may help the people re-establish their connection to country

Chapter 9: Cost-effectiveness of Different Control Methods

9.1. Introduction

Management of alien invasive animals such as feral pigs (*Sus scrofa*) is an important agenda for biodiversity conservation and protection of agricultural industries. In Queensland, Australia, the legislation governing the control of pest animals and plants is based on user- or beneficiary-pays principles (*Land Protection [Pest and Stock Route Management] Act 2002*). Individual landholders, who are the beneficiaries of pig control, are responsible for funding all control on their lands. Nonetheless, Regional Councils intervene and help landholders to provide community services as well as to protect conservation values on public lands. To maximise the outcomes from the limited resources available for control, cost-effectiveness is an important management consideration when assessing the relative benefits of adopting different control methods for both private and public landholders (Engeman, 2000, Hone, 1994, Hone, 2004, Izac and O'Brien, 1991, Moberly et al., 2004, Perrings, 2001, Tisdell, 1982). Cost-effectiveness is used to examine the feasibility of control methods particularly when the benefits cannot be easily estimated in dollar terms but the costs and outcomes (e.g. the number of feral pigs killed) can be estimated (Hone, 1994, 2004). Conventionally, 'effectiveness' is measured by the level of population reduction. However, effectiveness of control methods should rather be based on damage reduction (Braysher, 1993, Engeman, 2000, Olson, 2006).

Conventionally, cost-effectiveness of a particular control method has been measured in terms of 'average cost per pest killed' (e.g. Mitchell and Dorney, 2002). This is problematic because cost-effectiveness depends heavily on population density, and without accounting for this density factor, cost-effectiveness of different control methods cannot be accurately compared (Hone, 2007). Moreover, the relationship between damage reduction and the reduction in a pest population remains unclear for most pest animal species (Olsen, 1998). Consequently, past control efforts have mostly attempted to reduce pest numbers on the blind assumption that this reduces damage (Olsen, 1998). Lastly, to maximise cost-effectiveness of a control method, it should target feral pigs when they are most vulnerable to capture (Olsen, 1998). In particular, mortality may be associated with abiotic environmental factors such as rainfall (Sinclair,

1989). However, little research has investigated the effects of such factors in estimating cost-effectiveness.

To address the above problems, this study compared the cost-effectiveness of trapping, dogging (hunting with dogs) and ground shooting (hunting with rifles) based on prevailing population density. This research also examined the relationship between population levels and resulting damage; and the impact of rainfall on effectiveness of trapping. Population density was estimated in terms of Catch Per Unit Effort, or CPUE (Chapter 2). Generally, as a pest density increases, the cost per pest decreases exponentially; the higher the pig density, the easier it is to remove extra pests (Braysher, 1993, Hone, 2007) (Figure 9.1). Curves derived from the relationship between population density, or CPUE, and costs per pest are used to compare effectiveness of different methods. Theoretically, there are four different relationships between population density and resulting pest damage in any specific situation (Braysher, 1993, Hone, 1994, Hone, 2004, Hone, 2007, Izac and O'Brien, 1991, Olsen, 1998) (Figure 9.2).

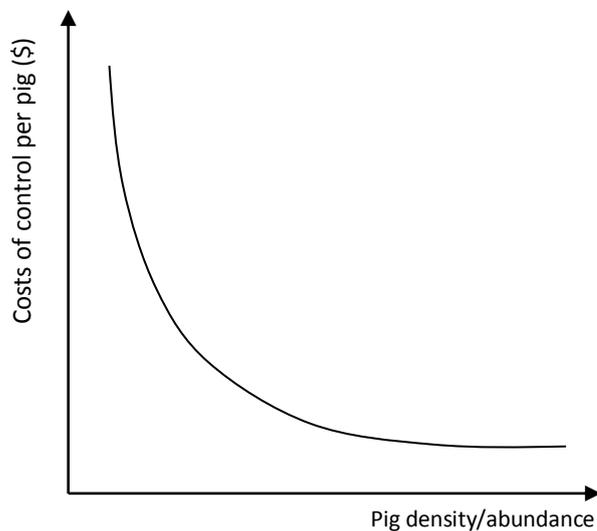


Figure 9.1. Theoretical relationships between costs of control and pest abundance (Hone, 2007, p. 59).

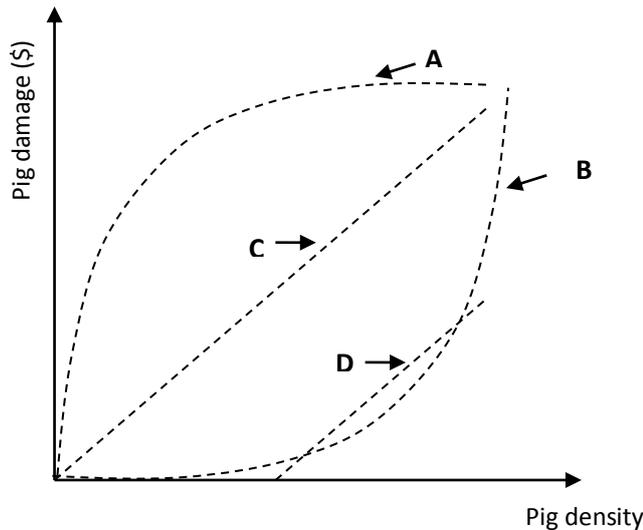


Figure 9.2. Alternative theoretical relationships between pig density and resulting damage.

(A) represents a situation where pig damage is high even at relatively low pig densities. (B) indicates pest damage is low until a critical threshold density is reached. (C) illustrates a direct linear relationship. (D) illustrates a situation where damage is negligible at low density but increases linearly at higher density (Braysher, 1993, Olsen, 1998).

“Costs” of control include not only the dollar value of the costs, but also intangible costs such as social impacts, including levels of social acceptability of control practices. For example, if the methods used to control pigs are perceived to be inhumane, acceptability of the methods may be low. Social costs may also arise when pig control compromises benefits accrued by some stakeholders such as pig hunters and Aboriginal communities. These aspects were covered in the other previous chapters (Chapters 3, 4, 5, 6, 7 and 8).

This chapter focuses on the analysis of control efforts (CPUE) to examine the most economically cost-effective method and the extent of pig damage to understand the relationship between pig density and damage, based on the raw data obtained by Mitchell and Dorney (2002) (see Chapter 2). The cost-effectiveness of fencing and poisoning was difficult to assess (see Chapter 2) so it was examined based on qualitative face-to-face interviews with the farmers (see Chapter 2). Other factors that determine the cost-effectiveness of control measures are also explored in this chapter, such as population dynamics, the geographical scale of control, the economic use of hunting, the motivations behind control efforts and animal welfare issues. Considering

all the advantages and disadvantages of each control measure, management recommendations are provided.

9.2. Cost-effectiveness of trapping, dogging, and shooting

9.2.1. Cost-effectiveness in terms of costs per pig at a given pig density

Control costs per pig for each control method were plotted against actual CPUEs across localities (Figures 9.3, 9.4 and 9.5).

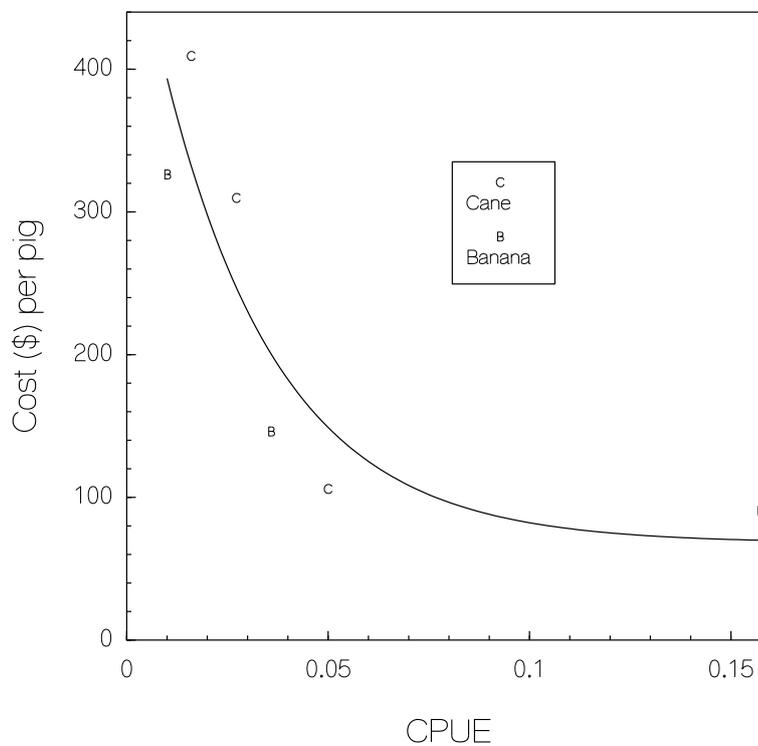


Figure 9.3. The costs per feral pig caught against Catch Per Unit Effort (CPUE) for trapping: $Y = 68 + 461 \cdot \exp(-37.09 \times \text{CPUE})$, $R^2 = 64\%$, $p = 0.10$

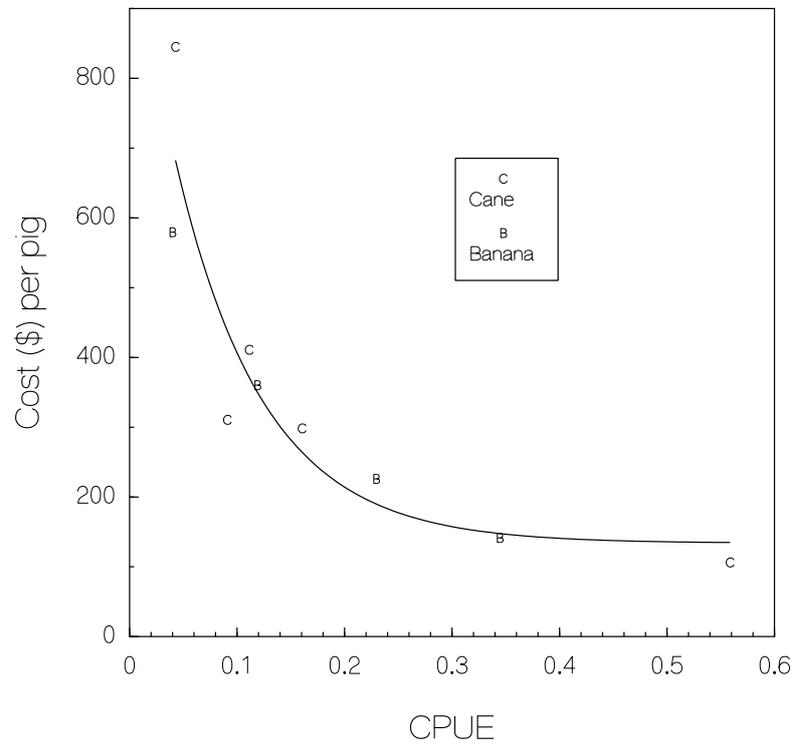


Figure 9.4. The costs per feral pig caught against Catch Per Unit Effort (CPUE) for dogging: $Y = 134 + 924 \cdot \exp(-12.21 \times \text{CPUE})$, $R^2 = 80\%$ and $p < 0.01$

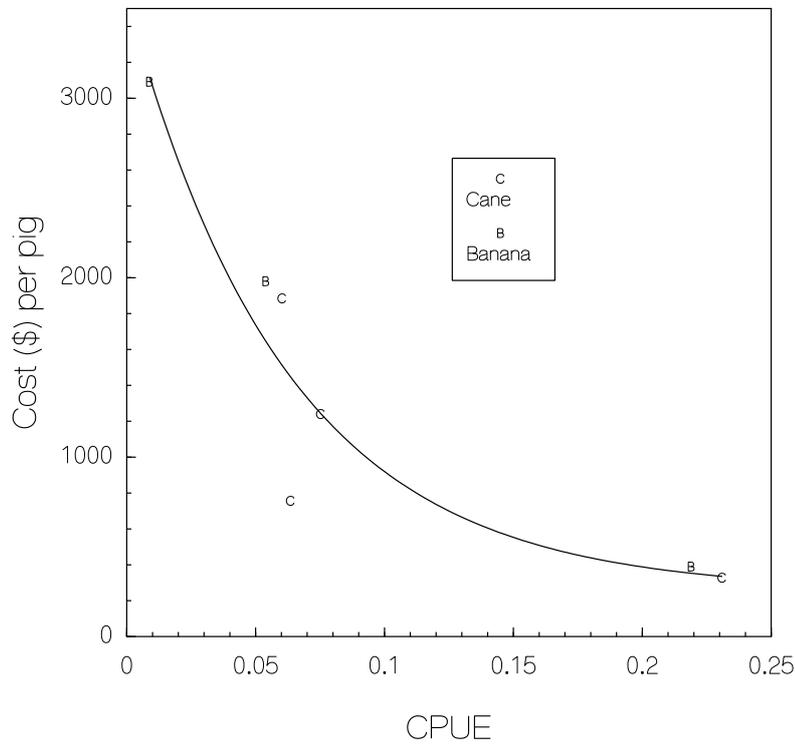


Figure 9.5. The costs per feral pig caught against Catch Per Unit Effort (CPUE) for shooting: $Y = 254 + 3303 \cdot \exp(-16.02 \times \text{CPUE})$. $R^2 = 82\%$, $p < 0.05$.

Standardised CPUE values were then used for plotting all the three control methods on the same graph (Figure 9.6). Trapping was the most cost-effective method of control, followed by dogging and shooting. Control costs increased exponentially for lower target pig densities, particularly for shooting. The curve for shooting was significantly different from those for dogging and trapping ($p < 0.01$). The curves for dogging and trapping had similar shape ($p = 0.05$) so could be parallel responses. When parallel curves were fitted, the displacement of \$141 per pig across all CPUE values was significant at $p = 0.06$.

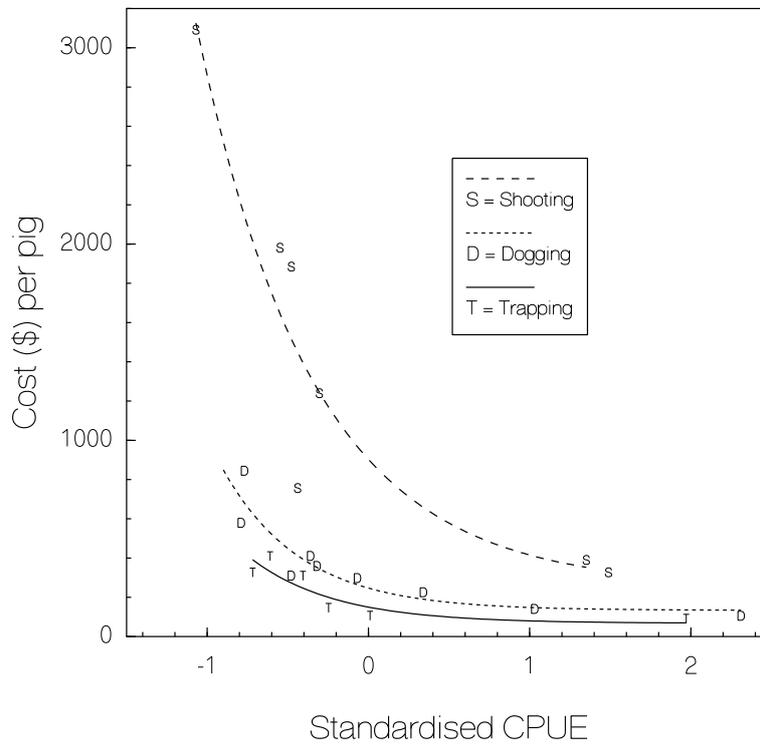


Figure 9.6. The costs per feral pig caught at any standardised Catch Per Unit Effort (CPUE) for: (1) trapping: $Y = 68 + 82.5 \cdot \exp(-1.905 \times \text{CPUE})$, $R^2=64\%$, $p = 0.10$; (2) dogging: $Y = 134 + 113.8 \cdot \exp(-2.045 \times \text{CPUE})$, $R^2=80\%$, $p < 0.01$; and (3) shooting: $Y = 254 + 649.0 \cdot \exp(-1.391 \times \text{CPUE})$, $R^2=82\%$, $p < 0.05$.

Some properties made control efforts but did not catch any pigs so a CPUE value could not be calculated. This occurred eight times for trapping, 26 for dogging, and seven for shooting. However, these data were used to calculate aggregated costs per pig across all farms. These were \$231 for trapping, \$364 for dogging, and \$1382 for shooting.

Whether crop type (sugarcane or banana) influenced the cost-effectiveness of control methods was examined for dogging (there were insufficient data points available for trapping and shooting methods). There was no significant difference ($p=0.40$) between crop types in terms of cost versus CPUE and the R^2 of a single fitted curve to all data was 80 per cent (Figure 9.4).

9.2.2. *The relationship between pig density and resulting damage*

Dollar values of agricultural damage pigs caused to 49 farms during the two year period 2000-2002 (estimated by farmers) were plotted against standardised density indices (CPUE) (Figure 9.7). Four high values of estimated damage to cane farms (exceeding AUS\$53,000) were excluded from this investigation because these would have had a disproportionately large influence on the overall relationship; even with these exclusions, distributions of damage to each crop type were still skewed with a small number of farmers estimating much higher damage than the rest. Pig density and the resulting total damage had different relationships depending on crop types (Figure 9.7). The low correlation (-0.05) between pig density and farmer-assessed damage to bananas was not significant ($p>0.05$). The correlation for sugarcane was also low (+0.48) but was significant ($p<0.01$) because there were more points. For banana farms, a horizontal line could be drawn for the mean damage value of \$2940 to apply to all localities surveyed during the two years.

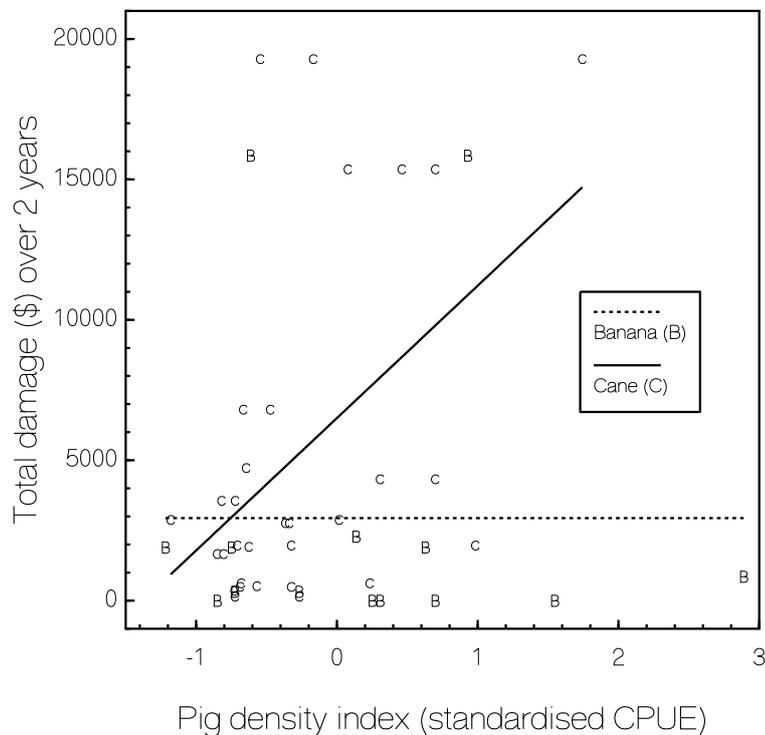


Figure 9.7. Dollar values of estimated agricultural damage caused by feral pigs over the period 2000 to 2002 at prevailing pig densities (standardised CPUE's) for the two crop types: (1) banana: $Y = 2940$; and (2) cane: $Y = 6502 + 4715 \cdot \text{standardised CPUE}$, $R^2=21\%$, $p<0.01$.

Regardless of the crop types, the economic costs associated with agricultural loss were relatively low compared to the costs associated with pig control; control costs accounted for 80 per cent of the total economic costs (i.e. agricultural loss plus control costs).

9.2.3. The effects of rainfall on effectiveness of trapping

Linear relationships between monthly rainfall and the number of pigs caught by trapping over four years were significant ($p < 0.01$) with more pigs caught during the drier months (Figure 9.8). Since the slopes of the lines fitted to data from each year were not statistically different ($p = 0.83$), parallel lines were fitted. These showed that an increase of 100mm of monthly rainfall resulted in a decrease of 2.5 pigs caught per month irrespective of year. The equation for Year 1 (the very first year when the trapping program commenced) was significantly “higher” than the equations for Years 2, 3 and 4 ($p < 0.05$), which themselves were not significantly different ($p = 0.43$). There was an average of 30 more pigs caught each month in Year 1 than in Year 2, 20 more than in Year 3 and 17 more than in Year 4.

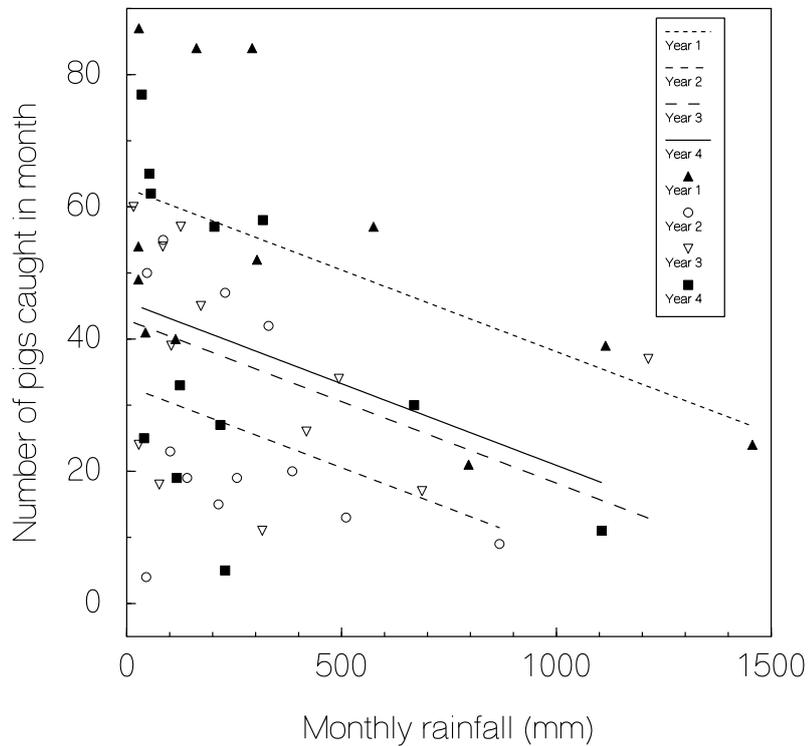


Figure 9.8. The number of feral pigs caught by trapping in Daintree and Cape Tribulation, north Queensland, plotted against monthly rainfall over the four year period: (1) Year 1: $Y = 62 - 0.0228 * \text{Rainfall}$; (2) Year 2: $Y = 32 - 0.0228 * \text{Rainfall}$; (3) Year 3: $Y = 42 - 0.0228 * \text{Rainfall}$; and (4) Year 4: $Y = 38 - 0.0228 * \text{Rainfall}$. Overall $R^2=33\%$, $p<0.01$.

