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# **Eradicating the Fox in Tasmania**

*A Review of the  
Fox Free Tasmania Program*

by

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## Preamble

In November 2002 I was asked if I would accept the role of an independent reviewer of Tasmania's fox eradication program. At the time, I was only aware that foxes were at large in Tasmania from media reports. Thus, there are no questions about my independence. As a reviewer, I was confident that my background of 24 years of research<sup>1</sup> on the fox in Western Australia, with its emphasis on fox control and the impact of the fox on the fauna, would prove to be an asset.

After arriving in Tasmania, I spent the next six days travelling and holding discussions with Taskforce staff involved in the implementation of a Fox-free Action Plan (Bryant, 2002). This plan defined four broad strategies designed to keep Tasmania fox free. The strategies are:

- Monitoring for foxes
- Direct fox eradication
- Border management
- Education and publicity

I also had access to Tim Bloomfield's reports (fox consultant to the Taskforce, 1/2002; 11/2002), which provided a detailed description of the Action Plan, and an assessment of its implementation to date. Other departmental reports describing a variety of projects were also provided (see Reference section); I will be referring to these in the appropriate sections.

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<sup>1</sup> The reviewer, now recently retired, was employed as a Principal Research Scientist with the WA Department of Conservation and Land Management (DCLM). During the period 1978-1998, he carried out pioneering field experiments, which identified the fox as major threat to medium-sized marsupials. In addition, his research demonstrated that the fox can be controlled on small and large areas of conservation estate (indeed, even locally eradicated) by the use of 1080 baits. He has also collaborated with microbiologists in developing a cost-effective bioassay for 1080. This technique, while significantly reducing the costs of analysing 1080, has simplified the analysis thus enabling researchers to design and rapidly assess baiting protocols. His research, along with a DCLM colleague (Dr. J. A. Friend), provided the stimulus that led to the implementation of WA's "Western Shield" a successful wide-area fox control program. A recent paper (Kinneer *et al.*, 2002) offers new insights as to why the fox is such a damaging predator and a major threat to Tasmanian wildlife (see Appendices).

## **Terms of Reference**

The terms of reference of this review were to consider whether the current strategy is likely to eradicate foxes in Tasmania, and to specify any changes that would facilitate this objective. In addition, I was asked to:

- Assess the effectiveness of the current baiting strategy
- Consider more innovative ways of locating foxes and their removal
- Review the communication and stakeholder engagement strategies
- Discuss and evaluate strategies designed to deter any future introductions of foxes into Tasmania, deliberate or otherwise
- Review and assess the expenditure of Commonwealth funds
- Describe the consequences that would follow given that the eradication of foxes is unsuccessful.

## **Target Audience**

The primary purpose of this review is to (1) evaluate the progress made to date by the Fox Free Taskforce (FFT), and (2) to make recommendations to the relevant Tasmanian and Commonwealth Government agencies regarding the future requirements and directions of the project. The review will also be made public and will be of interest to stakeholders and the general community.

# The Tasmanian Fox Free Taskforce Review

## Executive Summary

### Preamble

This summary is comprised of two parts; the first part provides a brief overview of the dire consequences that would follow should the fox become established in Tasmania. Two important recommendations are made.

The second part is an assessment of the performance and progress to date by the Fox Free Taskforce (FFT), which is charged with the task of eradicating the fox from Tasmania. Specific recommendations are made on a number of different issues.

### Part 1

#### Introduction

In the 1860s European red foxes (possibly 2 to 4 individuals) were introduced into Victoria, and by the 1920's foxes had colonised most of the mainland. This ill-fated introduction has proven to be a wildlife disaster without precedent anywhere else in the world. The fox has decimated much of the mainland Australian mammal fauna. In contrast, Tasmania's mammal fauna has remained largely intact because it has remained fox-free — that is, until now.

Tasmania's fox-free status was breached as the result of a deliberate introduction of several foxes into the Burnie and Launceston areas. This claim is based on: reliable sightings of foxes; the discovery of fox footprints and fox faeces (scats); a skin of a fox shot by a hunter; and a fox carcass, which on examination of the stomach contents, revealed the remains of a partly digested Tasmanian native (endemic) mouse.

#### Magnitude of the fox threat to Tasmania

The impact of an established fox population on Tasmania's biodiversity would be catastrophic and irreversible. In addition, a significant economic impact affecting tourism and agriculture would become evident. Lamb production would decline by 2-10% — at times more. The effect on Tasmania's unique mammals and ground-dwelling/nesting birds would be disastrous comprising of extinctions and widespread population declines of a range of common species. Tourism would be impacted, in particular nature-based activities (Eco-tourism), which would be devastated because key wildlife species would no longer be present to observe; bankruptcies would follow. To these, one must add the incalculable loss of aesthetic values to the Tasmanian public and tourists, which would be associated with the loss of biodiversity, and the concomitant ecosystem services normally provided by the affected species. The bush and countryside would never be the same.

#### Major recommendation

First and foremost, my most important recommendation is this: the Tasmanian and the Commonwealth Governments and their relevant agencies should recognise the fox threat for what it is — an impending disaster **comparable in magnitude** to an outbreak of a calamitous disease such as Foot and Mouth. The key word here is magnitude in reference to damage to the economy, and very much more so to Tasmania's biodiversity. Accordingly, while the response scenarios would be different, (see text, Boxes 1 & 2) the eradication of the fox nonetheless, should be given the highest priority within the relevant agencies in relation to staffing, funding, and the allocation of resources needed to complete the task.

Should failure be the result, anything less would be seen, both currently and historically, as a gross example of government irresponsibility.

### **The Eradication Process: a brief overview of the Tasmanian situation**

My first point is to emphatically state (see text for details and scenarios) that, given the necessary commitment, the fox can be eradicated from Tasmania. I can make this claim because it has been achieved on numerous occasions on the mainland — five documented examples are described. Thus, there should be no doubts harboured by anyone about the attainability of this goal. Nevertheless, without resiling, I hasten to qualify this point for reasons that, it is unlikely that eradication will be easily achieved in a straightforward way.

⇒ In essence, the basic reasons for this qualification are these: the Fox-Free Taskforce is faced with the difficult tasks of locating foxes, exposing the foxes to poison baits (the best method), and confirming that they have killed them. None of these problems are insurmountable, but in overcoming these obstacles, it will mean that eradication is likely to be a drawn-out process before one can claim with assurance that foxes have been eradicated from Tasmania.

### **Recommendation**

⇒ In view of the above, I recommend that the time frame for eradication be set at three years dating from the beginning of the forthcoming financial year. This would be subject to review as research into new methods for locating foxes, dead or alive, may well yield significant efficiencies thus shortening the eradication process.

## **Part 2**

### **Some general comments**

Given the background to this crisis, my overall assessment of the responses by the relevant government agencies has been generally satisfactory up to this point. Most importantly, the threat was acknowledged and accepted by both the Tasmanian and Commonwealth governments. Steps were taken to create a mission-oriented Taskforce that was allocated funds and resources. At the state level, the implementations of these responses would not have been achieved without pain, upheaval, and disruption, not to mention, some resistance and resentment within the agencies involved. It is pleasing to report that these issues have been largely resolved.

My overall assessment of the eradication process as it now stands is this: To date, the current level of support has enabled the Taskforce to reach a position whereby it has become a functioning entity appropriately focused and administered. It is also clear however, that the current level of funding, staffing and resource allocation is **inadequate** to complete the eradication tasks. As to how much more support is necessary, it is a matter for the Taskforce to decide. My role is to advise and to make recommendations about the future course of actions, according to the terms of reference listed below.

## **Terms of reference**

- The current baiting strategy
- The problem of locating foxes — alternatives
- Public communications in relation to the fox threat
- Quarantine issues
- The expenditure of Commonwealth funds

## **The baiting strategy**

There is a general consensus (see text) among mainland ecologists with expertise in fox control that 1080 poison baits are the method of choice for eradicating foxes. Control of the fox on the mainland is successful, because this predator is also a consummate scavenger that readily finds and consumes 1080 baits (meat typically). These innate scavenging tendencies are its Achilles heel.

The Taskforce has acknowledged this, and has carried out a useful amount of basic research in order to devise a baiting strategy suitable for its purposes. The present method consists of burying dried meat baits containing 3 mg of 1080 at a depth of approximately 10 cm. Burying baits was found to be necessary because non-target species were removing too many baits. Most experts however, (see text) are of the view that burying diminishes the probability of foxes finding baits.

**Recommendation:** That the Taskforce lay baits on the surface or lightly covered with litter or soil. To compensate for losses by non-target scavengers, the density of application should be increased and followed up by repeated baitings if necessary.

This proposal may result in localised unavoidable non-target mortalities, but this transient collateral damage to native fauna must be accepted as a cost of eradicating a damaging agent that would cause infinitely more deaths. Any population ecologist would support this action provided certain conditions are met (see text for more discussion).

## **Recommendation**

Apart from the above modifications, the Taskforce baiting program needs to be extended and better resourced, as the objective of exposing foxes to poison baits is the key to eradication. Currently the Taskforce is constrained because of a lack of funds and restrictions imposed on the employment of field staff. It is now in a position to effectively utilise more resources. This should be seen as a priority.

