

**Project report:  
Progress on the Whitsunday Regional Council Feral  
Animal Aerial Shooting Program**

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## Executive summary

The Whitsunday Regional Council commenced an Aerial Shooting Program in 2012. Over the last 10 years, the Aerial Shooting Program has been refined and improved. The following are the main outcomes from the Program:

- Feral pigs removed and costs:
  - Over the 10 years, 12,303 pigs removed at a cost of \$674,884 returning \$54.86 per animal based on cash contributions only.
  - If the in-kind costs are considered over the 10 years then the total costs are \$934,000, and the return per pig is \$75.92 per pig.
  - The total feral animals removed was 12,826 animals over the 10 years costing \$934,000 returned \$72.82 per animal (including in-kind costs).
  
- Feral pig population:
  - The Whitsunday Regional Council has used two methods to estimate feral pig populations:
    - The broad method of estimating population using broad landscape densities was 16,000 individuals.
    - The use of aerial shooting flight paths and the number of feral pigs destroyed returned an estimated population of 19,000 individuals.
  - It is thought that the feral pig population is holding steady or slightly declining because of land manager feral animal culling activities and the Aerial Shooting Program.
  - The Aerial Shooting Program in 2021-2022 covered approximately 982,000ha.
  
- The economic impact of feral pigs is summarised as:
  - Impact on sugarcane = \$0.6 Million/yr.
  - Impact on grazing = \$2.7 million/yr.
  - Impact on horticulture = \$4.0 Million/yr.
  - Total direct agricultural impact approximately \$7.3 million/yr.
  - Total agricultural impact including indirect impacts is \$12.58 million/yr.
  - The economic impact of feral pigs on agricultural systems is estimated at \$12.58 million a year given the current feral pig population of 19,000.
  - The economic impact on agriculture of the average feral pig in the Whitsunday region is therefore approximately \$662/pig/year at the current population level.
  
- The cost of impacts to environmental assets in the Whitsunday region:
  - The estimated impact of feral pigs on the environment was \$28 million/year.
  - The average cost of a feral pig to environmental assets is therefore approximately \$1473/pig/year at the current population level.
  
- Establishing an economic return on the Program:
  - For the 2020/2021 year, 1990 feral pigs were removed from the landscape. Therefore, the Aerial Shooting Program resulted in a saving to agriculture of  $1990 \times \$662 = \$1,317,380$ .
  - In addition, with 1990 feral pigs removed means that there is reduced damage on the environment of  $1990 \times \$1473 = \$2,931,270$ .
  - The combined economic and environmental benefits for the 2020-21 year was \$4,248,650.
  - The cost of the 2021-2022 year was \$163,200 cash with the total including in-kind of \$225,600. This means that for every \$1 invested by the Program, there was a \$18.83 return.

- The social outcomes of the program:
  - The Program has received funding from between 8 to 19 organisations per year as stakeholders and up to 80 land managers per year. The majority of the land managers have been engaged in the Program for more than one year.
  - The Program has been coordinated across five local government areas (Burdekin, Isaac, Charters towers, Mackay and Whitsunday).
  - The Program has been selected as a case study for the National Feral Pig Action Plan.
  - Council staff have been asked to present information to landholder groups outside of the Whitsunday Regional Council area on the Program.
  - There is a growing confidence from landholders that there is value being involved and financially supporting the Program based on verbal feedback and willingness to pay the participation fees.

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## 1. Introduction

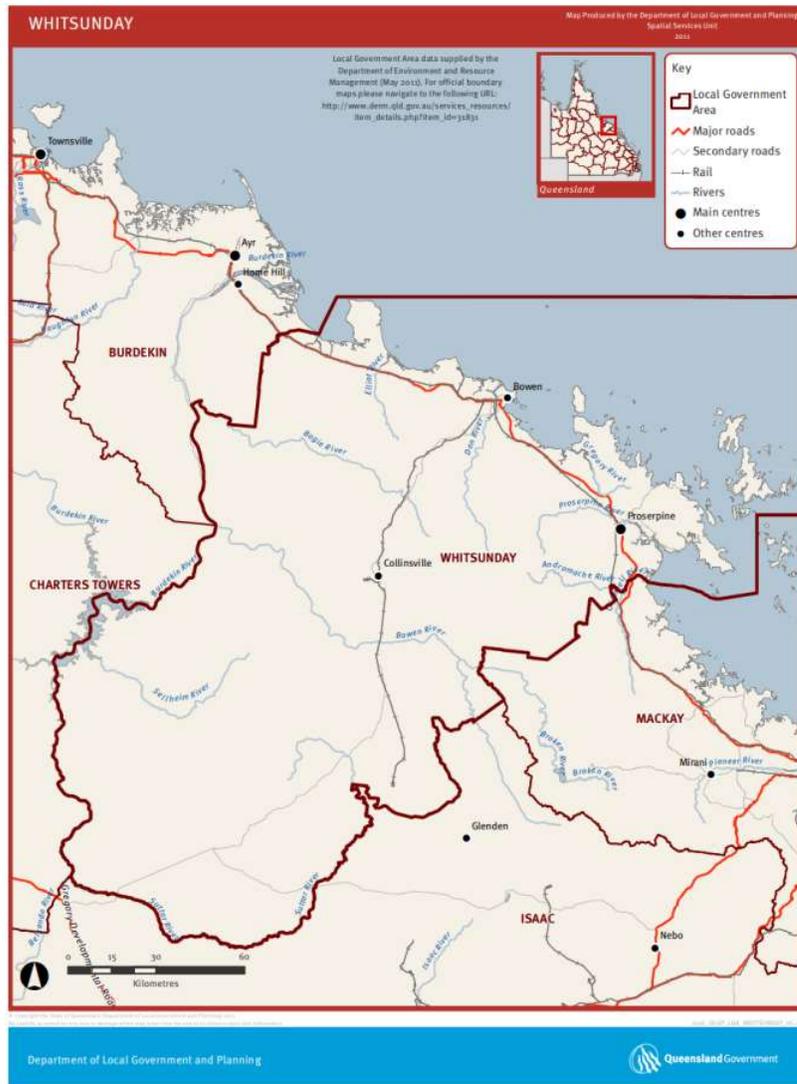
Feral pigs impact on Whitsunday environmental and agricultural systems. The pigs can be particularly damaging to stream banks, waterholes, wetlands, biodiversity, vegetative cover, water quality and aquatic fauna due to their rooting and wallowing behaviours. In addition, feral pigs impact on sugarcane, horticultural and extensive beef production businesses in the Whitsunday region. Under the *Queensland Biosecurity Act 2014*, local governments have a role in coordinating the control and reduction of restricted and prohibited pest animals in coordination with land managers. One of the tools which the Whitsunday Regional Council has been developing over recent years is the use of helicopters to conduct aerial shooting campaigns to reduce feral pig numbers.

The Whitsunday Regional Council has been coordinating a Feral Animal Aerial Shooting Program since 2012. In July 2012, the Council conducted an aerial shooting campaign consisting of three flights between Cape Upstart, Abbot Point and around the Caley Valley wetlands which was funded by the NQ Dry Tropics Natural Resource Management Group.

The Whitsunday Council has been conducting the Aerial Shooting Program now for 10 years and has conducted over 130 flights removing almost 12,300 feral pigs. In recent years the Council has been conducting 20 to 35 flights per year with an operating budget up to \$170,000/yr. Over the last ten years, the Program has had up to 80 land managers participating in the Program and up to 19 organisations. In recent years, the Program has been coordinated across five local government areas and has been selected as a case study for the National Feral Pig Action Plan. In 2020, the Council was also fortunate to use a Queensland Feral Pest Initiative grant to engage a consultant to model the economic impacts of feral pigs on horticulture, beef production and sugarcane land use which has been useful in determining the financial damage caused by feral pigs. This economic study found that feral pigs cause approximately \$12.6 million in damage to agriculture in the Whitsunday Regional Council area each year.

The purpose of this report is to review the Whitsunday Regional Council Feral Animal Aerial Shooting Program (FAASP) and document the results. The objectives of this report are to:

- Describe the outcomes and effectiveness from the Feral Animal Aerial Shooting Program.
- Outline some of the social outcomes from the Program.
- Collate the Council's list of learning outcomes from the last 10 years
- Describe how the feral animal populations are determined by the council.
- Describe how the impacts of feral pigs on agricultural systems are determined.
- Describe how the impacts on the environmental are measured by the council.



**Figure 1.** Location of the Whitsunday Regional Council area.

## 2. Background

### 2.1. The Whitsunday region

The Whitsunday Regional Council covers approximately 23,860 km<sup>2</sup> or 2.38 million hectares (Figure 2). The value of the agricultural sector in the Whitsunday Regional Council area has been calculated by REMPLAN (2016). The Whitsunday agricultural sector exports \$186 million/yr. and its total output value is \$271 million/yr. The Whitsunday region has 13 wetland areas listed in the directory of nationally important wetlands. The total area of highly significant wetlands is approximately 58,380ha, and the largest wetland in the region is the Goorganga wetland complex (16,850ha). There are over 82,000ha of land dedicated to National Park and Conservation Park.

## 2.2. Legislation and policy

The legislation that guides pest management in the Whitsunday region is the *Queensland Biosecurity Act (2014)* and the Whitsunday Regional Council Local law 3 (Community and Environment). The Queensland government introduced the *Queensland Biosecurity Act 2014* to guide the management of invasive plants and animals.

The *Biosecurity Act 2014* includes the concept of the General Biosecurity Obligation (GBO), which is an overarching obligation that requires all persons who deal with biosecurity matter to take all reasonable and practical measures to prevent or minimise the risk posed by the biosecurity matter. The GBO encourages all relevant parties to take a proactive role in preventing, managing and addressing biosecurity risks that relate to them.

The *Biosecurity Act* describes prohibited and restricted biosecurity matter. Prohibited matter is not currently present in Queensland and is prohibited because there are reasonable grounds to believe it could have significant adverse effects if introduced to the state. Restricted matter is found in Queensland and may have an adverse effect if restrictions are not imposed. Restricted matter is assigned category numbers from 1-7 based on its characteristics and the risk it poses. Pest plants and animals can be attributed to more than one pest category.

The list of the restricted categories under the Biosecurity Act and a brief explanation from the State government is listed in table 2. The category of declared pest animals is found in table 2.

**Table 2.** Biosecurity Act categories descriptions.

Category	Description
1	Includes insects such as red imported fire ants, electric ants and Asian honey bees, and certain animal and plant diseases, aquatic diseases and pathogens. This restricted matter must be reported to Biosecurity Queensland within 24 hours of you becoming aware of its presence.
2	Includes certain noxious fish, weeds and pest animals such as spotted gar, Miconia weed and red-eared slider turtle. This restricted matter must also be reported to an authorised person within 24 hours of you becoming aware of its presence.
3	Includes certain noxious fish, weeds, pest animals and insects. Examples of this category of restricted matter are gambusia, parthenium weed and foxes. You must not supply to another person or release into the environment this category of restricted matter.
4	Includes specific noxious fish, weeds and pest animals such as the giant cichlid, bitou bush and feral pig. You must not move this restricted matter to ensure that it does not spread into other areas of the state.
5	Restricted matter includes certain noxious fish, weeds, pest animals such as carp, Mexican feather grass and rabbits. You must not possess or keep this restricted matter under your control. These pests have a high risk of negatively impacting on the environment.
6	Includes certain invasive animals such as feral deer, foxes, rabbits and wild dogs and noxious fish such as carp, gambusia and tilapia. You must not feed this category of restricted matter. With the exception of the fish species, feeding for the purpose of preparing for or undertaking a control program is exempted.
7	Restricted matter includes the noxious fish carp, weatherloach, climbing perch, gambusia and tilapia. If you have these noxious fish in your possession you must kill the restricted matter and dispose of it by burying the whole carcass (no parts removed) in the ground above the high tide water mark or placing it in a waste disposal receptacle.

**Table 3.** Biosecurity status of feral animals found in the Whitsunday Region.

Pest Animal	Biosecurity category
Pig	3,4,6,
Dog	3,4,6
Dingo	3,4,5,6,
Cat	3,4,6,
Deer	3,4,6,
Rabbit	3,4,5,6
Fox	3,4,5,6,

### 2.3. Feral pig impacts

Feral animals cause extensive and widespread damage to environmental, agricultural, cultural and social assets areas and affect cropping and grazing practises. The social and environmental costs of feral animals have not been well studied. In 2009, Gong *et al* (2009) calculated that feral animals cost the Australian economy across all agricultural land uses \$620 million/yr., plus \$122 million spent on their control. The economic impact on Queensland is estimated at \$128 million /yr. based on selected data and modelling (Gong *et al.*, 2009). According to Gong *et al.*, feral pigs have a negligible impact on the beef cattle industry affecting less than 1% of production income, but may be reducing profits by 1-2% in the grain industry depending on feral pig densities. Wild dogs may be reducing beef cattle industry profits by 1-2% (Gong *et al.*, 2009). Gong *et al.*, reports that the average grazing farm expenditure on feral animals control and maintenance is between \$250-\$420/yr., with an average of \$325/yr.