9.2.4. Discussion of the results of cost-effectiveness of trapping, dogging and shooting

This study was based on the assumption that there was a direct proportionality between CPUE and pig population density (1:1). In marine fisheries research, non-proportionality between CPUE and fish abundance has been reported, with CPUE remaining high while abundance declines, which is known as “hyperstability” (Harley et al., 2001). An independent study on the proportionality of CPUE and population density of terrestrial species, therefore, would be useful for future research. Nonetheless, the resulting patterns from using CPUE values closely resembled the accepted theoretical model of control costs versus population density (Figures 9.3, 9.4, and 9.5

versus Figure 9.1). If the true proportionality was not 1:1, the x-axis in Figures 9.3, 9.4, 9.5, 9.6 and 9.7 would need to be stretched or contracted to reflect true densities. Nevertheless, comparisons such as shown in Figure 9.6 should not change substantially.

The cost-effectiveness of the three control methods differed significantly especially at low densities (Figure 9.6). The shape of the cost/standardised CPUE curve for shooting showed low cost-effectiveness at low pig densities (low CPUE values), which reflects the increased amount of search time for shooters in locating pigs. The curve for trapping did not reflect such rapid decline in cost-effectiveness at lower pig densities because the cost of trapping is mainly the fixed costs of deployment while costs for hunting with dogs and rifle shooting are dominated by variable costs. Hence, shooting is uneconomic at low densities. However, the fixed costs of trapping could be greater if free feeding time had been taken into account.

Considering that cost-effectiveness of the control methods was not influenced by crop types, the correlation between pig density and damage found in cane farms but not in banana farms (Figure 9.7) may have been due to pigs' preference for sugarcane. A lack of correlation in banana farms indicated that the theoretical relationships proposed by Braysher (1993) and Olsen (1998) did not apply for these data. In cane farms, pigs caused sporadic and localised damage with substantial variation in the extent of damage. In ecology, this pattern of damage is known as 'negative exponential frequency distributions', with many sites with little or no damage and a few sites with a higher level of damage (Hone, 1994). This variation may be due to several factors. Firstly, size and sex of pigs could have mattered because boars tended to cause more damage than sows or piglets (Mitchell and Dorney, 2002). Secondly, the effectiveness of control methods during the same period may have contributed to reducing damage; an experienced professional hunter may have prevented considerable damage whereas an inexperienced recreational hunter may not have. Thirdly, subjectivity of damage estimation could have led to inaccurate estimation of true damage levels. Situations where pigs caused more damage in the perimeter of fields may have led to overestimation of whole-field damage as farmers normally survey their fields from the perimeter (Conover, 2002).

Rainfall affected numbers of pigs caught in traps, with higher numbers caught during the drier months. This could be because pigs were not as attracted to bait during the wet season when other food (e.g. wild figs) was available and pigs tended to be

more dispersed. The first year when trapping commenced saw more pigs caught than the other years. This could be because of: (a) natural difference in ‘trappability’ between pigs; (b) a learned response to traps based on previous history of capture, which may produce ‘trap shy’ pigs or (c) home range of pigs, which determines the relative opportunity of capture (Saunders et al., 1993). Another explanation could be that control methods were starting to reduce pig numbers in the region.

Although trapping was found to be the most cost-effective method, use of the other methods such as dogging should not be discounted. For example, hunting with dogs was found to be a useful method to remove residual ‘trap shy’ pigs and to remove adult boars (which tend to be ‘trap shy’ but which dogs tend to encounter more frequently owing to boars’ solitary movements and larger home range) (Caley and Ottley, 1995). Thus, the use of a combination of methods such as trapping and dogging could be cost-effective for overall control of the pig populations. Furthermore, regardless of the types of methods, control will be more cost-effective if targeted during the dry season when food sources for pigs are more limited. Yet, considering that cost-effectiveness can vary with location (e.g. shooting being more cost-effective in an open landscape), comparative studies would be useful to offer empirical insights into the relationships between pest population density and cost-effectiveness, and density and resulting damage. Irrespective of the findings of cost-effectiveness, pig management faces a conundrum; given the sporadic and localised nature of damage, simply reducing pig numbers does not always result in less damage. It may be uneconomical to practise control for most farms even with the most cost-effective method such as trapping because 80 per cent of the total economic costs incurred by pigs on banana farms resulted from the costs of control while the rest was from actual physical damage to crops (Mitchell and Dorney, 2002). A comparative study on the relationship between pig density and resulting damage may be useful, taking into account the effects of the sex of pigs and the effects of hunters’ and trappers’ skills. If damage is independent of population density, management needs to re-define benchmarks with which they measure the ‘success’ of control strategies; how to minimise damage regardless of the population levels.

9.3. Cost-effectiveness of fencing and poisoning from farmers' perspectives

9.3.1. Results and Discussion

Three farmers (one sugarcane and two fruit) who were interviewed/surveyed used electric fencing in an attempt to protect their crops from feral pigs (Chapter 5). The use of electric fencing by the sugarcane farmer seemed to be ineffective; it failed to reduce pig damage to the property at all and the farmer still needed to employ other methods such as hunting:

“Pigs try to go under and over pig proof fences so we add another wire but they figure out another gap”.

His fences were built after detecting pig damage to sugarcane and this approach may have been ineffective because pigs tended to come back to the same spot where they preferred to feed. The farmer confirmed that pigs preferred cane that was particularly tender and sweet, and that if the cane had high sugar content, pigs would try to return to feed on it despite the presence of fences. One fruit and vegetable farmer surveyed who used fencing also asserted that it did not prevent pig damage.

In contrast, one fruit farmer in Daintree interviewed argued that since he erected it three years ago, electric fencing had protected 100% of his bananas. The difference was probably due to the erection of fencing prior to planting the bananas before pigs established their preference for the new food source.

“The protection level has been 100% since three years ago. During the first three months, pigs came to the edge of fencing [but did not damage it]. Bananas were planted after putting up fences. If pigs were already feeding on existing bananas and then we erect fences, electric fencing wouldn't work because pigs would keep coming back to the same spot and try to go through the fences despite the electric shock.”

Cost-wise, the electric fencing on the fruit farm cost approximately \$2,500 for 450 square metres. The controlling efforts (daily maintenance of fencing) could be estimated to be around 60 hours per annum (maximum). Hence, this cost of control through electric fencing before planting can be justified if fences are used in areas that are environmentally or economically valuable and also relatively small so that the higher initial and maintenance costs can be justified (Rainforest CRC, 2003). In contrast, ad hoc fencing in areas like sugarcane may not be effective because pigs would have already established food preferences.

Two farmers (one sugarcane - interviewed, and the other livestock and fruit - surveyed) deployed poison baits on their farms with assistance from the Queensland Department of Primary Industries and Fisheries (DPI). Poisoning appeared to be expensive for the sugarcane farmer because of the extensive labour costs required for free feeding before injecting poisons (i.e. 1080 compounds) into baits such as bananas. Free feeding was important for pigs to first become used to the baits and establish preference to feed on the baits without poisons. Although the sugarcane farmer bore no costs for poison baits (i.e. provided free of charge by DPI), the farmer and their family spent almost a month (two hours every day) to free feed pigs with bananas (which were also provided free of charge from a local banana farmer in Daintree). After confirming pigs' frequent presence on a feeding site, poison 1080 compounds were injected into the baits. For the first two weeks, pigs disappeared from the baited farm, so the farmer believed that poisoning was effective. After a while, however, another group of pigs, which was believed to have migrated from elsewhere, invaded the farm. A major drawback of such poisoning efforts is that it was exercised on a small paddock without coordination with the adjacent landholders and that the paddock was located adjacent to the national park; poisoning at a small scale seemed to fail to prevent pig populations from in-migrating. The livestock and fruit farmer surveyed also conducted poisoning and asserted that poisoning failed to completely prevent pig damage but estimated that it protected 70 to 80% of the property. Hence, as suggested by the government officer interviewed (Chapter 6), poisoning may need to be conducted over a larger scale for effective control.

9.4. Other determinants of cost-effectiveness of control methods

9.4.1. Geographical scale of control: coordination with adjacent landholders

Even though control efforts are concentrated at the vulnerable stages of the life cycle of the population (e.g. during the dry season), re-colonisation or in-migration reduces the effectiveness of control. Feral pigs are able to disperse from adjacent, uncontrolled sites and to re-establish quickly in an area of lower density. Failure to reduce pig numbers by more than 30%, for example, allows the population to return to the pre-control level within two years (Rainforest CRC, 2003). This fecundity and mobility of the animal reduces the incentive of farmers to control pig numbers on their property and to engage in long-term control strategies (Tisdell, 1982). Disengagement of landholders then

generates a cost for other landholders who wish to control pigs on their properties because pigs could in-migrate and reinvade while those landholders who control pigs generate a benefit for the non-participant landholders by reducing pig numbers; these costs and benefits refer to ‘control externalities’ (Izac and O’Brien, 1991), or free riding (Chapter 5). Such inconsistency in control among landholders leads to sub-optimal pig control and makes local eradication unfeasible. Hence, a large-scale control through coordination with adjacent landholders is important because it would address pigs’ population growth potential and have immediate and regional effectiveness (Bengsen et al., 2008, McGaw and Mitchell, 1998), thereby preventing in-migration. Poisoning, in particular, needs to be conducted at a large scale for a long-term population reduction with minimal costs (Giles, 2001, Mitchell et al., 2009, Spinaze, 2009).

Similarly, if traps were set up at a small scale (e.g. controlling pigs at an individual property scale), trapping would not achieve ‘regional’ effectiveness because controlled areas only create a temporary gap, which could be filled by in-migration. Previous studies also suggested trapping tended to achieve only localised reduction of pig damage (O’Keeffe and Walton, 2001, Vernes et al., 2001). Dogging, in contrast, may be useful to prevent temporary in-migration with the presence of dogs within the property. Coordination of control efforts, however, is difficult to achieve because not all the landholders perceive pigs to be a pest or a problem (Chapter 3).

9.4.2. The economic use of hunting: mutual dependence of farmers and hunters

Hunting with dogs and rifles was the most common control measure employed in sugarcane farms in the study area. Farmers often asked local pig hunters to hunt on their properties and occasionally they gave a ‘bounty’ to the hunters for the number of pigs caught as well as helping the hunters with dog food, petrol, bullets and vet treatment if dogs were injured (Chapter 5). In this situation farmers and hunters were in a mutually beneficial social relationship through pig hunting; by inviting hunters onto farms, farmers bore few costs of control yet they benefited from reduced pig damage with economic benefits. On the other hand, hunters benefited from farmers’ permission to hunt on their properties. In Australia, hunting is subject to permission by landowners and little public land is available under licence to hunters; current regulations on gun use and ownership, therefore, create competition for access to properties among hunters.

Consequently, it is important for hunters to maintain good relationships with landholders for privileges to access to land (Bauer and Giles, 2002). Although pig hunters bear the costs of hunting, it is part of their recreational activity and they are willing to pay the costs. Hunting has been recognised as an economic culling opportunity with social benefits (Tisdell, 1982, Choquenot et al., 1996).

9.4.3. Intrinsic motivation versus extrinsic motivation in pig control

Pig hunters' and Aboriginal people's engagement in pig management (Chapters 4 and 8) may arise from different values/attitudes and motivations compared to the other stakeholders. Pig hunters and Aboriginal people tend to control pigs based on *intrinsic motivation* because it is "inherently interesting or enjoyable" and entails fun and/or challenge; they hunt not for any instrumental reason but for the positive experiences in exercising and extending their capacities (Ryan and Deci, 2000). In contrast, others, such as farmers (Chapter 5), may control pigs based on *extrinsic motivation* because it leads to a separate "outcome", that is, mitigating economic costs (Ryan and Deci, 2000). Control actions based on intrinsic motivation are independent of an outcome, and thus, such actions are long-term as long as the actors (e.g. hunters) find that the activity itself is rewarding. Conversely, control actions based on extrinsic motivation may cease if the actions fail to lead to an expected outcome. For example, farmers may cease trapping pigs if they catch none, or if agricultural damage remains even with trapping. Hence, control actions taken by those who are intrinsically motivated may be cost effective and endure in the long term because the people would be willing to control at their own cost.

9.4.4. Animal welfare considerations: hidden social costs

The aim of pest management is generally not to kill maximum numbers of pests but to reduce their damage to valued assets and/or often to promote biodiversity conservation (Olsen, 1998, Cowled and O'Connor, 2004). Accordingly, conventional focus has been on the economic and environmental costs of control, and only recently has there been attention toward social costs such as social acceptability, and animal welfare (Sharp and Saunders, 2008). Animal welfare, that is, humaneness, has been so important that the consideration of the cost-effectiveness of control practices for the sake of reducing environmental and socio-economic damage is no longer considered sufficient (Cowled

and O'Connor, 2004). Animal welfare refers to a complex *social construct* because human interpretation of objective information and subjective judgements of humaneness are influenced by the extent of concern for the animal under consideration, for example, feral pigs (Sharp and Saunders, 2008). Humaneness in pest animal control refers to a killing method that avoids the infliction of unnecessary pain upon pest animals by minimising pain and reducing the time to death wherever possible (Sharp and Saunders, 2008). According to the *Animal Care and Protection Act 2001 (QLD)*, it is prohibited to cause intentional pain or suffering to an animal whether it is a pet or a pest animal (Heise-Pavlov, 2009). This research demonstrated that some stakeholders, especially those who were unfamiliar with feral pig issues, such as tourists and some local residents, opposed lethal methods including hunting and poisoning because of animal welfare concerns (Chapters 3 and 7). Therefore, animal welfare needs to be considered when adopting control methods.

9.5. Summary of cost-effectiveness of control methods

Trapping was found to be the most cost-effective method compared to dogging and shooting because of the lowest cost per pig at a given pig density index, and the cost-effectiveness of trapping can be maximised by targeting the dry season. Nonetheless, dogging and shooting could be useful on farms where farmers and hunters mutually gain socio-economic benefits, which are not taken into account by the economic analysis of its cost-effectiveness. Furthermore, although relative cost-effectiveness of fencing and poisoning is unknown, these methods could be useful in certain circumstances, such as fencing farms before planting crops or poisoning for coordinated larger-scale control. Thus, factors other than cost-effectiveness should also be taken into account such as geographical scale of control and coordination with adjacent landholders, motivations behind control and the social costs of animal welfare concerns.

Chapter 10: Discussion and Conclusion

10.1 Overview

This research investigated the perceived costs and benefits of feral pigs in the Wet Tropics World Heritage Area (WTWHA) from the perspectives of various stakeholders. The perceived environmental impacts of pigs were measured in terms of their implications for values that stakeholders attached to the WTWHA rainforest. Values identified from the qualitative semi-structured interviews, household surveys, and/or tourist surveys were then analysed and compared based on the two scientific value frameworks, the Millennium Ecosystem Assessment (MA) and Total Economic Value (TEV). The utility of the value frameworks was also assessed to determine whether the scientific construction of values was reflective of public construction of values. Perceived economic impacts of pigs were investigated in terms of their implications for the local agricultural and rainforest tourism industries. The perceived socio-economic impacts of pigs were measured based on their impacts on local stakeholders' livelihoods, such as property damage, illegal hunting and pig control practices, and the values of pigs associated with pig hunting.

Cost-effectiveness and social acceptability of the control methods commonly used in the WTWHA, specifically trapping, hunting, fencing and poisoning, were also investigated. The cost-effectiveness of trapping and hunting with dogs or rifles was examined based on costs per pig at a given Catch Per Unit Effort (CPUE) as a proxy for pig population densities and its relation to damage estimates. The effect of density-independent factors such as rainfall on the effectiveness of trapping was also examined. The cost-effectiveness of fencing and poisoning was qualitatively assessed based on the semi-structured interviews with farmers, and household surveys. Social acceptability of the methods used to control pigs in the WTWHA was measured by both the interviews and surveys, in which stakeholders were allowed, through an open-ended question, to freely express why they supported or opposed certain methods.

Regardless of type of control method used, an 'acceptable' level of control for stakeholders depends on their subjective perceptions of the severity of the 'problems' associated with pigs. Thus, their attitudes toward current pig management were also examined as an indicator for Wildlife Stakeholder Acceptance Capacity. The public

attitudes were then compared with the management agencies' perspectives particularly with regard to the government contributions to the Daintree feral pig trapping program and overall pig management in the local area.

This chapter discusses and synthesises the findings from the research and provides recommendations for future research and management of feral pigs in the WTWHA.

10.2 Perceived costs and benefits of feral pigs

10.2.1. Perceived environmental impacts of feral pigs

(a) Values that stakeholders ascribed to the WTWHA rainforest

The majority of the local residents (Chapter 3), tourists and tourism operators surveyed (Chapter 7) as well as some pig hunters (Chapter 4) and farmers (Chapter 5) articulated 'ambiguous' values of the WTWHA rainforest such as 'nature', 'environment,' 'ecosystem,' 'ecology,' 'very important' and 'the need for protection.' These terms did not correspond to any classified values identified by the TEV or MA frameworks. Firstly, the way the question attempted to identify values may have resulted in stakeholders' providing such ambiguous responses. However, the question was designed in a way that would not direct their responses to suit the frameworks (Lockwood, 1999); all responses should be legitimised to reflect stakeholders' own construction of values, based on a Grounded Theory or an inductive approach. Conversely, ambiguous responses may indicate that those stakeholders were possibly unable to articulate specific services or uses of the rainforest that resulted in the importance of the rainforest or the importance of protecting it. If this is more plausible, the acceptance of rainforest values may be because of a growing acceptance of environmental values in a broader society (Stern et al., 1999); the importance of the environment has become comprehensive and taken for granted (Greider and Garkovich, 1994). The acceptance that the environment is significant, or necessary, means that the public may not question its significance or value because it stands as an empirical fact. Therefore, the ambiguous responses which were intended to indicate values of the rainforest may be a reflection of the contemporary environmental paradigm (Greider and Garkovich, 1994).

The concepts used for rainforest values such as ‘nature,’ ‘environment,’ ‘balance of nature,’ ‘ecology’ and ‘ecosystem’ also may be symbolic of the stakeholders’ increasing interest and appreciation in preservation of the rainforest in response to its growing scarcity caused by humans, for example, through recent forest clearance (Frost, 2001). Such terms normally indicate human beliefs that “nature is at its best”: the environment is valued when there is no human intrusion because that is perceived to be the most ‘healthy’ or in its maximum environmental quality (Hull et al., 2001). The absence of human influence is valued because it corresponds to humans’ prejudged and predetermined desirability of the state of something ‘natural’ (Trudgill, 2001, Trudgill, 2008). Such a ‘natural’ state of the environment, or the condition that existed prior to human influence, has the greatest conservation value and is to be protected through ‘conservation’ (Eggleston et al., 2003, Soper, 2000). Therefore, the stakeholders’ desire to preserve the rainforest, or what is seen as an ecosystem ‘fragile’ to ‘disturbance’, was reflected in responses such as ‘conservation’ or ‘preservation’ as values of the rainforest (Trudgill, 2001). In addition, the concepts such as ‘ecology’ and ‘ecosystem’ also reflected the growing interest in ‘nature’, indicating similar ideas to the ‘natural’ environment in public discussions of the environment, rather than being associated with the roles of ecosystem structure (Croll and Parkin, 1992, Evernden, 1991). Hence, those stakeholders who articulated the values above may have had a general understanding of worth with ‘nature’, which is considered to be under threat, but they lacked knowledge in specific ecological values such as those used in the MA and TEV frameworks (Trudgill, 2001).

Other rainforest values that were commonly articulated across the different stakeholder groups included ‘biodiversity’ and ‘provision of habitats for flora and fauna.’ ‘Provision of habitats for flora and fauna’ is equivalent to ‘biodiversity’, and under the MA framework, the concept ‘biodiversity’ normally refers to structural features of ecosystems that support ecosystem services (Carpenter et al., 2009). Thus, biodiversity is an intermediate product of ecosystem services rather than an end product under the MA (Boyd, 2007). However, it is uncertain whether the stakeholders articulated ‘biodiversity’ with such understanding. Rather, they may have directly valued biodiversity or species populations as the end products, or for its existence values. This is because ‘biodiversity’ often means ‘conservation’ of the rainforest to the public (De Groot et al., 2002); the concept of biodiversity has increasingly and globally

been used as a conceptual focus of conservation policies and as a 'crisis' to which conservation responds with protective legislation and reserves (Jeffries, 2006). Awareness of 'biodiversity' has been increased through the media, resulting in public desires to conserve rainforests against 'threats' to biodiversity such as invasive animals as causes of extinction of native species (Jeffries, 2006). Ultimately, 'biodiversity' or the existence of native species has become some kind of cultural preference and is accepted as 'a good thing' (Trudgill, 2001). That is, the stakeholders attached values to the rainforest not because they benefited from the actual ecosystem services but because they believed that the rainforest was becoming scarce and needed protection from disturbance.

Hull et al. (2003) and Bentrupperbaumer et al. (2006) also highlighted that visitors/tourists and the public were incapable of clearly articulating values associated with an ecosystem, but placed values on the absence of human influence. Despite the difficulty they had in defining the terms, 60% of the visitors to the WTWHA placed high value on 'naturalness' and 'biodiversity' as indicators of 'environmental quality', and desired its protection, preservation or conservation as the value of the rainforest (Bentrupperbaumer et al., 2006). Hull et al (2003) also suggested that 'biodiversity', or diverse and available habitat for wildlife, is valued because it indicates a 'healthy' environment or an environmental condition where little or no human influence exists. Protected areas, such as the WTWHA, are not devoid of human influence because a certain degree of access and use is allowed, often for tourism (IUCN Protected Area Category II, i.e. national parks). However, in this case, considering that tourists tend to be mostly urban, middle-class, and from post-industrial Western societies, the rainforest represents a place for 'therapeutic' withdrawal from their normal residence, or offers the absence of 'the ills of human civilisation' (Fletcher, 2009). Hence, tourists were likely to have desired protection of 'natural' areas that were devoid of, or contrasted to, their normal 'urban' or 'human-dominant' environment. Similarly, 'biodiversity', the most common value among the tourists surveyed in this study, also implies romantic values associated with tourists' appreciation of 'naturalness' (Hull et al., 2003; Takacs, 1996) rather than as an ecosystem structure that supports ecosystem services. Among tourists, in particular, rainforests are also regarded as something to be preserved and protected, that is, have existence values, perhaps owing to media coverage, which has increased public interest in visiting and experiencing rainforests (Bridge, 1995, Frost,

2001, Jeffries, 2006). Tourists' interest and desire to protect rainforests can also be related to the tendency to see rainforests as heritage, or something worth saving, but considered to be under 'threat' (Davison, 1991).

Tourists appreciated the 'naturalness' of the rainforest, which was unique and novel, contrasting to their normal environment of residence. Thus, most 'ambiguous' values that they articulated relate to the opportunity for them to appreciate the uniqueness of the environment, that is, the 'aesthetics', which was the key element of their rainforest experience. Based on the nine typologies of human values of 'nature' (Kellert, 1993), that is, utilitarian, naturalistic, ecologicistic-scientific, aesthetic, symbolic, humanistic, moralistic, dominionistic and negativistic, most values of the WTWHA were 'naturalistic', provided a sense of fascination, wonder and awe; aesthetic, had physical appeal and appreciated the beauty of nature; and/or moralistic, felt an ethical responsibility for 'nature'. In particular, naturalistic and aesthetic values were related to recreational benefits of the WTWHA rainforest for the tourists surveyed. Hence, the ambiguous values that the tourists articulated were also related to recreation and ecotourism values of the WTWHA as existence values.