## **Detecting foxes: a difficult laborious task**

The detection of foxes in Tasmania is plagued with difficulties because of the prevailing circumstances — few individuals, widely dispersed — and the behavioural traits of foxes, which are secretive and normally nocturnal.

The Taskforce relies greatly on sightings by the public, but because of the abundance of native mammals, cats, and dogs, it is easy to be mistaken and many reports are therefore false. Sightings become more credible when recurrent sightings form clusters or “hot spots”. In dealing with sighting reports, the Taskforce has benefited from the use of computer technology, and from applying credibility criteria — a spin-off from the thylacine experience. While credibility criteria can help to set priorities in regards to allocating resources, the procedure is not infallible and real sightings of foxes may remain unknown.

It is absolutely essential that the distribution of the fox be known, but the present level of support does not enable the Taskforce to ground-truth many sightings — indeed, the public has been critical of the Taskforce for being slow to respond to reports, or for not responding at all.

**Recommendation:** More resources are needed to enable the Taskforce to respond and assess sighting reports.

### **Detecting foxes: use of indirect methodologies**

The presence of a species can often be confirmed by collecting distinctive scats (faeces), but fox scats may be confused with native carnivores. Grooming hairs in scats can reveal the presence of foxes, but fox scats seldom contain telltale hair. DNA analysis of scats can be used instead and may be even able to reveal the presence of different individuals — a bonus.

**Recommendation:** that funds be made available to enable the Taskforce to submit suspected fox scats for DNA analyses.

Dogs trained to detect foxes and to identify their sign are currently being trialled. This is a logical step that would seem to be promising.

**Recommendation:** Dog trials should be thoroughly explored and adequately supported.

In summary, given the prevailing situation and circumstances unique to Tasmania, there is no panacea for detecting foxes. At this stage persistence and perseverance are the key attributes that will lead to eradication. Innovation and experiment should be encouraged and supported as this could lead to efficiencies that shorten the eradication process.

### **Communications**

The importance of public communication and education regarding the fox threat cannot be overstated, and it is gratifying to note that the strategy employed to date has produced some encouraging results. This conclusion is borne out in two reports by market research consultants, *Myriad Consultancy*.

The most welcomed finding in my view is this: 91% believed that foxes would be a major concern if they became established. Moreover, a high percentage acknowledged that foxes would be a threat to the farming sector, and even more so to native wildlife. The other good news was the muted opposition to the use of 1080.

These findings are reassuring for they mean that the public at large understand and approve of the need to eradicate foxes. Many were not convinced however, that foxes are present. This highlights the need for the Taskforce to produce concrete evidence that foxes are present. A special effort should be made to produce a specimen.

There was a disappointing response from the Eco-tourism sector, as only 60% believe the fox to be a major concern. Clearly, this sector needs to be educated about the potential impact of the fox on this industry.

Stakeholder groups (farmers, sporting shooters) supported the need for eradication, but were critical of the Taskforce for a number of reasons. Some of the criticisms levelled at the Taskforce are undeserved for reasons that it lacks the necessary resources to effectively liaise with community organisations. Ideally, partnerships should be part of the Taskforce's agenda for obvious reasons, but not to the detriment of the eradication process (baiting). The aspect has been discussed in more detail in the text.

**Recommendations:** The communication campaign has been successful in meeting most of its objectives, and its momentum should be maintained. I recommend that the current level of support be maintained for the duration of the project. More resources are required to enable the Taskforce to liaise more effectively with stakeholders and the public at large.

### **Deterrent strategies: preventing future introductions**

The task of preventing the entry of foxes is a daunting one as it is unrealistic to believe that an impassable barrier can be created around Tasmania. As a minimum, a deterrent strategy should aim to achieve these goals (1) provide severe punishments (2) provide substantial rewards for informants and (3) implement detection procedures that create a genuine fear of apprehension. Points (1) and (2) have

been fully implemented; point (3) partly. Why this is so can only be explained by the Quarantine Service.

It is not for the reviewer, as an ecologist, to instruct the Quarantine Service on the mechanics of implementing a strong deterrent strategy. What I have done is to define the magnitude of the threat (see Part 1), which should in turn provide a basis for a commensurate response.

The resolution of this situation is an intradepartmental one. Given human nature, a repetition will happen if the logistics of introducing foxes are simple, and if the risk of apprehension is low.

### **Commonwealth funding expenditures: projects**

Commonwealth monies from a variety of sources were used to fund four projects: (1) public relations (2) dog training (3) the development of baiting protocols and (4) to engage with landholders and stakeholders. Projects 1-3 addressed relevant and purposeful objectives and in general, all have been executed (or are under trial) in a satisfactory manner. In short, the funds were put to good use.

The objective of training farmers in the use of 1080<sup>2</sup> for eradicating foxes was not achieved. I do not see this as a serious shortcoming. In my view, the elimination of foxes is a job for dedicated specialists. If Foot and Mouth were detected, farmers would not be expected to eradicate the virus. Obviously their cooperation and assistance would be necessary (even compelled), and undoubtedly willingly given because of the nature of disease threat would be fully appreciated. Whether the fox threat would be perceived in such a way is debatable.

I maintain that a calamitous disease response model should apply to the fox in Tasmania because the magnitude of threat is equivalent or worse. The public and stakeholder groups should be encouraged to help eliminate another potential scourge, but their role should be complementary, not mainstream.

### **Concluding remarks**

It is reviewer's contention that the eradication of the fox from Tasmania should be assigned the highest priority on both the Commonwealth and State government conservation agendas. The presence of the fox should be seen as a crisis and addressed accordingly. The Taskforce's requirements should take precedent to all other Australian conservation projects.

The eradication project should be seen as an exercise in crisis management and not as a typical conservation project competing for funds. Above all, it needs to be adequately funded and resourced in a flexible manner that avoids unnecessary red tape, and the lengthy procedures and approval processes that are typically associated with government bureaucracies. Innovation and experimentation should be encouraged and contingency funds should be held in reserve to rapidly exploit any advances, or to deal with emergencies. Accountability can be maintained by periodic external reviews.

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<sup>2</sup> Recently, in WA steps have been taken to restrict the use of 1080 by the public for fear of mishaps.

# **Taskforce Review- Terms of Reference**

## **Introduction**

The Discovery of Foxes in Tasmania: a chronology<sup>3</sup>

In early May 2001 the Parks and Wildlife Service received information from an English couple staying at the Longford Caravan Park, located south of Launceston, having reported hearing the sounds of two foxes calling one another in the early hours of the morning. A few days later on the 15th of May 2001, a highly regarded and experienced field naturalist reported a sighting of a fox at close range on Illawarra Road, north east of Longford.

With such a positive sighting, the Department of Primary Industry, Water and Environment's (DPIWE) Parks and Wildlife Division initiated a door knock and subsequent search of the area. On information received from local residents and from members of the public on further sightings, an area covering Hadspen, Cressy, Bishopsbourne, Longford and the South Esk River was identified as a possible range for a fox. At this time the Parks and Wildlife Service (PWS) was unsure of the number of foxes, if any, that may be in this location.

Surveillance of the area was stepped up to include the use of infra red cameras, sand pads, bait stations, use of lures and sound recordings in an attempt to lure a fox into an area where a photo or print could be obtained. On the 10<sup>th</sup> of July 2001, an article was published in the Tasmanian Examiner showing a picture of three persons from St Helens who had claimed they had shot a fox in the area. Parks and Wildlife officers investigated but neither the carcass nor the skin could be produced to support the claims.

In Mid July 2001, a photo was sent into the papers showing two persons holding a fox, which was taken near a sign at Longford. It was alleged that the fox was shot on a property near by. The persons in the photo would not come forward, but did send a fox skin into the Taskforce which was subsequently sent for DNA analysis. No further evidence could be obtained to support these claims.

By the end of July 2001, the Taskforce still lacked physical evidence to support the many claims of sightings in the Longford area, which were now nearly a daily occurrence. The decision was made that a dedicated team of officers be taken off line from their normal duties to

undertake this investigation. Part of this process included extensive training in Victoria, which included the practices used in tracking, trapping, hunting and monitoring of foxes.

In early August 2001, two Parks and Wildlife Fox Taskforce Officers came across several footprints when checking sand pads and cameras in the Longford area. Casts were taken of these prints and these were sent around Australia to various experts for advice. Our suspicions were confirmed that we were in possession of fox prints. This was the first real physical evidence to support the sightings that the Taskforce had been receiving from the Longford area.

On Thursday the 13<sup>th</sup> of September 2001, Erick Bosworth and Scott Geeves of Perth, Tasmania allegedly shot a male fox at Symmons Plains. Tests conducted by experts in Victoria were undertaken to determine its age, stomach contents and DNA testing. The fox was aged at between 12 and 18 months. Analysis of the stomach contents showed that it had been feeding on a variety of products from corby grubs, berries, a bird, a skink and a small mammal. On examination, the fur (of the small mammal) was identified as being the remains of a native long tailed rat, *Pseudomys higginsii*. This rat is endemic to Tasmania, thus confirming the story of Bosworth, who had claimed that he had shot this fox in Tasmania.

Since September 2001 no further animals have been shot. Sightings have since increased and clusters of reported sightings are now apparent, indicating that other areas of the state may also contain foxes.

January 31 2002: The Minister of Primary Industries Water and Environment announces an increase in the Taskforce. Teams are to be located in the hotspot areas being Burnie, Launceston, Campania and St Helens. The team at St Helens was eventually relocated to Launceston due to the reduction in sightings in that area.