Bomford and Hart (2002) stated that "feral pigs inflict direct losses on the agricultural sector through predation of newborn animals, reduce grain and cane yields by devouring and destroying crops, compete with livestock for pasture land, and damage infrastructure such as fences". The damage bill caused by feral pigs to Australian agricultural production was conservatively estimated to be at least \$100 million per annum (Bomford and Hart, 2002). Tisdell (1982) estimated that 0.1% of the Queensland sugarcane crop was affected by feral pigs which amounts to 20,000 tonnes. In 1993 a study of sugarcane crops put the loss at 25,000 tonnes worth around \$625,000/yr. (McIlroy *et al.*, 1993).

McLeod (2002) estimated that feral pigs cause \$107 million in control and production loss costs per year, with \$80 million loss for the Queensland economy (McLeod, 2004). The QDNRM (2002) estimate that feral pigs cause \$12 million worth of damage to the grain industry each year.

Bomford and Hart (2002) also noted "that feral pigs can act as vectors for a number of wildlife diseases that affect both livestock and humans". In addition, pigs can transmit leptospirosis, brucellosis, melioidosis, tuberculosis, porcine parvovirus, sparganosis and other arbovirus, and can also transmit and act as reservoirs for exotic diseases such as African swine fever, Foot and Mouth Disease and Japanese encephalitis. McLeod (2004) estimated the environmental cost of just the fox and cat at \$350 million/yr.

In 2020, the Whitsunday Regional Council successfully obtained a Queensland Feral Pest Initiative grant to expand its Aerial Shooting Program and conduct an economic modelling exercise to determine the financial cost of feral pigs on horticulture, sugarcane and beef production businesses. The outcome from this economic modelling project was that feral pigs caused approximately \$12.58 million/year of direct and indirect economic damage in the Whitsunday Council area (Synergy, 2020).

The impact on the environment can be more difficult to evaluate. Perry *et al.*, (2021) have reviewed a number of studies into feral pig impacts and have conducted an investigation in the Archer River area in Northern Queensland. The Archer River investigation developed a process to record feral pig damage and allocate a score. The other innovative developments from the Perry *et al.*, (2021) study was the design of a feral pig population calculator and a process to record shooting outcomes.

The Queensland government determined the value of various ecosystems as part of their Environmental Offset Policy. The Queensland government has introduced the *Queensland Environmental Offsets Act (2014)*. The purpose of this piece of legislation is to account for the value and replacement cost of habitat areas caused by their loss due to development. According to the DEHP (2014), *Environmental offsets (offsets) provide the flexibility to approve development in one place on the basis of a requirement to make an equivalent environmental gain in another place where there is not the same value to industry*. The Queensland government have developed values for various ecosystems and have incorporated the value of habitats into the environmental offsets legislation (DEHP, 2014).

## 2.4. Feral animal populations

It is difficult to determine an accurate population for feral animals. The Whitsunday Regional Council is home to a number of feral animal species. The main feral mammals include pigs, dogs, cats, rabbits, fox and deer. The population of feral animals can fluctuate year-to-year and will be driven by factors including:

- control programs,
- food availability,
- terrain constraints and geology,
- water availability, and,
- season and yearly conditions such as drought (QDNRM, 2002).

The feral animal population is likely to fluctuate year-to-year based on climate and feral animal control activities. The estimation of the feral animal population is important because;

- the population of feral animals can be relative to impacts on agricultural systems and environmental attributes. Essentially, the more feral pigs in the landscape, the larger the potential impacts on agricultural and environmental systems.
- The population of feral animals and their location can influence management methods and responses.
- The population can inform how limited funds and resources can be allocated to manage feral animals.

The population of other feral pest animals has also been estimated. Estimates of population density in New South Wales, for example, range from 0.1 to 0.3 wild dogs per square kilometre (or 1 per 300ha to 1000ha) (Fleming *et al.* 2001). Pimentel *et al.* (2001) indicated that there are approximately 3 million pet cats and 18 million feral cats in Australia. However, Legge *et al.*, (2016) have estimated that there are 2.1 to 6.3 million feral cats.

According to the Queensland Department of Agriculture Forestry and Fisheries (QDAFF, 2008) “the total number of feral pigs in Queensland is not accurately known, but estimates range from 3–6 million, with the majority in North Queensland”. In the Queensland Feral Pig Control Manual, QDAFF (2008) state:

- Population densities in the wet tropics were estimated at 3.1/km<sup>2</sup> (3.1 pigs / 100ha or 1 per 30ha).

- Densities in the dry tropics range from 40/km<sup>2</sup> (40 pigs /100ha or 1 per 2.5ha) in some coastal wetland areas in Cape York, to 4/km<sup>2</sup> (4 pigs/100ha) in freshwater lagoons and swamps, and 1/km<sup>2</sup> in drier woodland and savanna areas.
- Home range size varies from as little as 0.16 km<sup>2</sup> for farrowing sows, to greater than 40 km<sup>2</sup> (4,000 ha) for individual boars in the semi-arid rangelands (QDAFF, 2008).

In 2019, Hone (Hone, 2019) stated that the mean feral pig population across 142 studies was 1.03 per km<sup>2</sup>, or one pig per 100ha. The Whitsunday Regional Council covers 23,819km<sup>2</sup>. If the average pig density is applied to the Whitsunday Council area, then the estimated population is 23,000 feral pigs.

The determination of feral animal populations, their preferred habitat and location in the landscape is needed to plan, develop, implement and monitor control programs and evaluate outcomes from control activities.

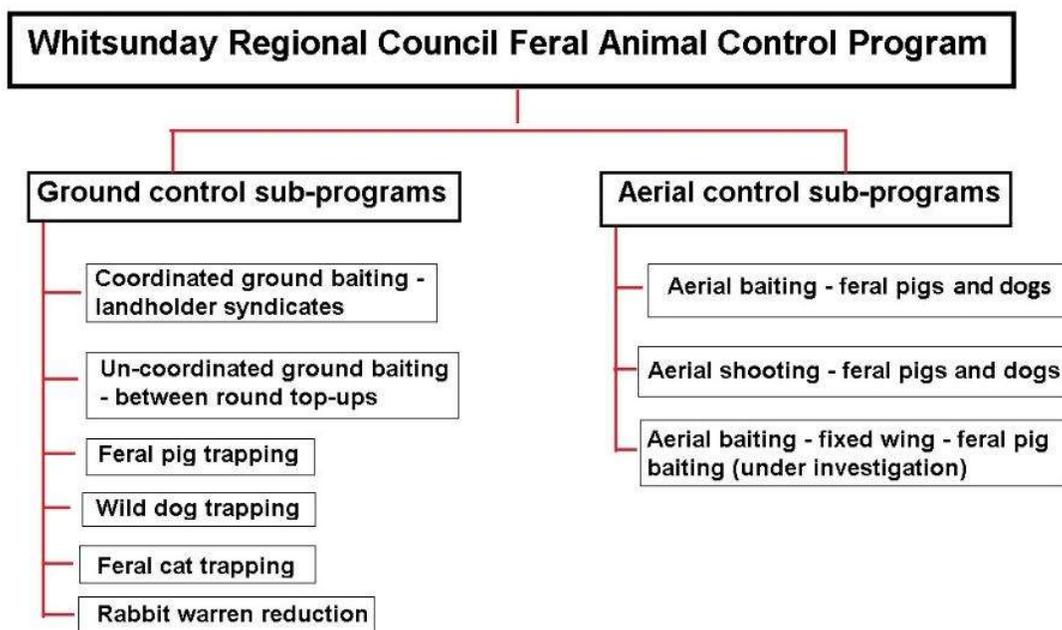
## 2.5. Whitsunday Feral Animal Control Program

The Whitsunday Regional Council's Feral Animal Control Program includes the following pest activities (Figure 1):

- Ground sub-program
  - Activities
    - Ground baiting
    - Cage traps
    - Set traps
- Aerial sub –program
  - Activities
    - Aerial baiting
    - Aerial shooting

The ground control methods have been used by the Whitsunday Regional Council since 2004. The aerial baiting sub-program was first used by the Council in 2007 targeting feral pigs, and aerial shooting commenced in 2012.

The Whitsunday Regional Council ground baiting activity is coordinated across the whole of the Shire. The ground baiting relies on groups of landholders forming syndicates to coordinate and deliver ground baits over large areas. The ground baiting program has utilised 1080 injected meat baits and the use of fruit such as rockmelons and mangos targeting feral pigs. The use of cage traps and leg hold traps are primarily used in residential or rural residential areas where ground baiting is constrained. Leg hold traps are used for individual wild dogs near residential areas.



**Figure 1.** Whitsunday Feral Animal Control Program and activities.

In 2015-2016, the Council estimated the cost of the different feral animal control measures. The number of landholders who utilised the on-ground sub-programs and the estimated number of feral animals destroyed is summarised in Table 1. The estimated costs have provided a useful guide in selecting the most cost-effective method for the target location.

**Table 1.** The number of landholders and area covered by the ground activities (2015-2016).

Activity	No of landholders 2015-16	Area serviced by program 2015-16 (Ha)	Cost of providing the service 2015-16 \$/yr.	Service	% of Shire serviced	Estimated impact on population	Estimated population reduction for 2015-16 (destroyed)	Estimated benefit/cost of program 2015-16
Ground baiting – syndicates	50	1,200,000	\$36,000	20,704 baits (5 tonnes)	70%	Low-medium	500?	\$72/head
Ground baiting – supplementary	1	1400	\$1500	48 baits	1%	Low	25?	\$31/head
Cage traps	10	1000	\$7,200	20 traps	1%	Low	200	\$36/head
Foot hold	7	500	\$7,200	10	1%	Low	10	\$72/head

Notes:

- **Assumptions:**
  - *Estimated population reduction for ground baiting based on local population density and a 20% reduction of the feral animal population in the baited area.*
  - *Area serviced. Estimates based on:*
    - *Cage traps – 1 services 50ha area.*
    - *Ground bait – 1 services 25ha*
    - *Foot hold trap – 1 services 50 ha.*
  - *The cost of providing the service is determined based on:*
    - *Ute hire rates of \$80/day (including fuel).*
    - *Landholder in-kind labour rates \$50/hr.*
    - *Council in-kind rate of \$90/hr (including on costs of 25%)*

### 3. Methods

#### 3.1. Review of Program coordination, management and funding over-time

The management, coordination and funding of the Whitsunday Feral Animal Aerial Shooting Program (WFAASP) has evolved over the last 10 years. The review on how the coordination of the Program has evolved over time will be expressed as a table with information on funding sources.

#### 3.2. Determining Whitsunday feral animal population abundances

The feral pig population is likely to vary throughout the region. Consequently, the Whitsunday Shire were divided up into landscape areas to estimate population densities and population numbers. The landscape areas include:

- Coastal National Parks (50,000ha).
- Coastal lowlands (0-10km from coast) – south of Bowen (120,000 ha).
- Coastal lowlands (0-10km from coast) – north of Bowen (110,000 ha).
- Coastal wetlands – (20,000ha).
- Inland (1,900,000 ha).



**Figure 2.** Showing the inland and coastal landscape boundaries.

The Whitsunday Regional Council has used two methods to estimate feral animal populations. The first method estimated the feral pig population based on feral pig densities from published studies in similar environments. The second method involved using the aerial shooting flight path as a transect noting the number of pigs destroyed.

The method of estimating feral animal populations largely rely on the use of surveys then extrapolating the survey data out to a larger area. The use of feral animal densities in one area is sometimes used to reflect feral animal populations in the wider region.

However, the population of feral pigs for instance could be higher where there are more favourable habitats and conditions for feeding and breeding. Studies in Queensland have shown that feral pig population densities can range from 1 per 30ha to 1 per 200ha (QDAFF, 2008).

The aerial shooting flight paths were used as the transects to gauge feral pig population densities. The width of the flight paths were based on the visual observation distance estimated at 200m either side of the helicopter. The number of feral pigs destroyed along the 400m wide flight paths provide a density per Feral Animal Management Area (FAMA).

The Feral Animal Management Area (FAMA) is described as an area with a relatively high population of feral animals where management effect is focused. The feral pig density was determined for the flight path area which in theory should be a higher density of feral animals compared to the balance of the FAMA and the landscape. The flight path should represent a line through the FAMA where a relatively higher proportion of feral pigs could be expected. Consequently, a depreciation factor was applied to the areas outside of the FAMA flight path to account for a lower population density outside of the flight path.

The method of estimating feral pig populations was:

- Flight path transect within FAMA
  - Flight path x 400m = Xha (Flight area)
  - The number of feral pigs destroyed in the FAMA flight path = X flight path animals destroyed. Density of feral pigs in the flight path = Flight area / animals destroyed in flight path area.
- Balance of FAMA
  - The feral pig density will be 1.2 x flight path density. The density will be applied to the FAMA balance area. This assumes there are 20% less pigs in this zone.
- Balance of landscape
  - Density of feral pigs outside of the FAMA flight path = Flight path density x 2. (FAMA Balance area density) which is 50% less feral pigs in this zone.
  - Feral pigs in landscape outside of the FAMA = FAMA balance pig density x FAMA balance area (Ha).

The population densities will be shown in a table for the various FAMA and landscapes. The estimation of the feral pig population was used to estimate the average cost of damage to agricultural systems and environmental systems per pig.