Conversely, Aboriginal rangers (Chapter 8), some pig hunters (Chapter 4) and farmers (Chapter 5), as well as a minority of other local residents and tourists, expressed rainforest values that corresponded to the classified values of the MA and TEV frameworks. Aboriginal rangers, in particular, articulated values that reflected their direct and daily interactions with the rainforest ecosystem, which related to their entire economic, cultural and social world. This is in contrast to the ambiguous values attached by the majority of the local residents and tourists, and those who may have not necessarily often visited, used or lived in the rainforest. This antithesis between clear and unclear articulations of values may be related to their 'endogenous' and 'exogenous' knowledge about the benefits that the rainforest provides for humans. 'Endogenous' knowledge is similar to the concept of 'Indigenous' knowledge, 'traditional' knowledge, or 'local' knowledge, referring to "knowledge coming from local people themselves, knowledge available in the land, in its history, its culture, its memory, its geography, and its linguistic heritage" (Herman, 2009: 187). Endogenous knowledge, therefore, is wisdom that grows from within communities, or professional networks, rooted in, and emerging from, local contexts and practices as a result of close interaction with the natural environment. Conversely, 'exogenous' knowledge refers to the information

made available and gained from sources outside such as the MA and TEV frameworks, which are based on mainstream scientific knowledge. Aboriginal rangers, for instance, may have developed understanding of the values and services of the rainforest for their livelihoods, which became their 'endogenous' knowledge about the rainforest. In contrast, the majority of the local residents as well as the tourists surveyed were likely to have relied on 'exogenous' knowledge about the rainforest to appreciate its values, which may have been gained through the media and/or education. Their reliance on such exogenous knowledge to express values of the rainforest was manifested in their responses such as 'biodiversity', 'ecology' and 'ecosystem', the concepts commonly used in scientific discourses. Such exogenous knowledge, however, may have not been 'integrated' because of a lack of actual interactions with the rainforest, thereby resulting in ambiguous responses that reflected their acceptance of rainforest values regardless of its benefits to their wellbeing.

(b) The perceived effects of pigs on the rainforest and its values

The majority of the values ascribed to the rainforest corresponded to the 'idea' of the forest being in the untouched/pristine environment that had no or little human influence, thereby needing conservation/preservation. This concept of 'untouched nature' may be negatively affected by the presence of pigs, if pigs were perceived to be detrimental to the rainforest, or if they realised that pigs were a 'pest' animal. Stakeholders across the different groups suggested that the forest values were diminished by pigs' through "damage to the rainforest", "competition with native species" and "deterioration of water quality and soil erosion". These impacts generally represent poor forest quality (Hull et al. 2001), thereby decreasing the value of the rainforest owing to pig disturbance. Conservation, or "cues to care", then becomes important to address sources of 'poor forest health' (Hull et al., 2001) or to protect the 'natural' state of the rainforest. Evidence of dead trees and of erosion or exposed soil, for example, would signify disturbance and hence poor health through conservation failure, for which the public tend to feel a sense of ethical responsibility and the need to protect the 'natural' state of the area. This preservationist conservation philosophy often results in the public's desire to eradicate 'alien' introduced species, such as feral pigs, from protected areas (Eggleston et al., 2003). In a similar manner, some of the tourists surveyed perceived that feral pigs diminished rainforest values based on their 'pest' or 'alien' status

(Chapter 7). This is because exotic species, such as pigs, tend to be perceived negatively; they are considered to live outside of their 'natural' range, as opposed to native species (Woods and Moriarty, 2001). Hence, the concept of a 'pest' determined stakeholders' judgments about their impacts on rainforest values (Robinson and Whitehead, 2003).

Nonetheless, some stakeholders, especially Aboriginal rangers, articulated more specific impacts of feral pigs on the rainforest, which had direct and immediate implications for the socio-economic and cultural benefits that they derived from the rainforest. The environmental impacts of pigs that affected rainforest values included weed dispersal and predation of native plants and animals, which are culturally and traditionally significant food sources ('bush tucker'). Hence, those who had more direct relationships with the rainforest either in their profession or through their livelihood may have perceived the environmental implications of pigs not as an abstract but as a direct or indirect consequence for their wellbeing. Conversely, those who valued the rainforest based on the 'condition' that they appreciated may have articulated the impacts of pigs as causing disturbance to the condition, which signifies 'poor' forest health.

Regardless of the kinds of values attached to the rainforest, a minority of the local residents interviewed/surveyed did not perceive that pigs affected rainforest values. This was because: they acknowledged positive aspects of pigs as a resource in the form of food or recreational opportunities, and/or because they did not believe that the rainforest was 'fragile' to 'damage' caused by feral pigs, which was perceived to be relatively negligible, compared with that caused by humans. Some even considered pig digging to be 'natural' rather than 'damaging' (Chapter 3). Such acceptance of pig digging as being 'natural' was one of the reasons why sighting of pig diggings did not lead to a negative rainforest experience (Chapter 7). The concept of 'naturalness', in general, is based on three forms: history based, property based, and relation based (Siipi, 2008). Exotic species like feral pigs are normally considered 'unnatural', as the majority of the stakeholders perceived them, because they are introduced by humans (i.e. history based), change the ecosystem that they have invaded (i.e. property based), and are 'out of place' in their new locations (i.e. relation based). However, pigs could be 'natural' if people were accustomed to the animal or its existence or behaviour in the environment (i.e. relation based, familiarity as naturalness). Thus, their perceived

environmental costs may have partly depended on stakeholders' perceptions of whether or not the presence of pigs was compatible with their interpretation of what is 'natural'.

The perceived environmental costs, moreover, may be 'exaggerated' for some stakeholders in an attempt to use pigs as a scapegoat, or such costs may be disregarded because of stakeholders' lack of concern about, or familiarity with, issues associated with pigs. For example, most farmers emphasised soil erosion as a major environmental impact of pigs in the rainforest in an attempt to counteract the legislative accusation of run-off of soil into the reef from the use of fertilisers on farming lands (Chapter 5). In a similar manner, feral goats were used as a scapegoat to account for environmental degradation that was caused mostly by change in land uses (Morton, 1998). A negative view of an animal, such as feral pigs, as 'noxious' can serve the role of 'cleansing' the guilt of people (Knight, 1999). Thus, in the WTWHA, the perceived environmental costs of feral pigs such as soil erosion served as a 'political' means for some cane farmers to defend their agricultural practices. Furthermore, pig hunters have also stressed the negative environmental costs of pigs in an attempt to justify hunting as a conservation tool to mitigate those costs (Chapter 4). Their concerns about the negative environmental impacts of pigs may have been genuine, based on their direct engagement with the environment through hunting, which could have increased their 'environmental sensitivity' (Holsman, 2000). However, the existing literature also suggests that hunters tend to justify hunting of feral animals as a conservation practice by arguing that the animals degrade the Australian environment (Booth, 2010, Cahoon, 2009). With such justification of hunting as a 'good' conservation action, negative social images of hunting held by the public (e.g. Chapter 3) could also be altered. Lastly, some local residents, especially newcomers and dwellers in the urban periphery did not perceive any environmental costs of pigs because they were unfamiliar with, or unconcerned about, pig issues (Chapter 3). The perceived environmental costs, therefore, need to be carefully interpreted if used for policy development.

10.2.2. Perceived economic impacts of feral pigs

(a) Economic impacts on the agricultural industry

Most research participants across all the stakeholder groups perceived that feral pigs caused negative economic impacts on the agriculture industry, such as loss in agricultural production of sugarcane and tropical fruit, as well as having potential for

transmission of diseases such as Foot-and-Mouth Disease. In contrast, the economic impacts of pigs were estimated by the farmers to be sporadic and locally intensive. A few Mossman-based sugarcane farmers interviewed did perceive that feral pigs had caused ‘significant’ economic damage to their farms. This was possibly because the farms were located near water sources, or pig habitats, i.e. the rainforest or Daintree National Park (e.g. Takahashi et al., 2009), although not all the farms close to the rainforest had received ‘significant’ damage, and the extent of damage to those farms appeared to vary from year to year. Such variation in the extent of damage among farms could be because of different ways farmers had for dealing with feral pigs such as variation in hunting pressure and strategies of planting different cane types (Chapter 5). Such variation in damage patterns was also observed in the southern coastal areas of the WTWHA (Mitchell and Dorney, 2002) (Chapter 9). Conversely, no tropical fruit farmers based in Daintree and Cape Tribulation claimed that pig damage had caused significant financial costs. In comparison, agricultural damage was also caused by other animals to an extent that rodent and bird damage may have been more of an economic problem to the sugarcane industry than pig damage in the WTWHA (Mitchell and Dorney, 2002). Thus, the perceived negative economic impacts of pigs may have resulted from a tendency to exaggerate and blame feral animals including pigs for crop damage even though many other animals were also responsible (Knight, 1999). Hence, there were differences in the actual and perceived costs of pigs: between the perceived economic impacts of pigs on the agricultural industry by the farmers and those by the public, or other stakeholders.

(b) Economic impacts on the rainforest tourism industry

Government officers (Chapter 6) and tourism operators (Chapter 7) showed concern that the presence of pigs may pose safety risks to tourists visiting the Daintree National Park and threaten the ‘presentation’ of the WTWTA because of ground digging damage. Safety risks were also associated with concerns regarding legal pig hunting activities in Daintree and Cape Tribulation. Presentation values of the rainforest were perceived to be threatened by vegetation damage caused by pigs around boardwalks as well as predation of, or competition with, iconic native animals such as cassowaries. Such negative environmental impacts were then considered to be detrimental to tourists’ rainforest experience (Chapter 7). An economic downturn in the tourism industry as a

result of potential outbreaks of diseases carried by pigs was also a concern among some operators.

Nevertheless, such perceived economic impacts by the operators may not be a matter of urgency because most tourists did not know about the existence of pigs. This lack of knowledge also indicates that they are unlikely to be able to notice, or identify, ground diggings caused by pigs, or associate them with feral pigs. A main recreational benefit that the tourists attributed to rainforest experience was the novelty and uniqueness of the environment, which was reported in the previous studies (Chan and Baum, 2007, Wight, 1996). This aspect of the tourism experience, however, could be obtainable regardless of the existence of feral pigs because most tourists did not find sighting of pig digging to be negative rainforest experience. Even for those who knew about the presence of pigs, and therefore more likely to be able to identify damage as being caused by pigs, sighting of pig digging was not necessarily translated into negative rainforest experience. This was because digging was regarded as being ‘part of the environment’, indicating a general acceptance of this ‘exotic’ species and its existence in the WTWHA. Thus, the implications of the presence of pigs for the tourism industry were negligible.

However, rainforest values were perceived to be negatively affected by feral pigs (see 10.2.1.). This is in contradiction to the result that the occurrence of feral pigs did not affect rainforest experience. Normally, if pigs were perceived to have a negative impact on the values placed on the rainforest by tourists, this would then negatively influence their rainforest experience. However, the dichotomous results were possible because two thirds of the tourists surveyed were informed of the presence of pigs for the first time by the survey for this study after they visited the rainforest. These tourists were unaware of the presence of pigs and/or their damage in the rainforest when they walked along the tracks, thereby gaining rainforest experience irrespective of the presence of pigs. In responding to the survey, however, some of these tourists knew or guessed the ‘non-native’ status of pigs. This acknowledgement of the exotic status through the survey then resulted in their perception that pigs were deleterious for the environment and thus degrading of rainforest values. Such negative perceptions were based on the incompatibility of the existence of such exotic species with the ‘natural’ rainforest (King, 2009). Hence, the provision of the information about the existence of feral pigs could decrease values of the WTWHA rainforest appreciated by tourists.

Nevertheless, pigs may not be totally negative for rainforest tourism in the WTWHA. Pigs may actually enhance rainforest experience because tourists may perceive them to be an exciting 'wild' animal when they become aware of their existence. However, they may hold negative attitudes to the presence of pigs subsequently if they acknowledge the exotic status of the animal, as argued by the tourism operators. The positive evaluation of feral pigs could be because of tourists' inherent desire to see wildlife in rainforest environments. Hill and Gough (2010) found that the inability of tourists to view wildlife during their visit in the rainforest was one of the most disappointing rainforest experiences. This component of recreational benefits 'seeing wildlife' could also be part of the 'novelty' and 'uniqueness' of the rainforest under this study, and thus, the presence of pigs could indicate opportunities for tourists to see 'wildlife' rather than a 'nuisance', especially for those who were unaware of the 'exotic' status of pigs.

10.2.3. Perceived socio-economic impacts of feral pigs

(a) Pig hunting

The social impacts of feral pigs were more positively perceived than the environmental and economic impacts, mostly because of recreational pig hunting opportunities. Pig hunting itself had social and cultural benefits for pig hunters because it was valued as a hobby, pastime and/or sport and retains hunters' family inheritance and connection to the Australian bush. Although motivations for hunting varied, pig hunting featured similar social and cultural traits to Indigenous hunting in that it required a myriad of skills that involved 'learning about pig behaviours' and continual searching for pigs, in which hunters' social status, social bonding and relationships were developed (e.g. Cahoone, 2009, Ingold, 1986). Hunters' territorial behaviour was also a social aspect of hunting as part of social appropriation of land, or a form of practical, indirect negative cooperation, communicating about the location of hunters dispersed in space so that they would not spoil others' hunting success (Ingold, 1986). Thus, pig hunting had its own social and cultural significance for the actors.

Similarly, Aboriginal rangers especially in remote areas, for example Wujal Wujal, valued pig hunting because it prevented boredom and deviant behaviours, provided local Aboriginal people an opportunity to recuperate from city life and re-

establish connection to country, and aided social structuring of the people (Chapter 8). Hunting, even when used as a control method, was equivalent to ‘walking in country’ for Aboriginal people, by which they could learn their Aboriginal law system, sacred sites, medicinal plants and local Aboriginal language. Socio-economic benefits associated with pig hunting resulted from the use of pig meat as a food source for human consumption and for hunters’ dogs. Thus, feral pigs provided both a socio-economic resource through opportunities for hunting and a justification for hunting through their feral status.

Recreational pig hunting as a conservation tool was also perceived to potentially provide lucrative economic opportunities especially for remote communities, such as Cooktown, in the form of ‘safari hunting’ (Chapter 4). It is difficult to gauge economic benefits of hunting because the Australian Bureau of Statistics (ABS) does not collect the data. However, the benefits are expected to be considerable given that feral pigs were the most preferred species for hunting by both domestic and international hunter tourists (Dryden and Craig-Smith, 2004).

Although the socio-economic and cultural benefits of pig hunting seemed to be justified based on its contribution to ‘conservation’ or pig management, maintenance of such benefits and simultaneous reduction in the perceived environmental and agricultural costs of pigs may be challenging. If tangible economic benefits arise from hunting such as safari hunting, pig hunting could provide an incentive to maintain pig populations and so no longer a management tool (Dryden and Craig-Smith, 2004). The use of a bounty system through chiller/pig boxes was advocated by the pig hunters as a ‘reward’ for pig hunters ‘controlling’ pigs. This could become a scheme for an ongoing source of income rather than an incentive to increase their ‘control’ activity (Hassall and Associates, 1998). Thus, the socio-economic benefits of pigs through pig hunting, a ‘by-product’ of pig management, could conflict with original management goals to reduce the environmental and agricultural costs attributable to the animal (Davidson, 2004).

(b) Property damage, quality of life, and social impacts of pig control

The perceived negative social impacts of feral pigs in terms of property damage, disease transmission potential, and safety issues varied considerably among the local

residents. Because higher exposure to pig damage, for example, is related to their likelihood to perceive pigs negatively (Decker et al., 2002), variation in the extent to which the residents were exposed to property damage accounted for the greater deviation in the residents' perceptions of the social impact. The residents' views on illegal hunting also varied; it was perceived to be a social cost of pigs, particularly if they sighted the activity, but was not negative if it was considered to have resulted in 'fewer pigs' or 'pig control'. Such variation in the perceived social costs of pigs was also evident in the residents' views on the implications of pigs for their quality of life. The household survey found no significant socio-economic factor that related to the perceived negative impacts of feral pigs on quality of life. However, a mere perception of pigs as a 'nuisance' for whatever reasons could lead to the residents' evaluation of their quality of life as being negatively affected by the animal (O'Keeffe and Walton, 2001). That is, pigs become a 'nuisance' and incur 'socially significant' costs when they change some aspects of the residents' livelihoods that were considered important for their quality of life (Fitzgerald and Wilkinson, 2009).

Other perceived social costs of pigs such as those arising from practising pig control may also depend on practitioners', such as farmers', attitudes to pig control because the perceived costs were irrelevant to how often they controlled pigs (Chapter 5). Those farmers who found control to be stressful also perceived that control caused 'financial difficulty' while those who were pig hunters did not find control to be stressful or a financial burden possibly because of their intrinsic motivations to control pigs (Chapter 9). Thus, the utilisation and perception of pig control as part of the social benefit of recreation may indicate few social costs associated with pig control. Conversely, such perceived social costs may be significant for non-hunter property owners who suffer agricultural loss caused by feral pigs.

10.3. Cost-effectiveness and social acceptability of the different control methods

10.3.1. Cost-effectiveness of the control methods

Cost-effectiveness of the methods used to control feral pigs in the WTWHA varied depending on prevailing pig densities and rainfall (Chapter 9). Based on its performance in population reduction, trapping appeared to be more cost-effective than hunting with dogs or rifles. Although this study did not compare cost-effectiveness of these two methods with that of poisoning, Coblenz and Baber (1987) reported that

poisoning was the most cost-effective method in terms of cost per pig compared to trapping and shooting because it was less labour-intensive than trapping and less time consuming than shooting. Thus, as other existing literature suggested (e.g. Bengsen et al., 2008), poisoning could potentially be the most effective method to maximise pig population reduction. However, this research suggested population reduction would not necessarily correspond to a concomitant decline in damage. Furthermore, cost-effectiveness is not the only measure for the utility of the methods. Hunting with dogs or rifles could be useful on farms where hunters and farmers benefit from the use of hunting though such benefits were intangible. Motivations behind control, cooperation with adjacent landholders as well as social acceptability can all determine the utility of the methods available to control pigs.

10.3.2. Social acceptability of the control methods

Trapping was the most socially accepted method across the different stakeholder groups while poisoning was the least accepted. The positive aspects of trapping, such as socio-economic benefits from the use of pig carcasses for food, resulted in higher acceptability, while the negative aspects of poisoning, such as perceived lack of target specificity, resulted in lower acceptability. The unpopularity of poisoning was possibly because the word 'poison' itself entails high degrees of uncertainty, thus leading to public dislike for poisons (Fraser, 2006, Reiter et al., 1999). This could be especially the case for the household survey, in which type of poison (1080) was not specified but the method was merely described as 'poisoning'; thus, those who were unfamiliar with pig control practices were likely to reject 'poisoning' owing to uncertainty about the method. Nonetheless, 1080 poisoning still appeared to be the least acceptable among the interviewees because of their concerns about target specificity as well as lack of humaneness. A recent study showed that if these two major public concerns were addressed by potential 'new' poisons, such as para-aminopropiophenone (PAPP) and sodium nitrite, the acceptability of 'poisoning' was higher compared to 'traditional' poisoning, such as 1080 (Fisher and Cribb, unpub. data). Considering that most local stakeholders in this study were likely to be familiar with trapping and its target specificity and humaneness owing to the Daintree trapping program, the social acceptability of the control methods can vary, depending on whether concerns such as target specificity and humaneness are addressed by those methods and acknowledged

by stakeholders. Overall, social acceptability was determined mostly by socio-economic and environmental concerns rather than technical and practical implications of control methods such as cost-effectiveness (Decker et al., 2002).

Furthermore, factors that determined social acceptability of the pig control methods could be classified into social factors such as type of stakeholder group, gender, age, duration of residence and cognitive factors such as perceived severity of the problems associated with feral pigs, as suggested by Bruskotter et al. (2009) as well as other factors such as animal welfare (Reiter et al., 1999). Firstly, type of stakeholder group was important in this research. The attitudes held by the local residents from special interest groups such as pig hunters and farmers were distinctive because they tended to support methods perceived to be practical, or cost-effective, such as pig hunting, based on their practical experience in pig control (Chapters 4 and 5). In this respect, government officers as practitioners of pig control showed similar attitudes, supporting or opposing methods based on their practicality in a given circumstance, for example, the applicability of trapping and infeasibility of pig hunting in national parks (Chapter 6). Aboriginal rangers, being directly involved in pig management, also focused on 'practical' methods such as trapping and hunting. This is because they could use those methods as customary activities, obtaining socio-economic and cultural benefits from pig management (Chapter 8). These considerations by those who controlled pigs were absent among the tourists and the majority of the residents surveyed (Chapters 3 and 7). That is, stakeholders' involvement in pig management, which varied with type of stakeholder group, resulted in different attitudes toward the use of the methods available for pig control.

Type of stakeholder group also mattered for stakeholders' attitudes toward the methods and their levels of social acceptability because different stakeholder groups tended to have different degrees of familiarity with, and concern about, feral pig problems and management methods, that is, social factors relating to cognitive factors. This was most evident between the local residents and tourists surveyed in this study. The local residents surveyed supported pig control more than tourists, possibly for a few reasons. Firstly, the residents' higher exposure to pig damage tends to result in higher support for pig control (Decker et al., 2002). Moreover, given that nearly half of the residents surveyed had lived in the area for more than 20 years (Chapter 3), they were more likely to be familiar with the impacts of pigs on the local environment

(Koval and Mertig, 2004). In addition, the residents' greater support for trapping and hunting (Chapter 3) could have also been because of a greater familiarity with the control methods based on past local trapping programs and common use of hunting by local farmers and pig hunters (Mitchell and Dorney, 2002, WTMA, 2010). In contrast, most of the tourists lived outside the WTWHA, and accordingly, their willingness to control pigs was reduced owing to their lack of familiarity with and knowledge about feral pigs and the management practices.

The importance of cognitive factors in determining levels of social acceptability of control methods was also apparent among other stakeholder groups. In general, lethal methods tended to be supported when pest problems were evaluated as 'severe enough' to be rectified (Decker et al., 2002, Loker et al., 1999, Reiter et al., 1999, Woodroffe et al., 2005). A desire to rectify 'pig problems' was particularly evident among pig hunters and farmers, those who were more likely to suffer or witness damage caused by pigs; thus they were less concerned about animal welfare in pig management. Even within the same stakeholder group, cognitive factors, or the perceived severity of 'pig problems' varied. Compared to overseas tourists, domestic tourists, particularly from Queensland, tended to support control more, most likely because they were more aware of the State's problems associated with pest animals, an issue with which international tourists were likely to be unfamiliar. Thus, perception of the impacts, or problems feral pigs were perceived to cause, played an important role in levels of social acceptability of the control methods.