On the 10<sup>th</sup> of May 2002 a scat (faeces) was recovered from Ogden Street in Burnie and was identified by a Victorian expert, Barbara Triggs, as a fox scat because of the presence of grooming hairs (methodology described by Brunner and Triggs, 2002).

On the 16<sup>th</sup> of May 2002 a scat was retrieved from the Campania area and identified by Triggs as possibly a fox scat. No fox grooming hairs were present however; hence it was not possible to absolutely confirm that it was of fox origin.

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<sup>3</sup> This edited account was provided by Chris Emms, a senior Taskforce member.

On the 15<sup>th</sup> of August another scat was recovered from Ogden Street in Burnie and identified as possibly a fox scat. No grooming hairs were present.

On the 30<sup>th</sup> of September 2002 a scat was retrieved from the Campania area and also identified by Triggs as possibly a fox scat — again, no grooming hairs.

More findings — Longford, 18 Oct; Conara, 29 Jan. 2003 — produced the same results i.e., no hairs, but otherwise fox-like as based on other criteria.

To date there has been no further animals shot in Tasmania. The Taskforce has collected over 480 sightings from around the state, 86 of these were classed as reliable sightings, 234 were classed as likely and the rest as unlikely (Fig.1). Several of the reliable sightings have been made by experienced members of the Taskforce, thus adding weight to their authenticity.

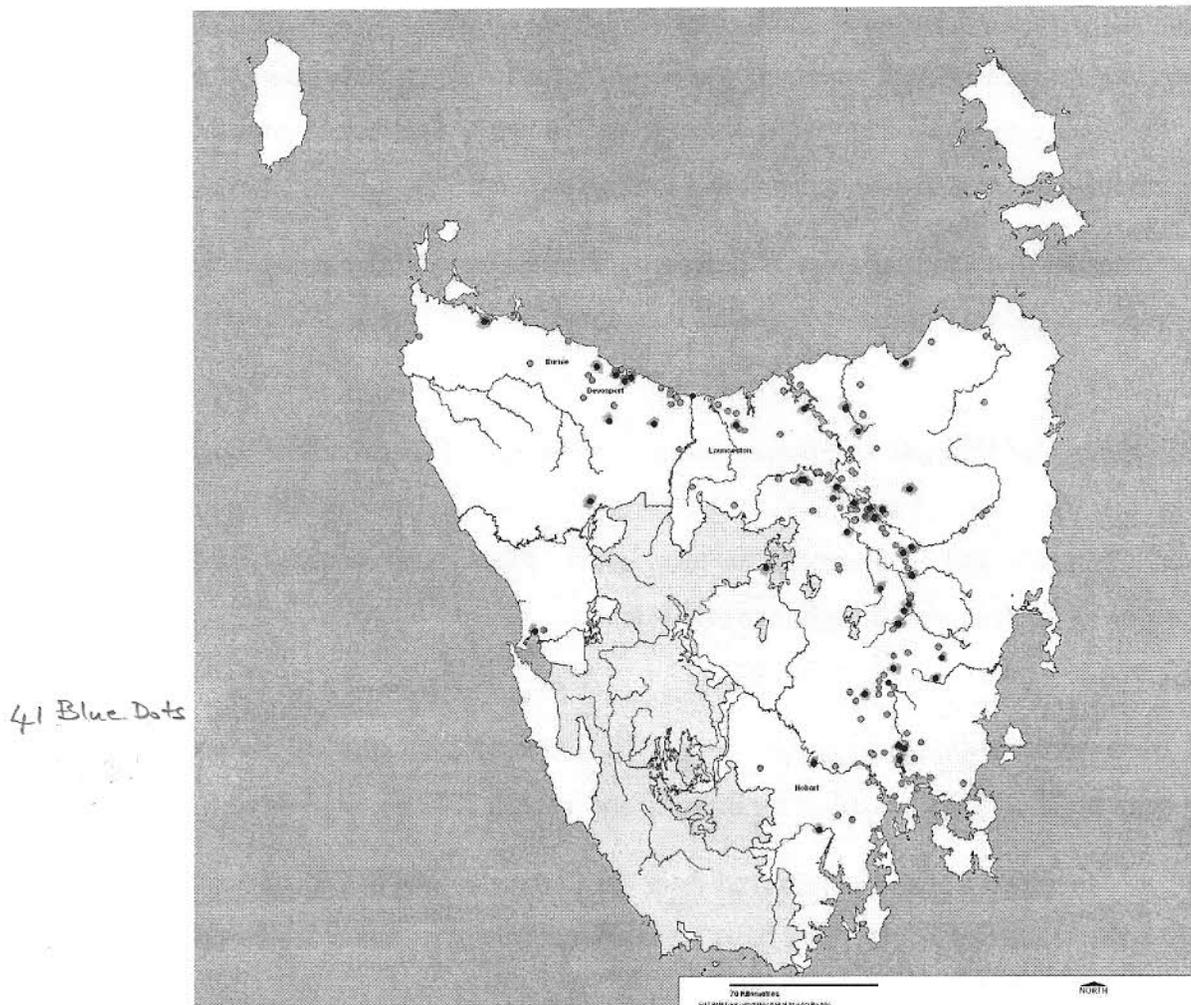


Figure 1. Map of Tasmania showing location of sighting reports based largely on sightings by the public. With a history of no foxes and an abundance of native wildlife, plus domestic dogs, feral and domestic cats, it is easy for the public to be mistaken. The color dots are weighted according credibility criteria (Mooney file note; 079687, 079688): red -; Symmons Plains Fox (shot by Bosworth) and alleged fox shot at Longford, blue - most reliable; green - possible sighting.

## **The MAGNITUDE of the Fox Threat to Tasmania: ecological considerations**

In the ecological literature there is a famous paper written by a marine scientist<sup>4</sup> who introduced a new concept — the idea of a *keystone species*. Keystone species play an important role in fostering and maintaining biodiversity in ecological communities. Remove a keystone species and ecosystems lose other species; hence communities become less diverse.

In a perverse way, the fox in Australia is a keystone species as it has (and still does) exercised a profound effect on biodiversity over much of the mainland. But in this case, its effects are negative and frequently permanent as the fox is linked to numerous mammal extinctions. In other words it is a ‘biodiversity reducer’, which becomes evident when the removal of the fox from sites on the mainland dramatically restores some biodiversity. Clearly, the term keystone does not fit the fox down under, but the ecological literature provides no alternative; perhaps a more accurate term might be “tombstone species” because it causes nothing<sup>5</sup> but death and destruction.

In more concrete everyday terms, the magnitude of the fox threat to Tasmania may be more readily appreciated by comparing two grim scenarios — an outbreak of the Foot & Mouth virus (Box 1) and the colonisation of Tasmania by foxes (Box2).

### **Box 1**

#### **Scenario 1: An outbreak of Foot & Mouth virus**

Tasmanian farmers begin to note that their cattle, sheep, pigs and goats are suffering from blisters around the mouth, lameness, loss of appetite and condition. Veterinary scientists recognise the symptoms as Foot and Mouth disease caused by a highly contagious virus. Pandemonium reigns for a while. Tasmania is quarantined and exports of these agriculture products banned. An emergency is declared and a fully funded contingency plan is set in motion. Stock on infected properties are slaughtered and countryside is dotted with fires of burning carcasses.

The economic impact is severe, but eventually, some good news emerges — the terrible scourge has been eradicated. Tasmania has been declared free of Foot and Mouth, albeit at a considerable cost, but nonetheless, a cost, that everyone is prepared to bear.

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<sup>4</sup> Robert T. Paine, Professor of Zoology, University of Washington

<sup>5</sup> Claims have been made that the fox helps to control rabbits, but this is debatable.

Let me now describe another scenario (Box 2) improbable, as it might first seem. Suppose the 'keystone' fox is allowed to become established in Tasmania. What would happen?

**Box 2**

**Scenario 2: Foxes become established in Tasmania**

There would be no major dramas, no pandemonium because the damage would be insidious. Eventually, agriculture statistics would reveal that lamb production was down — as much as 2-10% *per year* and sometimes more (Saunders *et al.* 1997). Poultry owners would experience heavy losses; they would have to fox-proof yards, not an inexpensive undertaking.

Tasmanians would begin to notice the absence of familiar wildlife road kills, but there would still be numerous victims, now comprised largely of foxes. People would come to realise that wildlife had disappeared — no more bettongs, barred bandicoots, pademelons, possums, or plovers. The wildlife-based tourist industry would be crippled for there is nothing much to see anymore. Conservation agencies would try to protect pockets of rare wildlife in nature reserves by baiting for foxes, but at cost, year in, year out.

Are the two scenarios equivalent? The answer is very much yes, and no, the latter because there are aesthetic values that cannot be measured in economic terms. In the long term, the fox would have a greater impact economically (See the cost analyses in the Bloomfield report 11/2002 and Bryant 2002). This is because the Foot and Mouth virus can be eradicated, and once achieved, the agriculture sector would recover. In contrast, the fox scenario is irreversible, because once established it is unlikely that foxes could be eradicated<sup>6</sup>, and hence the economic costs are cumulative and permanent. Ecologically, the biodiversity<sup>7</sup> of Tasmania will have been conspicuously diminished, but the consequences of the loss cannot be predicted or calculated. Nor could the loss of aesthetic values; to the bushwalker and nature lover, the bush would never be the same; to the tourist, the countryside would seem empty of wildlife just like the mainland.