### 3.3. Determining the impact of feral pigs on Whitsunday agricultural systems

In 2020, the Whitsunday Regional Council engaged Synergy Pty Ltd (Synergy, 2020) to undertake an economic analysis of the feral pig impacts on Whitsunday agricultural systems. The economic impact analysis was conducted on sugarcane, grazing and horticultural crops. The investigation involved conducting a survey of agricultural landholders in the Whitsunday region to gauge costs. The survey involved conducting an interview with:

- 8 sugarcane farmers
- 10 graziers
- 6 horticultural landholders

The economic impact of feral animals in the Whitsunday's also considered the methods outlined in Gong *et al*, 2009. Gong *et al.*, (2009) estimated that feral animals at low densities could be reducing the income of the agricultural sector by 1-3%. The economic analysis provided an appraisal of the economic cost of feral pigs on sugarcane, grazing and horticultural land uses.

The economic impact of feral pigs used the percentage outlined by Gong *et al.* (2009) and compared this value to the impact costs derived by Synergy in 2020. The costs of impacts from feral pigs on agricultural systems were compared against the estimated feral pig populations.

### 3.4. Determining the impact of feral pigs on Whitsunday environmental systems

The financial value of the various Whitsunday Regional Council ecosystems was based on the Queensland Environmental offsets legislation values. Representative regional ecosystems were selected and their financial value per hectare used to estimate their financial value. Representative regional ecosystems were chosen to represent the five Whitsunday landscapes of wetland, coastal lowlands (north and south), National Parks and inlands, then the following values can be attributed to the ecosystems in each landscape region;

- Wetlands - (representative regional ecosystem – RE 8.3.6) \$80,000/ha
- Floodplains -south - (representative regional ecosystem – RE 8.3.6) \$80,000/ha
- Floodplains -north - (representative regional ecosystem – RE11.3.32) \$8,000/ha
- Inland – (representative regional ecosystem - RE11.12.3) = \$8,000/ha
- National parks - (representative regional ecosystem – RE 8.12.3) = \$80,000/ha

It is estimated that 0.5% of the landscape may be impacted by feral pigs based on studies such as Gong *et al.*, (2009). It was assumed that feral pigs only impact on components or attributes of an ecosystem. The value of the ecosystem was apportioned as follows:

- Lower, middle and upper strata – 40%
- Soils – 20%
- Ground fauna – 10%
- Birds and arboreal animals– 10%
- Ground layer – 10%
- Waterways – 10%

The apportionment of the value of the regional ecosystem was used to place a more realistic value on the damage caused by feral pigs. Feral pigs may not completely damage the soil, ground cover and waterways through diggings. To accommodate the incomplete damage caused, a “damage factor” was applied at a discount rate of 30%. The incomplete “damage factor” of 30% assumed that the feral pigs will not completely damage all the ground resources or water resources in the area which they occupy.

The determination of the impact of feral pigs on environmental systems was also analysed against the estimated feral pig populations. It could be assumed that the higher the feral pig population, then higher the impact of feral pigs would be on environmental systems.

### 3.5. Collating the outcomes of the Whitsunday Regional Council Aerial Shooting Program

The Whitsunday Feral Animal Control Program has a number of environmental and social outcomes. The outcomes of the Program will be expressed in a table using data collated from the 10 years. The outcomes of the Program will include:

- Number of feral animals destroyed
- Economic impact of feral pigs
- Impact of feral pigs on environmental systems
- Development of a unit rate of impact per average feral pig

- Determining a point when the Aerial Shooting Program will not be economically viable as a control measure.
- Stakeholders involved
- The number of landholders involved
- Other social or co-benefit outcomes.

### **3.6. Collation of Program lessons learnt**

The Whitsunday Council staff involved in the Aerial Shooting Program have trialled various techniques and strategies over the years to find efficiencies and continually improve the Program. The collation of lessons learnt will be captured in a table under the following headings:

- Financial sustainability
- Helicopter/ marksman/ pilot partnership
- Project organisation and coordination
- Strategies to find feral pigs in the landscape
- Use of thermal cameras to assist in locating feral pigs in the landscape
- Collating outcomes

## **4. Results**

### **4.1. Program coordination, management and funding over-time**

The management, coordination and funding of the Whitsunday Feral Animal Aerial Shooting Program (WFAASP) has evolved over the last 10 years. The main resources used for the Program over the last ten years has been consistent:

- 2012-2014
  - 1 Council staff member – Technical Officer / Land Protection Officer (marksman)
  - 1 Helicopter Contractor using a Robinson 22
- 2014 – 2021
  - 1 Council staff member - Technical Officer / Land Protection Officer (marksman)
  - 1 Helicopter Contractor using a Robinson 44

The Whitsunday Feral Animal Aerial Shooting Program funding has varied over the last 10 years. The external funding from State and Commonwealth sources have varied over the years, making the aerial shooting Program often difficult to forward plan and Program future flights. The funding arrangements have been summarised in Table 4.

**Table 4.** External grants utilised by the Council for feral animal control activities.

Funding period	Funding organisation	Grant name	Value	Target activity
2012-13	Commonwealth government via North Queensland Dry Tropics NRM (NQDT)	Feral animal control – CF21-9503	\$4,500	Feral animal – aerial shooting –Euri creek catchment
2012-13	Commonwealth government via North Queensland Dry Tropics NRM (NQDT)	Feral animal control – CF21-9500	\$18,329	Feral animal – aerial shooting- WRC
2013-2016	Commonwealth Government	Everyone's Environment Grant	\$69,640	Feral animal – aerial shooting
2014-16	Commonwealth government via North Queensland Dry Tropics NRM (NQDT)	Feral animal control – QGB14-301	\$24,400	Feral pig control - Coastal management
2014-15	Commonwealth government via Reef Catchments NRM	(Via Reef Catchments NRM – wetland asset improvements)	\$5,000	Aerial shooting
2015-16	Commonwealth government via Reef Catchments NRM	(Via Reef Catchments NRM – wetland asset improvements)	\$9,000	Aerial shooting
2016-17	Commonwealth government via North Queensland Dry Tropics NRM (NQDT)	Feral animal control – QGB16-301	\$12,000	Aerial shooting
2016-17	Commonwealth government via Reef Catchments NRM	(Via Reef Catchments) – wetland	\$17,000	Aerial shooting
2019-2022	Queensland State - direct	Feral Animal Initiative (QFAI)	\$136,000	Aerial shooting
2019-2020	Commonwealth government via North Queensland Dry Tropics NRM (NQDT)	Feral animal control -wetlands	\$82,000	Aerial shooting
2020-2021	Queensland State - direct	Nest to ocean	\$46,000	Aerial shooting
2020-2021	Commonwealth government via North Queensland Dry Tropics NRM (NQDT)	Feral animal control – wetlands	\$16,000	Aerial shooting

**Table 5.** Program costs over the 10 years.

Year	Flights		Commonwealth	State funding	Regional NRM Group - NQDT	Regional NRM Group -Reef Catchments	Whitsunday Landholders	Land holders/properties involved	Stakeholders / industry	Whitsunday Council (Cash)	Whitsunday Council (in-kind)	Other Councils	Annual operating budget (Cash)	Total cost (Cash + In-kind)
2012-2013	4				\$11,000						\$7,200		\$18,200	\$25,400
2013-2014	2		\$2,210		\$24,400						\$3,600		\$26,610	\$30,210
2014-2015	5		\$24,465			\$5,000					\$9,000		\$29,465	\$38,465
2015-2016	11		<b>\$38,857</b>			\$9,000					\$19,800		\$47,857	\$67,657
2016-2017	9				\$12,000	\$17,000		83		\$8,250	\$16,200		\$37,250	\$53,450
2017-2018	19				\$34,900	\$11,000		83	\$5,000	\$15,000	\$34,200		\$65,900	\$100,100
2018-2019	12				\$15,600	\$16,800	\$14,400	95	\$12,000	\$20,400	\$21,600		\$79,200	\$100,800
2019-2020	34			\$32,800	\$90,150	\$5,000	\$12,400	62	\$23,800	\$7,000	\$61,200		\$171,150	\$232,350
2020-2021	26			\$32,800	\$24,100	\$7,552	\$11,700	59	\$16,600	\$20,740	\$46,800		\$113,492	\$160,292
2021-2022	26			\$32,800	\$14,850	\$5,000	\$15,800	79	\$26,500	\$9,900	\$46,800		\$104,850	\$151,650
<b>Total</b>			<b>\$65,532</b>	<b>\$98,400</b>	<b>\$227,000</b>	<b>\$76,352</b>	<b>\$54,300</b>		<b>\$83,900</b>	<b>\$81,290</b>	<b>\$266,400</b>	<b>\$0</b>	<b>\$675,774</b>	<b>\$934,974</b>

Note: Council in-kind contribution = 20 hours x \$90/hr = \$1,800 per aerial shoot to cover:

- Landholder communication (6 hours – based on 30 minutes per landholder with 16 landholders)
- Flight time (6 hours)
- Flight time preparation – flight planning and travel (6 hours)
- Invoicing and accounts (1 hour)
- Project management and reporting (1 hours)
- Labour costs include 25% on-costs.

## 4.2. Whitsunday feral animal populations

### 4.2.1. Feral pig population using broad industry densities

Council officers have estimated feral animal densities and population for the main landscapes in the Whitsunday Region. The feral animal densities are based on landholder advice, trapping, aerial observations and road fatalities and densities from other studies. The estimated feral animal populations in the Whitsunday region are shown in table 6.

**Table 6.** Estimated feral animal populations in the Whitsunday Regional Council area.

Feral Animal	Coastal National Parks		Coastal lowlands (north)		Coastal lowlands (south)		Coastal wetlands		Inland		Total Pop.
	Density	Population	Density	Population	Density	Population	Density	Population	Density	Population	
Pigs	Low: 1 per 30ha	1,500	Low 1 per 50ha	2,200	Low 1 per 50ha	2,200	1 per 30ha	850	Low 1 per 200ha	9,500	16,250
Dogs*	Low: 1 per 30ha	1,500	Low 1 per 50ha	2,200	Low 1 per 50ha	2,200	1 per 50ha	500	Low 1 per 200ha	9,500	15,950
Cats	Low: 1 per 30ha	1,500	Low 1 per 100ha	1,100	Low 1 per 100ha	1,100	1 per 100ha	500	Low 1 per 200ha	9,500	13,950
Deer	Nil observed	0	Low 1 per 500ha	220	Low 1 per 500ha	220	Low 1 per 1000ha	25	Low 1 per 500ha	3,800	4,265
Fox	Low: 1 per 100ha	500	Low 1 per 200ha	600	Low 1 per 200ha	600	1 per 500ha	200	Low 1 per 1000ha	1,900	3,800
Area (ha)	50,000		110,000		110,000		25,000		1,900,000		
Total		5,500		6,500		6,500		2,300		36,100	54,215

- Note – The wild dog densities may be higher in this table than observed in the Townsville region where dog densities may be approximately 0.1 to 0.3 per km<sup>2</sup> (1 per 1000ha to 1 per 300ha) (Pers Com. M. Gentle 2022)

The broad analysis using densities indicated that there may be a total feral animal population of around 55,000 animals, including 16,000 feral pigs and 15,000 wild dogs.

### 4.2.2. Feral pig population using flight path feral pig densities

The Whitsunday Regional Council has used the aerial shooting flight paths to estimate the feral pig populations. The feral pig population estimate has used two rounds of aerial shooting from 2019 to calculate the feral pig population in the Feral Animal Management Areas (FAMA) and the broader landscape areas.