Furthermore, demographic factors such as duration of residence, or residential stability, influenced the willingness to support control among the local residents. Long-term and/or rural residents tended to have stronger opinions about pest management with 'utilitarian' orientations, supporting control and traditional forms of management such as hunting (Eriksen, 2001, Manfredo et al., 2003, Monaghan and Just, 2000, Teel, et al., 2002). The majority of the residents surveyed were long-term and were supportive of more pig control, evident from their support for more funding for control (Chapter 3).

However, variation in long-term residents' attitudes was inconsistent because those who had lived in the study area for 10 to 19 years were disinclined to support control compared to other longer- or shorter-term residents (Chapter 3). This was possibly because of their different demographic background, which was associated with

a burst of urban-to-rural migration that had occurred in the study area. A dramatic demographic change occurred during the 1990s, that is approximately 10 to 19 years ago, when coastal towns emerged following the Queensland Government initiative to create a rural subdivision in Daintree (Wills Burden, 2008). From the early 1990s, the population increased particularly between 1991 and 1996 as a result of this creation of new residential areas (ABS, 2007b). This population increase also followed the World Heritage Listing of the Wet Tropics rainforest in 1988, which created business opportunities for the tourism industry as a new source of income (Willis Burden, 2008). Such economic opportunities tend to attract migrants, and the migration was likely to have been further driven by the broader lifestyle phenomenon, in which those from large urban areas migrated into rural coastal areas in search of a better lifestyle in attractive settings featuring high natural and rural scenery values, a warm climate, and relatively affordable residential land such as in Mossman and Daintree (Gurran and Blakely, 2007, Holmes et al., 2005). Thus, those migrants in the study area, residents of 10 to 19 years, may have come from an urban background and therefore been different from the residents who had originally lived in the areas in terms of their attitudes toward the pig control methods.

Such a migration effect within the rural areas, therefore, challenges the conventional generalisation about long-term versus short-term residents as well as rural residents being 'post-materialist' (Manfredo and Zinn, 1996). The effect of migration and duration of residence was found to have no effects in other studies (Manfredo and Zinn, 1996), but the difference between this study and others may have been owing to different geographical scales of local versus regional in which the area of interest was studied. Hence, generalisation about demographic factors and their effect on acceptability need to be carefully considered because of different social contexts where management occurs.

Irrespective of socio-demographic characteristics of stakeholders, animal welfare is commonly regarded as one of the most important criteria in selecting control methods (Sharp and Saunders, 2005). This research also found that animal welfare was an important factor particularly in stakeholders' opposition to hunting and poisoning (Chapters 3 and 7). Animal welfare considerations involve 'affection and sympathy', or uneasiness with traditional methods focused on culling populations, owing to which lethal control methods such as hunting and poisoning tend to have lower acceptability

(Massei et al., 2010; Serpell, 2004; White and Ward, 2010). Nevertheless, animal welfare concerns did not apply to all the methods, for example, trapping and fencing (Chapter 3). Although trapping is ultimately a lethal method involving shooting of trapped pigs, this lethal aspect was not discussed in the tourist or household surveys. The tourists surveyed, in particular, who tended to be unfamiliar with pig control, could have been ignorant of this lethal aspect of trapping and supported it as a non-lethal method. Conversely, the local stakeholders were more likely to have acknowledged the lethal aspect of trapping but supported it as a humane method owing to their familiarity with the method from the government trapping program in the study area. Thus, the argument that animal welfare was one of the most important factors in selecting methods (Reiter et al., 1999) depends on type of control method. Furthermore, such animal welfare concerns may also depend on type of stakeholder group. For example, the pig hunters, farmers, and Aboriginal rangers interviewed did not particularly discuss animal welfare in supporting or opposing control methods. This was possibly because they rather focused on other aspects such as cost-effectiveness or socio-economic benefits of control as discussed above.

Lastly, based on the household and tourist surveys, gender and age also determined acceptability (Chapters 3 and 7). The females surveyed were more likely to be concerned about animal welfare and tended to oppose lethal methods such as hunting regardless of type of stakeholder group. Conversely, the males surveyed tended to support hunting as a control method, possibly because they had greater knowledge about, and interest in, wildlife-related management and/or recreational activities (Agee and Miller, 2009, Dougherty et al., 2003, Kellert and Berry, 1987, Lauber, 2001, Miller and Jones, 2006, Sanborn and Schmidt, 1995). This greater interest in wildlife related management may also explain the higher response rate from males in the household survey. Gender, however, did not determine the acceptability of poisoning in the household survey, but did in the tourist survey, challenging the generalisation about gender effects on acceptability of poisoning (Sanborn and Schmidt, 1995). Age also mattered as the younger tourists surveyed tended to oppose lethal methods especially hunting and poisoning. This could be because current or younger generations were less 'traditional' or 'utilitarian', therefore caring more about the welfare of animals, as opposed to older generations who tended to view a nuisance animal as a pest and to be more a serious problem (Fitzgerald et al., 2007; Manfredo and Zinn, 1996). However,

the acceptability of hunting was independent of age among the residents surveyed; this challenges the above argument that older people were more 'utilitarian' and younger ones 'humanistic' (Koval and Mertig, 2004). In this case, the effects of gender on acceptability may have depended on the type of stakeholder group. Hunting was overall supported by the local residents and had common use in the rural landscape.

Management implications of the findings of social acceptability of the control methods are that there may be no universal management guideline in selecting socially acceptable control methods because different stakeholder groups with different socio-demographic backgrounds have different attitudes toward the methods. Such different variables contribute to the complexity of the human dimensions of pig management.

10.4. Management implications: how to apply the different control methods

The use of a combination of methods known as Integrated Pest Management (IPM) may be appropriate to manage feral pigs (Chapter 6) because of the advantages and disadvantages of each control method in a given circumstance. The concept of IPM is often applied to insect pest management in agricultural sectors (Koul and Cuperus, 2007) but its core idea is also applicable in pig management. IPM primarily indicates a combination of methods to deliver the most effective and socially acceptable control (Wittenberg and Cock, 2005), based on cost-effectiveness, resource availability, regulation, safety, target specificity and public/social acceptability (Sharp and Saunders, 2008). The results on the different pig control methods are integrated based on cost-effectiveness, social acceptability, practicality, socio-economic impacts, safety and other aspects in Table 10.1. For instance, trapping would be the most appropriate method in areas adjacent or within the rainforest, or protected areas, and in townships because it was the most socially acceptable method and because of the current restrictions of other methods such as hunting and poisoning. Hunting could be economical for farmers and socially beneficial for hunters on private properties such as cane paddocks. Poisoning was the least accepted method but could potentially be useful for a large-scale control through effective communications and consultations with stakeholders to alleviate concerns related to the method.

In addition, IPM focuses not only on population management through reduction of pig numbers or damage but also on 'people management,' reflecting the importance

of the human dimensions, or stakeholder perceptions. IPM, for instance, requires understanding of the relationships of the pest species to human activities, including land uses and management practices (Witmer, 2007). People management includes discretion in the crops, or crop varieties that farmers grow, the timing of planting, and the location and size of specific crop fields (Witmer, 2007). In this respect, cane types, for example, could be differentiated for farming areas susceptible to pig damage. Private gardening such as lawn, disposal of compost, vegetable and/or fruit gardens could be minimised near pig habitats such as the rainforest and/or sugarcane, if damage was to be reduced because those gardening practices attracted more pig damage particularly in rainforest-dominant Daintree and Cape Tribulation (Chapter 3). However, stakeholders' willingness to change their land uses, for example, depends on their perceptions of the severity of problems caused by feral pigs. Thus, cultural tolerance to feral pigs, such as no longer perceiving them as a nuisance, may be another important alternative management strategy in 'people management', which helps stakeholders to co-exist with the animal (Madden, 2004). Hence, the success of people management may partly depend on their willingness to change the practices and their perceptions of the impacts of feral pigs.

Table 10.1. The various criteria in Integrated Pest Management to identify the overall costs and benefits of using the different methods to control feral pigs in the WTWHA (✓ : advantageous; ▲ : could be either advantageous or disadvantageous; ✗ : disadvantageous)

	Cost effectiveness	Practicality (Resource availability)	Regulation (Legal approval)	Safety	Target specificity (environmental impacts)	Public acceptability (Socioeconomic impacts)	Applicability in different context
Trapping	✓ However, only for localised reduction	▲ Can be expensive if a lot of traps are required	✓	✓	✓ Pig specific trigger mechanism; native animal friendly	✓ High public approval reduces # of complaints	Rainforests Near township Fruit farms
Fencing	▲ Could be effective but costs for maintenance	▲ Large-scale fencing is costly	✓	✓	? May disrupt wildlife corridors?	▲ High initial outlays & maintenance costs	Small-scale farms Not suitable for large-scale control
Hunting (Dogs)	✓ May shift pigs to another area; interfere with other methods	✓	▲ Prohibited in national parks	▲ Unleashed dogs near township would be problematic	▲ Uncertain whether dogs can target pigs only	▲ Animal welfare issues Economic culling by hunters	Farms Not applicable in protected areas due to regulations
Hunting (Rifles)	▲ Time-consuming to locate pigs	✓	▲ Prohibited in national parks	▲ Gunfire near township or tourist attraction would be problematic	✓	▲ Shooters need to be licensed & responsible Economic culling by hunters	Farms Not applicable in protected areas due to regulations
Poisoning	? In-migration would offset the efforts A larger scale coordination is necessary	✓	▲ Prohibited in national parks	▲ Need to be away from township (regulations)	▲ Uncertain whether only pigs feed on poisoned baits	✗ Unfavourable social environment: Strong perception of its inhumane nature and risks to non-target species	Away from township Suitable for large-scale control

10.5. Stakeholders' attitudes toward current pig management

Given the perceived impacts of feral pigs, the most 'significant' perceived costs of feral pigs occurred in the national parks, outside the local residents' normal place of residence (Chapter 3). Thus, the local stakeholders' attitudes toward current pig management by the government become important because public lands such as national park are a main stage for conflicts between humans and feral pigs. Some residents were satisfied with current pig management and its level of control because they perceived that the Daintree feral pig trapping program was successful, resulting in 'fewer' sightings of pigs in the study area (Chapter 3). The government officers interviewed also saw this as a positive outcome of the trapping program as it reduced public complaints about government management of feral pigs (Chapter 6). This positive view held by some local residents on the trapping program could be because such government action was a manifestation of 'cues to care', or the signs of the intention of the government to care for the rainforest. Such 'care' normally refers to 'neatness', 'stewardship', and 'naturalness' (Nassauer, 1995). Neatness refers to a place under human care, associated with the human desire to control the landscape; stewardship indicates 'good conservation', and naturalness is related to a cultural concept of ecological quality such as 'plenty of trees' (Nassauer, 1995). The appearance of human intention, or 'care', in a landscape is important because otherwise people tend to perceive that land is being neglected and lacking neatness and stewardship (Nassauer, 1995). The presence of the trapping program, therefore, served as 'care', providing the appearance of good stewardship to maintain 'naturalness' in the rainforest, thereby leading to public satisfaction with the government to an extent. Such demonstration of control efforts is considered to be effective at least for the short-term to reduce conflicts with local stakeholders (Madden, 2004).

Positive views about the trapping program also resulted from locals' positive interactions with the professional trapper (Chapter 6). The positive rapport of the locals with the trapper was important in pig management as acknowledged by the government officers interviewed. This is because negative attitudes of local communities toward government employees generally tend to weaken the levels of support for the government management of protected areas (Fiallo and Jacobson, 1995, Infield, 1988, Ite, 1996, Newmark et al., 1993, Parry and Campbell, 1992). The trapper's informal and frequent personal contact with local residents (Chapter 6) also was an important factor

for locals' trust in the trapper and the trapping program because government performance could be easily monitored (Blind, 2006). Such informal interactions also offer opportunities for locals to communicate their perspectives on feral pig issues, which could enhance trust in the government (Hough, 1988).

Regardless of the government's trapping program, the local stakeholders' satisfaction with current pig management also depended on their levels of expectation for management outcomes. Those who understood that the aim of control was damage reduction, not eradication, were satisfied with the current level of pig control because they had lower expectations of control levels (Chapter 3). Conversely, overall, those with higher expectations, who expected eradication to be the aim of management, were generally dissatisfied and perceived that pig control was underfunded. Normally, 'control' is not favoured compared to eradication by the public owing to their misperception of the feasibility of eradication success (Bomford and O'Brien, 1995). As the government officers interviewed argued (Chapter 6), eradication of pigs is impractical or impossible because the geographical scale of the WTWHA is too large and because pigs have already established and spread (Hulme, 2006) (Figure 10.1).

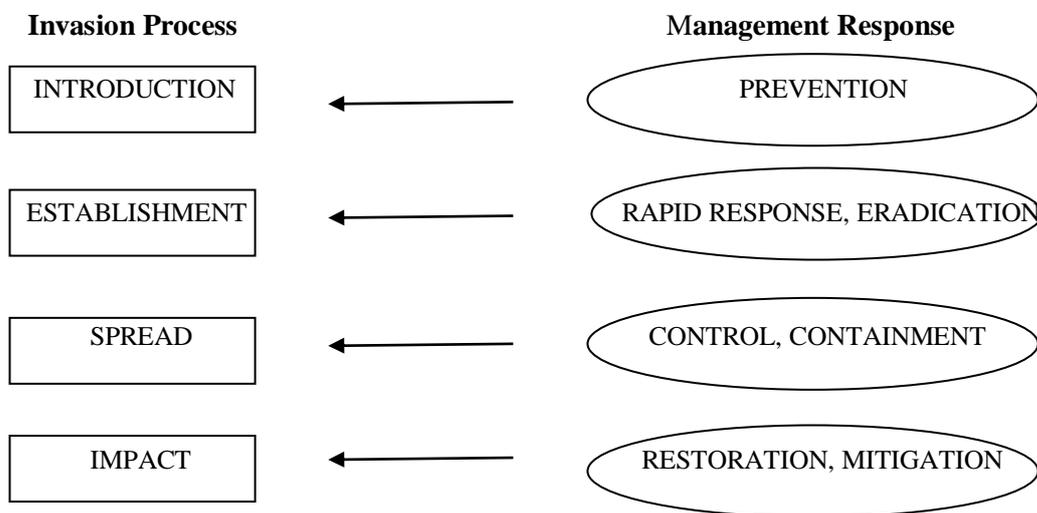


Figure 10.1. Parallel, mirroring relationships between the major stages of biological invasions and the targeting of management actions (Hulme, 2006, p. 836).

Eradication is also impractical in the WTWHA because of (Bomford and O'Brien, 1995):

- pigs' high fecundity
- easy in-migration
- difficulty of targeting all reproductive sows
- impracticality of detecting pigs at low densities in the rainforest
- high risks of failure and waste of limited resources
- conflicting social goals in terms of pig management among different stakeholder groups because of different costs and benefits assigned by different groups.

Therefore, one way of mitigating public dissatisfaction with current pig management, that is, reducing conflicts with the public in pig management, is effective communication about the most feasible management response to the invasion process.

Furthermore, the feasible outcome based on 'available funding' should also be effectively communicated for better public satisfaction with, and support for, pig management. As the government officers interviewed suggested, the current paradigm of pest management is based on 'prioritisation'. Thus, the Daintree pig trapping program had continued (Janson, 1995), successfully attracting funding from both the local and State governments. Such prioritisation was based on varying 'conservation' values of lands within the WTWHA; for instance, the Daintree region has a higher conservation value owing to the large number of endemic and 'of-concern' species (Harrison and Congdon, 2002). As a result, control efforts tend to concentrate on such small parcels of lands of high conservation value while other areas may not see an equivalent level of pig management (Chapter 6). Given that national parks account for approximately 80% of the total study area and the perceived costs of feral pigs were mainly related to the impacts on the rainforest, the public may perceive pig management to be insufficient without an understanding of funding availability and prioritisation.

Another source of dissatisfaction with current pig management was the restrictions imposed on access to national parks and use of guns and dogs, which limited local stakeholders' ability to control feral pigs in areas where they perceived that the animal caused problems. Such restrictions also symbolised a lack of pig control within national parks, leading to locals' perceptions that the government was providing a refuge habitat for feral pigs (Chapters 3, 4 and 5). Such legal restrictions, moreover, could be a great source of conflicts with local stakeholders, because they tend to

alienate the land from the local community, thereby preventing them from undertaking 'stewardship' to manage their local areas including national parks (Mather, 1999). This alienation between land, now called national parks, and local people also creates a feeling of powerlessness for the people and leads to conflicts in the aspirations and objectives of the government and the people (Mather, 1999). National parks also feature 'absenteeism', or static, low intensity land use and conservatism, because of such perceived lack of management and stakeholder engagement which tends to create perceptions of 'unfairness' with local residents (Mather, 1999, Pretty, 2003). If authorities fail to address stakeholders' aspirations to engage in pig management on public lands, it is likely that the local stakeholders will feel inadequately empowered to deal with feral pigs, thereby increasing their grievances against, and opposition to the government and current pig management (Madden, 2004). Therefore, conflicts in pig management were a matter not only between humans and pigs but also among people themselves, stakeholders versus the government, over management of national parks.

Aboriginal rangers interviewed were also dissatisfied with pig management because of the government's top-down approach to pig management in the national parks through the exclusion or limited participation of Aboriginal people (Chapter 8). Historically, Aboriginal people's interests have been neglected in the management arrangements of the WTWHA, and their unmet aspirations, such as collaborative or joint management of national parks, have been a significant source of dissent (Dale et al., 2000). The management of feral pigs should address Aboriginal people's interests and needs, taking into account the unique cultural and socio-economic benefits that Aboriginal people could derive from pig management, such as the use of pigs for subsistence and cultural activities; and potential employment opportunities (see Appendix 8).

Lastly, stakeholders' dissatisfaction with current pig management resulted from free riding of control efforts by others, often adjacent landholders, because of different perceptions of the severity of pig problems, particularly among farmers (Chapter 5). Some farmers were concerned that a lack of cooperation from adjacent landholders resulted in a lack of effectiveness of control and that those uncooperative landholders free rode others' control efforts. Free riding is a type of market failure and often occurs when the outcomes derived from pig control are not valued equally by all the

landholders (Hendrichs et al., 2007). Free riding then could eventually discourage those who control pigs from continuing the management (Izac and O'Brien, 1991).

To overcome this market failure, government interventions such as the Daintree pig trapping program, State subsidies, involuntary government provision through taxation, or partial or full funding, may play a key role in a community-level management (Hendrichs et al., 2007). However, free riding of government control efforts by local stakeholders was also a concern for the government officers (Chapter 6), who stressed the importance of controlling pigs with a 'tenure-blind' approach to prevent private landholders' reliance on the government for pig control according to the user-pay or beneficiary-pay principle. 'Tenure-blind' is also known as 'nil-tenure' or 'cross-tenure', referring to the management strategy that the pest problem should not be restricted to any particular land tenure but to be managed irrespective of tenure boundaries and legal obligations to enable control at the landscape level rather than at the land tenure level (Dickman et al., 2010, Norris and Low, 2005). Although there will always be reinvasion unless the population is eradicated, this tenure-blind approach is particularly effective for a coordinated and long-term control of highly mobile pest animals like feral pigs because they could repopulate and reinvade control areas if only part of the population was managed (Norris and Low, 2005). For example, for a landholder who owns properties prone to periodic substantial damage, cooperation of adjoining landholders in control is important to mitigate continuous damage resulting from the absence of control in the neighbours' properties (Witmer, 2007). However, tenure-blind is often inappropriate where the pest problem is highly localised and landholders disagree over the severity of problems (Buller et al., 2005), which was observed in this research. Moreover, it was a common perception especially among the property owners who controlled pigs (Chapter 5) that pig control was a 'government responsibility'; they blamed national parks for 'protecting' feral pigs. Similar perceptions were also reported in other parts of the WTWHA (Noble, 1997). Thus, government's collaboration with private landholders becomes important to gain better public support for pig management and prevent conflicts as a result of free riding of control efforts.

10.6. The utility of the value frameworks for understanding the public's construction of the environmental values of the WTWHA rainforest

The utility of the scientific value frameworks such as the Total Economic Value (TEV) and Millennium Ecosystem Assessment (MA) was limited to those who had 'endogenous' knowledge about the rainforest, such as Aboriginal rangers. This is because most other stakeholders tended to predominantly express existence values of the rainforest as a result of lack of integration of 'exogenous knowledge' of rainforest values. As evident from the values articulated by the stakeholders, the public do not understand all of the attributes of the rainforest ecosystem that serve as 'ecosystem services' which contribute to human wellbeing; thus, this lack of information limits their abilities to place a value on ecosystem attributes (Bingham et al., 1995). This limited utility of the value frameworks is alarming considering that they are commonly used in environmental decision making but lack incorporation of public values. Different social groups including experts have their own interpretive value frameworks, within which they construct reality and attach meanings to the environment and its change. Thus, the value frameworks merely represent expert construction of values. For successful management of environmental change, in this case feral pigs, management authorities need to appreciate the different frameworks that the public use to interpret the meanings of environmental change (Greider and Garkovich, 1994). Problematically, the goals of management such as pest control are often based on decision makers' ideas and ideals of what is best for the environment (Hull and Robertson, 2000), and then environmental policies are often framed in ways that are not meaningful to the general public (Trudgill, 2001). Therefore, framing of management focus including the kinds of environmental values to 'conserve', and problems such as feral pigs, through experts' own conceptual frameworks ignores the public construction of values and downplays their political power in, and influence on, management (Greider and Garkovich, 1994). Hence, the challenge for pig management is how to bridge the gap between the experts' and public's constructions of environmental values so that management goals can be socially meaningful to the public (Infield, 2001).

In summary, the dependence of experts or decision makers on the theoretical value frameworks such as the MA and TEV is not recommended in understanding the public construction of values of the environment in a management context. There may be a need for a separate value framework that reflects the public construction of values

associated with an environment. Kellert (1993) identified nine value categories that describe human affiliation with a physical natural environment: utilitarian, naturalistic, ecologicistic-scientific, aesthetic, symbolic, humanistic, moralistic, dominionistic and negativistic. Although these classifications may reflect ways in which the public value an environment, it is difficult to determine the perceived effects of invasive animals such as pigs on those values. In this respect, the utility of the MA and TEV value frameworks cannot be denied. Instead, this research suggests a more successful application of these frameworks by finding a common discourse, which makes such scientific constructs more accessible to the public in a common language for the management of pigs. To further test the utility of the frameworks, a future study can help investigate values of another kind of ecosystem and to assess whether values identified in this research are idiosyncratic to the rainforests.

10.7. Synthesis and conclusions

This research aimed to assess:

- iii. The costs and benefits of feral pigs perceived by different stakeholders in the WTWHA and
- iv. The cost-effectiveness and social acceptability of different control measures.

A mixed methods approach (Chapter 2) was used to meet the aims. The strength of this approach was that various stakeholders' perceptions were investigated in depth and were corroborated by other methods such as quantitative surveys and participant observation, which could enhance the validity of the research findings. This research met the objectives as follows:

- (i) Assess the perceived environmental costs and benefits of feral pigs by analysing values that stakeholders ascribe to the rainforest and the impacts of pigs on those values.