I trust the gist of these two scenarios is clear; the colonisation of Tasmania by foxes would be a calamity worse than an outbreak of the Foot and Mouth virus. Fortunately, there are proven methods for eradicating foxes.

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<sup>6</sup>Technically, it may be possible given that Tasmania is an island with no immigration by foxes, but the cost would be horrendous.

<sup>7</sup> See Appendix 2 for more details

## The Eradication Process

Eradication may be defined as simply the process of causing a species to become extinct within a defined area. Some species can be (1) eradicated easily, (2) others, with considerable difficulty, (3) and some not at all. Eradication of the fox from certain sites in WA has been achieved easily because of favourable circumstances (See Box 3 for five examples). **The eradication of the fox from Tasmania is also achievable**, but most likely, with considerable difficulty, due to the prevailing circumstances as explained subsequently (see Fig.2).

### Box 3

#### The eradication of fox populations: five examples

1. A small population of rock-wallabies was resident on a 168ha nature reserve, and the object was to make this site fox-free by baiting. The presence/absence of foxes was determined from footprints on a system of tracks through out the reserve that were graded and read daily. On numerous occasions the site was found to be fox-free for a period, but eventual recolonisation by new foxes was the rule (Kinnear *et al.*, 1988). This would not be a problem in Tasmania.
2. Fox-free Garden Island near Perth WA carries a flourishing population of tammar — a wallaby similar in size to the Tasmanian pademelon. A causeway connecting it to the mainland was built in 1973, and in 1996 a fox gained entry via this route (Short *et al.*, 2002). At least 25 tammars were killed by the fox some of which were not eaten. Dried kangaroo meat (DKM) baits were laid and on the 10<sup>th</sup> day, the fox took 3 baits. No further tammar kills or fox tracks have since been recorded.
3. Heirisson Prong is a small peninsula in Shark Bay WA. A barrier fence was constructed across its base creating a 1200ha area that was isolated by the sea and the barrier. Foxes were eradicated inside the barrier using poison 1080 baits (*ibid*).
4. A similar project was implemented on the nearby Peron Peninsula, but on a much grander scale (*Project Eden*). A single aerial baiting virtually eradicated the fox population (Algar and Smith, 1998).
5. In the Gibson Desert, an area of 1600km<sup>2</sup> was aurally baited at rate of 5 DKM baits per km<sup>2</sup>. Fox track counts fell to zero and remained so for at least 12 months (Christensen and Burrows, pers comm).

Because of favourable circumstances, these eradication examples were readily achieved both time-wise and logistically because (1) the targeted area was defined (2) baiting was not subject to any constraints and (3) methods were available to confirm that eradication was successful. None of these advantages are currently available to the Taskforce.

## Two eradication scenarios

As the result of many attempts to eradicate pest species, a rough and ready 'rule' has been formulated that more or less epitomises the expected course of events. It reads as: "It takes 10% of the time/effort to remove 90% of a targeted population, and 90% of the time/effort to remove the remaining 10 percent". The current Tasmanian situation fits the latter stage (Fig. 2, curve B), which demands persistence and perseverance to succeed.

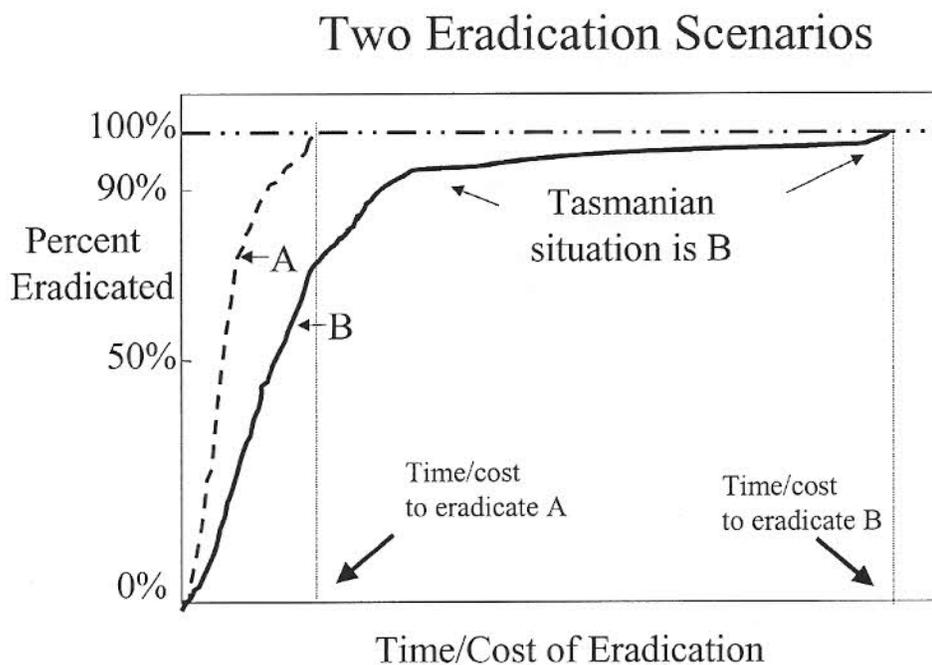


Fig.2

Figure 2 depicts two eradication scenarios that cover a range of eradication case histories. The five WA examples (Box 3) fit Curve A. Eradication was highly successful because (1) foxes readily take 1080 baits and there were no baiting constraints, (2) the boundaries of the baited area were clearly defined and (3) methods were available — absence of fox foot prints and fox-sign on a graded network of tracks — to confirm that eradication had been achieved. The Tasmania situation fits Curve B for the following reasons: it is faced with a rare and dispersed fox population that is difficult to locate in an agricultural landscape with numerous non-target species competing for baits. Furthermore, given that every fox does find a bait and is poisoned, the Taskforce lacks a convenient and simple method to confirm this outcome. These conditions, unless overcome, will make the eradication process a lengthy drawn-out process.

## **Detecting the fox in Tasmania: major constraints**

The prevailing situation indicates that foxes are present at a number of sites. From a purely eradication viewpoint, this is both good and bad; the good news is that numbers are still low; the bad news is that the low numbers make the task of detecting foxes a formidable one.

Currently, the Taskforce relies primarily on sightings by the public and DPIWE staff. Details about each sighting are entered into a relational database. On a map, different coloured flags indicate the location of the sightings, the colour being an indication of the reliability of the sightings.

Experience gained from investigations of alleged thylacine sightings has shown that public sightings are notoriously unreliable as most are mistaken identities (N. Mooney file note, 079687-8) Accordingly, sightings are assigned to one of three levels of credibility (See Fig. 1), which can help to eliminate many false sightings and set priorities. There still is an unknown probability however, that a true sighting may be dismissed as unlikely or false.

Currently, there is a public perception that the Taskforce is slow to respond to reports (*Myriad Consultancy* reports). Some sightings are not investigated at all. When I asked why this was so, the answer was — “not enough staff and funds.”

## **Detection methodologies**

### **Use of dogs**

The Taskforce is fully aware of the need to devise more effective methods to detect foxes. It has plans to trial dogs expertly trained. At the time of my visit, the delivery of one dog was imminent. I strongly recommend such trials, which should be thoroughly tested; it may prove to be a much-needed method for effectively detecting fox sign and foxes per se.

### **Spotlighting**

On the mainland, spotlighting is a widely used technique for locating foxes. When foxes are abundant, it is a rewarding exercise, but given the densities of foxes in Tasmania, there would be a very low probability of sighting a fox per night. Nevertheless, if resources permit, it may prove useful to do so preferably in an area where a reliable sighting has been reported. Weapons should be carried. In WA we relied on a 12 gauge, 5 shot auto-loader loaded with BB shot for

running and close range shots, and a .17 Remington caliber rifle, but any of the 22 high velocity centrefire cartridges would do.

### Sporting shooter organisations

Hunter groups may possibly have role, but I would imagine that the initial enthusiasm of most members would soon subside, mainly because the probability of sighting a fox would be so low. Hunters typically like to sight game and fire their guns, but spotlighting hour after hour without the satisfaction of firing a shot would not be an attractive proposition to most hunters.

### **Indirect methods for detecting foxes**

It can be extremely difficult to detect animals when they exist at low numbers, but presence of scats (i.e., faeces) can provide reliable clues of their presence. In Tasmania, positive identification of fox scats is frequently not possible because the scats of native carnivores (devils in particular) can be confused with fox scats.

As a rule, scats contain hair as a consequence of an animal grooming itself. If such hair is found in scats it can be used to identify the producer, as hair structure is typically species-specific and thus unique. The Taskforce cannot rely solely on this useful tool, because on average only 20 percent of fox scats contain fox hair (mainland data). This is an unfortunate handicap.

### Using DNA technology

If scats are available and hair is absent, then DNA technology can be applied. Methods for identifying fox DNA in faeces are available. This technology has been applied in Victoria and has been shown to be capable of identifying different individuals within a population (Banks *et al.*, 2002). Thus it would be a powerful tool. I strongly recommend that the Taskforce proceed to investigate the use of this technology. A contact person is Clive Marks ( email: [camarks@attglobal.net](mailto:camarks@attglobal.net)).