**Table 7.** The calculation of feral pig population using round one aerial shooting flights from 2019.

(Feral Animal Management Area) Round 1	FAMA description	Date	FAMA total area (Ha)	Flight distance km	Flight metres	Flight path area (Ha) using 400m width	Feral Pigs Culled in flight path area	Feral Pig density in flight path (Ha/pig) (Col D / Col E)	Feral pig density in FAMA balance (area minus flight path) (= Col F x 1.2)	FAMA balance area (Ha) (=Col A - Col D)	Feral pigs in balance FAMA (Col H / Col G)	Total Feral pigs in FAMA (Col E + Col H)
			Column A	Column B	Column C	Column D	Column E	Column F	Column G	Column H	Column I	Column J
Birralee	Collinsville bridge to Bowen River mouth	24/07/2019	182344	463.8	463800	18552	178	104.22	125.064	163792	1310	1488
Bogie	Glen Alpine to Strathalbyn	25/07/2019	174571	570.3	570300	22812	250	91.25	109.5	151759	1386	1636
Rocky Ponds	Leichardt Creek, Rocky Ponds Creek to coast	26/07/2019	48379	400.6	400600	16024	95	168.67	202.404	32355	160	255
Don River	Selina Creek to Reeves Road	29/07/2019	20213	156.9	156900	6276	72	87.17	104.604	13937	133	205
Abbot Point	Eurie Creek to Elliot river	30/07/2019	52606	246.6	246600	9864	60	164.4	197.28	42742	217	277
Goorganga	Goorganga to Andromache	31/07/2019	69255	113.5	113500	4540	6	756.67	908.004	64715	71	77
Suttor River/	Centaur Park to St Annes inc Mt Douglas	21/08/2019	419934	399.8	399800	15992	63	253.84	304.608	403942	1326	1389
Logan Creek	Avon Downs to Kenmar	22/08/2019	198800	562.3	562300	22492	223	100.86	121.032	176308	1457	1680
Diamond Creek	Avon Downs to Lambing Lagoon	23/08/2019	90100	223.5	223500	8940	132	67.73	81.276	81160	999	1131
Burdekin Falls Dam	Dam Wall, Selheim, Suttor	24/09/2019	227446	469.6	469600	18784	190	98.86	118.632	208662	1759	1949
Cape/ Campaspe	Redhill Road to Burdekin Falls Dam	25/09/2019	167200	393	393000	15720	60	262	314.4	151480	482	542
Burdekin Dalbeg/ Millaro	Gorge Weir to Bogie River mouth	26/09/2019	58746	399.7	399700	15988	63	253.78	304.536	42758	140	203

Gregory	Billy's, 10 Mile, Gregory	3/10/2019	19350	122.2	122200	4888	13	376	451.2	14462	32	45
	Sub-Total		1728944				1405				9471	<b>10876</b>
	Average pig density (Ha/pig)							214				159
	Balance area											652056
	Pigs in balance area											1522
	Total pig population											12,398

**Table 8.** The calculation of feral pig population using round two aerial shooting flights from 2019.

FAMA Round 2	Syndicate Area	Shoot Date	FAMA total area (Ha)	Flight Distance (km)	Flight metres	Flight path area (Ha) using 400m width	Feral Pigs Culled in flight path area	Feral Pig density in flight path (Ha/pig) (Col D / Col E)	Feral pig density in FAMA balance (area minus flight path) (= Col F x 1.2)	FAMA balance area (Ha) (=Col A- Col D)	Feral pigs in balance FAMA (Col A / Col G)	Total Feral pigs in FAMA (Col E + Col H)
			Column A	Column B	Column C	Column D	Column E	Column F	Column G		Column H	Column I
Birrallee	Collinsville bridge to Bowen River mouth	16/10/2019	182344	447.5	447500	17900	218	82.11	99	164444	1669	1767
Bogie	Glen Alpine to Strathalbyn including	17/10/2019	184429	502.2	502200	20088	186	108	130	164341	1268	1398
Rocky Ponds	Leichardt Creek, Rocky Ponds Creek to coast	18/10/2019	55381	426.3	426300	17052	337	50.6	61	38329	631	692
Don River	Marengo and Boundary Creek	22/10/2019	12985	166.6	166600	6664	68	98	118	6321	54	171
Abbot Point	Eurie Creek to Abbot Point	23/10/2019	52606	151.1	151100	6044	44	137.36	165	46562	282	447

Goorganga	Goorganga, Silver, Thompsons Creek	20/11/2019	69255	121.7	121700	4868	6	811.33	974	64387	66	1040
Suttor River/Bellyando River	Centaur Park to St Annes inc Mt Douglas	29/10/2019	419934	592.5	592500	23700	257	92.22	111	396234	3581	3691
Logan Creek	Avon Downs to Kenmar	30/10/2019	198800	606.3	606300	24252	177	137.02	164	174548	1062	1226
Diamond Creek	Avon Downs to Suttor Lagoon	31/10/2019	90100	314.2	314200	12568	78	161.13	193	77532	401	594
Burdekin Falls Dam	Dam Wall, Sellheim, Suttor	13/11/2019	227446	530.1	530100	21204	192	110.44	133	206242	1556	1689
Cape/Campaspe	Redhill Road to Natal Creek	14/11/2019	167200	507.4	507400	20296	62	327.35	393	146904	374	767
Burdekin Dalbeg/Millaroo	Gorge Weir to Bogie River mouth	15/11/2019	58746	347.4	347400	13896	78	178.15	214	44850	210	424
Gregory	Billy's, 10 Mile, Gregory	19/11/2019	19350	138.8	138800	5552	14	396.57	476	13798	29	505
Abbot Point	Abbot Point to Elliot River	19/11/2019	52606	215.6	215600	8624	78	110.56	133	43982	332	464
Gibson Creek	Gibson Creek, Condor Hills	20/11/2019	6000	89.2	89200	3568	29	123.03	148	2432	16	164
	Total		1797182	5156.9	5156900	206276	1824					15039
	Average pig density (ha/pig)							195				119
	Balance area (ha)											583,818.00
	Pigs in balance											1,497.55
	Total pig population											16,537

The number of feral pigs in the Whitsunday Regional Council FAMA areas using the flight path calculation method in 2019 was between 10,876 and 15,039. The calculation of the feral pigs outside of the FAMA's is shown in Table 9. When the calculation of the feral pigs in the FAMA areas is added to the feral pig population calculations outside of the FAMA's , this represents the total feral pig population across the Whitsunday Regional Council area.

**Table 9.** The feral pig population outside of the Feral Animal Management Areas (FAMA).

Landscape unit	Total landscape area (Ha)	Landscape area – FAMAs (Ha)	Landscape balance (Ha)	Flight path feral pig density (Ha per pig)	Feral pig density factor (0.5) – density outside of FAMA	Estimated population in landscape balance
Inland	1,900,000	776,849	1123151	104	208	5400
Coastal National Parks	50,000	50,000	0	100	200	0
Coastal lowlands north	110,000	68,592	41408	168	336	123
Coastal lowlands - south	120,000	88,605	31395	756	1512	21
Coastal wetlands	20,000	20,000	0			
Total	2,200,000	1,004,046	1,195,954			5,544

- Notes:

- o 1) Feral pig density in National Parks is estimated.
- o 2) The Coastal wetlands – the FAMAs cover the entire wetlands, there is no balance area.

The estimated feral pig population for the Whitsunday Regional Council area using the flight path method is between 10,876+5,544 (16,420) and 15,039 + 5,544 (20,583) with the average estimated population being 18,502. For the purpose of this report, the feral pig population will be 19,000.

### 4.3. The impact of feral pigs on Whitsunday agricultural systems

#### 4.3.2 Calculation of damage by feral animals to the agriculture sector

The value of the Whitsunday agricultural sector is \$271 million/yr. (Remplan 2016). Gong *et al.* (2009) suggests that wild dogs could account for 1-3% of the value of the grazing sector profits and feral pigs less than 1%. If the combined feral animal impact on the Whitsunday economy is estimated at 3%, then the financial impact of feral animals on the Whitsunday economy is estimated at \$9 million/yr. The impact of the \$9 million also means the potential loss of 35 local jobs/yr (Remplan 2016).

The other method of determining the economic impact of feral animals is the use of the Synergy Pty Ltd report data (Synergy, 2020). The Synergy economic impact data are shown in Tables 10-14. The economic impact of feral pigs is summarised as:

- Impact on sugarcane = \$0.6 million/yr.
- Impact on grazing = \$2.7 million/yr.
- Impact on horticulture = \$4.0 million/yr.
- Total impact approximately \$7.3 million/yr.
- Total impact including indirect impacts is \$12.58 million/yr.

**Table 10.** Total annual cost of feral pig damage on livestock producers in the Whitsunday region.

<b>Total annual cost of feral pig damage on livestock producers in the WRC region</b>			
<b>Cost impact</b>	<b>Total annual cost for livestock producers</b>		
	<b>Low scenario</b>	<b>Medium scenario</b>	<b>High scenario</b>
Reduction in cattle sale weight	\$635,176	\$1,587,940	\$3,175,880
Reduced calving rate	\$780,493	\$780,493	\$780,493
Vaccination	\$27,799	\$27,799	\$27,799
Feed Supplements	\$132,243	\$132,243	\$132,243
On-farm infrastructure	\$135,961	\$135,961	\$135,961
<b>TOTAL IMPACT</b>	<b>\$1,711,671</b>	<b>\$2,664,435</b>	<b>\$4,252,376</b>

Source: Synergies analysis.

**Table 11.** Annual cost of loss of cane yield due to feral pig damage on cane farms.

<b>Annual cost of loss of cane yield due to feral pig damage (based on average cane farm)</b>				
<b>Cane rotation</b>	<b>Total revenue without feral pig damage</b>	<b>Total revenue with feral pig damage</b>	<b>Annual revenue lost per cane farm</b>	<b>Region-wide annual cost</b>
Plant Cane	\$61,200	\$60,710	\$490	\$109,670
Ratoon 1	\$59,040	\$58,568	\$472	\$105,800
Ratoon 2	\$57,600	\$57,024	\$576	\$129,024
Ratoon 3	\$56,160	\$55,430	\$730	\$163,538
Ratoon 4	\$54,000	\$53,190	\$810	\$181,440
<b>TOTALS</b>	<b>\$288,000</b>	<b>\$284,922</b>	<b>\$3,078</b>	<b>\$689,472</b>

**Note:** The regional impact is based on a farm population of 224 and a total planted area of 20,160ha. The estimates have been derived based on the characteristics for an 'average' cane farm in the region with a cropped area of 90 hectares and a cane yield of 80 tonnes per hectare.

**Source:** Synergies analysis.

**Table 12.** Annual cost of loss crop yield for horticulture.

<b>Annual cost of loss of crop yield for horticulture growers due to feral pig damage</b>			
<b>Crop</b>	<b>Total revenue without feral pig damage</b>	<b>Total revenue with feral pig damage</b>	<b>Region-wide annual cost</b>
Mangoes	\$18,402,712	\$18,356,705	\$46,007
Melons	\$18,402,712	\$18,034,657	\$368,055
Capsicum	\$110,056,159	\$107,855,036	\$2,201,123
Pumpkins	\$6,748,727	\$6,512,521	\$236,206
Corn	\$21,803,579	\$21,727,266	\$76,313
Beans	\$70,602,064	\$70,249,054	\$353,010
Tomatoes	\$191,040,879	\$190,276,716	\$764,163
<b>TOTAL</b>	<b>\$437,056,830</b>	<b>\$433,011,954</b>	<b>\$4,044,876</b>

**Note:** The regional impact is based on a total planted area of 12,800 ha.

**Source:** Synergies analysis.

**Table 13.** Total annual economic cost of feral pig damage on agricultural systems

<b>Total annual economic cost of feral pig damage on agricultural producers in the WRC region</b>				
<b>Category</b>	<b>Livestock</b>	<b>Sugarcane</b>	<b>Horticulture</b>	<b>Total</b>
Lost productivity	\$2,368,433	\$689,472	\$4,044,876	\$7,102,781
Infrastructure damage and fencing costs	\$135,961	\$147,414	-	\$283,375
Feed replacement	\$132,243			\$132,243
Livestock vaccination	\$27,799			\$27,799
<b>TOTAL</b>	<b>\$2,664,435</b>	<b>\$836,886</b>	<b>\$4,044,876</b>	<b>\$7,546,197</b>

**Table 14.** Regional economic impacts of feral pig damage.

<b>Regional economic impacts of feral pig damage</b>				
<b>Indicator</b>	<b>Direct losses</b>	<b>Indirect losses</b>	<b>Total losses</b>	
 <b>Output</b>	<b>\$9.13 million</b>	<b>\$3.45 million</b>	<b>\$12.58 million</b>	
 <b>Value add (or GRP)</b>	<b>\$4.51 million</b>	<b>\$1.45 million</b>	<b>\$5.96 million</b>	
 Wages paid	\$0.78 million	\$0.54 million	\$1.32 million	
 Operating surplus and mixed income	\$3.5 million	\$0.84 million	\$4.34 million	
 Taxes less subsidies	\$0.23 million	\$0.08 million	\$0.31 million	
 <b>Employment</b>	<b>16 FTEs</b>	<b>9 FTEs</b>	<b>25 FTEs</b>	

**Source:** Synergies modelling.

## 4.4. The impact of feral pigs on Whitsunday environmental systems

### 4.3.3. Calculation of environmental damage by feral animals and environmental benefits

The estimated environmental damage to the Whitsunday environment by feral animals is shown in Table 15.

**Table 15.** Estimated environment damage caused by feral animals on the Whitsunday ecosystems.

Landscape	Total landscape area	0.5% of the land area (Ha) *	Value per ha	Soil cost /ha (30%)	Cover cost /ha (20%)	Water way cost /ha (10%)	Damage – per Ha of land impacted (\$)	Incomplete damage factor (- 30%/ha)	Value of damage/yr. by combined feral animal population
Inland	1,900,000	9,500	\$8,000	\$2,400	\$1,600	\$800	\$4,800	\$1,440	\$13,680,000
Coastal south	110,000	600	\$80,000	\$24,000	\$16,000	\$8,000	\$48,000	\$14,400	\$8,640,000
Coastal north	120,000	600	\$8,000	\$2,400	\$1,600	\$800	\$4,800	\$1,440	\$864,000
wetlands	25,000	125	\$80,000	\$24,000	\$16,000	\$8,000	\$48,000	\$14,400	\$1,800,000
National parks	50,000	250	\$80,000	\$24,000	\$16,000	\$8,000	\$48,000	\$14,400	\$3,600,000
Total									\$28,584,000

- \*Note – Studies estimate that only 0.5% of the landscape may be impacted by feral pigs (Gong et al., 2009 and Tisdell, 1982). Of the areas impacted, there are areas which are highly impacted and areas of low impact. This table attempts to capture the incomplete destruction of the ecosystem by feral pigs.