Feral pigs were considered to diminish the values associated with WTWHA rainforest, mostly because their impacts such as physical damage to the rainforest plants, competition with native species and soil erosion were incompatible with stakeholders' interpretation of 'naturalness' or 'good forest health'. Consequently, feral pigs were

almost unanimously perceived as an environmental pest. Nonetheless, such perceptions depend on stakeholders' contextualisation of feral pigs in the idea of 'naturalness'. Moreover, the perceived environmental costs could be claimed as a political means by some stakeholders to use pigs as a scapegoat.

- (ii) Assess economic costs and benefits of feral pigs by examining the extent of agricultural damage and the implications of the presence of pigs for the tourism industry.

A gap between the 'actual' and 'perceived' impacts of pigs was identified in the economic dimension: most stakeholders perceived the economic costs of pigs as a result of agricultural loss in sugarcane and tropical fruit production, but actual impacts assessed by farmers were limited to a minority owing to sporadic and locally intensive damage. Although some tourism operators showed concern, the presence of pigs had negligible implications for rainforest tourism in the WTWHA because of tourists' lack of knowledge about the existence of pigs and rare sighting of pig damage. Rather, such lack of knowledge resulted in positive rainforest experience because pigs were perceived to be a 'wild' animal rather than a nuisance pest. Nevertheless, tourists' appreciation of WTWHA values of the rainforest may be diminished once they acknowledge the existence and non-native status of feral pigs.

- (iii) Assess socio-economic costs and benefits of feral pigs by analysing the implications of pigs for local residents' livelihood.

Perceived social impacts of pigs were more positively valued than environmental and economic impacts, mainly because of benefits attributed to pig hunting as a recreational and/or customary activity for pig hunters and Aboriginal people in remote areas. The meat obtained from hunting was also a social benefit of feral pigs as a source of food particularly for Aboriginal people in remote areas. Pig hunting could potentially be of socio-economic value in the form of safari hunting for remote communities adjacent to the WTWHA such as Cooktown. These socio-economic benefits of feral pigs were a 'by-product' justified by the pest status of pigs; however, those positive values of pigs may be incompatible with control efforts that are aimed to reduce their environmental and economic costs. Moreover, feral pigs were perceived to be a social nuisance in

terms of property damage, safety concerns, quality of life, and pig control. However, because of the dual social values of feral pigs, both negative and positive, the local residents' perception of the severity of the social impacts of pigs had greatest variation.

- (iv) Assess social acceptability of trapping, fencing, hunting and poisoning to identify social costs of the methods used to control pigs.

Levels of social acceptability varied with the control methods. Main determinants for acceptability included the perceived socio-economic and environmental costs and benefits attributed to the methods as well as moral and ethical concerns such as humaneness, rather than cost-effectiveness. Consequently, trapping was the most favoured and poisoning the least supported method overall. Cost-effectiveness was an important consideration particularly for those who engaged in pig control. Social acceptability also depended on social factors such as type of stakeholder group, gender, age, duration of residence and cognitive factors such as the degree of familiarity with issues associated with feral pigs.

- (v) Conduct economic valuation of cost-effectiveness of the different control measures.

Trapping was the most economically cost-effective method compared to hunting with dogs or rifles in terms of population reduction. The effectiveness of trapping could be maximised by targeting the dry season. However, a reduction in population numbers did not necessarily correspond to a reduction in damage. Moreover, the economic evaluation of control methods based on cost-effectiveness failed to take into account intangible benefits of the other methods, such as hunting as creating socio-economically mutually beneficial relationships between farmers and pig hunters, who control pigs based on intrinsic motivations. Poisoning could be cost-effective at a larger scale if animal welfare concerns were to be alleviated and cooperation with other landholders was to be gained.

(vi) Assess stakeholders' attitudes toward current pig management

Local stakeholders' focus on current pig management was within the context of national parks, with pig control being regarded as 'government responsibility' because the perceived costs of feral pigs were mainly related to their impacts on the WTWHA rainforest. The trapping program played a role in gaining public satisfaction with government or current management to an extent by serving as cues to care. However, pig management in national parks by government as a sole agency was perceived to be insufficient owing to the restrictions posed on locals' ability to manage pigs in public lands where they perceived that pigs or 'pig problems' mainly occurred. 'Prioritisation' or concentration of control efforts on particular lands also led to a perceived lack of control in national park areas where the government was responsible. Variation in stakeholders' perceptions of the severity of 'pig problems' also resulted in market failure in pig control, such as free riding of control efforts, thereby leading to their views that the current control level was insufficient.

(vii) Determine the utility of the value frameworks to reflect the public construction of values.

The utility of the Millennium Ecosystem Assessment (MA) and Total Economic Value (TEV) was limited, but related to whether stakeholders had 'endogenous' knowledge of rainforest values, as the stakeholders tended to mainly articulate existence values rather than specific uses or services of the WTWHA rainforest.

10.8. Recommendations

There was a mismatch between stakeholders' perceptions of the impacts of feral pigs and the reported status of the animal. The perceived environmental costs mismatched the recent research results that showcased that pigs had no significant impact on rainforest dynamics in the lowland rainforest in Daintree such as invertebrate populations, nutrient cycles and plant regeneration (Elledge, 2011). Such differences between 'reality' and the perception of the impacts of pigs on the rainforest can contribute to public dissatisfaction with management. Furthermore, given the great variation in the socio-economic implications of pigs across different stakeholder groups, the main 'pest' status of pigs commonly shared by stakeholders resulted from the

perceived environmental costs. Such 'costs' mainly occurred on public lands in the rainforest, or national parks. This is related to their dissatisfaction with current pig management because they regarded pig control as government responsibility. The government aims to manage pigs across different tenures regardless of public and private lands, but given the different perceptions of feral pigs, it will be difficult to find common discourses with stakeholders, especially about pig management in national parks, where most sources of conflicts and dissatisfaction arise. Nonetheless, it is critical for the government to clarify and communicate the aim of management as control rather than eradication, and seek understanding from local stakeholders to mitigate public dissatisfaction resulting from higher expectations of management outcomes. A management challenge is that pigs have become a resource for some stakeholders while being a pest for others. Moreover, pigs can be neither a resource nor a pest for some residents who are uninterested in the impacts and management of the animal. That is, a management action needs to focus separately on specific needs and aspirations that a particular stakeholder group may have and then assess whether and/or how different needs and aspirations can be met.

Another conundrum that pig management faces is whether tourists, one of the main economic users of the WTWHA, should be informed of the presence of pigs in the World Heritage rainforest. The inclusion of information about invasive animals, or environmental education, is an important feature of ecotourism to raise environmental awareness and promote biodiversity conservation (Blamey, 2001). This research demonstrated that there is a room for improvement in rainforest ecotourism experience in the WTWHA because overseas tourists, in particular, were unaware of the existence of pigs and their ecology. Ecotourism, in particular, has been proposed as a major economic justification and strategy to finance biodiversity conservation, especially in protected areas such as the WTWHA because it entails environmental education (Kohl, 2008). Withholding, or not providing, the information about the presence of pigs, therefore, represents a lack of an essential part of the ecotourism experience. Provision of information about feral pigs may also be a positive entertainment factor for tourists as they may perceive pigs as a 'wild' animal. Nonetheless, informing tourists of the presence of pigs could result in the perceived incompatibility of 'naturalness' they may expect from the rainforest with the existence of such 'exotic' species, thereby decreasing rainforest values. Thus, such environmental education should be provided in

a way that maintains values of the WTWHA rainforest while encouraging management, for example, by attracting funding for pig management.

Furthermore, based on the findings of this research, there were a few topics or issues that could be explored for future research. Firstly, it is important to understand what constitutes quality of life for local residents and in what manner feral pigs can affect it, that is, how pigs are perceived as a social ‘nuisance’. Secondly, the implications of feral pigs for rainforest tourism can be understood better if bus-tour tourists are also surveyed. How to deliver environmental education about the presence of pigs to the tourism industry is of interest for sustainable ecotourism in the WTWHA. Thirdly, investigating local Aboriginal people’s views can be useful to assess whether Aboriginal rangers’ views were representative. Lastly, the utility of the value frameworks can be explored further, using other types of ecosystems as case studies.

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Appendix 1: Background information about feral pigs

1. Origin of feral pigs

Commonly, feral pigs are thought to have been introduced into the country by early European settlers in the 1700s (DEH, 2005, McLeod, 2004, Rainforest CRC, 2003). However, their origin in Australia can be Asian Wild Boar (*Sus scrofa cristatus*) judging from the finding of a small nematode in their stomachs called *Simmondsia paradoxa*, the nematode only known from New Guinea, Eastern Europe and India (Heise-Pavlov, 2009). The high incidence of the Melanesian tick (*Amblyomma cyprium cyprium*) on feral pigs from the Wet Tropics World Heritage Area (WTWHA) also supports the possibility that trading of pigs existed between New Guinea and the Aboriginal people of Far North Queensland (Heise-Pavlov, 2009).

2. Biology and ecology of feral pigs

Feral pigs have distinct morphological features, such as an elongated snout, long coarse hair and sloping hindquarters (DPIF, 2004). Although typical body size and weight varies with location, adult body weights are 80 to 100 kg on average, with males being bigger than females (Wilson et al., 1992). The home range of pigs varies significantly with habitat and sex; boars have an average of 10 to 50 km² in comparison to sows and young of 5 to 29 km² (Wilson et al., 1992). Pigs are well known for high fecundity owing to sows' early maturity approximately at six months when they weigh 30kg; gestation lasts 15 weeks (Wilson et al., 1992). Pigs in the lowland rainforest, such as the WTWHA, have sufficient food sources and therefore breed continuously with two birth pulses (Heise-Pavlov and Heise-Pavlov, 2008). Sows conceive after the wet season and give birth in the late dry season; when piglets are nursed for two months, food availability is optimal at the onset of rain (Heise-Pavlov and Heise-Pavlov, 2008). Feral pigs are also nocturnal, omnivorous and opportunistic predators. They eat roots and grass, the shoots and leaves of edible woody species; and animal carcasses (Wilson et al., 1992). With high fecundity, mobility, adaptability; and omnivorous and opportunistic feeding patterns, pigs can easily increase in numbers.

3. Population dynamics of feral pigs

A lack of natural constraints in the environment, such as predators and diseases, encourages population growth of feral pigs (Lapidge, 2009, McCann and Garcelon, 2008, Rainforest CRC, 2003, Seward et al., 2008, Tisdell, 1982). However, the population density of feral pigs in the lowland rainforest is relatively low, estimated to range from 0.5 to 2.2 pigs per km² (Heise-Pavlov, 2009) and 3.1 pigs per km² in the WTWHA (Rainforest CRC, 2003). This is because of a combination of high infections of bacterial diseases and parasites from consumption of earthworms and the seasonal availability of food (Heise-Pavlov, 2009). Particularly a lack of food causes juvenile mortality through starvation and is a major determinant of population dynamics of feral pigs (Wilson et al., 1992). Water is a source of crucial importance to pigs' survival and thus, they prefer areas of reliable or permanent water supplies as habitats (i.e. areas of high rainfall), protected from extremes of temperature with dense foliage and seclusion (DEH, 2005, McGaw and Mitchell, 1998, Wilson et al., 1992).

Appendix 2: Reported worldwide environmental effects of feral pigs

Pigs' direct consumption of native plant species is the most commonly reported negative environmental effect in the existing literature (Nogueira-Filho et al., 2009). In the Western Great Smoky Mountains, species on the U.S.A. rare and endangered lists were found in pig-rooted areas at both high and low elevations (Bratton et al., 1982). In New Zealand, feral pigs have eliminated many endemic plants through predation (Challies, 1975). Feral pigs can also alter the structure and dynamics of ecosystems by changing the dominance patterns of plant species (Nogueira-Filho et al., 2009). In Hawaii, feral pigs were reported to have foraged on at least 40 plant species, 75% of which were native plants such as tree ferns (*Cibotium chamissoi* and *C. splendens*). As a result, pigs created seed beds on disturbed soil and carried their seeds in their guts and on their coats, dispersing non-native plant species such as strawberry guava (*Psidium cattleianum*) (Nogueira-Filho et al., 2009). Ultimately, pigs are responsible for replacing native Hawaiian forests with non-native guava (Bratton et al., 1982, Stone and Loope, 1987). Trampling of native plants can also accelerate damage to native plant populations by increasing soil fertility. This is because many native species are adapted to poor soil and non-native plants can easily establish their populations (Bratton et al., 1982). For instance, pigs disperse seeds of a non-native nitrogen fixing tree *Myrica faya*, which increases earthworm populations because of the increased soil nitrogen generated by *M. faya*. Subsequently, an increase in earthworm populations attracts pigs to forage near the trees, which causes more dispersal of *M. faya* seeds (Aplet et al., 1991, Aplet, 1990). Ground disturbance by pigs may also reduce resilience of above-ground native vegetation as a result of interaction between above- and below- ground components of terrestrial ecosystems (Choquenot, 2005). Space clearing by pigs can provide greater opportunities for reduced competition and colonisation, promoting the invasion of exotic plant species (Cushman et al., 2004). In the Pasoh Forest Reserve in Malaysia, pig rooting resulted in the establishment of an invasive shrub (Laurence, 2000).

Nonetheless, the environmental effects of feral pigs can be positive or negligible. In central Florida, pig disturbance may enhance native plant species richness and the microhabitat diversity in wet lands at least in the short term (Arrington et al., 1999). The vegetation of Horn Island, Mississippi, was resilient against frequent disturbances such as intense sunlight, drought conditions, high salt levels, hurricanes and fire; thus,

the vegetation rapidly recovered from pig disturbance because pig damage was minor compared to the other main disturbance forces to the island ecosystem (Baron, 1982). In Santiago, the Galapagos, the plant communities were resilient against habitat degradation caused by pigs because of the historical exposure to the heavy use by the herbivorous tortoise (Coblentz and Baber, 1987). Pigs may even aid the spread of some native plants by passing their seeds in dung, or even help to create additional breeding pools for endangered Northern Corroboree Frogs (*Pseudophryne pengilleyi*) in the WTWHA (DEH, 2005, McGaw and Mitchell, 1998). Pig rooting was even found to have increased shoot elongation of large beech trees in North America as a result of increased humus breakdown and greater aeration of soils (Lacki and Lancia, 1986). Space clearing induced by pigs also reduced below-ground competition and enabled poor below-ground competitors to grow, increasing plant growth and community diversity (Cahill and Casper, 2003).

However, the environmental effects of pigs are complicated after all. Increased litter decomposition induced by pigs results in nutrient mobilisation, which could be either positive or negative in the long term: enhanced tree growth and productivity by rapid nutrient cycling, or declined tree health and vigour by continued drain of already limited nutrient supplies (Lacki and Lancia, 1983). The benefits of space clearing by pigs (i.e. creation of gaps in soil resources), such as increased light availability, soil moisture and nitrogen, could be offset by decreased moisture or the increased irradiance (Goldberg, 1987). Disturbance caused by pigs have dual roles: the facilitation of exotic species invasion and the maintenance of the species composition, diversity and structure of native-dominated ecosystems. Thus, the net effects of pig disturbance on the native species diversity are complicated and difficult to be quantified (Kotanen, 1995). Rather, the effects of pigs on biodiversity may depend on the measure used. For instance, pigs may be beneficial for native species richness by creating habitat for uncompetitive native species, but they may be harmful for the maintenance of evenness, species composition or vegetation structure (Kotanen, 1995). Nonetheless, highly frequent pig disturbance could reduce seedling populations, and if native species are different in their ability to tolerate physical disturbance, the cumulative effects of disturbance could result in changes in community dynamics and composition (Clark, 1990). Hence, the effects of pigs depend on the biology and disturbance history of the affected communities (Doupe et al., 2010).

Appendix 3: Ecosystem services (Millennium Ecosystem Assessment, 2005)

Services	Categories	Description
Production services	<i>Food & fiber</i>	The vast range of food products derived from plants, animals and microbes as well as materials such as wood, cotton and wool
	<i>Fuel</i>	Materials serving as sources of energy including wood, dung and other biological materials
	<i>Genetic resources</i>	The genes and genetic information used for animal and plant breeding and biotechnology
	<i>Biochemicals</i>	Natural medicines, pharmaceuticals, biocides and food additives
	<i>Ornamental resources</i>	Animal products such as skins and shells, and flowers are used as ornaments, although the value of these resources is often culturally determined. An example of linkages between the categories of ecosystem services
	<i>Fresh water</i>	An example of linkages between production and regulation services
Regulation services	<i>Air quality maintenance</i>	Ecosystems both contribute chemicals to and extract chemicals from the atmosphere, influencing many aspects of air quality
	<i>Climate regulation</i>	Ecosystems influence climate both locally and globally. At a local scale – changes in land cover can affect both temperature and precipitation At the global scale – ecosystems play an important role in climate by either sequestering or emitting greenhouse gases.
	<i>Water regulation</i>	The timing and magnitude of runoff, flooding and aquifer recharge can be strongly influenced by changes in land cover
	<i>Erosion control</i>	Vegetative cover plays an important role in soil retention and the prevention of landslides
	<i>Water purification and waste treatment</i>	Ecosystems can be a source of impurities in fresh water but also can help to filter out and decompose organic wastes introduced into inland waters and coastal and marine ecosystems.
	<i>Regulation of human diseases</i>	Changes in ecosystems can directly change the abundance of human pathogens and disease vectors such as mosquitoes.
	<i>Biological control</i>	Ecosystem changes affect the prevalence of crop and livestock pest and diseases.
	<i>Pollination</i>	Ecosystem changes affect the distribution, abundance and effectiveness of pollinators.
	<i>Storm protection</i>	The presence of coastal ecosystems such as mangroves can dramatically reduce the damage caused by hurricanes or large waves.
Cultural services	<i>Cultural diversity</i>	The diversity of ecosystems is one factor influencing the diversity of cultures
	<i>Spiritual and religious values</i>	Many religions attach spiritual and religious values to ecosystems or their components
	<i>Knowledge systems</i>	Ecosystems influence the types of knowledge systems (traditional and formal) developed by different cultures
	<i>Educational values</i>	Ecosystems and their components and processes provide the basis for both formal and informal education in many societies
	<i>Inspiration</i>	Ecosystems provide a rich source of inspiration for art, folklore, national symbols, architecture and advertising
	<i>Aesthetic values</i>	Many people find beauty or aesthetic value in various aspects of ecosystems, as reflected in the support for parks, 'scenic drives' and the selection of housing locations
	<i>Social relations</i>	Ecosystems influence the types of social relations that are established in particular cultures (e.g. fishing societies, agricultural societies)
	<i>Sense of place</i>	Many people value the "sense of place" that is associated with features of their environment, including aspects of the ecosystem.
	<i>Cultural heritage values</i>	Many societies place high value on the maintenance of either historically important landscapes (cultural landscapes) or culturally significant species.
	<i>Recreation and ecotourism</i>	People often choose where to spend their leisure time based in part on the characteristics of the natural or cultivated landscapes in a particular area.
Supporting services	<i>Soil formation</i>	Many production services such as food production depend on soil fertility, and the rate of soil formation influences human wellbeing in many ways.
	<i>Photosynthesis</i>	Climate regulation is categorised as a regulation service whereas the production of oxygen gas through photosynthesis is categorised as a supporting service since any impacts on the concentration of oxygen in the atmosphere would occur over an extremely long time.
	<i>Primary production</i>	The assimilation or accumulation of energy and nutrients by organisms
	<i>Nutrient cycling</i>	Approximately 20 essential nutrients for life – including nitrogen and phosphorus – cycle through ecosystems and are maintained at different concentrations in different parts of ecosystems.
	<i>Water cycling</i>	Water cycles through ecosystems, essential for living organisms.

Appendix 4: Interview Questions

Common questions for all stakeholders:

A. Perceptions about the costs and benefits of feral pigs

1. What impacts do you believe feral pigs have?
2. (If they mention only negative aspects) Are there any positive aspects to pigs?

B. Values ascribed to the rainforest and effects of pigs on the values

3. What do you think is the importance of the rainforest?
4. How do feral pigs affect those values that you just ascribed to the rainforest?

C. Social acceptability of different control measures

5. What do you think about the control measures practised in this area? There are trapping, fencing, hunting (with dogs/rifles) and poisoning. Do you support them or oppose them? And why so?
6. What do you think about the current level of pig control in this area? Do you think it is sufficient or insufficient? And why so?

Questions specific to pig hunters:

D. Social aspects of pig hunting

7. What does pig hunting mean to you?
8. Is pig hunting important for the quality of life? If so, why?
9. Do you think pig control is taking pigs away for recreational hunting?
10. Do you use pig carcasses after pig hunting?
11. Do you have any preferences for boars?

Questions specific to farmers:

E. Economic impacts of pigs on agricultural production

12. How much pig damage did you approximately receive in 2009? In terms of dollars, cartons/tonnes, % of their property size?
13. Did you consider the damage to be severe enough to cause financial costs and/or to exceed your tolerance?
14. Were there any seasonal/monthly variations in the extent of damage?

F. Socio-economic aspects of pig control

15. How do you feel about controlling pigs? Is it easy, stressful or just another job to do?
16. Have you experienced any financial difficulties that arose from controlling pigs?
17. Did you have to change anything about your business because of pig damage?

G. Cost-effectiveness of control measures (if they exercise one or more)

18. How much effort do you normally put into controlling pigs? (daily, weekly, hours in a day)
19. Is there any seasonality in pig control? (e.g. more control during a harvest season)
20. (If they practise fencing or poisoning), how much protection do you think you gained from fencing/poisoning?
21. (If they have hunters control their farms), do you give any bounty to hunters for controlling pigs?
22. Do you use pig carcasses after controlling?

Questions specific to government officers:

H. Government's perspectives of the pig control program

23. To what extent do you think the government-funded feral pig control has prevented the negative impacts of feral pigs?
24. What kinds of complaints do you receive from residents?
25. Is there any seasonality in residents' complaints?
26. Does the pig control make a difference to reduce the number of complaints?
27. (Based on the interviews with the other stakeholders), many locals argued that pigs are protected in national parks and that national parks are not managed because of a lack of control. What do you think about that?
28. (Based on the interviews with the other stakeholders), many locals also argued that national parks should give access to accredited hunters to control pigs. What do you think about that?
29. (Based on the interviews with the other stakeholders), what do you think about Aboriginal people's use of feral pigs as a source of food?

Questions specific to tourism operators:

I. Socio-economic impacts of pigs on the tourism industry

30. Do you think the presence of pigs would degrade or enhance tourists' rainforest experience? Why?
31. Do you think the presence of pigs reduces the profitability of your tourism business? Why?

Questions specific to Aboriginal rangers:

J. Socio-economic impacts of pigs on Aboriginal communities

32. Do you have any concern about pig damage to bush tucker and/or culturally significant sites or animals?
33. Do local Aboriginal people eat feral pig meat? If so, how often and how important?
34. Do local Aboriginal people hunt pigs actively for meat? If so, how often and how important?
35. Do you have any concerns about animal waste as a result of pig control?

Appendix 5: Household surveys

Survey of Local Residents of the Northern Wet Tropics: Local communities' perspectives of feral pigs and their control

Dear Resident,

I, Kana Koichi, am a researcher from James Cook University, exploring local resident perceptions and opinions about feral pigs and their control practices in the Wet Tropics World Heritage Area (WTWHA). I am particularly interested in your opinions about the positives and negatives of feral pigs and the control practices of the animal and how pigs are affecting your everyday life and the quality of the environment in which you live.