In a similar vein, DNA analyses can be used for forensic purposes. For example, it might be used to determine the mainland source of foxes introduced into Tasmania in the event of a reintroduction of foxes. A small sample taken from the external ear (a leather punch is normally used), stored in 80% alcohol, (or higher) is all that is needed. Specimens do not need to be freshly killed.

## Using sexual lures

At the April 2002 workshop, it was suggested that the Taskforce employ so called “red hot vixens” as a lure to attract males outside of the breeding season. The capacity to bring female foxes into heat (oestrus) out of season would provide the Taskforce with another means of detecting foxes, as male foxes, in typical canid fashion, seek out females. Foxes breed only once per year in winter, and during this phase the social structure and territory boundaries break down. Normally, this is comprised of mated pairs who defend a territory.

Research in Europe has demonstrated that oestrus can be artificially induced in females out of season and males responded accordingly<sup>8</sup>. Ideally, one would like to detect both sexes, but nonetheless, the ability to attract male foxes year around would be a step forward as females are likely to be nearby. Sterilised (ligated) captive females could be “staked-out” and kept under observation by some means either directly or remotely. I suggest that the Taskforce explore this approach if other methodologies are wanting.

## Sentinel Traps

N. Mooney (pers comm) has proposed to set out a series of trapping enclosures designed to attract foxes by the use of lures. These traps could serve as chook runs and be serviced by farmers. Sterilised vixens as described above could also serve as lures. The traps would act like passive, strategically located, sentinels.

## **Summary and recommendations**

In summary, the problem of detecting foxes when they exist at low densities is fraught with difficulties. Foxes are typically nocturnal, secretive, and only become conspicuously evident when they are numerous. The planned use of dogs should be thoroughly trialled and the Taskforce needs to have access to DNA scat technology. At this stage, a multi-prong approach is the best approach coupled with persistence and perseverance.

There is also a need for innovation, because detecting foxes at such low densities given the Tasmania landscape with its abundance of wildlife and prevailing circumstances is outside of the mainland experience. Thus, it is up to the Taskforce to develop new tools and approaches, as

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<sup>8</sup> I am indebted to Dr. Gerhard Reubel, of the Pest Animal CRC, Canberra (email: [Gerhard.reubel@csiro.au](mailto:Gerhard.reubel@csiro.au)) for this information.

advances would greatly accelerate the eradication process. Such endeavours would need to be adequately resourced and funded in a flexible manner.

### **Baiting Foxes: the route to eradication<sup>9</sup>**

The five eradication examples previously described (Box 3) were achieved by poisoning foxes with dried-meat baits containing 3.0-4.5 mg. of 1080. This method exploits the scavenging tendencies of foxes, which, besides being efficient<sup>10</sup> predators, are also consummate scavengers. This is one of the reasons why foxes are so adaptable and successful as a species worldwide, but it is also the fox's Achilles heel, as it makes them extremely vulnerable to baiting. And moreover, they have an astonishing ability to find surface-laid baits. All baiting programs rely on this amazing ability (see Box 4 for an example).

#### **Box 4**

In WA, baits are routinely dropped from aircraft in a linear fashion at rate of 5-6 baits/km<sup>-2</sup> over deserts, woodlands, heath-lands, and forests, with the result that one can be confident that foxes will find and consume them. For some convincing evidence, the reader is referred to a paper by Thomson *et al.* (2000) to quote:

*" An area of 3180km<sup>2</sup> was aerielly baited with dried meat baits containing 3 mg 1080 poison (5 baits km<sup>-2</sup>) in August 1995. All 45 radio-collared foxes monitored in the area were killed by baits. More than half the foxes died within 3 days of baits being laid; the last surviving fox died 44 days after baits were laid".*

The message here is that the Taskforce has access to a certified tool guaranteed to kill foxes. Eradication, minus the details and problems, simply becomes a matter of (1) finding foxes and (2) exposing them to baits.

Moreover, it requires no great skill to poison foxes, just common sense; the necessary skill and expertise actually resides within the fox because of its uncanny ability to find surface-laid meat baits, which they readily consume.

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<sup>9</sup> I have consulted with four other experts about eradicating foxes in Tasmania — Drs. T. Friend; N. Marlow; J. Short; G. Saunders. All are agreed that 1080 baiting is the primary method of choice. References to their research can be found in the Reference section.

<sup>10</sup> See Appendix 1 for an explanation of predator efficiency.

The key to eradicating foxes is exposing them to baits and ideally one would prefer to do this without placing non-target species at risk. Nevertheless, while eradicating foxes, if it is found to be absolutely necessary to employ methods that cause non-target mortality, then it should be done for reasons explained below.

### Baiting and non-target species: ecological considerations

Non-target species generally consist of native fauna — mainly carnivores and omnivores — domestic dogs and cats, and any species that is capable of consuming a sufficient amount of dried meat baits. For ongoing baiting programs (the mainland situation), the risk to non-targets needs to be factored into the design of baiting protocols, and on the mainland, many studies have addressed this issue. This has also been the case by the Taskforce, as it has conducted some useful trials that have assessed the risk to Tasmanian wildlife (see below).

Nevertheless it is important that the risk to native fauna in Tasmania be kept within a proper perspective, and subject to sound ecological principles and analysis. A species exposed to a baiting event is only at risk if its entire population is at risk of being killed (or a very large part<sup>11</sup>). This is highly unlikely to be the case in Tasmania as the mortality would be localised and transient.

The message here is this: if some mortality of native fauna is unavoidable during the course of eradicating foxes, then this should be accepted as part of the cost of removing an infinitely greater cause of death. Localised mortality in a species can be tolerated, because in nature, mortality is never constant; populations fluctuate, cycle and decline (and even become locally extinct for periods) for a number of reasons, but invariably they have the capacity and the resilience to restore numbers after the cause of mortality is no longer operative. No population ecologist would oppose this argument.

### **The current baiting strategy**

The baiting strategy is essentially based on mainland (eastern state) protocols. (Fig. 3 illustrates the locations of baiting efforts to date; Fig. 4 outlines additional areas in need of baiting). An adaptive management approach (i.e., “learning by doing”) has been usefully employed to

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<sup>11</sup> In this case, matters such as the loss of genetic diversity would be of concern, but this would only be a problem if the species consisted of a single isolated population — an unlikely scenario in Tasmania.

accommodate new information generated from ongoing research. The current baiting recommendations are outlined in Box 5 (N. Mooney report, 6/12/02):

- Box 5
- Bait materials: dried kangaroo meat baits (DKM), or intact fresh fowl eggs; eggs are recommended during wet periods
  - Toxin and dosage: 1080, 3 mg per bait (formerly 2.5 mg)
  - Presentation method: baits buried to 10cm (formerly 15cm)
  - Application density: 15 baits/100ha (formerly 5/100ha)

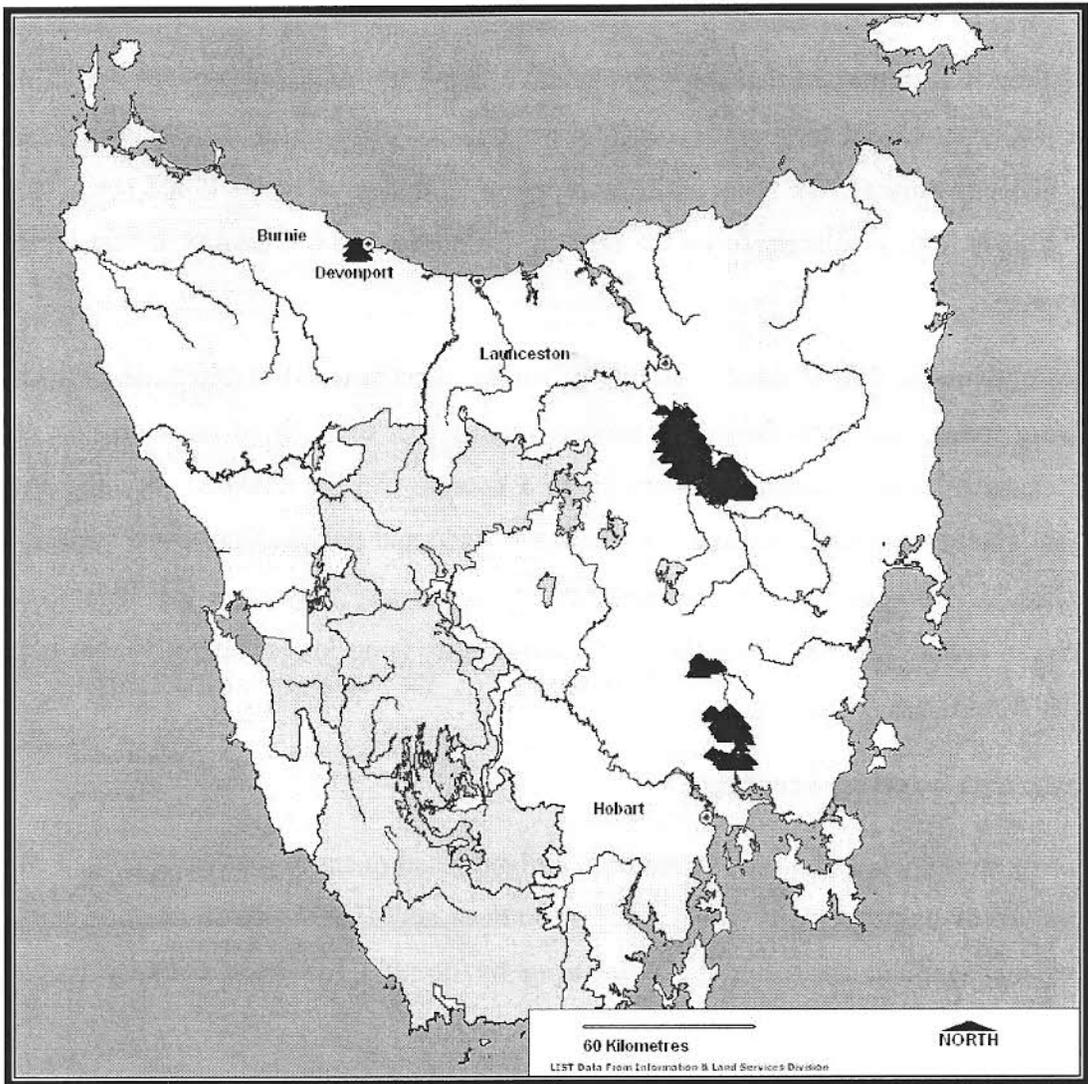


Figure 3: Shaded areas showing the locations of sites that have been baited.