## 4.5. Program lessons learnt

The Council reviews the Aerial Shooting Program at the end of each year and noted outcomes and areas for improvement. The review process has enabled discussions to occur to improve the various components of the Program. The lessons learnt and continual improvement process can be reflected in the following categories:

- The helicopter flights – path planning and timing
- The helicopter -pilot and shooter relationship
- Monitoring on-ground sites for feral pig damage and improvement
- Feral pig population monitoring
- Data collection and statistics
- Financial sustainability
- Developing a relationship on feral pig locations in the dry tropics and the humid tropical areas across the seasons.
- Landholder relationships

**Table 16.** Summary of lessons learnt.

No.	Theme	Comments
1	The helicopter flights – path planning and timing	The helicopter flight path is planned in advance with take off points, refuelling and lunch locations identified well before the day.  Landholders are called to ascertain the likely impact of rain and other variables to gauges likely effectiveness of the flights.
2	The helicopter -pilot and shooter relationship	The helicopter pilot and shooter need to develop an “understanding” of how to approach feral pigs, the best shooting angle and to manoeuvre around cattle.
3	Monitoring on-ground sites for feral pig damage and improvement	The monitoring of dedicated monitoring sites from the air can be challenging to get the same photo and angle over-time for comparisons. This is an area for improvement.
4	Feral pig population monitoring	In some areas the feral pig population has been greatly reduced via the Aerial Shooting Program. The feral pigs in the Proserpine

		wetlands (Goorganga) has been reduced to a point that the landholders now only need to do limited baiting or trapping.
5	Data collection and statistics	The collection of data over time has been valuable in “telling the story” concerning the impacts of feral pigs and the reason why they should be culled. The collection of data has also provided some level of credibility and transparency of the Program over time.
6	Financial sustainability	Most landholders are supportive of providing a \$200 payment, with some indicating that the current fee is too cheap. The stakeholder involvement in the Program over – time has been very supportive with most organisations seeing the value in providing cash towards an established Program which reports results back to stakeholders.
7	Developing a conceptual model on feral pig locations	The use of Feral Animal Management Areas (FAMA) has been useful in defining and describing feral pig “hot-spots” or locations where a higher proportion of feral pigs can be expected. The FAMA are usually located around wetlands, large watercourses and horticultural areas. The landholders within the FAMA form a “Syndicate”. A FAMA could have 1 or 20 landholders.
8	Landholder relationships	Landholders like to talk and build a relationship with the staff involved. Credibility is everything. Landholders like feedback on whether the shooting activity was successful or not.

#### 4.6. The outcomes of the Whitsunday Regional Council Aerial Shooting Program

The outcomes of the Whitsunday Regional Council Aerial Shooting Program can be summarised under the following areas:

- Feral animals removed.
- Economic impact of feral pigs
- Estimating the feral animal populations
- Financial sustainability
- Estimating the cost of controlling feral pigs
- Lessons learnt and continual improvements
- Social outcomes

##### 4.6.1. Feral animals removed

The feral animals destroyed in the aerial shooting over the 10 year period is 12,826 (Table 17). The collection of data concerning the cost of the aerial shooting operation can be used to determine the average cost of destroying feral pigs. The long term average cost of destroying feral pigs using aerial shooting is approximately \$54.86 (excluding in-kind costs).

**Table 17.** Number of feral animals destroyed over the last 10 years.

Activity	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	Total
Aerial shooting – total feral animals	311	18	288	940	1013	1424	862	3280	2647	2043	12826
Aerial shooting – total feral pigs only	311	18	288	922	941	1203	844	3229	2557	1990	12303
Total cash	\$11,890	\$26,610	\$29,465	\$47,857	\$31,166	\$65,900	\$79,200	\$168,180	\$157,628	\$163,200	\$674,884
Ave cost per pig	\$38.70	\$1,478	\$102.31	\$51.90	\$33.12	\$54.78	\$93.86	\$52.08	\$61.64	\$82.01	\$54.86

#### 4.6.2 *Economic and environmental impact of feral pigs*

The economic impact of feral pigs on agricultural systems is estimated at \$12.58 million a year given the current feral pig population of approximately 19,000 (based on the Synergy, 2020 report). The estimated impact of feral pigs on the environment was \$28 million/year. The economic impact of the average feral pig was thus determined to be approximately \$662/year on agriculture. Costs of environmental damage per pig is approximately \$1473/yr.

With the average economic impact of feral pigs established, the economic benefit of removing feral pigs from the landscape can be estimated. For the 2020/2021 year, 1990 feral pigs were removed from the landscape. Therefore, the Aerial Shooting Program alone has resulted in a saving to agriculture of  $1990 \times \$662 = \$1,317,380$ . In addition, with 1990 feral pigs removed means that there is reduced damage on the environment of  $1990 \times \$1473 = \$2,931,270$ . The combined economic and environmental benefits for the 2020-21 year was \$4,248,650. The cost of the 2021-2022 year campaign was \$163,200 cash, and when in-kind costs are included the total cost was \$225,600. This means that for every \$1 invested by the Program, there was a \$18.83 return.

The development of the economic impact model enables the council and decision makers to estimate the potential cost to agriculture and the environment if feral pigs are not controlled across the landscape. If the population of feral pigs are not controlled, each 1000 additional feral pigs in the landscape could result in \$662,000/yr. impact on agriculture and \$1,317,380 impact on the environment per year.

It is recommended that further investigations are conducted into the environmental impact of feral pigs on the environment and develop more robust cost modelling. Developing a more accurate environmental cost should assist in further supporting the need to reduce feral pig populations. There could be more investigations into the impact of feral pigs on flora and fauna resilience in relation to future impacts of climate change. If feral pigs are not controlled and the population increases, this is likely to lead to more environmental damage and impacts to important habitats for vulnerable flora and fauna species. The uncontrolled population will also result in increased stream bank erosion, sediment delivery to the waterways and offshore.

#### 4.6.3 *Estimating the feral animal populations*

The Whitsunday Regional Council has used two methods to estimate feral pig populations. The broad method of estimating population using broad densities was 16,000 individuals. The use of aerial shooting flight paths and the number of feral pigs destroyed returned a population estimate of 19,000 individuals.

The council has noticed that the population of feral pigs is likely to be slowly declining due to the range of integrated control measures being implemented, including aerial shooting. It is estimated that the feral pig population is being reduced by a net 300-500 a year (1-3%/yr.) through the council programs and landholder actions after birth and death rates are considered. The actions undertaken by landholders to reduce feral pig numbers is not being collected. The collection of landholder feral pig population reducing actions would be useful to assist in determining population numbers, identifying impact areas and reviewing control strategies.

The time taken per feral pig shot could be determined to reflect feral pig population densities.

#### 4.6.4. Financial sustainability

The Council has been interested in developing a more financially sustainable model for the Aerial Shooting Program. The Program has relied on a mix of State government grants, grants from regional NRM groups, contributions from stakeholders and landholders. The aim of the financial sustainability strategy is to move towards landholders contributing up to a third of the project costs. In 2021-2022, the landholders contributed \$15,800 towards the project representing 9.7% of the cash costs.

If the landholder contributions are increased from \$200 per property to \$400 per property, and if all landholders contributed, then this would contribute approximately \$30,000 and represented potentially 20% of the project costs. For the 2021-2022 year the financial contribution from organisation stakeholders was \$26,000 which equates to 16% of the project cash contributions. If the landholders and stakeholder contributions are combined for the 2021-22 year, then this contribution was 26% of project costs. The balance of the 2021-2022 costs were from Council, State and Commonwealth government sources.

There are a number of funding models possible for the Program:

- Option 1 – Council only option - Whitsunday Region Council funding 100%
- Option 2 – All government option - Whitsunday Council funding 30%, State 30%, Commonwealth 40%
- Option 3 – Partnership and stakeholders (no government) - WRC 30%, Stakeholders 30% and landholders 40%
- Option 4 – Multiple stakeholder involvement
  - Full costs shared equally amongst stakeholders and landholders.
  - Probably reflects current funding model

The current funding model can be time consuming to coordinate, build relationships, build credibility and gain enough funds to develop a campaign which delivers results. However, involving the landholders, stakeholders and government in the Program has built a sense of ownership in the Program, analysis of results, and a sense of “funding fairness” and equity. With landholders funding 10% of the Program, they are contributing towards a solution to the feral problem which many see as an issue which should be solved by a combination of landholder, community and government funding. It should equally be recognised that under the *Queensland Biosecurity Act* it is the landholders responsibility to control feral pigs. It is worth considering the development of a landholder support Program to offer more training on strategies and methods of feral pig control.

#### 4.6.5. Estimating the cost of controlling feral pigs

The Council collects data on the cost of each flight. With 130 flights now completed over the 10 years, the costs can now be determined in detail and the benefits of the flights more easily explained. Over the 10 years, 12,303 pigs removed at a cost of \$674,884 returning \$54.86 per animal based on cash contributions only. If the in-kind costs are considered, over the 10 years at \$934,000, then the return per pig is \$75.92 per pig. The total for all feral animals removed at 12,826 animals over the 10 years costing \$934,000 returned \$72.82 per animal (including in-kind costs).

#### 4.6.6 Lessons learnt and continual improvements

The 10 years has enabled the Council and stakeholders to refine and improve how the Program has been conducted over-time. In summary, the positive benefits observed from the Program have been:

- The use of Feral Animal Management Areas (FAMA) to identify feral pig hot spots and where a higher proportion of feral pigs are likely to occur.
- The data collected from the flights is very important for communicating project outcomes.
- The development of Job Safety Analysis (JSA) procedures has been very beneficial to the building of a safe operation.
- Support from council management on the use of the aerial shooting technique.
- The need for a staff member with an interest and skills to undertake the work.

#### 4.6.7. Social outcomes

There are a number of social outcomes from the Program. The human element of the Program should be documented and reported as well as the on-ground outcomes. It could be said that managing pests relies on managing people. If you don't have people undertaking pest management activities, then pests can quickly expand causing more damage. Some of the social and institutional arrangement outcomes from the Program include:

- The Program has received funding from between 8 and 19 organisations per year as stakeholders and up to 80 land managers per year. The majority of the land managers have been engaged in the Program for more than one year.
- The Program has been coordinated across five local government areas (Burdekin, Isaac, Charters towers, Mackay and Whitsunday).
- The Program has been selected as a case study for the National Feral Pig Action Plan.
- Council staff have been asked to present information to landholder groups outside of the Whitsunday Regional Council on the program.
- There is a growing confidence from landholders that there is value being involved and financially supporting the Program based on verbal feedback and willingness to pay participation fees.
- There has been cross jurisdictional cooperation across local government boundaries, but also tenure with the Program operating on State land, private land and land owned by Corporate organisation.

The Whitsunday Regional Council staff have received a range of landholder/ land manager feedback in recent years. A short list of some of the comments include:

- Goorganga wetland land manager - hasn't had to 1080 bait for feral pigs since commencing aerial shooting, "I have never seen this place (Goorganga) looking so good". The land manager was referring to the lack of pig damage since shooting began.
- Collinsville land manager - "I can drive some places now where I couldn't before the aerial shooting".
- Numerous land managers have commented they would be willing to put in more money to keep the Program if funding was low.

## 5. Discussion

### 5.1. Program effectiveness

The Whitsunday Regional Council has been interested in developing and implementing a cost effective Aerial Shooting Program which the benefits can be measured. The first step in the process has been the identification of project goals and objectives, identification of feral pig “hot spots”, identification of sensitive environmental and agricultural areas and the collection of data. Early in the project it was identified that the collection of data was critical to develop a transparent and accountable Program which can also be used to establish the effectiveness of the Program. The effectiveness of the Whitsunday Feral Animal Aerial Shooting Program can be gauged by:

- The number of feral animals destroyed.
- The cost of removing feral pigs.
- Positive anecdotal reports from land managers indicating a reduction in feral pig impacts
- Determining whether the Aerial Shooting Program is more cost effective compared to other control methods.
- Determining at what point, aerial shooting is no longer a cost-effective method of removing feral pigs.
- Whether the program is financially sustainable.
- Whether the benefits to agriculture and environment can be measured.

The Program effectiveness is summarised in Table 18.