The main purpose of my research is to investigate the perceptions of socio-economic and ecological costs and benefits of feral pigs and the control practices in this region and ultimately to explore management recommendations to current pig control.

This is a great opportunity for you (an adult member of the household) to offer your comments on this issue and inform management and government agencies of the current issues related to the animal and its management that you observe in this region.

The questionnaire consists of 4 different sections. Please answer all questions. Section 1 is for all local residents, Section 2 is for farmers, Section 3 is for pig hunters, and Section 4 is for those who are involved in nature-based tourism. Section 1 will take 5 – 10 minutes and if you are a farmer, hunter and/or tourism operator, please continue answering the subsequent sections. All responses are completely anonymous.

If you would like to discuss this project in more detail, or you would like a copy of the key findings of this survey, please contact the Project Manager. If you would like to discuss any ethical matters regarding this project, please contact the Ethics Administrator. This project has Human Ethics Approval from James Cook University.

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How to complete this questionnaire:

- Where questions require a Yes or No answer or include multiple responses, please tick in the box beside or below the response which best applies (unless multiple ticks are allowed).
- Where questions are open-ended, please write down your answers.

Sponsors:



Section 1 – for ALL local residents

1. Other people have described the impacts of feral pigs in these ways. What impacts do YOU believe feral pigs have (multiple ticks OK)?

IMPACTS	Positive	Negative	Don't Know
Environmental Impacts	<input type="checkbox"/> NO positives <input type="checkbox"/> Dispersal of some rainforest seeds <input type="checkbox"/> Other: _____	<input type="checkbox"/> NO negatives <input type="checkbox"/> Damage to the rainforest (undergrowth plants) <input type="checkbox"/> Disruption of rainforest nutrient cycling <input type="checkbox"/> Soil erosion into the reef <input type="checkbox"/> Deteriorated water quality of creeks <input type="checkbox"/> Predation of turtle eggs in Cape York <input type="checkbox"/> Predation of native species <input type="checkbox"/> Competition with native species (for habitat & food) <input type="checkbox"/> Weed dispersal <input type="checkbox"/> Other: _____	<input type="checkbox"/>
Economic Impacts	<input type="checkbox"/> NO positives <input type="checkbox"/> Food source for humans <input type="checkbox"/> Food source for dogs <input type="checkbox"/> Meat used for bait <input type="checkbox"/> Commercial value of pig meat <input type="checkbox"/> Job opportunities <input type="checkbox"/> Other: _____	<input type="checkbox"/> NO negatives <input type="checkbox"/> Damage to agricultural crops <input type="checkbox"/> Possibility of Foot and Mouth Disease <input type="checkbox"/> Other: _____	<input type="checkbox"/>
Social Impacts	<input type="checkbox"/> NO positives <input type="checkbox"/> Recreational hunting opportunity <input type="checkbox"/> Other: _____	<input type="checkbox"/> NO negatives <input type="checkbox"/> Disease transmission potential <input type="checkbox"/> Damage to the garden/property <input type="checkbox"/> Danger to pets <input type="checkbox"/> Safety issues (car accidents etc) <input type="checkbox"/> Bringing illegal pig hunters <input type="checkbox"/> Other: _____	<input type="checkbox"/>

2. How would you rate the impacts of feral pigs (please tick where it best applies)?

	Very bad	Bad	Neutral	Good	Very good	Don't Know
Ecological	<input type="checkbox"/>					
Economic	<input type="checkbox"/>					
Social	<input type="checkbox"/>					
Overall	<input type="checkbox"/>					

3. Have you experienced any pig damage to your property (excluding farming land)?

Yes (go to Question 4 and 5) **No** (go to Question 6) **Unsure** (go to Question 6)

4. If **Yes** (Q3), please tick the following of damage targets on your property.

Garden (including lawn) Compost Vegetables Fruits Other: _____

5. If **Yes** (Q3), how bad was the damage?

Not at all	Not very	Neutral	Bad	Very bad	Don't know
<input type="checkbox"/>					

6. Have you seen illegal hunters accessing to private properties without permission?

Yes **No** **Unsure**

Section 2 – for farmers

Socio-economic impacts of feral pigs on agricultural commodities and of pig control

1. What kind of agricultural commodities do you grow for your business?

Sugarcane Livestock (cattle) Fruit & Trees Vegetables Other: _____

2. Have you experienced any pig damage to your agricultural commodities or properties in 2009?

Yes (go to Question 3 to 5) No (go to Question 7) Unsure (go to Question 7)

3. If Yes (Q2), how much pig damage did you approximately receive in total?

- a. Dollar value of the damage to your commodities: _____ (\$)
 b. Physical amount of commodities damaged: _____ (kg/tonnes/cartons/other: _____)
 c. Percentage of the property damaged: _____ (%) of total property (size: _____ ha)

Or Negligible financial damage

4. If Yes (Q2), how would you rate the severity of the pig damage?

Not at all	Not much	Neutral	Quite a lot	A great deal	Don't know

5. If Yes (Q2), were there any seasonal/monthly variations in the extent of pig damage?

Yes (go to Question 6) No (go to Question 7) Unsure (go to Question 7)

6. If Yes (Q5), please specify the seasons/months.

During the **harvest** season (from _____ to _____)

During the **wet** season (from _____ to _____)

During the **dry** season (from _____ to _____)

7. Do you control pigs privately on your property?

Yes (go to Question 8 to 15) No (the end of Section 2)

I get someone else to control pigs on my property

→ Do you give any bounty? Yes No (the end of Section 2)

8. If Yes (Q7), what control method do you employ?

Trapping Hunting with dogs Hunting with a rifle Poisoning Fencing Other: _____

9. How much effort did you put into control in 2009 by the method you specified in Q8?

a. Throughout the year

Everyday (____ hours) _____ days per week/month (____ hr(s) per day) If trapping → _____ trap nights

b. During a particular season (from _____ to _____)

Everyday (____ hours) _____ days per week/month (____ hr(s) per day)

c. Very opportunistic control

10. About how many pigs did you catch in 2009 (except poisoning and fencing)? _____ (pigs)

11. If you employ poisoning/fencing, how much protection you believe you gained from it in 2009?

100% protection of the property 80-90% 70-80% 60-70% Didn't make a difference

12. Do you use pig carcasses for any purpose after control?

Yes → Home consumption Dog food Mud crab bait Other: _____

No

13. How stressful do you find dealing with or controlling pigs?

Not at all	Not much	Neutral	Quite a lot	A great deal	Don't know

14. Do you think controlling pigs privately is causing you a financial burden?

Not at all	Not much	Neutral	Quite a lot	A great deal	Don't know

15. If you are able to take part in a 10min in-person interview, please provide your contact details:

Phone: (07) _____ or Mobile _____ or

Email: _____

Section 3 – for pig hunters

Social impacts of pig control on pig hunting

1. How important is pig hunting to you?

Not at all	Not much	Neutral	Quite a lot	A great deal	Don't know

2. Why do you hunt pigs? (multiple ticks OK)

- Passion to protect Australian wildlife
 Past time with family and friends
 Doing the environment a favour
 A sport
 Other: _____

3. Do you believe pig control practices are taking pigs away from hunting?

Not at all	Not much	Neutral	Quite a lot	A great deal	Don't know

4. Do you try to hunt boars rather than sows or young?

Not at all	Not much	Neutral	Quite a lot	A great deal	Don't know

Section 4 – for those involved in nature-based tourism

Socio-economic impacts of feral pigs on tourism

1. Do you believe that the presence of feral pigs negatively affects your business or the tourism industry?

Not at all	Not much	Neutral	Quite a lot	A great deal	Don't know

2. Do you believe that the presence of feral pigs degrades tourists' experience of the rainforest?

Not at all	Not much	Neutral	Quite a lot	A great deal	Don't know

3. Do you think there is a positive entertainment (thrill, excitement) factor in the presence of pigs for tourists?

Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Don't know

→ If you (strongly) disagree (Q3), please tick the following for the reasons (multiple ticks OK)

- Public safety issues with feral pigs
 Tourists' disappointment with the introduced species in the rainforest
 Other: _____

4. Do you believe the disease transmission potential of feral pigs is a concern to nature-based tourism?

Not at all	Not much	Neutral	Quite a lot	A great deal	Don't know

Please add any additional comments here.

Appendix 6: Notes to absent residents in distributing and collecting survey



Survey of local residents regarding feral pigs

Dear Resident,

Attached is a survey which explores your opinions about feral pigs and related control practices in your region. This is your chance to have your say on the current issues with feral pigs and their continued management. Please complete the attached survey and we will return to collect it tomorrow. You may leave the survey in your letterbox or we can collect it personally from you. Your contribution is highly valuable.

Many thanks,
Kana Koichi
MSc Candidate and Research Scholar
School of Earth and Environmental Sciences
James Cook University



Survey of local residents regarding feral pigs SORRY, we missed you.

Dear Resident,

Yesterday we delivered a survey to your residence. We are sorry that we have missed you today for collection. Please complete the survey and return it in the supplied pre-paid envelope as soon as possible. This is your chance to have your say on the current issues with feral pigs and their continued management. Your contribution is highly valuable.

Many thanks,
Kana Koichi
MSc Candidate and Research Scholar
School of Earth and Environmental Sciences
James Cook University



Survey of local residents regarding feral pigs THANK YOU

Dear Resident,

We would like to thank you most sincerely for participating in our survey. Your time in completing the survey is greatly appreciated. The information you have provided will enable us to provide community views on the feral pig issues to governmental agencies.

Many thanks,
Kana Koichi
MSc Candidate and Research Scholar
School of Earth and Environmental Sciences
James Cook University

Appendix 7: Tourist Surveys

Investigation of tourists' experience of the rainforest in relation to the presence of feral pigs in the Wet Tropics World Heritage Area

VISITOR SURVEY

(It will take 5 minutes to complete the survey.)

This is your chance to contribute to a management issue for the Wet Tropics.

I, Kana Koichi, am a Master of Science student at James Cook University in Townsville, researching socio-economic and ecological benefits and costs of feral pigs, in the Wet Tropics World Heritage Area, especially in the North Mossman, Daintree and Cape Tribulation.

The purpose of this visitor survey is to understand tourists' experience of the rainforest in relation to the presence of feral pigs in the Wet Tropics.

The research is **voluntary** and **all responses remain completely anonymous**. No personal details are required in this survey. Withdrawal from the participation in this survey is permitted at any time. There are 8 major questions. **When answering the questions, please circle/tick the answer boxes that best reflect your opinion. If you do not have any opinion about the subject, please tick 'Don't know' box .**

Please feel free to keep this survey cover.

If you would like to discuss this project in more detail, or you would like a copy of the key findings of this survey, please contact the Project Manager. If you would like to discuss any ethical matters regarding this project, please contact the Ethics Administrator. This project has Human Ethics Approval from James Cook University.

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Questions

1. How important was *visiting the rainforest* for your travel in this area?

Not at all	Not much	Neutral	important	Very important	Don't know

(1) What is the reason of visiting the rainforest? _____

(2) What do you think is the importance of the rainforest? _____

2. Did you know there are feral pigs in the Wet Tropics before this survey?

YES NO

3. Did you see any digging in the soil/ground in the rainforest? *(It is likely to be due to feral pigs)*

YES NO I DON'T KNOW

→ (1) If YES, how did it affect your experience?

Very negative	Negative	Neutral	Positive	Very positive	Don't know

Why? _____

4. How do you think pigs affect *the values you have for the rainforest* [Question 1(1)]?

Very negative	Negative	Neutral	Positive	Very positive	Don't know

Why? _____

5. Do you think the rainforest should be protected against feral pigs?

Not at all	Not much	Neutral	Quite a lot	A great deal	Don't know

Why? _____

6. There are different methods to control pigs. Do you support or oppose each method?

Control method	Strongly Oppose	Oppose	Neutral	Support	Strongly Support	Don't know
<i>Trapping</i>						
<i>Hunting</i>						
<i>Fencing</i>						
<i>Poisoning</i>						

If Oppose, why? _____

7. [Background Information] Where is your place of residence?

- Overseas:** Which country are you from? _____
- Local** (the Wet Tropics region from Cooktown in north to Townsville in south)
- Other Queensland cities/towns**
- Other States** (NSW, VIC, SA, WA, TAS, NT, ACT)

8. [Background Information] How long have you stayed in this area so far?

_____ (Days)

Thank you very much for your participation😊

Additional Comments: _____

Appendix 8: The management implications of the positive values of pigs attached by Aboriginal rangers in remote areas

Remote Aboriginal communities exist in areas that are generally sparsely populated and distant from markets both geographically and culturally. Thus, few alternative economic opportunities exist, and Aboriginal people in remote areas often face socio-economic disadvantages such as higher food pricing and low income (Altman, 2001, Altman, 2004, Altman et al., 1997, Collins et al., 1996, Duncan, 2003, Roach and Bek, 1997, Tisdell and Nantha, 2005). Accordingly, the government/state and the customary sector disproportionately dominates the remote area economy with a small private sector, and Aboriginal people in those areas tend to live off the land (Altman et al., 2005). The importance of the public and customary sector in such remote area economy is also underpinned by different systems of land ownership; Aboriginal land is held under various common property systems rather than private ownership. For example, Wujal Wujal, where one of the Aboriginal groups of this study was based, is a Deed of Grant in Trust (DOGIT)⁸ community because of its remoteness and recent history of colonisation (ATSIS, 2009). The existence of the DOGIT system means that customary, or kin-based, systems and practices are still robust compared to metropolitan regions where individualism is central to market-based activity (Altman et al., 2005). Hence, the presence of customary system under the DOGIT was related to the rangers' desire to boost socio-economic wellbeing of their remote Aboriginal community, or Wujal Wujal, by using customary activities, such as hunting, in pig management. Problematically, the socio-economic values of such customary activities tend to be overlooked, and there is a lack of recognition of the need to earn cash to support a subsistence lifestyle in remote Aboriginal communities (Caughley et al., 1996).

The hybrid economy model (Altman, 2004, Altman, 2001) reflects the positive role of customary activities in remote Aboriginal economies; it is a model of a three-sector hybrid economy to represent the Aboriginal customary economy and links the market, the state and the customary components of the economy. The hybrid model reflects that culture and economy is inseparable and that all kinds of human productive

⁸ DOGIT is a system of community-level land trust, established by the Queensland Government to create community councils, which administer former reserves and missions; councils act as a local government although they own the administered land on behalf of the community.

activity are culturally embedded and occur outside the realm of the conventional market (Altman, 2001, Altman, 2009). In this model, pigs play a role in the customary sector as a source of food, hunting and cultural potential for linking people to their country. It is important to recognise customary activities as a part of a meaningful economy and then to provide Aboriginal people with high self-esteem and the meaningfulness of their livelihood (Pearson, 2000), Such recognition can also encourage the capacity building of Aboriginal people to operate within the economy and promote socio-economic and health benefits for the people (May, 2010). By encouraging customary activities, social problems can also be solved, such as alcohol abuse, which has reduced Aboriginal people's engagement in customary activities (McKnight, 2002).

The contribution of use of customary activities to pig management is a form of "Payments for Environmental Services" (PES). PES is a conservation paradigm based on a voluntary, negotiated framework, and creates incentives for local landholders to provide Environmental Services (ES) in return for payments (Wunder, 2005). For example, hunting pigs is the equivalent of a voluntary environmental service to conserve the WTWHA rainforest and payments are in-kind at present in the form of the maintenance of cultural activities and obtainment of pig meat as food sources. PES is attractive to areas especially where ES providers, such as Aboriginal people, are poor and marginalised (Engel et al., 2008). Nonetheless, a means through which the people can receive real "payments" is important to provide sufficient returns for local Aboriginal people other than free pig meat. As a rule, PES is based on the beneficiary-pays principle because payments should be made by those who benefit from improved environmental management, such as the public, for the cost of providing that benefit. The government support of commercialisation of pig meat, for instance, can be one way of "paying" for the service provided by local Aboriginal people. By the government investing in the system of PES, environmental services of the WTWHA rainforest will also be improved while the disadvantaged and poor in remote Aboriginal communities will derive benefits from increased food provision and enhanced cultural activities via hunting as a pig management tool.

Although using customary activities as part of management seems applicable, there are some counterpoints. For instance, merely using customary activities to reduce pest populations is inappropriate because the population level needs to strike a "balance" to maximise socio-economic benefits and minimise environmental costs of the pest. For

the Aboriginal community at Arukun in Cape York, the species hunted for subsistence have changed such that feral pigs have become integral to subsistence because of a decline in native prey which pigs could be responsible for (Collins et al., 1996). This utilisation of feral pigs as a supplement to traditional food meant that they were managed as a resource for harvest, rather than controlled as a pest (Bomford and Caughley, 1996, Caughley et al., 1996). Subsequently, there was an emerging need for the people to strike a balance between leaving enough pigs for local consumption and taking enough for environmental protection to protect native species. Likewise, in Kakadu, Northern Territory, feral buffalos (*Bubalis bubalis*) were important economic resources for the local Aboriginal people although buffalos degraded wetlands. When feral buffalo control was introduced, there was an increased exploitation of estuarine crocodiles (*Crocodylus porosus*) for food by some Aboriginal residents as a replacement for feral buffalos (Altman and Allen, 1992). In the WTWHA, the Aboriginal rangers in Wujal Wujal, where there was a lack of native prey and economic opportunities, wished to ‘harvest’ pigs by raising them in a confined fenced area while culling in the rainforest so that they could manage pigs both as a resource and a pest. Hence, policies need to be developed to manage pigs in such a way that Aboriginal people can derive socio-economic, cultural and environmental benefits from management.

For successful integration of the customary sector of the remote Aboriginal economy, cross-cultural conflicts that exist in management of national parks need to be resolved. *The Aboriginal Land Act 1991* (QLD) gazetted national parks as crown land available for claim, and land granted under this Act is held by Aboriginal people as freehold title under the condition that the Aboriginal owners lease back the park in perpetuity to the Director of the Queensland Parks and Wildlife Service (QPWS) (Symonds, 1992). This leaseback structure of Aboriginal “owned” national parks is considered mere “tokenism”, reflecting the government’s reluctance to “allow” Aboriginal people to have overall control in management of public lands (Birckhead and Smith, 1992, Muller, 2003). The declaration of national parks has been of great concern to many Aboriginal people because it has excluded Aboriginal land management practices even though the people rely on the resources from local ecosystems for their economic and cultural survival (Collins et al., 1996). Their dissatisfaction with national park management was observed in this study as many

Aboriginal rangers desired formal “inclusion” of Aboriginal people in management, that is, collaboration with the government and more equal arrangements of management, to meet their own aspirations. Decision making of pig management can be better “contextualised” through such collaboration so that the needs and circumstances of Aboriginal people can be reflected in cross-cultural contexts (Aslin and Bennet, 2005).

Appendix 9: Quotes from interviews and responses to open-ended questions

Local residents (Chapter 3)

1. Rainforest values ascribed

Ambiguous responses “very important”:

- “Extremely [important]”
- “Very high [importance]”
- “Very important”

Ambiguous responses “need for protection”:

- “We should keep as much as possible.”
- “Essential to our environment and should be protected at all costs.”
- “The rainforest is enormously important and should be cared for at all costs.”
- “Our rainforests are very important. We need to do what we can do to protect them.”
- “Conservation”
- “All remnant rainforests around the world should be protected and preserved.”
- “Nature at its best. Needs saving.”

Ambiguous responses – e.g. key concepts in environmental discourse:

- “Overall good for the environment”
- “Nature’s garden”
- “To sustain nature’s natural cycle”
- “It is a necessary part of our natural system”
- “Necessary for life”
- “Life”
- “Ecological”
- “Environmental”
- “Ecosystem”
- “The trees”

2. Negative perceptions of environmental impacts of pigs

- “Pigs are not very good because they destroy the rainforests.”
- “They are ruining the rainforest.”
- “Digging up small palms in the rainforest for the heart of the palms.”
- “Around the board walks in Cape Tribulation, it’s all dug up by pigs.”
- “They dig up the creeks and cause erosion.”
- “They do enormous damage to waterways and eat cassowary eggs and other native food. They are the biggest threat to the environment and it is a very severe ecological impact.”

3. *Dissatisfaction with current pig management*

Satisfaction with the trapping program

- “As long as trap control is constant, it is sufficient and good at the moment”
- “Keep up trapping.”

Dissatisfaction with the State government’s management of national parks

- “We need accredited hunters in national parks.”
- “Government should do more. They have no interaction with locals and are not accountable. They are not doing anything at all. We want to control pigs but can’t hunt or shoot pigs in national parks, which is a big part of the community. Another problem is that we don’t get attention from them. Feral goat issues in south west Queensland were broadcasted widely, but the pig problem here is much bigger than feral goat. Especially in Cape York, the problem is acute.”
- “Anna Bligh’s pigs (referring to Queensland’s State Premier)”
- “Government does nothing to control pigs but individuals do marginally. Pigs are in national parks, and national parks are a source of pig breeding.”
- “Total eradication is not possible but governments need to keep them out of national parks.”
- “Can’t get in to trap where pigs are breeding – national parks etc. ”
- “Access to breeding grounds in national parks as in VIC & NSW.”
- “Government wasting time and money. Private hunters are better.”
- “The best control so far is the now annual October pig shoot [privately organised pig control by residents] in Cooktown: results noticeable immediately.”

Impossibility to eradicate pigs

- “Pigs will never be eradicated because they are too widespread.”
- “Eradication is desirable but probably not possible/realistic.”
- “Band aid approach is not good enough.”
- “Costly and insufficient.”

4. *Attitudes toward the different control methods*

Support for trapping

- “The trapper is doing a good job and it is proving that pig trapping works. About 7 years ago before the trapping program started, there were four or five times as many pigs as now. I saw more pigs before.”

Negative aspects (perceived lack of cost-effectiveness) of trapping

- “Pigs around here are difficult to trap. I have been here for 30 years and have only caught one pig [by trapping]. Pigs are too suspicious of any fenced areas.”
- “Control methods are limited because it is a rainforest [so only trapping takes place]. Pigs work out the traps because they are cunning so it takes a while until they catch a pig.”
- “The problem with trapping is that my dog chases pigs away when they are around the trap. Pigs’ trap shyness could also be a problem if they have escaped from trapping.”
- “Trapping is a very labour intensive activity, but we haven’t got anything ideal to get rid of pigs.”

Preferences for humane methods

- “They are another animal which should be treated humanely.”
- “The more humane, the better off.”
- “As long as it’s humane and pigs don’t suffer.”
- “I still think getting rid of pigs needs to be done in a humane way even though they are pests.”
- “I wish to see them culled with the least amount of pain.”
- “These days you have to think about animal welfare and humane killing. I really hate the idea of using a lot of types of dogs only bred for fighting because sometimes pigs get away after getting bitten pretty severely by dogs. It’s not very humane. We have to look at the animal welfare aspect of using dogs. And I’m worried too about the use of sulphate phosphate poisoning in Queensland. It’s absolutely no way that it’s humane poisoning. You can’t imagine the pain it causes; it burns the soft tissues. It’s still allowed in Queensland.”