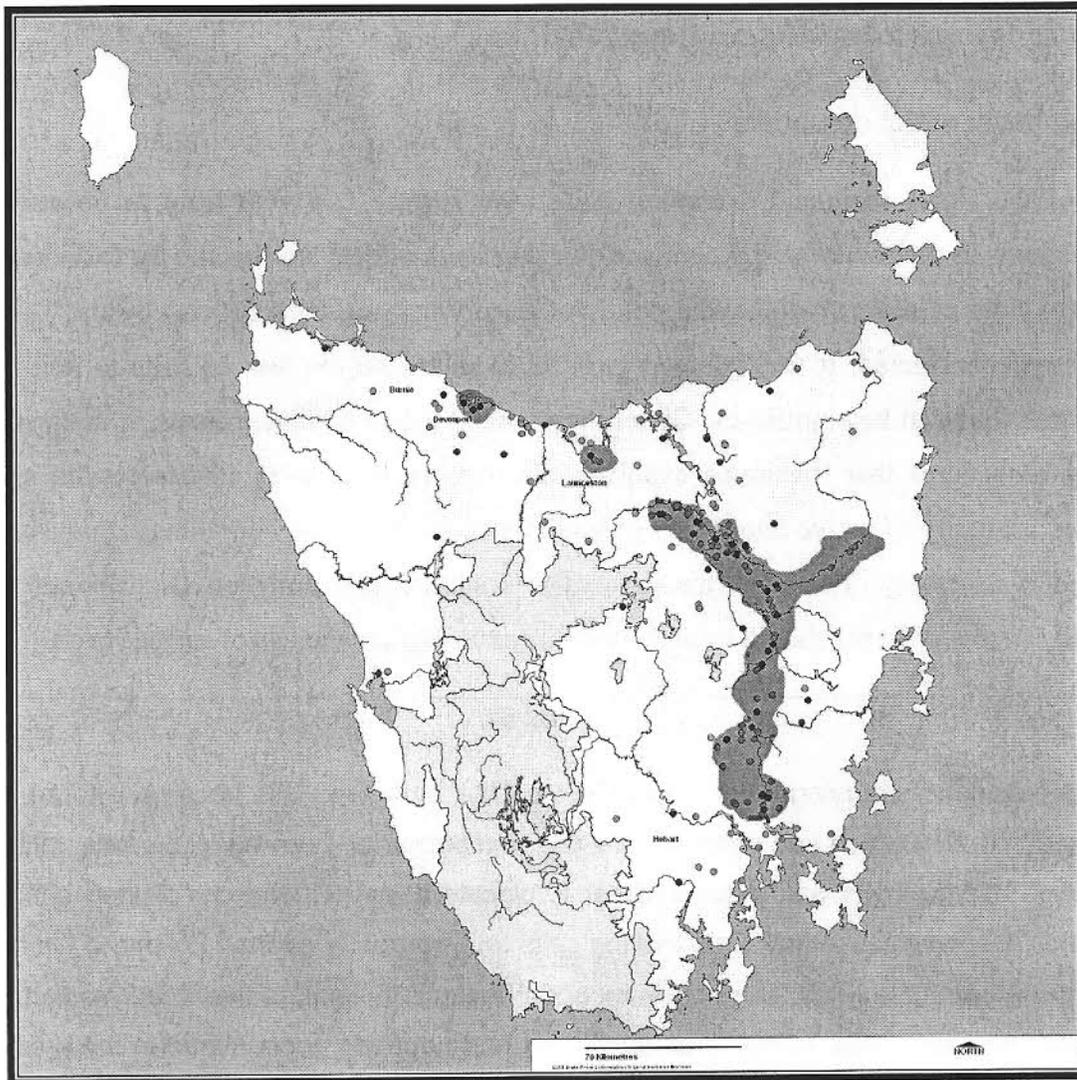


Figure 4: Shaded area indicates areas judged to be in need of baiting (compare with areas in Fig. 3). More resources will be needed.

A useful amount of research has been accomplished regarding the risks to non-target species. Researchers have investigated bait takes by non-target species, presentation methods, scent lures, buried bait depths, rates of 1080 degradation, suitability of different bait materials and more. Details can be found in reports by Mooney (1/10/02 updated 22/11/02; 1/8/02; 6/12/02).

The production of this data has provided a sound foundation upon which to implement a baiting strategy appropriate to the situation in Tasmania. Apart from some additional recommendations and suggestions described below, I have no hesitation about endorsing the basic strategy.

## **Some recommendations and suggestions**

### **Burying baits: effect on uptake**

In all of the above mainland examples, baits were surface laid with little or no attempt at concealment. In the reviewer's experience, burying baits affects bait uptake by foxes (see Box 6). In the light of these findings, the policy of deeply burying baits (10cm) by the Taskforce should be reconsidered. It was adopted in order to minimise the loss of baits to non-targets, which was found to be significant. Given the urgent need to eradicate foxes, it is essential to employ procedures that maximise exposure of foxes to baits even if this results in some localised mortality of native fauna. Baits should be covered lightly, laid at higher densities and repeated if necessary. The latest amendment is a step in this direction (N. Mooney report, 6/12/02) but this protocol should be amended further to include the use of surface baits.

#### **Box 6**

In my experience, burying baits does affect uptake by foxes. This became evident at the rock-wallaby site, which had been surface-baited monthly for more than 15 years. In 1998 a switch to burying baits was made in order to placate a farmer, who complained about dog fatalities allegedly caused by birds moving baits to his property nearby. Following the baiting change, a bout of surplus killing by a fox soon became evident as five, barely eaten, rock-wallaby carcasses were found — an event that had not been encountered in the previously 15 year history. The baiting protocol has since reverted to surface baiting without a recurrence.

## **Baits and baiting: some variations**

### **Auto-detoxifying baits**

In some situations it would be useful to produce a bait that becomes non-toxic after a predetermined period. If this were possible, it could eliminate the need to retrieve baits and it would eliminate any risks to non-targets that might otherwise occur if ordinary baits were used. Theoretically, this could be achieved by injecting baits with 1080 in a suspension of 1080-degrading microbes, so designed to detoxify the bait after a certain period.

This should be technically feasible. The bioassay technique (Wong *et al.*, 1995, as modified by Kirkpatrick, 1999) would provide the means to design and test such a bait. I have forwarded a

copy of the bioassay procedure to the Taskforce. At present the DPIWE lacks the capacity to analyse 1080; the bioassay is recommended, as it is low-tech, rapid, and cost effective.

### Long-life baits

In contrast to the above, it may be desirable in some situations for baits to retain their toxicity for long periods. Eggs can fulfil this role. Twigg *et al.*, (2001) demonstrated that most egg baits remain lethal for up to 42 days irrespective of season. Furthermore, they estimated that some eggs would still be lethal for as long as 32 weeks under certain circumstances. Sterile injection techniques were not necessary.

### M-44 Ejector

The M-44 ejector for fox control (see Marks *et al.*, 1999) is under consideration by the Taskforce and the author recommends that this device be trialled. (Supplies would have to be ordered from the USA) There is scope for it to be made target specific for foxes and there is a choice of toxins, either 1080 or cyanide. The latter toxin kills instantly allowing victims to be recovered. Cyanide devices should only be used by trained DPIWE staff under remote circumstances. However, there is scope for employing 1080-toxic M-44s by reliable landholders.

### No victims, no evidence

The major drawback to 1080 baiting is that it does not produce on-the-spot victims. The only option is to search for victims. This would be labour intensive, but volunteers could be enlisted to systematically search a baited area. Moreover, the area searched need not be that large (see Box 7).

#### Box 7

In WA, we baited a small Nature Reserve (1400m by 1200m) and the reserve was periodically searched for fox victims (Kinnear *et al.*, 1988, Fig. 3). In addition farmers recorded every victim encountered during seeding and harvesting on the adjacent properties. More than 220 victims were recorded, but the majority of the records were of victims that died within the reserve. Thomson *et al.* (2000; pers comm) found that their 45 radio-collared foxes died in the vicinity of the captured site. Bait uptake was initially rapid with more than 50% taking baits within 3 days. Younger foxes were quick to do so; by day 34, only four male foxes >4 years of age remained and all were dead by 44 days. This makes a case for long-lived baits or repeated baitings of the area.