**Table 18.** Measuring the effectiveness of the Program.

No	Effectiveness measure	Qualitative effectiveness assessment
1	The number of feral animals destroyed.	This information is collected by the helicopter pilot on a computer tablet in communication with the shooter. There is a good level of confidence that the number of destroyed animals is accurate. These data are then compared. The time taken to destroy feral pigs could be used to estimate feral pig populations.
2	The cost of removing feral pigs	The cost of the aerial shooting is quite easy to document. The Council has developed a spread sheet to document the pre-planning and the actual costs of the aerial shooting.
3	Aerial Shooting Program is more cost effective compared to other control methods	The Council has developed cost estimates for other feral animal control activities. The estimated costs for 1080 ground baiting and trapping have been estimated. It is however difficult to establish a number of feral pigs destroyed via 1080 baiting on large properties.
4	Aerial shooting is no longer a cost effective method of removing feral pigs	The pivot point for cost effectiveness is \$750 per animal. Once the cost of shooting feral pigs is more than the impact, then the aerial shooting is no longer the best approach. However, it is acknowledged that pig traps can be operated at a lower cost for small pig numbers and for an estimated lower cost. The practicalities of operating a larger number of pig traps may result in higher costs per pig.
5	Program is financially sustainable	The Whitsunday Program has attracted between 8 and 19 organisation stakeholders to contribute each year to the Program. The number of landholders contributing has been up to 80/yr.. The landholder contribution has been approximately 9-10% of project costs. The project stakeholders in 2020-21 contributed 16% of the cash required for the program. The State and Commonwealth government (via NRM Groups) contributed 32% of the cash for the Program in 2020-21. The Program is moving towards a more financially sustainable funding model.
6	Benefits to agriculture and environment can be measured	The economic impact of feral pigs on grazing, cane and horticultural businesses have been determined. The impact of feral pigs is approximately \$12.5 million/yr. on agriculture. The impact of feral pigs on the environment is estimated to be \$28 million/yr., however it would be useful to develop a more refined model to develop the environmental costs.

## 5.2. Feral pig population observations and recommendations for future feral animal aerial control programs

The following are feral pig observation notes from the last 10 years;

- Feral pigs congregate around water holes during the dry season which can lead to higher cull rates.
- Pre-feeding approximately 2-4 weeks before an aerial shoot at key locations can lead to better culling rates. The type of pre-feeding will be influenced by the current food available.
- Aerial shooting of feral pigs around sugarcane is best undertaken towards the end of the crushing when the cane fields are shorter.

There are a number of further recommendations which can be made from the Whitsunday Regional Council Aerial Shooting Program.

- It is recommended that more funding could be made available to detect and map feral pig populations in one or more Feral Animal Management Areas in the region so that the estimated feral pig population can be completed more accurately. If a more detailed feral pig study is conducted, the relationship between measured feral pig population and the estimated population for aerial flight paths could be established leading to a more accurate feral pig population.
- The development of a reporting process so that landholders can report in the number of feral pigs euthanised. This information would be useful to assist with gauging feral pig population, impact areas and the success of management actions over-time. The reporting process could be extended to include feral pig damage.
- The development of a landholder feral pig control training Program. The Program could provide assistance to landholders on developing control strategies and training on how to best use control methods.
- The monitoring of feral pig damage can be difficult and time consuming. The first issue is finding where feral pig damage occurs. The other issues include site accessibility, staff time to undertake site photo monitoring, and deciding what site attributes to measure. It is recommended that a simple and quick method is developed for technical staff to measure on-ground feral pig damage. This method could include how to measure soil damage, plant damage, take suitable photographs and how to record the data.
- The current Whitsunday Regional Council Aerial Shooting Program has good engagement and support across State and local government, landholders who participate and the various stakeholders. The current Program is really built on the principles of; trust, accountability, transparency and professionalism. Building personal relationships has been an important aspect to the Program but can be time consuming. It is recommended that studies are conducted into the importance of the social and human aspects of pest management programs and identify suitable support tools.

## 6. Conclusion

The Whitsunday Regional Council commenced an Aerial Shooting Program in 2012. Over the last 10 years, the Aerial Shooting Program has been refined and improved. The following are the main outcomes from the Program:

- Feral pigs removed and costs:
  - Over the 10 years, 12,303 pigs removed at a cost of \$674,884 returning \$54.86 per animal based on cash contributions only.
  - If the in-kind costs are considered, over the 10 years at \$934,000, then the return per pig is \$75.92 per pig.
  - The total for all feral animals removed at 12,826 animals over the 10 years costing \$934,000 returned \$72.82 per animal (including in-kind costs).
  
- Feral pig population:
  - The Whitsunday Regional Council has used two methods to estimate feral pig populations.
  - The broad method of estimating population using broad densities was 16,000 individuals.
  - The use of aerial shooting flight paths and the number of feral pigs destroyed returned a population estimate of 19,000 individuals.
  - In the 2021-2022 year, the Aerial Shooting Program covered 982,000ha.
  
- The economic impact of feral pigs is summarised as:
  - Impact on sugarcane = \$0.6Million
  - Impact on grazing = \$2.7 million
  - Impact on horticulture = \$4.0 Million
  - Total impact approximately \$7.3 million/yr.
  - Total impact including indirect impacts is \$12.58 million/yr.
  - The economic impacts of feral pigs on agricultural systems is estimated at \$12.58 million a year given the current feral pig population of 19,000.
  - The economic impact of the average feral pig is therefore approximately \$662/year on agriculture.
  
- The environmental costs:
  - The estimated impact of feral pigs on the environment was \$28 million/year. The average cost of a feral pig on the environment is therefore approximately \$1473/yr.
  
- Establishing an economic return on the Program:
  - For the 2020/2021 year, 1990 feral pigs were removed from the landscape. Therefore, the Aerial Shooting Program resulted in a saving to agriculture of  $1990 \times \$662 = \$1,317,380$ .
  - In addition, with 1990 feral pigs removed means that there is reduced damage on the environment of  $1990 \times \$1473 = \$2,931,270$ .
  - The combined economic and environmental benefits for the 2020-21 year was \$4,248,650.
  - The cost of the 2021-2022 year was \$163,200 cash with the total including in-kind of \$225,600. This means that for every \$1 invested by the Program, there was a \$18.83 return.

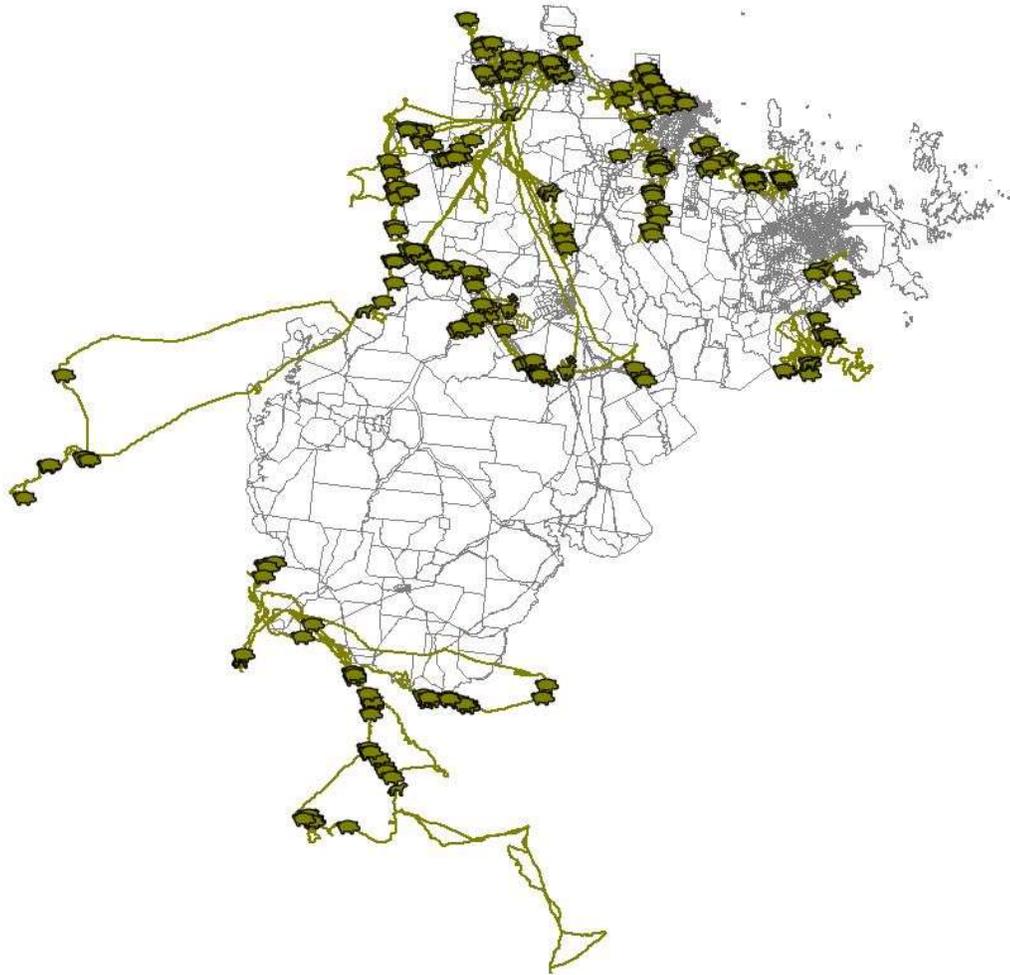
- The social outcomes of the program:
  - The Program has received funding from between 8 and 19 organisations per year as stakeholders and up to 80 land managers per year. The majority of the land managers have been engaged in the Program for more than one year.
  - The Program has been coordinated across five local government areas (Burdekin, Issac, Charters towers, Mackay and Whitsunday)
  - The Program has been selected as a case study for the National Feral Pig Action Plan.
  - Council staff have been asked to present information to landholder groups outside of the Whitsunday Regional Council on the Program.
  - There is a growing confidence from landholders that there is value in being involved and financially supporting the Program based on verbal feedback and willingness to pay participation fees.

## 7. References

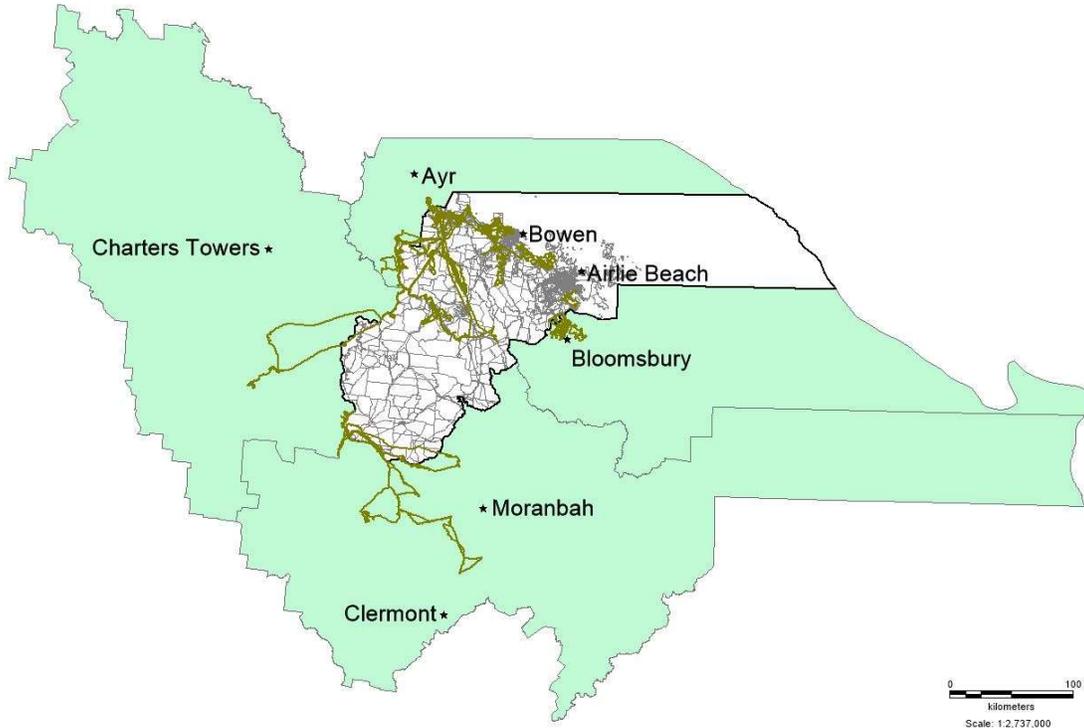
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## 8. Appendix

### 8.1 Aerial shooting flight paths

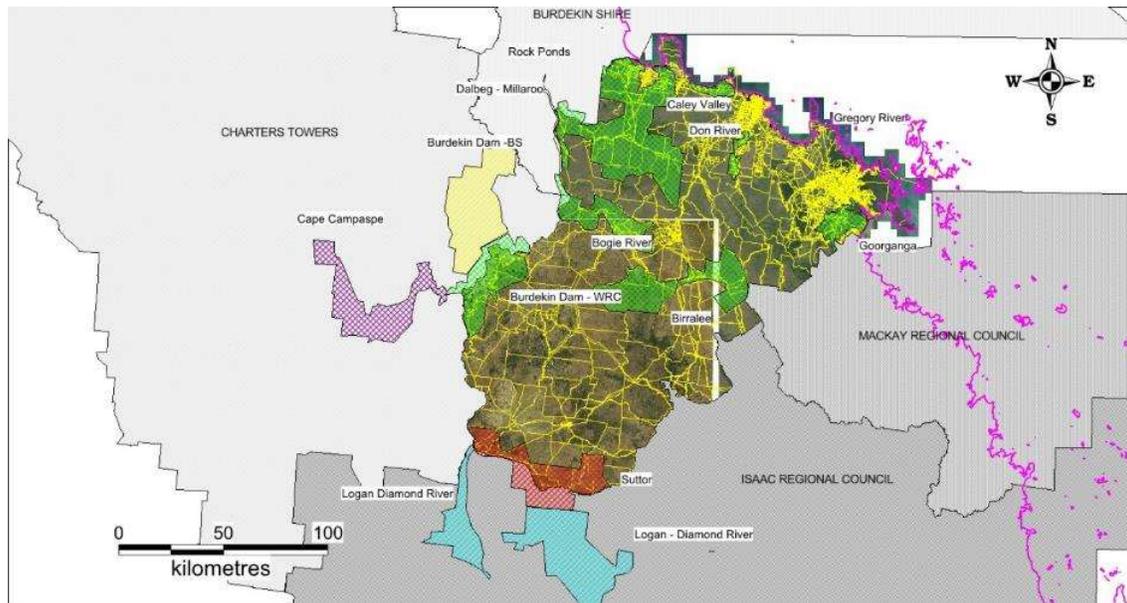


Map 1. Aerial shooting flight paths 2021.