Opposition to hunting and/or poisoning due to perceived environmental impacts

- “Dogs are good for paddocks and open areas to hunt but they can get away in the rainforest.”
- “Dogs could kill other animals.”
- “One thing I’m worried about 1080 poisoning is that there is never been a comprehensive impact assessment of 1080 use. If you are going to control any particular animal, you should monitor it. Pigs vomit (poison baits) and other things like rats can pick up the vomitus. If we poison bananas with 1080 and they vomit it up there, it is a concern because red kangaroos, rats and cassowaries like fruits.”

Support for *any* control options to control/eradicate pigs in any means

- “As pigs are notoriously difficult to control, use of multiple control practices is indicated.
- “Multiple methods are needed to suit terrain and vegetation.”
- “All methods need to be implemented to have any effect of controlling or eradicating feral pigs.”
- “Strongly support all the methods for eradication of feral pigs.”
- “Should be able to remove them by any means necessary.”
- “Anything to get rid of problem is a positive.”

Quotes for Table 3.10

	Approval		Disapproval	
	Reasons	Quotes	Reasons	Quotes
Trapping	Economic benefits	Culling for market Creates jobs Good for commercial value of meat	Expensive & ineffective for eradication	Pig trapping by the government agencies is expensive and does not work towards eradication or long-term reduction of numbers. Research should continue in other potential means of control.
	Humaneness	Pigs can be humanely disposed of. Easy no painful outcome		
	Effectiveness	It is the most effective way to get rid of pigs. We have trapped some with good results.		
	Safety	It is the safest for everyone. A lot safer		
	No negative environmental impact	It does not have an environmental impact. It only affects the feral pigs with little effect on native wildlife.		
	Other	It is a social activity. It is currently the only method allowed in national parks and the WT.		
	Fencing	Useful for critical areas		
Humaneness		Less painful for the pig. Most humane	Costs	A waste of time and money, too costly
Economic benefits		Creates jobs Helps local economies	Ineffectiveness	Pigs break down fences. Lack of effectiveness to keep them off.
Hunting with dogs or rifles	Conditional support	Support if by professionals. Hunting for recreation with better regulations Only when permission given/ Licensed hunting is okay. We support shooting with reason but don't support guns – no rednecks shooting up the area.	Lack of Humaneness	Dogging causes a lot of pain for long periods Hunting with dogs is cruel and inhumane. Inhumane for dogs to tear at pigs Mistreatment of dogs Hunting generates and endorses a culture of brutality and extreme cruelty to all animals
	Social benefits	It can provide recreational activities Fun/Social activity	Undesirable impacts of dogs	Dogs get lost and end up with wild dogs. Disturbance to management – pulling calves down, cow's ears chewed, killing stock. Dogs can attach anything that runs – cassowaries etc.
	Effectiveness	Very effective Better outcomes Keeps pig numbers down.		
	Economic benefits	Culling for market Helps local economies Pigs can be 'recycled' to dog or human meat.		
	Humaneness	Seems more humane if result is instant. Each animal dealt with quickly	Safety issues	Safety issues for humans and other animals Accidents can occur Rifle hunting around homes has some risk.
	Target specific	Guarantees the right predator is shot. It only affects the feral pigs.		
Poisoning	Efficiency	Quickest and cheapest method to eradicate pigs. Kills pigs with little effort May solve the problem over large inaccessible areas.	Undesirable environmental impacts (e.g. on non-target species)	It could go down the food chain – carnivorous animals who dine on rotten carcasses. It is bad because poison gets into the water systems, poisons other animals. They destroy natural vegetation, which affects native wildlife. Affects native animals, pets & domestic stocks.
	Conditional	Only accepted if wild pigs are the dead ones (e.g. only if poisoning is target specific).	Lack of humaneness	Poison baits are cruel and inhumane. It would possibly involve a lot of suffering to the pig.
			Safety issues	Poisoning close to towns with 1080 is risky. Unsafe, very dangerous
			Socio-economic impacts	I have eaten feral pigs many times and would support industry in the region; if poisoned, the ability to eat would be at risk.

Pig hunters (Chapter 4)

1. *Various perceptions of pig impacts*

Implications of pigs on rainforest values

- “I don’t think there is much damage in the rainforest.”
- “It is significant that pigs damage it although I don’t know the severity.”

Negative environmental impacts of pigs

- “They are bad in terms of environmental damage. They rip everything to eat. Pigs’ consumption level per day is the same as humans.”
- “Pigs eat anything like humans. They crush seeds of native plants instead of swallowing like cassowaries do, so do not contribute to seed dispersal or germination of certain plants.”
- “They go to swampy mangroves and dig up for food.”
- “Pigs can dig in at one metre depth to get turtle eggs.”

Negative socio-economic impacts

- “They also spread diseases, Foot and Mouth.”
- “In the neighbour caravan park, pigs go for rubbish and dump and root up the ground for new grass.”

Positive socio-economic impacts

- “Pig meat has a good wild taste. If someone is going to have a party or wedding or something like that, we quite often go and catch pigs.”
- “Pigs have no positive aspects but the use as dog meat.”
- “Good meat, I eat sometimes. It’s for dogs too.”
- “Pigs are a pest but they are good to eat. Pigs are the best organic food. They eat berries and grubs. North-west from Cooktown, they eat dead animals and don’t taste good at all.”
- “I hunt them for sport with bow and arrow once per fortnight, not as often as I’d like to though.”
- “Some hunters have a pig safari, earning \$4,000 per person for a week of pig hunting from customers, mainly from Melbourne. They pay to hunt for trophies.”
- “I offer safari hunting on my property with basic services provided for \$250 per day per person for a group of 4 people. A lot of people come from Melbourne for holiday. One time I put a tiny advertisement for this safari hunting business on one of the pig hunting magazines and I’ve received so many calls.”
- “From Cooktown north, people make a lot of money from pig hunting. People from the South and U.S. pay \$400 to \$500 a day for pig hunting. Everyone loves big boar especially young ones and Americans.”
- “I sometimes give pig meat to Aboriginal elder people.”

2. *Socio-cultural aspects of hunting*

Values of hunting for hunters

- “Hunting is very important for me. It keeps me happy. It’s also a family thing – I’ve been hunting for 10 years as a kid.”

- “I hunt pigs for control but it is not difficult at all. I enjoy it at the same time because I was brought up with pig control when I was a kid.”
- “I love hunting. Pig hunting is love for sport and is addiction like drugs. It’s in blood. My grandfather and father hunted pigs and taught me how to hunt since I was six years old. Hunting is social fun and I like dogs and like seeing what young dogs can achieve from hunting. Hunters are like fishermen.”
- “Hunting is both fun and necessity.”
- “Hunting is hobby and a job and is a mental asylum. It sends you around the bend. I started hunting out of necessity. When my brother passed away, there was nobody to look after the farms. It was also something to do with dogs and is a good hobby.”
- “Hunting is very similar to fishing. We go for a bigger target and it is an adrenalin rush when we catch them. It is not a joy to shoot small suckers. Bigger ones are beauty. For trophy hunting, which is pure recreational, we might target big boars, but for farm control we shoot them all. But for the fun part, bigger ones are better.”
- “Hunting was very important because I enjoyed being in the wild and it was something that humans have inside themselves or in their blood. It is an evolutionary thing, but there was no pleasure from killing animals.”
- “Since I was eight, I have been hunting with friends and family. There is a chiller box in Georgetown, and you can sell pig meat for \$1.5 per kg so it is sometimes good money.”

Aspects of skill hunting

- “Pigs change the timing of coming around the sugarcane because of control. If they get hunted during the night, they change their habit of being active at night and instead come around during the day time. So you cannot go hunting every night.”
- “I hunt pigs by working out wind and weather, which many people avoid doing. With less rain and cooler weather when water sources dry up, pigs come to cane every night because cane has got sugar and is sweeter. It happens around May/June to September. Normally around the wet season there is no taste in the cane so there are not many pigs [coming to cane farms]. Cane hunting [i.e. hunting on cane farms] is hard and challenging and dogs are not easy to handle. It is a lot harder to catch them in crops. I don’t get any bounty for hunting pigs because farmers cannot afford to pay hunters. Mossman mill used to pay \$10 a pig in the past but they cannot afford it anymore and neither can farmers. Hunting isn’t about money. It’s about passion.”

Territorial behaviours in hunting

- “They [hunters who trespass without permission] sometimes wreck my hunting plan because the paddock I planned to hunt was already messed up by poaching hunters releasing their dogs into the field a day before.”

Mutually beneficial relationships between hunters and farmers in pig control

- “Among cane hunters there are good skilled hunters and bad hunters. And hunters make a big difference. If you have unskilled ones, you cannot reduce pigs on the farm. One sugarcane farmer in Mossman is getting enormous damage just because he doesn’t have a good pig hunter controlling his farm.”

- “Farmers rely on hunters in this area because funds for control are only available through government. So farmers pay hunters to control pigs. Nowadays it’s around \$20-30 per pig but it is nothing if you consider fuels, dog food and time you spend on the whole hunting process. So hunters do not do this to make profits. We cannot put a price on our efforts. Farmers sometimes give us other than money like fuels, bullets, dog food or help us with vet treatment.”

Negative social issues surrounding hunting

Conflicts of pig hunting with control

- “I want to catch more pigs. Control is very bad. I catch enough pigs but don’t want too much control.”
- “I don’t want pigs to be wiped out because I want to hunt them.”
- “We are never going to get rid of pigs in up north around Cooktown because people make money out of pigs and they keep pigs for tourists.”

Difficulty of obtaining licences

- “I used to hunt for 15 – 20 years but quit 10 years ago because it’s too hard to get a licence for a shot gun because of safety issues, and things can happen. I don’t have farms so was only allowed to have two shots instead of nine shots to kill pigs but it is very dangerous to hunt pigs in the cane with only two shots at night because pigs can get very dangerous and attack hunters. It is also expensive to use dogs for hunting because of vet treatment.”

Difficulty of pig hunting as a control (decreasing numbers of hunters who engage in pig control)

- “I have lost interest in hunting and got sick of it because I have been doing this for a long time and it is not much fun if you don’t have a good dog to hunt with. I lost my dog last year and it takes a long time to train a good pig dog because not all dogs are suitable for hunting and plus you need to train them when they are puppy.”
- “Shooting around sugar cane is too hard. Crop is thick and the field is not open so hunters can’t run through. A lot of hunters nowadays go up to Cape York so there are not many hunters in cane situations like Mossman.”
- “Sugarcane hunting is very hard and so not many people nowadays do cane hunting.”

Negative social image of pig hunters

- “People think pig hunters are barbaric, cruel to pigs and starving dogs and dogs are aggressive but it is not true. We treat dogs better than wives.”
- “Pig hunters are hated people. And it is getting harder to hunt. A lot of people here are from city, the south of Australia like Sydney and Melbourne, and are greenies and don’t like dogs used for hunting. And national parks hate pig hunters. But there are different kinds of hunters. Some hunt only three times a year and get drunk while hunting, and others are serious but have fun and hunt regularly. Unprofessional hunters poach and give bad reputation about hunters. Those hunters don’t train dogs properly, either.”

3. Dissatisfaction with current pig management

National parks should be open to hunters (Dissatisfaction with the government’s national park management)

- “If hunters are trained with extra licence or dogs are trained, it would be a great idea to hunt in national parks to control pigs but not a free range thing. If you had a scheme set up, it would definitely help.”
- “They should get pig hunters accredited. The government should spend on hunt support and allow hunters to hunt pigs. In Cooktown, there are many hunters but there are still too many pigs. But proving that your dogs hunt only pigs and you have GPS tracks on dogs is important.”
- “National parks do nothing to control pigs. They should allow hunters with a permit to control pigs in the rainforests because a ranger cannot look after the whole national park. It is way too big.”
- “They [hunters] are limited because it’s rainforest. They are not allowed to shoot. If they were allowed to shoot, it would be more effective because pigs work out the traps. They are very cunning and it takes a while until they catch a pig. I support hunting in national parks as long as it’s done sensibly. Dogs are good for paddocks and open areas to hunt, but they can get away in the rainforest.”
- “National parks should be open to accredited hunters like New South Wales Game Council to manage the national parks better. In Queensland, not many people are on the ground to manage national parks. They need to start opening commercially in national parks to maintain facilities, visitors and camping grounds. For example, during non-tourist seasons, hunters can come in national parks. But public liability is the biggest problem for property owners when something goes wrong from hunting because nobody wants to be responsible.”
- “The biggest problem is national parks. National parks are the biggest capital of tourism, having cassowaries there and so we cannot hunt there. Daintree is a problem. They are really doing well with the trapping program but they are never going to run out of pigs. National parks should be open to hunters but not just opening but controlling who can go in there for hunting and creating right corridors for hunters to hunt, and keep the areas away from traps. We need a good system to control hunters.”

Current management is insufficient because pig is winning the control and/or control is underfunded

- “We are never going to run out of pigs. We could never beat nature [pigs]. We can just control them. We need to keep controlling them otherwise they reproduce quickly and recover and keep pigs in the hill otherwise pigs come too far.”
- “It’s definitely underfunded.”

Whether pig hunting could involve selective culling – cane hunters target all.

- “We target all pigs, sows, saplings and boars. I hunt everything because they all eat cane. I don’t hunt for tusks because there is no money in tusks.”

4. Attitudes toward the different control options

Not hugely in favour of trapping (therefore supporting hunting)

- “Pigs are smart and they become trap shy. As soon as they see other pigs getting trapped, they would communicate and do not go back to the same spot anymore after a while. Shooting and

dogging are more effective. Trapping is 70% good but not catching 30% of the population. Trapping young ones is easier.”

- “I don’t oppose trapping but shooting and dogging are more efficient than trapping. And shooting is more effective than dogging because it sometimes takes three or four dogs to control pigs whereas you can shoot pigs in the right spot straight away in shooting. So in dogging you don’t catch as many as possible. Shooting can take 9 out of 15 pigs in one minute but dogging can take only one or two and the rest of pigs run away. If there is only one pig to hunt, it is easier for dogs to get it because there is only one scent to follow.”

Opposition to poisoning due to negative environmental impacts, animal welfare and safety issues

- “No poisoning because of the possible negative effects on non-target native wildlife.”
- “I don’t support poisoning. 1080 is nasty.”
- “Baiting is good but it is very risky because there are houses and kids running around baited areas. Poisoning is a very touchy issue. Pigs eat poison and dogs may eat pigs – you never know the side effects. When one farmer put the baits out, everyone in the neighbourhood was so concerned.”

Farmers (Chapter 5)

1. *Rainforest values ascribed*

Personal attachment to the rainforest, aesthetics and provision of habitats for wildlife

- “[The rainforest is] absolutely [important]. I was born here and am 76 years old now and we’ve had the rainforests for granted. It’s a beautiful thing, pretty wild inside, but we accept the fact that it’s there. If the mountains were denuded, it would be very bad. I couldn’t even think about that. It’s my own imagination that the mountains are our rainforests. I feel very upset about pigs causing damage to the rainforest. I don’t even want to think about it. The rainforests are important for numbers of creatures and I think it’s silly that Queensland Forestry put pine forests on the hillsides. I grow native fruits for cassowaries. We all are a little bit environmentally conscious.”

2. *Negative perceptions of environmental impacts of pigs*

- “Pigs are a major Australian disaster.”
- “They cause incredible damage and the impacts of pigs are greater than those of dingoes.”
- “Disease transmission.”
- “Damage in Cape York is enormous. Pigs dive down to eat water lilies’ roots in billabongs.”
- “Destruction of hillsides of the rainforests and bleaching of topsoil – turkeys do but pigs do turn up soil more.”
- “Creeks harshly dug up by pigs. When the wet season starts, it causes the dirt to wash down and it goes to the reef and ocean.”

Particularly in reference to soil erosion (pigs as a scapegoat)

- “Soil erosion in the main.”

- “Rummaging of pigs is destabilising the creek banks, creek beds, mangroves, lowland rainforest, which is the flushing silt to the ocean.”
- “Why is the government giving more attention to the reef rather than the rainforests? Soil erosion is coming from pigs digging up creek banks rather than cane. So, more nitrogen is actually coming from national parks than farming land. We want to keep our dirt, we can’t afford to lose it; fertilisers cost us \$1,000 per tonne. We are not going to put that to the reef. It’s too expensive. Fertiliser loss is rather due to evaporation, and we are better off when it rains than evaporation. Anna Bligh is getting like a dictator as far as agriculture goes. What’s happening in Brisbane is more important for Queensland Government. Remote areas like Mossman are always disadvantaged. Our previous Premier, he was not bad as a politician because he was a farmer so he had an idea of what farmers go through. [...] We put fertilisers on, do chemical work and clean and slash headlands and pigs are still there. It’s disheartening. Politicians don’t understand this and we just want to eat their heads off.”
- “Pigs are the ones that cause soil erosion because we cannot afford to lose our soil.”
- “The government people, who have university education, although there is nothing wrong with education, never see what is really like in sugarcane. Fertiliser run-off into the reef argument is a good example. They tried to sample water quality both in Daintree farms and here, but they couldn’t get the right figures to justify their argument that farmers are the ones to be blamed for run-off. We cannot afford to lose these fertilisers.”
- “Creeks are all dug up [by pigs]. When the rain comes, erosion causes but farmers are blamed, not the pigs. We have Captain Bligh [Queensland Premier] who insists that farmers put 25,000 tonnes of fertilisers into the reef last year. Farmers are very restricted in what they use today and now Captain Bligh is putting further restrictions. If you have 250 acres, you have to take soil samples, get them analysed and take them to the department and make the application based on what plants need and what your soil test is. Each soil test costs about \$90 so each year presuming you’ve got 10 paddocks on farm and take 10 soil samples it costs \$900 plus all the time used to make the application and nothing is processed within six months when dealing with the government. It just set us up in the craft of corruption. Anything to do with the government departments is just hopeless.”

3. *Perceived economic impacts of pigs*

Substantial economic damage claimed by a minority of farmers

- “They do absolutely enormous damage. The cost of economic damage was roofing. It is hard to estimate in dollars because the price of sugarcane varies so does the extent of damage. It varies too often but it is significant. Some farms get damaged far more extensively but varying from year to year. Pigs can cause damage up to 20% of the property. They completely destroy it. They find cane farms that they particularly like and prefer canes that are more tender and sweeter. Particularly during the harvest season, they beat in the cane and live almost indefinitely in the cane because apparently they live on carbohydrate and are short of protein [during that season]. [Pigs damage to cane] is in the same manner as a thief walking into a grocery store stealing those”. (*A former sugarcane farmer in Mossman with his properties facing the forest*)

No significant damage claimed by most cane farmers (owing to hunting pressure)

- “[Pig damage to the farm is] only a little bit – we almost have no damage and it is totally negligible. We own 88 ha of sugarcane and the farm is adjacent to the rainforest but we had an actual harvest of 6,000 tonnes and we had estimated 6,500 tonnes. The loss [i.e. 500 tonnes] was not due to pigs but due to too much rain in December 2008 and January to March 2009. The last noticeable damage was five years ago but it was still minor and not enough to worry about in financial terms. There are pig dogs in the neighbourhood and I believe that those dogs are keeping the pigs away.” *(A sugarcane farmer adjacent to the forest in Mossman)*
- “Pig damage happens around March to November but it’s not too bad because I’ve got pig hunters on my property. I’ve got around 30 hectares and I get at most 1% of the property damaged by pigs. When I first took over the lease six years ago, I had roughly 10% of it damaged but it has been reduced because of hunting. We need good professional hunters to reduce damage. The area damaged is mainly around swamps and the rainforest where there is enough water.” *(A sugarcane farmer in Mossman)*
- Normally, at the bottom, the cane is at 12 months of maturity, and the higher it gets, the less maturity and sugar. Pigs used to come around the swamp side of the property but during the recent dry seasons there has been less fresh water so we don’t get pig damage anymore and pigs seem to have moved back to the hill. *(A sugarcane farmer in Mossman with his property facing the rainforest)*

No significant damage (claimed by all the fruit farmers)

- “They [pigs] are not getting into the tea because they get cut up by branches if they walk in.” *(A tea farmer in Daintree)*
- “They ringbark our breadfruit trees. Breadfruit and banana trees are soft and easy to be reached by pigs. They destroyed many trees to get the sap out of trees. One tree is worth 20 years of breadfruit and we’ve lost 10 trees in the last five years and we never lost any before. But we haven’t been really damaged financially. Normally we get damage during the dry especially in the last six months of the year.” *(A tropical fruit farmer in Cape Tribulation)*
- “At the end of wet season around May when the ground becomes soft, there is a lot of digging. We maintain the property daily and try to pick up fallen fruits before pigs come around. Pigs tend to come back to the same spot and target specific fruits including black sapote and jackfruit. But they mainly target worms in the ground and around the fruit tree roots. It is very hard to quantify in terms of damage to the health and yield of fruits but there is no significant dollar damage because of our daily management.” *(A tropical fruit farmer in Daintree)*

Use of pigs as meat

- “I used to raise a wild boar to eat because I live on a farm. He became really big part of the family.”

4. Dissatisfaction with current pig management

Dissatisfaction with restrictions in national parks

- “We cannot poison them here. Twenty years ago, we could kill 50 pigs in one night by poisoning but we are not allowed to use it anymore.”

- “We are treating the symptom [i.e. pigs], not the cause [i.e. national parks].”
- “It is hard to control pigs in national parks. No hunters are allowed because of the cassowary.”
- “There are too many restrictions [when it comes to pig control, especially hunting in national parks]. They say ‘you can’t do that’ but they don’t give you alternatives. We are doing environmentalists a favour by controlling pigs. We never had a problem with cassowaries when we hunted pigs with dogs near the rainforest.”
- “Dogs are not allowed to catch pigs in national parks. The national park is a pig habitat.”
- “We can’t go hunting in national parks, where pigs breed. Access to national parks would be handy because we are only controlling on lowland, and even if we get everyone together here, we can get farmers together, but not national parks. There is not enough money, resources [contributed to control] from the government.”
- “Pigs inhabit national parks because shooters are not allowed to take dogs into the national parks so they are a breeding ground for pigs. They need to register the shooters in national parks. National parks made the edicts and the World Heritage came in and say ‘you can’t do this’ ‘you can’t do that’. We had a reasonable control on pigs before, but since the people in the authority, the ‘greens’, came in, pigs got to an enormous number. Basically, the World Heritage Area is becoming a pig safety area and habitat. Pigs eat the bottom and deer [feral deer in the Wet Tropics] eat the top.”
- “I think it is a non-sense that pig hunters aren’t allowed to hunt in the national forest. I absolutely advocate hunting in the national forest.”
- “There should be a collective approach between national parks and farmers.”
- “National parks are up to ‘the shit’. World Heritage Area has had no person since 1997 who is actually managing the rainforest on the ground; no hunters are allowed to go in. Where would pigs go when they escape from cane? National parks! As soon as they run into national parks, we have to leave pigs alone. You need to put people on the ground there or give the landholders who live adjacent to the national parks some tax advantages to cover some of the expenses spent for pig control.”

Perception that the government does not contribute to pig control but pig hunters

- “Hunters do their best in Mossman on private properties and keep the pig population low. If it were not for hunters, there would be overwhelmingly enormous damage.”