The message here is that 1080 victims tend to die within a relatively restricted area that could be systematically searched by a party of volunteers. The search might take place 3-10 days after baiting, and repeated if necessary. Devils could negate this strategy by scavenging carcasses. If this is the case, then devil scats should be checked for fox hair.

### **Summary and recommendations**

In summary, it is evident that the Taskforce has shown good judgment in selectively applying mainland technology and methodologies for baiting foxes. In addition it has carried out the necessary research needed to understand the risks to non-targets.

Baiting should be seen as the primary method for eradicating foxes. It is important that the baiting procedure maximises the opportunities for foxes to find baits. In regards to this point, some modification to the baiting protocol should be made, in particular in relation to burying baits — the shallower, the better the uptake, with surface baiting being the most effective. An increase in the bait density per unit area is likely to be necessary and repeat baitings are options that should not be ruled out.

Baiting does have some shortcomings because 1080 leaves no immediate evidence of a kill. There is a need to find a more efficient way of locating poisoned foxes with certainty, because without this information, the Taskforce cannot tell whether it is successful or not.

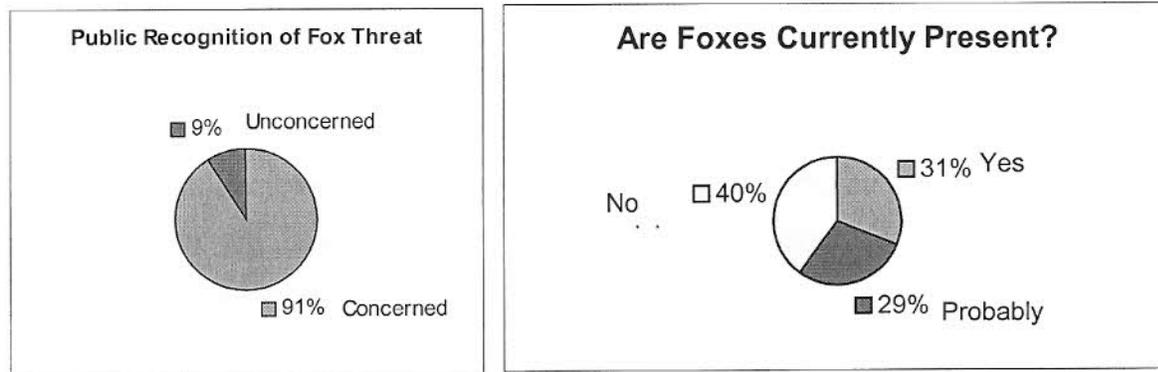
#### **Box 8**

The Tasmanian situation poses new problems that can only be solved in Tasmania. On the mainland, wildlife managers do not need to locate poisoned foxes, because they can be confident that foxes will find baits and die as a result. Their objective is to reduce fox numbers to a level (or turn them over quickly enough) that enables the predation affected fauna to prosper. Success is measured by a positive population response by the prey. Eradication is not a goal, because it is not necessary, nor is it feasible. Therefore, mainland research has not developed the tools and procedures that the Taskforce requires. Accordingly it is incumbent on the Taskforce to address the above issues.

### **Public communication and stakeholder engagement strategies**

The importance of public communication and education cannot be overstated, and it is significant to note that the strategy employed to date has produced some substantial results. This conclusion is borne out in two reports by market research consultants, *Myriad Consultancy*.

## Community surveys



Figures 5a and 5b

A community survey of Tasmanian residents (27/9/02) revealed that 80% of the respondents were aware of the eradication program when prompted. Moreover, a high percentage acknowledged that foxes would be a threat to the farming sector, and even more so to native wildlife.

The signals from these statistics however, are mixed; a large majority of Tasmanians now believe the fox to be a major concern (Fig.5a), but many are not convinced that foxes are actually present (Fig.5b). The former is good news; the latter stresses the need for the Taskforce to produce concrete evidence that foxes are present. A special effort should be made to produce a victim, as it would erase the existing scepticism and legitimise the Taskforce.

The community survey revealed that the public was solidly in favour of eradicating foxes and more than 96% strongly disapproved of anyone caught importing foxes. Only a minority thought poisoning to be the method of choice for eradicating foxes. A majority held the view that the PWS was the appropriate agency for co-ordinating the fox program.

There was a disappointing response from the environmental tourism industry, as only 60% believe the fox to be a major concern. Clearly, this sector needs to be educated about the potential impact of the fox. However the consultants suggested that terminology (e.g., "Eco-tourism") might be confusing the respondents; "nature-based" tourism may have produced a more positive response.

## Focus Groups: Community and special interest

Three community groups generally believed that foxes were present and that the fox posed a threat to native wildlife and agriculture. The labels, *Environmental tourism and Eco-tourism*, were not well understood. Nature-based tourism was deemed to be more acceptable. In general, participants were generally aware of the Fox Taskforce Hotline, but unaware of the website. TV was judged to be the most effective medium for conveying information, but the messages to date were not considered to be hard hitting enough in regards to the threat posed by foxes.

While poisoning was not favoured, the response to 1080 was muted. The groups were prepared to accept the judgements of experts regarding the use of 1080. This is a surprising, but a welcomed outcome, considering the campaign against the use of 1080 in Tasmania.

### Hunter Group

The group consisted of nine participants; four believed that foxes were present; five believed they were probably present. All agreed that the fox was a menace to wildlife.

The performance of the PWS was initially judged to be poor, but has since improved. They felt that the PWS had not involved hunters enough, in particular, about using their local knowledge. It was suggested that senior PWS personnel should interact more with hunter groups, and that promotional material should be included with licenses. Game Management Plans were held up as a model for facilitating co-operation.

Not surprisingly, the hunter group was not enamoured with 1080 baiting, as it was perceived to be too risky in regards to non-targets. And besides, a shot fox is a fox in the hand representing much sought after evidence.

### Farmer Group

The Farmer Group expressed the view that it was highly probable that foxes are present. They were also deeply concerned about their potential impact.

Their perceptions about the effectiveness of Taskforce were largely negative (see Box 9).

#### Box 9

- The group felt that there were too many constraints within the PWS bureaucracy that were hindering the Taskforce in its ability to make decisions and to respond quickly to events. These matters have been recently addressed.

- Farmers expected a quick response to sightings, but sometimes nothing happened or the Taskforce was slow to respond.
- Given that an area was recognised as a “hot spot”, ongoing communication was often lacking about the situation.
- The group believe that Taskforce activity and enthusiasm had waned in recent months.
- The group was keen on forging a working partnership.
- They expressed a need for more research, better entry surveillance and co-operation with the Victorian Government.

### **Comments and recommendations**

Some of the criticism levelled at the Taskforce is undeserved for reasons that it currently lacks the necessary resources to effectively liaise with community groups. Given the present level of support, forging partnerships run the risk of compromising the Taskforce’s principal goal of eradicating foxes. Western Australia’s successful “Western Shield” program is based on a government organisation adequately trained, resourced and funded. While it welcomes public participation, it does not rely on such support. A functional partnership with the farming community should be part of the Taskforce’s agenda for obvious reasons, but only when it is in a position to productively engage with the community without compromising core activities.

### **Deterrent strategies: creating and maintaining a barrier**

If one views humankind through the eyes of a realist, then the deliberate introduction of foxes into Tasmania would be seen as an event that was bound to happen. Indeed, this act of ecological vandalism would be seen as merely another expression of mindless and destructive behaviour, which seems to surface whenever an opportunity arises.

Historically, one might argue that there has never been a problem so why worry about the recent, and presumably, ‘one-off’ incident? Perhaps an explanation for this is that in the past, there was never a ‘reason’ to release foxes. Nowadays, since the mainland tragedy involving the fox has become known, one can speculate that a good reason has surfaced to cause mischief and mayhem. Furthermore, given the high profile nature of the current response by government agencies, it is possible that the attendant publicity might trigger a ‘copy cat’ response by those so inclined.

## Response scenarios

There are broadly speaking, three courses of action (1) do nothing, and assume no future episodes, (2) do nothing, assume that a repetition will occur, and rely on eradication, and (3) devise a strong deterrent strategy.

The reviewer's responses are these: the first defies human nature; the second — eradication — is inadmissible given the present difficult situation. Clearly, the only option is eternal vigilance supported by a strong deterrent strategy.

The Bloomfield reports make a number of useful recommendations some of which are listed below along with comments:

### Box 10

- Carry out a public education campaign. *Within Tasmania this has been quite successful as indicated in the Myriad Consultancy reports.*
- Increase the severity of penalties e.g., fines and imprisonment; provide rewards for informants. *This has been done.*
- Inform the travelling public at dis/embarkation points about the risks posed by foxes and the penalties for breaching the laws. *Some effort has been made.*
- On ports of entry, implement containment measures to prevent dispersal of stowaway foxes into the countryside. *More needs to be done*
- Provide sufficient staff and trained sniffer dogs at quarantine points. *Resources are inadequate.*
- Liaise with mainland port authorities with the aim of reducing opportunities for foxes to become stowaways. Pregnant foxes would pose the greatest threat during the winter months. *Some liaison has occurred.*

The task of preventing the entry of foxes is a daunting one as it is unrealistic to believe that an impassable barrier can be created around Tasmania. Nevertheless, a barrier should aim to achieve these objectives (1) create widespread public awareness that it is a criminal act to import foxes which carries severe penalties (2) offer a substantial reward for information the

leads to convictions and (3) implement procedures capable of detecting foxes and thus create a genuine fear of being apprehended.