**Map 2.** Showing the 2021-2022 flight paths across the local government areas.

## 8.2. Feral Animal Management Areas (FAMA)



**Map 3.** Showing the Feral Animal Management Areas (FAMA).

No	FAMA	Area	Shire
1	Goorganga	25,210	Whitsunday
2	Bogie River	58,100	Whitsunday
3	Caley Valley	10,490	Whitsunday
4	Rocky Ponds Dalbeg	205,200	Whitsunday
5	Don River	8,606	Whitsunday
6	Birralelee	42,260	Whitsunday
7	Burdekin Dam	82,350	Whitsunday
8	Gregory River	24,630	Whitsunday
9	Brisk Bay	3,670	Whitsunday
10	Suttor	104,200	Whitsunday / Isaac
	Sub total	564,716	

11	Cape Campase	97,010	Charters Towers
12	Logan Diamond	52,220	Isaac
13	Logan Diamond	136,700	Isaac
	Sub total	285,930	
14	Burdekin Dam	122,000	Burdekin
15	Gibson creek	4,166	Mackay
16	Exmoor	5,535	Mackay
	Sub total	9,701	
	Total	982,347	

### 8.3. Log of aerial shooting flights and outcomes

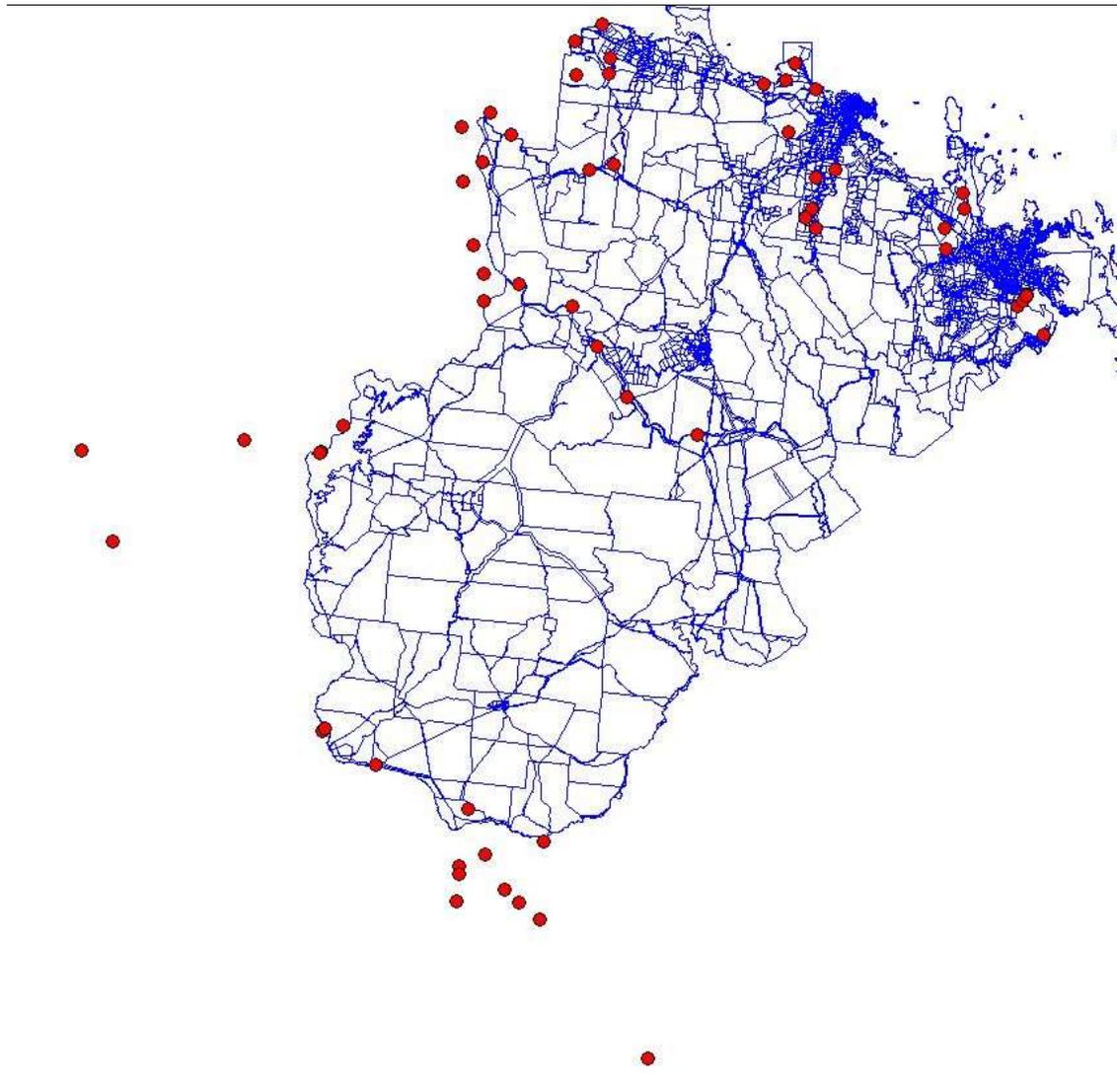
Date	Location	Landscape Unit	Flight path distance km	Feral Pig	Wild Dog	Feral Cat	Feral Deer	Flight hours	Flight cost	Cost per head \$
26/02/2014	Goorganga	Wetland		8				4	\$3,400	\$425.00
27/02/2014	Andromache	Inland -wet		10				4	\$3,400	\$340.00
18/09/2014	Abbot Point	Wetland	269.6	61				4	\$3,400	\$55.74
5/11/2014	Goorganga	Wetland		106				4	\$3,400	\$32.08
30/11/2014	Birralee	Wetland	144	59				2.1	\$1,785	\$30.25
3/12/2014	Abbot Point	Wetland	170.6	35				2.6	\$2,210	\$63.14
4/12/2014	Wangaratta	Inland-dry	153.8	27				1.9	\$1,615	\$59.81
29/07/2015	Goorganga	Wetland	328.5	38				3.63	\$3,086	\$81.20
30/07/2015	Abbot Point	Wetland	332.5	57				5.17	\$4,395	\$77.10
11/08/2015	Birralee	Wetland	125.7	203				6.6	\$5,610	\$27.64
1/12/2015	Birralee	Wetland	176	61				6	\$5,100	\$83.61
2/12/2015	Bogie	Wetland	379.5	199	6			6	\$5,100	\$24.88
3/12/2015	Abbot Point	Wetland	295.2	24	3			6	\$5,100	\$188.89
04/12/2015	Goorganga	Wetland	136.6	14	2			6	\$5,100	\$318.75
16/05/2016	Birralee	Wetland	339.9	175	2			7.5	\$6,375	\$36.02
17/05/2016	Burdekin, Bogie	Wetland	324.7	85	2			5	\$4,250	\$48.85
18/05/2016	Molongle	Wetland	182	25		1		5.5	\$4,675	\$179.81
19/05/2016	Wangaratta	Inland-dry	177	41	2			2.5	\$2,125	\$49.42
21/09/2016	Goorganga	Wetland	100	6				2	\$1,700	\$283.33
21/09/2016	Andromache	Inland - wet	191.1	28				2	\$1,700	\$60.71
22/09/2016	Abbot Point	Wetland	219.5	22				4	\$3,400	\$154.55
26/09/2016	Birralee	Wetland	100	10				2	\$1,700	\$170.00
26/09/2016	Bowen River	Inland-dry	289.4	109	3		5	7	\$5,950	\$50.85
27/09/2016	Bogie	Wetland	311.1	45	12			5	\$4,250	\$74.56
28/09/2016	Wangaratta	Inland-dry	298.1	60				5	\$4,250	\$70.83
24/11/2016	Peter Faust Dam Goorganga	Wetland	369.3	57	3			6.2	\$5,270	\$87.83
25/11/2016	Abbot Point Eurie Creek	Wetland	185.9	104	1			5	\$4,250	\$40.48
28/11/2016	Birralee	Wetland	139.9	85	5		12	6.7	\$5,695	\$55.83
29/11/2016	Bogie	Wetland	229.2	57				5	\$4,250	\$74.56
30/11/2016	Wangaratta	Inland-dry	236.2	74	4			5	\$4,250	\$54.49
16/05/2017	Goorganga	Wetland	306.9	49				7.4	\$6,290	\$128.37
17/05/2017	Abbot Point Eurie Creek	Wetland	157.27	74	2			7.5	\$6,375	\$83.88
1/06/2017	Bowen River	Range land	414.5	86		1		6.7	\$5,695	\$65.46
2/06/2017	Rocky Ponds	Wetland	305.5	75	1			5.5	\$4,675	\$61.51
21/09/2017	Bogie	Wetland	239	122	6			8.1	\$6,885	\$53.79
22/09/2017	Bowen River	Inland-dry	239	114	2		38	8.8	\$7,480	\$48.57
25/09/2017	Rocky Ponds	Wetland	277.5	152				6.7	\$5,695	\$37.47
26/09/2017	Abbot Point	Wetland	319.3	130	1			7.1	\$6,035	\$46.07
27/09/2017	Goorganga	Wetland	194.5	18	5			4.7	\$3,995	\$173.70

28/11/2017	Birralee	Wetland	296.9	90			5	\$4,250	\$47.22
29/11/2017	Bogie	Wetland	413.6	101			8	\$6,800	\$67.33
30/11/2017	Rocky Ponds	Wetland	264.8	150			6	\$5,100	\$34.00
5/12/2017	Abbot Point Eurie Creek	Wetland	323.3	91			5.5	\$4,675	\$51.37
6/12/2017	Goorganga	Wetland	157.5	20	6		4.2	\$3,570	\$137.31
16/05/2018	Suttor River	Wetland	378.7	198			6	\$5,100	\$25.76
23/05/2018	Goorganga	Wetland	363.9	17			6	\$5,100	\$300.00
12/09/2018	Birralee	Wetland	343.4	248	1		8	\$6,800	\$27.31
17/09/2018	Bogie	Wetland	474.6	117	4		6.9	\$5,865	\$48.47
18/09/2018	Rocky Ponds	Wetland	400.5	149	1		6.9	\$5,865	\$39.10
28/09/2018	Abbot Point	Wetland	317.2	117	2		6.7	\$5,695	\$47.86
3/10/2018	Goorganga	Wetland	190.9	34	7		3.8	\$3,230	\$78.78
18/10/2018	Don River	Inland - dry	151.6	107	3		4.2	\$3,570	\$32.45
19/11/2018	Burdekin Dam	Wetland	430.3	47			6.5	\$5,525	\$117.55
17/04/2019	Rocky Ponds	Wetland	271.1	25			5.7	\$4,845	\$193.80
24/07/2019	Birralee	Wetland	463.8	178	3		7	\$5,950	\$32.87
25/07/2019	Bogie	Wetland	570.3	250			9.2	\$7,820	\$31.28
26/07/2019	Rocky Ponds	Wetland	400.6	95			7.4	\$6,290	\$66.21
29/07/2019	Don River		156.9	72			5.4	\$4,590	\$63.75
30/07/2019	Abbot Point	Wetland	246.6	60			6.4	\$5,440	\$90.67
31/07/2019	Goorganga	Wetland	113.5	6			2.5	\$2,125	\$354.17
21/08/2019	Suttor River	Inland - dry	399.8	63			6.2	\$5,270	\$83.65
22/08/2019	Logan Creek	Inland - dry	562.3	223			7.5	\$6,375	\$28.59
23/08/2019	Diamond Creek	Inland - dry	223.5	132			2.7	\$2,295	\$17.39
24/09/2019	Burdekin Dam	Wetland	469.6	190	1		7.3	\$6,205	\$32.49
25/09/2019	Cape/ Campaspe	Inland - dry	393	60	1	1	5.8	\$4,930	\$79.52
26/09/2019	Burdekin Dalbeg/ Millaroo	Inland - dry	399.7	63	2		5.7	\$4,845	\$74.54
3/10/2019	Gregory	Wetland	122.2	13	2		2	\$1,700	\$113.33
16/10/2019	Birralee	Wetland	447.4	218	1	3	7.3	\$6,205	\$27.95
17/10/2019	Bogie	Wetland	502.2	186	7		7.5	\$6,375	\$33.03
18/10/2019	Rocky Ponds	Wetland	426.3	337			8.5	\$7,225	\$21.44
22/10/2019	Don River	Inland - dry	166.6	68	1		3.7	\$3,145	\$45.58
23/10/2019	Abbot Point	Wetland	151.1	44	3		4	\$3,400	\$72.34
29/10/2019	Suttor River	Inland - dry	592.5	257			7.5	\$6,375	\$24.81
30/10/2019	Logan Creek	Inland - dry	606.3	177			7.5	\$6,375	\$36.02
31/10/2019	Diamond Creek	Inland - dry	314.2	78		1	3.9	\$3,315	\$41.96
13/11/2019	Burdekin Dam	Wetland	530.1	192	6	1	7.2	\$6,120	\$30.75
14/11/2019	Cape/ Campaspe	Inland - dry	507.4	62	4		5.5	\$4,675	\$70.83
15/11/2019	Burdekin Dalbeg/ Millaroo	Wetland	347.4	78	5		5	\$4,250	\$51.20
19/11/2019	Abbot Point	Wetland	215.6	78			3.9	\$3,315	\$42.50
19/11/2019	Gregory	Wetland	138.8	14	3		4.3	\$3,655	\$215.00
20/11/2019	Goorganga	Wetland	121.7	6	4		2.3	\$1,955	\$195.50