Lack of coordination or cooperation (i.e. inconsistent control efforts) with adjacent landholders

- “Pig control becomes political but we should be able to help each other regarding pig control. We need our neighbours to do it too.”

Pigs’ fecundity winning the control

- “Time is the burden [when it comes to control]. Control is a full-time job. We catch 60 to 70 pigs every year [by hunting] but it is nothing because pigs reproduce and come back to the same spot.”

5. Attitudes toward the different control methods

Support for trapping

- “Trapping appears to be the best but you’ve got to make sure that there’s food all the time in the trap, laying heaps of bananas and fruit.”
- “Trapping works.”

Not hugely in favour of trapping

- “I have four traps but they are not catching many pigs in the sugarcane.”
- “Trapping will work but costs.”

Support for fencing

- “It was a four-wired fence and it did work. The best fence is ring loc [wire mesh], it is high enough for pigs to not jump over it and pigs can’t go under.”

Support for hunting (because of target specificity)

- “Hunting is a guarantee the right predator is shot; seems more humane if result is instant.”

Support for hunting (with conditions)

- “Hunting is good when we have good respectful hunters.”
- “[I support hunting but] rifle hunting around homes has some risk.”

Support for hunting (usefulness of shooting as ad hoc control)

- “In the property of 300 acres, we hunt with dogs once in two weeks on average as soon as we see pigs or footprints. We normally follow the water in hunting and go for roughly two hours. Pigs do come around to the farm but we don’t give them the time to damage here. We keep it minimal. If pigs come in around the windows at night, we grab a gun and shoot a pig. It’s a true story.”

Opposition to hunting due to its recreational aspect

- “Hunting is entertainment, not control. It has no impact on the population.”

Opposition to poisoning due to lack of target specificity

- “I don’t support poisoning unless they could specifically target the pig.”
- “Poisoning 1080 is a concern because of the impacts on the non-target species.”
- “I oppose poisoning because of the potential impacts on other animals.”
- “Poisoning take out too much wildlife and is not viable.”
- “Poisoning is indiscriminate.”
- “Poisoning is NOT the way to go including risk of poisoning other animals (so Q10 - poisoning is not good).”
- “Poisoning results in too many native animals being killed.”

Support for any control methods to control/eradicate pigs in any means

- “There are bloody greenies saying that they should kill pigs humanely. You kill them anyway you can. Anything.”

Government officers (Chapter 6)

1. *Negative perceptions of environmental impacts of pigs*

- “[Negatives are their] impacts on marine turtles. It’s 100% predation on the West Coast of Cape York Peninsula.”
- “In Cow Bay 300 acres is covered with pond apple trees and pigs like the fruits.”

2. *Attitudes toward their trapping program*

Positive contributions of trapping to the government and community (including the local Aboriginal community in Wujal Wujal)

- “The [government trapping] program is sufficient to a reasonable extent. The number of pig complaints has been reduced. There used to be more complaints before the program although people still complain to politicians most of the time.”
- “They catch around 600 pigs a year over the last five years [through the trapping program]. So 3,000 pigs caught from such a tiny area. A lot of people used to see pigs everywhere you drove, see damage everywhere whereas now in the last five years, you can see a little bit of damage but you rarely see pigs anymore. 15 years ago it was common to see a mob of 20 pigs when driving along.”
- “Before the control program, there use to be more complaints but in the last five years of government control of pigs, fewer pigs are around and people are happy. Perception management is important.”
- “Once a month I [the pig trapper contracted for the Daintree pig trapping program] take a load up there [to Wujal Wujal]. If some Indigenous guys drive past and see pigs on my ute, they take pigs to their community. So they probably get pigs [caught through the trapping program] once every two weeks. Indigenous people appreciate this. Part of this arrangement is that we are trapping on their traditional land so [it is] their hunting ground. Any pigs are given to the community. Pig meat is mainly for home consumption but if I take a big sized thing [pig], it becomes a community thing. There was a big funeral before, when one of the oldest passed away, and I took some 6 good sized pigs and the whole community would have used the meat. The bigger the better for the community and they prefer boars for some reason. Boar meat may taste better but not sure why. The governments don’t want all pigs taken up there because of the risks of parasites and potential diseases. So it’s at their own risk if they want to take pigs. The community hunts pigs by themselves anyway.”

Control is the aim of the program, not eradication

- “The aim of trapping [program] is not eradication but control, to reduce the number of pigs in areas of high conservation value, and in terms of this aim, we have been very successful. Once or twice a year we trap pigs in areas close to the walking tracks in Mossman Gorge and near the suspension bridge. Pigs normally cause concentrated damage near waterways so we focus our efforts on those areas.”
- “We can take out one group [of pigs] by trapping, but another group would move in. That’s why all those methods need to be on-going, constant. If we stop trapping here [in Daintree] now, in

two or three years, all the work we've done will be for nothing. It will be back to square one. Keep it to an acceptable level, and you are winning."

- "They are feral pests that need to be controlled but eradication is impossible in large areas."

Resource allocation determines the level of control (therefore public's satisfaction with pig control)

- "It [pest management] is always underfunded. If there were a lot of money available, there wouldn't be any pigs. Because the State government is dealing only with Class 1 pests, the priority of control in the Wet Tropics is mainly weeds of Class 1 for the State government. Council is dealing with Class 2 pests including feral animals, and as long as the Council has funding, they can continue community trapping program such as the one in Daintree."

3. Attitudes toward the different control methods

Not hugely in favour of fencing

- "Fencing is too impractical and costly unless you want to control a specific area."
- "Fencing is not favourable due to the costs."

Opposition to hunting in national parks

- "No hunting because of the restrictions [of national parks]."
- "No shooting in national parks. Don't let people cut loose in national parks because a few accidents would be expected. Trapping is the only method in national parks because it is the safest. Keep people out of it [the national park]."

Support for hunting in private properties

- "Farmers' opportunistic shooting, that's fine if you can shoot a few pigs that way."

Not hugely in favour of poisoning (but not totally opposing it)

- "Poisoning baiting is the most effective [method] but there is some concern about risks."
- "Poisoning is used as the last resort for properties more than 40 acres."

Advocating the use of a combination of methods

- "It's hard to control pigs so you need to combine all control methods."
- "They [the four different control methods used in the study area] are all good if everyone plays their part. If all control methods are combined, I support all those even in Daintree but [do] not [support] the dogs because it's a national park."

Tourists (Chapter 7)

1. Rainforest values ascribed

Ambiguous responses – values related to unspoilt 'nature'

- "Extremely untouched"
- "Uninterrupted environment"
- "One of the few untouched areas by human interference."
- "Natural surrounds"
- "Nature"
- "Environment"
- "Vegetation"

- “Trees and plants”
- “Part of the environment”
- “Original states of the environment”
- “Ecosystem preserving the environment”

Ambiguous responses – values related to “preservation” or “conservation”

- “Preserve some nature.”
- “Keep nature as is.”
- “Keep remaining areas untouched.”
- “Keep clean”
- “Keep it green”
- “Conservation”
- “Preservation”
- “Sustainability”
- “Need to preserve them.”
- “Must preserve natural reserves.”
- “Maintain natural forests”
- “Preserving the wild”
- “Preservation of the wild”
- “Teaching us all to care for nature”
- “To keep biodiversity intact”
- “Preserving forest animals/plants”
- “To protect and preserve species and life on earth.”
- “Protection of ecology”
- “Very important for preserving different wildlife”
- “To protect wildlife”

Ambiguous responses – “ecosystem” or “ecology”

- “Part of the ecosystem”
- “Natural ecosystem”
- “Ecosystem”
- “Because they are an impressive ecosystem.”
- “Complex and delicate ecosystem”
- “It provides an important ecosystem.”
- “Important part of ecosystem”
- “Its ecosystem”
- “Healthy ecosystem”
- “Important in ecosystem”
- “Important to local ecosystem”
- “It’s important for the ecosystem.”
- “Ecology”

- “Ecological”
- “It’s an important ecological niche.”
- “Very important ecology”
- “Ecological value”
- “It’s ecologically important.”
- “[The rainforest is] highly significant ecologically”

Ambiguous responses – “survival of species” and “balance of nature”

- “To safeguard the planet”
- “Very important for all life”
- “Survival of our species”
- “Essential for natural balance”
- “Balance the environment”
- “Maintain a balance”
- “Balance of native”
- “Balance of all ecological things”
- “To balance the whole ecology”
- “Critical for earth and nature”

Ambiguous responses “very important”

- “Very important”
- “Very important – natural wonder”
- “Very”
- “Very high”
- “Crucial importance”
- “Extremely important”
- “Very important for world environment”
- “High”

2. *Negative tourist experiences due to sighting of pig diggings*

Those who perceived the environmental effects of pigs on the rainforest

- “Feral pigs damage the natural ecology.”
- “They shouldn’t be here; do so much damage.”
- “Concern about destroying the rainforest.”
- “Too many pigs destroy plants.”
- “Damage to native habitat.”
- “They are a pest and affect local wildlife.”

3. *Perceptions of pig impacts on rainforest values*

Positive perceptions of pig impacts on rainforest values

- “They must have a role to play.”
- “They participate in that way to the equilibrium of the forest.”

- “Soil nutrients mixture.”
- “For the ecosystem”.

Neutral or indifferent about pig impacts on rainforest values

- “I’ve never heard of any pigs in the rainforest before.”
- “Natural habitat affected (assumption).”
- “Don’t know enough about them.”

Negative perceptions of pig impacts on rainforest values

- “They are not green.”
- “Not natural”
- “Pest?”
- “Because they are foreign.”
- “Introduced”
- “They obviously don’t belong here.”
- “Can cause harm to ecological balance.”
- “Ecology is being damaged.”
- “Upset natural balance.”
- “Feral animal, denude the environment.”
- “They are very destructive.”
- “Damage the ground/forest.”
- “Like rabbits, foxes, feral cats and sparrows – they are not native and cause great damage.”
- “Because they alter the landscape and soil of the rainforest.”
- “Negative if they are not native. They are digging the seeds planted naturally.”
- “Destroy/disturb natural habitat.”
- “They eat cassowary eggs and other fauna.”
- “Creates damage to the scene.”

4. Attitudes toward the different control methods

Support for trapping (animal welfare, target specificity, use of meat, aesthetics)

- “Ethical reasons”
- “Trapping is not painful to pigs.”
- “No cruelty to pigs.”
- “Unharmful, ethical and not violent.”
- “Trapping seems to be the less cruel method.”
- “Pigs are still alive in traps.”
- “More humane the better.”
- “Target pigs only.”
- “Trapping if carefully done – care of non-target species.”
- “Trapping means they can be put down humanely or used other ways e.g. fur, meat for pets”
- “Useful and can eat the pigs.”

- “Least invasive.”

Opposition to fencing (due to its lack of cost-effectiveness and perceived negative environmental impacts)

- “Fencing – impossible to stop feral pigs with mere fences. They dig.”
- “Fencing doesn’t really work.”
- “Damage forest, cost money.”
- “Don’t like the idea of fencing as what it affects native animals.”

General disapproval of inhumane methods e.g. hunting and poisoning (inflicting killing)

- “Why kill animals and not just protect the fields through fences.”
- “Animal welfare – keep them away if they are a pest rather than kill them.”
- “Try to keep them out than kill them if possible.”
- “Best to move them.”
- “Don’t kill – relocate.”
- “Humane methods should be used where possible.”
- “Support friendly trapping as this method doesn’t kill the animal such as poisoning or hunting.”
- “I don’t agree with the pigs painfully suffering.”
- “I do not believe in killing animals in general.”
- “They are animals and they need her place to live.”
- “I am generally against hunting, trapping and poisoning – doesn’t matter whatever animals.”
- “I’m opposed to the killing of any animals or natural things.”
- “I don’t like seeing animals harmed.”
- “Disagree with cruelty to ANY animals.”
- “It’s sad and painful for those pigs.”
- “Don’t hurt animals, they can’t help it.”
- “Try to use as little violence as possible.”
- “Because I don’t want that they have pains.”
- “They are still animals and had no control over being brought here thus should not be harmed inhumanely.”
- “I love all animals and there is a place for everything.”
- “Animals should be respected.”
- “Not too keen on inflicting unnecessary pain and suffering on animals including feral pigs.”
- “Control is okay but not killing.”
- “Fencing doesn’t kill them.”

Opposition to hunting due to animal welfare

- “Dogs are a cruel method.”
- “Dogs – inhumane”

- “Pain to the animal [pigs]”
- “Dogs cause increased stress.”
- “Dogs are a cruel method.”
- “Harmful to pigs”

Opposition to hunting due to negative environmental impacts

- “Dogs in rainforest are not a good idea.”
- “Hunting with dogs harms even more than the pigs do.”
- “Hunting is bad for the other animals.”

Opposition to hunting due to safety concerns

- “Danger to people (guns)”
- “Safety issues with families and elders”

Support for hunting (particularly with rifles)

- “Hunting has been practised for a long time and is very effective and humane way of eradicating.”
- “Hunting with a rifle is fine but not dogs as they can be hurt too.”
- “Target pigs only.”

Opposition to poisoning due to lack of target specificity and environmental impacts

- “Other animals can be affected.”
- “Poisoning may affect all wildlife.”
- “Concern about poison reaching native animals.”
- “Could cause 2nd poisoning.”
- “Culling must not cause another problem - we have to fix, however it is done.”
- “Poisoning may have a strong impact on the ecosystem and is hard to handle properly.”
- “Poisoning should not be put out in such a sensitive area.”

Opposition to poisoning due to animal welfare

- “Poisoning is cruel.”
- “Must avoid suffering.”

Conditional support for poisoning if target specific

- “Support poisoning if specific to pigs.”
- “As long as it does not harm other species.”
- “Poisoning – would have to target the pigs only.”
- “Acceptance of poisoning depends on impact on other life.”
- “Poisoning needs to be done very carefully.”

Support for any control methods to control/eradicate pigs in any means

- “Any method as long as we get rid of the pigs.”
- “Any method of control is good.”
- “Anything to get rid of them is good.”
- “All are ways to ridding the forest of pigs.”
- “Whatever method works the best.”

- “Either option is a good way to deal with the problem.”
- “Feral pigs are out of control in certain areas.”
- “Needs large scale action.”
- “Need for urgent control.”
- “Get rid of them!”
- “Kill them and then will get rid of them.”
- “Like the cane toad, these ferals need to be controlled more quickly as they are evasive.”
- “Do not believe wild pigs contribute to the environment.”
- “Feral animals are detrimental to forest fauna and flora.”
- “Conservation.”

5. *Additional comments in the survey*

Comments regarding the research/survey

- “Thanks”
- “Keep up the great work.”
- “Keep up the good work.”
- “Keep up the good work. All surveys help to make people aware.”
- “Good luck!”
- “Good luck with your studies!”
- “Good luck with your research.”
- “Hopefully my comments helped your research. Good luck!”

Comments regarding pigs and their related issues

- “Topic needs enhanced awareness amongst broader community and funding support.”
- “Pigs could be used as a food source to export to Germany. We eat wild boar and the meat is good to eat.”
- “National parks should have a stronger presence – private owners are very visible and vocal in terms of land management (they have a lot to say! National parks are not doing enough.)”
- “Keep the area protected and natural. Don’t allow commercialisation to destroy the natural beauty. Dams in Western Australia get dug up by pigs at the edge of the forests. Causes water turbidity and affects water for drinking.”
- “I am from Blue Mountains – we also have a huge pig problem.”
- “Have experienced devastating damage pigs cause in numerous areas in North Australia.”
- “Hunting is the best solution out of all the four methods. Certainly NO to poisoning.”
- “Feral pigs don’t belong in Australia and all efforts must be made to eradicate them.”
- “[I] cannot be very informative as do not know much about feral pigs in area.”
- “All feral and introduced pests should be destroyed. I lived in Atherton Tablelands for years, and every year all creeks were dug up by pigs. Dogs catch only pigs if they are trained well. Hunters should be allowed into the rainforest.”
- “Saw lots of rooting during the tour in the rainforest and the tour guide explained about the pig damage.”

1. Perceived environmental impacts of pigs and implications for tourism

Concerns about pigs' predation on turtles and the implications for tourism

- “The value of mega fauna including sharks, turtles, manta rays, potato cods and Maori wrasse are the actual things people really remember so you need to have a high level of protection for those mega faunas. One of the top three that people really want to see is turtles and they are always the real highlight so there is a huge tourism value to turtles. [...] Pigs are incredibly destructive to the turtle population on the mainland. It's very credible that it's probably wiping out 80-95% of the nesting turtles on Cape York. The reason that it is particularly bad is climate change and the rising sea. The nests on the islands, which are safe for turtles, are now getting wiped out and will be getting wiped out. So what's happening now on the mainland becomes more important because that used to be the safety guard, but now it's worse because pigs are getting into everything on the mainland and so turtles are now in serious threat. Considering that Australia is basically the only place where turtles are protected in the Indo-Pacific oceans, this becomes incredibly more important. So the introduced species is not only damaging the rainforests but smelling turtle eggs and eating them.”

2. Opinions about current pig management

Satisfaction level with current management (because of limited options available for pig control in the rainforest)

- “It's a little bit tricky because you cannot hunt pigs with a gun or bring dogs in the rainforests because of the disturbance to wildlife.”

Dissatisfaction with state government

- “The problem in Australia is that there is a capital in every State with 80% of the State population living there, and all wanting some meaningful expression of connection with nature while wanting the economic advantage of being in the central metropolitan area. [...] So what they do is to notionally create another national park. [...] They create the illusion that they've done something good for the environment.”
- “Protection and health of this World Heritage Area, all it's done is provide a sanctuary to feral pigs, the most damaging environmental impact in Australia.”
- “I can't even get permission to take two people into the national park for any kind of activity; it's so heavily regulated but pigs can do whatever they want.”
- “Under *the Land Protection (Pest and Livestock Management) Act*, every landholder in Queensland is required by law to keep their land free of pigs except for the State. So every piece of State-held land national parks doesn't have to keep their land free of pigs. Everyone else does by law. 168 freeholds World Heritage land, we are expected to keep our portions free of pigs whereas 87,000 ha of public land protects pigs. The State government is protecting this environmental disastrous problem, the biggest problem facing this rainforest. The government is the issue. [...] A lack of action is just another way of saying they are protecting. The marvellous legislative protection that they police is causing and creating a pig paradise.”

3. Attitudes toward the different control methods

Opposition to hunting (negative image of hunters, environmental impacts of pigs)

- “We support shooting within reason but don't support guns - no rednecks shooting up the area.”
- “Hunting pigs without dogs in the rainforests is uneconomic but I don't want dogs to be in the national park.
- “Dogging is cruel and can affect the native wildlife.”
- “Dogs and firearms could accidentally harm cassowaries. Public shooting is a big problem when cassowaries are here. To send people into the cassowary habitat with dogs and firearms would lead to the consequence that cassowary's deaths would be too great to support. A solution should be the most cost-effective way, enabling the local communities to maximise the benefits and minimise the costs, but it shouldn't have risks like not manageable shooters.”

Opposition to hunting (recreational aspect of hunting)

- “Hunting is entertainment, not control, and would have no impact on the pig population.”

Support for hunting (with conditions)

- “[I strongly support] hunting and dogging only when permission is given.”
- “Hunting with dogs can be cruel, but licensed hunting is OK.”
- “The other control methods cost a lot of money whereas people enjoy on-ground hunting and even pay for it.”
- “Dogs and rifles keep the pig numbers down. If there was a bounty on pigs for registered hunters, pig numbers would drop but will never be eradicated if they continue to breed in national parks.”

Support for hunting due to lack of on-ground staff to manage national parks

- “In Queensland national parks, there are not many people on the ground to manage and they need to start operating commercially in national parks to maintain facilities, visitors and camping grounds.”

Opposition to poisoning due to lack of target specificity/animal welfare

- “I don't support poisoning unless they could specifically target the pig.”
- “No poisoning because of negative effects on non-target species.”
- “Poisoning is not a good idea because of risks to other native animals.”
- “I wouldn't go for poisoning because it would end up killing a lot of animals.”
- “Poisoning endangers native wildlife and domestic stock.”
- “Poisons could harm other wildlife and pets.”
- “I don't like poisoning unless pig specific.”
- “Poisoning could go down the food chain.”
- “Poisoning is cruel and also can affect the native wildlife.”
- “Animal welfare issues make things hard and I'm not for animal cruelty.”
- “As long as control is done humanely (I support any control but) 1080 is nasty.”

Appendix 10: Publication outcomes of the thesis

Peer reviewed publications:

Koichi, K., Kaur, K., Cottrell, A., & Gordon, I.J. (in review). Aboriginal rangers' perspectives of feral pigs: are they a pest or a resource?. *Journal of Australian Indigenous Issues*.

Koichi, K., Kaur, K., Cottrell, A., & Gordon, I.J. (in review). Management implications of the dual values of feral pigs. *Australasian Journal of Environmental Management*.

Koichi, K., Kaur, K., Cottrell, A., & Gordon, I.J. (reviewed, and being revised for re-submission). Are feral pigs a pest to rainforest tourism? *Journal of Ecotourism*.

Koichi, K., Kaur, K., Cottrell, A., & Gordon, I.J. (in review). What determines acceptability of wildlife control methods? Australian case. *Human dimensions of wildlife*.

Koichi, K., Mayer, B., Kaur, K., Cottrell, A., & Gordon, I.J. (in review). Cost-effectiveness of methods commonly used to control feral pigs (*Sus scrofa*) and its relation to damage reduction. *Wildlife Research*.

Koichi, K., Kaur, K., Cottrell, A., & Gordon, I.J. (in draft). The utility of existing Value Frameworks for understanding the public's construction of the environmental values of Australian tropical rainforests. *Environmental Values*.

Koichi, K., Kaur, K., Cottrell, A., & Gordon, I.J. (in draft). The implications of invasive alien species for rainforest tourism. In: Prideaux, B. & Carmody, J. (2012). *Rainforest tourism*.

Conferences and symposium presentations:

Koichi, K. (2011). How stakeholders perceive the impacts of pigs on the rainforests and related control methods? In G. Saunders, A. Glanznig, E. Murphy, L. Hinds, A. Woolnough & D. Dall (Chairs). *15th Australasian Vertebrate Pest Conference*, Dockside, Sydney, NSW, 20 – 23 June, 2011.

Koichi, K. (2010). Are feral pigs a pest to everybody?: Socio-economic dimensions of the impacts of feral pigs (*Sus scrofa*) in north Queensland. In T. Peacock (Chair), *Invasive Animals CRC Review Conference*, Rydges Eagle Hawk, Canberra, ACT, 15 – 18 June, 2010.

Koichi, K. (2010). Are feral pigs a pest to the tourism industry? – A case study in the Wet Tropics World Heritage Area. In: B. Prideaux & J. Carmody (Chairs). *International Rainforest Tourism Symposium*, James Cook University, Cairns QLD, 22 -24 June, 2010

Gordon, I.J., Bengsen, A.J., Elledge, A.M., **Koichi, K.,** & Meurk, C. (2010). Protecting the northern Australia's Wet Tropics World Heritage Area from pig damage: Is it worth it? *24th Vertebrate Pest Conference*, Sacramento, California, the United States, 22 – 25 February 2010.