20/11/2019	Gibson Creek	Inland - dry	89.27	29	2			2.9	\$2,465	\$79.52
4/08/2020	Birralee	Wetland	442.8	110	3		4	7.5	\$6,600	\$56.41
5/08/2020	Bogie	Wetland	514.8	184	2			8	\$7,040	\$37.85
6/08/2020	Rocky Ponds	Wetland	212.2	188	1			4.6	\$4,048	\$21.42
18/08/2020	Suttor River	Inland - dry	304.9	48	1			3.2	\$2,816	\$57.47
19/08/2020	Logan Creek	Inland - dry	509	100				8	\$7,040	\$70.40
20/08/2020	Diamond Creek	Inland - dry	412.9	125				5	\$4,400	\$35.20
1/09/2020	Burdekin Dam	Wetland	348.2	68				4.5	\$3,960	\$58.24
2/09/2020	Cape River	Inland - dry	351.2	61	1			6	\$5,280	\$85.16
3/09/2020	Burdekin Dalbeg/ Millaroo	Wetland	187.7	62	1			8	\$7,040	\$111.75
30/09/2020	Don River	Inland - dry	193.1	185	2			6.1	\$5,368	\$28.71
30/09/2020	Gregory river	Wetland	112.8					1.9	\$1,672	\$0.00
1/10/2020	Goorganga	Wetland	154.7	26	1			2.2	\$1,936	\$71.70
2/10/2020	Abbot Point	Wetland	271	83	4	1		5.2	\$4,576	\$52.00
22/10/2020	Abbot Point	Wetland	234.6	93	2			3.6	\$3,168	\$33.35
11/11/2020	Logan Creek	Inland - dry	607.9	201	16			6.5	\$5,720	\$26.36
12/11/2020	Diamond/ Logan Creek	Inland - dry	216.1	75				2.5	\$2,200	\$29.33
23/11/2020	Birralee	Wetland	411.6	177			37	6.7	\$5,896	\$27.55
24/11/2020	Bogie	Wetland	450.1	98	6	1		7	\$6,160	\$58.67
25/11/2020	Rocky Ponds	Wetland	297.3	138	2			5.2	\$4,576	\$32.69
12/05/2021	Brisk Bay	Inland - wet	252.7	90	4			6.5	\$5,720	\$60.85
13/05/2021	Gregory	Wetland	148.4	54				6	\$5,280	\$97.78
14/05/2021	Exmoor	Inland - wet	147.6					5	\$4,400	\$0.00
26/05/2021	Saltwater Creek	Inland - wet	300.4	108				6.7	\$5,896	\$54.59
27/05/2021	Cape Upstart	Wetland	245	118				4.4	\$3,872	\$32.81
28/05/2021	Abbot Point	Wetland	254.8	93				6.5	\$5,720	\$61.51
8/06/2021	Abbot Point NQDT CCA20-004	Wetland	192.3	69	1			7.5	\$6,600	\$94.29
9/06/2021	Abbot Point NQDT CCA20-004	Wetland	124.1	3				3.2	\$2,816	\$938.67
6/07/2021	Goorganga	Wetland	109.8	21	2			1.8	\$1,584	\$68.87
7/07/2021	Birralee	Wetland	438.5	233			4	8.2	\$7,216	\$30.45
8/07/2021	Bogie	Wetland	581.4	228	1			8.6	\$7,568	\$33.05
9/07/2021	Rocky Ponds	Wetland	157.4	79				2.8	\$2,464	\$31.19
15/09/2021	Abbot Point	Wetland	343.2	59	2			7.5	\$6,600	\$108.20
16/09/2021	Don River	Inland -dry	194.3	159	2			5.5	\$4,840	\$30.06
28/09/2021	Birralee	Wetland	496.5	195	1	1	7	7.5	\$6,600	\$32.35
29/09/2021	Bogie	Wetland	448.6	132	4			6.5	\$5,720	\$42.06
30/09/2021	Rocky Ponds	Wetland	325.5	120	3			5.5	\$4,840	\$39.35
13/10/2021	Cape River	Inland - dry	533.9	153	4			5.7	\$5,016	\$31.95
14/10/2021	Dalbeg	Inland - dry	233.5	55				4.4	\$3,872	\$70.40
26/10/2021	Suttor River	Inland - dry	412.3	151	7			5	\$4,400	\$27.85
27/10/2021	Belyando	Inland - dry	231.2	25	4			3.5	\$3,080	\$106.21

28/10/2021	Logan Creek	Inland - dry	564.4	204	6			6.8	\$5,984	\$28.50
29/10/2021	Diamond	Inland - dry	209.7	99				4.2	\$3,696	\$37.33
15/11/2021	Abbot Point	Wetland	208.7	27	1			3.5	\$3,080	\$110.00
16/11/2021	Gregory	Wetland	118.5					1.5	\$1,320	\$0.00
17/11/2021	Bloomsbury	Inland - wet	348.5	48				6.7	\$5,896	\$122.83
30/11/2021	Bloomsbury	Inland - wet	275.8	2	4			4.6	\$4,048	\$674.67
<b>Totals</b>		<b>0</b>	<b>37245.64</b>	<b>11992</b>	<b>219</b>	<b>8</b>	<b>110</b>	<b>692.7</b>	<b>596214</b>	<b>\$48.36</b>

### 8.4. Monitoring points



**Map 3.** Monitoring sites across the five Local government areas.



Photo 1. A monitoring site at Birralee.



Photo 2. Monitoring site on Bogie River



Photo 3. Burdekin dam monitoring point.



Photo 4. Burdekin dam monitoring point.



Photo 5. Cape River monitoring point.



Photo 6. Goorganga wetland monitoring point.



Photo 7. Goorganga wetland monitoring point.



Photo 8. Goorganga wetland monitoring point.



Photo 9. Gregory River monitoring point.



Photo 10. Diamond Creek monitoring point



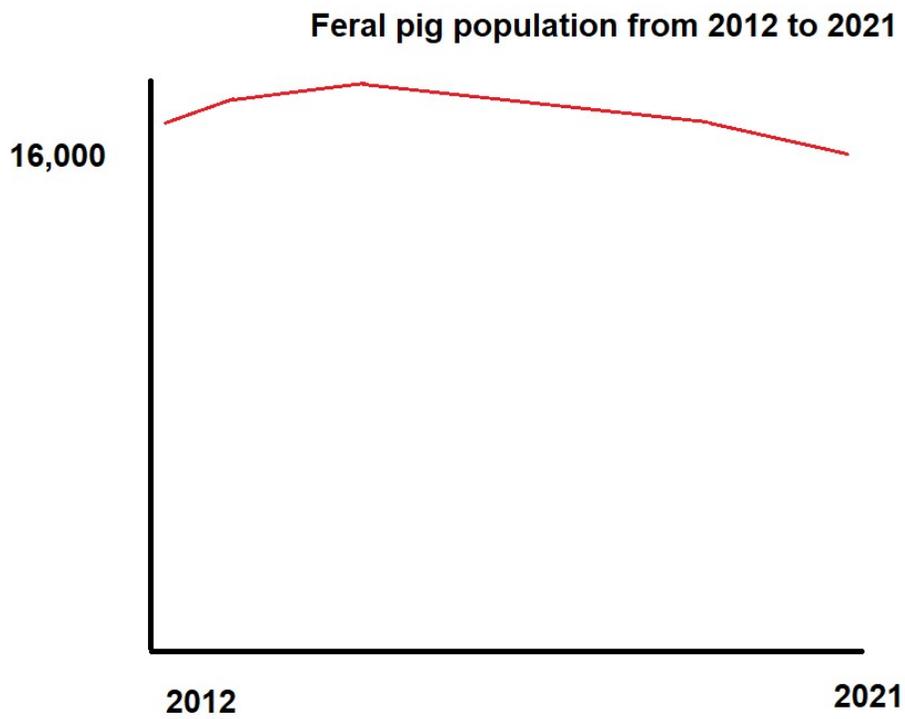
Photo 11. Don River monitoring point.

### 8.5. Feral pig damage

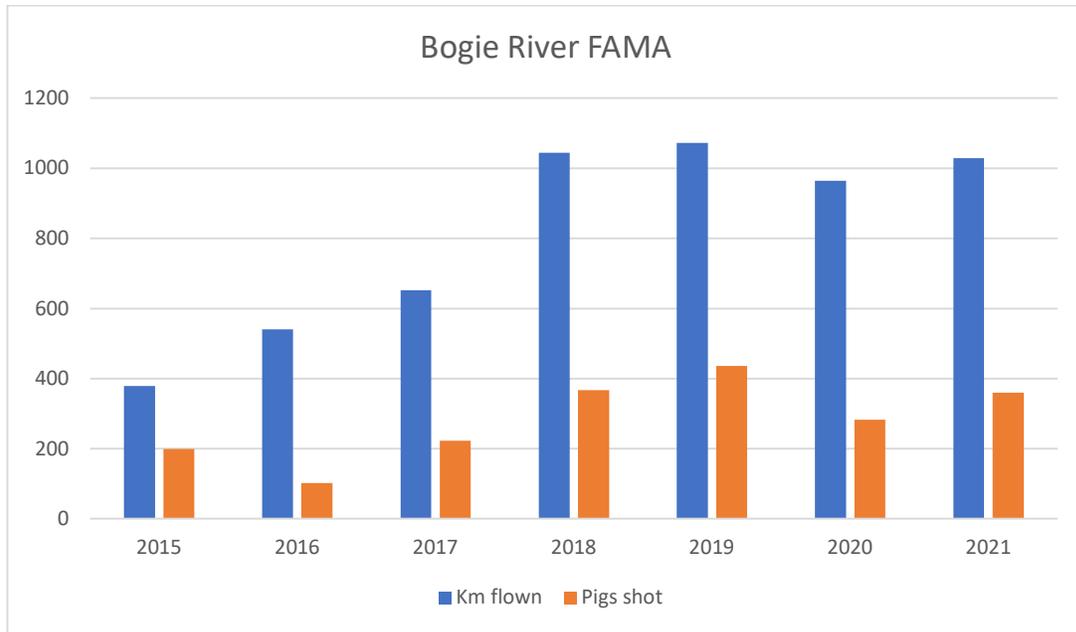


Photo 12. Feral pig damage on cane.

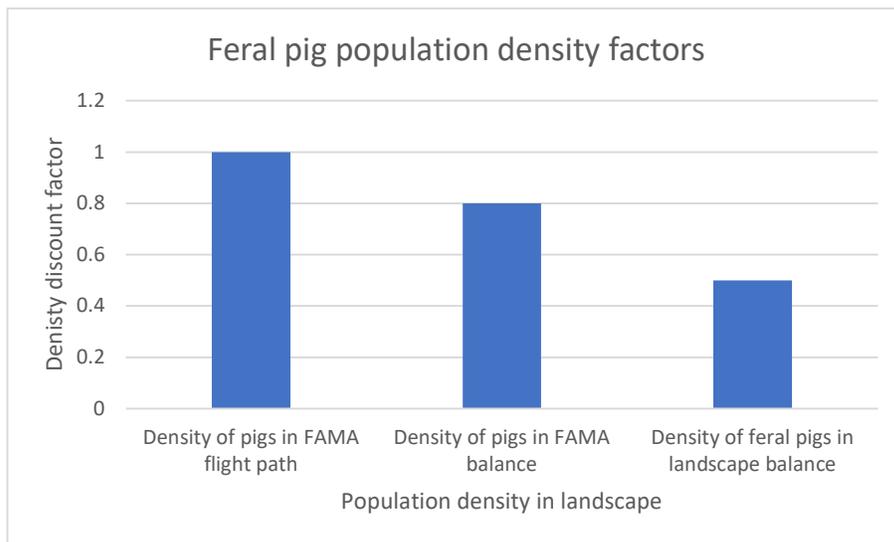
### 8.6. Program conceptual models



Model 1. Estimated feral pig population from 2012 – 2022.



Model 2. Bogie River FAMA – the various flight path distances verse feral pigs shot.



Model 3. Relationship between feral pig density and location in the landscape