At this stage, the deterrent strategy is incomplete. Rewards and penalties have been increased, but the Quarantine Services, which are part of DPIWE, have responded reluctantly presumably because management does not see the introduction of foxes as a sufficient threat. The areas of Burnie and Davenport require effective barriers, as these entry points would be targeted if security were perceived to be lax. Warnings and security measures should be conspicuously evident at (dis)/embarkation points. Bloomfield recommends that Quarantine services conduct random searches at the Victorian side, on the journey over, and at disembarkation points. I concur.

### **Summary and recommendations**

In making recommendations, the reviewer, as an ecologist, does not propose to advise the Quarantine Service on the mechanics of implementing a strong deterrent strategy. What I have done is to define the magnitude of the fox threat, which was compared to a calamitous disease such as Foot and Mouth, and as such, it deserves to be treated accordingly — nothing less will do. A repetition will most likely occur, if the logistics of importing foxes are simple and the risk of apprehension is low.

**Recommendation:** It is likely that even after eradication has been achieved, the DPIWE will be plagued with fox sighting reports of questionable veracity for years to come. To contend with this juncture, the Department should be prepared to allocate resources to deal with such matters, and to devise a contingency plan should there be any genuine quarantine breaches.

## **Commonwealth-funded components of the eradication plan**

The Commonwealth provided from a number of sources \$400,000 to fund four projects. These will be discussed separately.

### **Project C3: Public relations and engagement of landholders**

Allocation: \$190,000

Objectives: see Box 11

#### **Box 11**

- To increase public awareness about foxes and the threat they posed
- To explain why it is essential to eradicate foxes
- To educate the public and landholders so as to enable them to identify foxes and their sign
- To train farmers and key landholders in the use of 1080 baits and to equip them to do so
- To conduct attitude surveys

A community engagement officer was employed under contract. In general, the publicity and education campaign was on balance, a success. The *Myriad Consultancy* surveys indicated that there was a high level of awareness about the fox threat and the need for eradication. Furthermore, while the public was not in favour of using 1080 poison, opposition to the use of 1080 was muted. These findings are gratifying and most welcomed. Without public approval, the Taskforce would be seriously handicapped in carrying out its duties, and those responsible for this outcome are to be commended. It was money well spent.

**Recommendation:** It is important that the publicity and communication campaign be maintained at an appropriate level until eradication is achieved.

### **Baiting and the farming community**

The objective of training farmers in the use of 1080 for eradicating foxes was not achieved. I do not see this as a serious shortcoming. In my view, the elimination of foxes is a job for dedicated specialists. If Foot and Mouth were detected, farmers would not be enlisted to eradicate the virus. Obviously their cooperation and assistance would be necessary (even compelled), but no government would rely on the farming community to eradicate the scourge. I recommend that

this model should apply in relation to the fox in Tasmania. The public and stakeholder groups should be encouraged to help eliminate another potential scourge, but their role should be complementary, not mainstream.

In WA with its long history of fox control, public opinion supports fox control unreservedly. The cooperation of the farming community is sought and welcomed, but the government does not expect or rely on farmers to control foxes. Recently, in WA, steps have been taken to restrict the use of 1080 by the public for fear of mishaps.

#### Project D6: Dog training

Budget: \$35,000

This project, involving the use of dogs to detect fox sign and foxes per se, was not operational during my visit. Two dogs were being trained. In my opinion, it is a most worthwhile project that may well produce great dividends.

#### Project E4: Native wildlife and 1080 fox baiting

Budget: \$115,000

#### Project E7: Developing bait selectivity

Budget: \$60,000

The Mooney reports (1/8/02; 1/10/02, updated 22/11/02; 6/12/02) provide details about a comprehensive range of trials designed to define the operational guidelines for eradicating foxes by the use of 1080 baits. The risks to non-target native fauna were assessed as was the rate of loss of 1080 from buried baits. Additional trials were undertaken to compare methods of presentation and two bait types (DKM and "Foxoff") were tested and compared.

The results of this work provide a solid foundation on which to base a baiting protocol that would minimise the risk to non-target native species. My only concern is that burying baits is an impediment as foxes are less likely to find them. It is important to maximise the exposure of baits to the fox. Elsewhere I have recommended that baits be covered lightly or not all, be laid at a greater density and repeatedly, even if this results in conspicuous deaths of non-target species.

In conclusion, I am of the view that the Commonwealth funds were monies well spent.

### **A national fox summit?**

The Bloomfield report recommends that a national fox summit be convened presumably to provide ongoing advice and comment about eradicating foxes. I have reservations about the value of another workshop. Whether another workshop would be productive is debatable. I believe that such monies might be better used to promote ongoing interactions/liaisons with mainland scientists about specific issues and for staff training on the mainland.

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### **Unpublished DPIWE Reports**

The following departmental reports were provided.

Anonymous, (9/2002). Research report summary: Community survey: *Myriad Consultancy*, 11 pp. (A report assessing the communication strategy).

Anonymous, (11/2002). Research report summary: Focus groups — Community and special interest. *Myriad Consultancy*, 6 pp. (A report assessing the communication strategy).

Bloomfield, N. (1/2002). A plan for a fox-free Tasmania.

Bloomfield, N. (11/2002). Review of effectiveness of the fox eradication program in Tasmania. (File 079787)

Brennan, W. Communication strategy for making Tasmania fox free (Stage I).

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Bryant, S. Fox-free Tasmanian Action Plan 2002- 2004.

Mooney, N. (1/8/02). The use of 1080 for fox eradication in Tasmania.

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## Appendices

### **Appendix 1- The Fox in Australia: why it is such a menace to Australian wildlife**

#### Preamble

The ecology of predators and their prey can be made out to be very complex, but the essentials are quite simple. Mathematical ecologists, with their advanced maths, are attracted to the subject with the result that in the literature, there are more mathematical papers about predation than facts. This is because predation is such a difficult subject to research in the bush, and thus most models remain untested. Unfortunately, like advertising, if a scientific argument is promoted often enough, it tends to be absorbed over time and thus becomes an entrenched 'fact'. Therefore, it is important to realise that most mathematical models remain products of fertile imaginations restrained by mathematical rules, **and not established facts upon which to base eradication strategies** (see also Appendix 3).

The following account is based on a recent paper by Kinnear *et al.*, (2002) and references therein. I have endeavoured to keep things as simple as possible. Footnotes have been used to help clarify certain terms and concepts.

#### The fox menace

Why should the presence of the fox in Tasmania be viewed with alarm by so many scientists? The reason is this: scientists do not want to see a repeat of the prevailing mainland situation, which has experienced a catastrophic decline of its unique mammalian fauna. Indeed, the Australian mainland has suffered more mammal extinctions, more range contractions, and more population declines than any other continent (Burbidge and McKenzie, 1989). It is now known, albeit somewhat belatedly, that the fox has been a major cause of this unprecedented disaster. This claim has been disputed on the grounds that nature, as a general rule, does not allow predators to cause such havoc. The following account explains why the fox breaks all the rules.

#### The fox as a typical predator

In general, predators in their natural environments are not rampant killers of their prey. For example, studies carried out in Africa involving predators and their prey — e.g., lions and wildebeest; cheetahs and Thomson's gazelle etc — have found the relationships to be

dynamically stable. By that ecologists simply mean that predators and their prey have struck a balance, whereby predators kill some prey, but not so many that would threaten the existence of its prey. Over the long term, prey remain sufficiently abundant, and likewise predators even though both fluctuate in abundance. In Tasmania, the relationships between devils, quolls, raptors, and their natural prey would be dynamically stable<sup>12</sup>, and likewise for the fox and the rabbit in Australia, as well as the fox's prey in the northern hemisphere.

To achieve a dynamic balance between a predator and its prey, adaptations on the part of both partners are required. Rather surprisingly, there is some evidence that pressure to adapt falls mostly on the prey. This seems to be somewhat unfair, but following quotation succinctly supports the logic of this conclusion: "*A rabbit is running for its life, while a fox is running for its dinner.*" Which has more to lose? Clearly the rabbit and those that escape survive to pass on their athletic genes to their offspring. Thus, the onus is on prey to develop appropriate anti-predator defenses<sup>13</sup> if they are to survive. This however, does not happen overnight; evolution is not like fast food.

On the other hand, one would expect predators to show some restraint by being prudent harvesters of their prey. Why destroy ones food supply by needlessly by over harvesting? Apparently some predators never evolved such measures, most notably, members of the dog family (canids). Canids, when given the chance, become surplus killers that kill for the sake of killing. Dingos are well known for this sort of behaviour with sheep and likewise, foxes in a hen house.

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<sup>12</sup> The task of confirming that a given predator-prey relationship is stable is a tough ask, because wildlife populations seldom appear stable. For various reasons, populations decline, increase, cycle, and fluctuate, but still manage to persist — in other words they exhibit dynamic stability. Unfortunately, this makes it very difficult to recognise truly unstable predator-prey relationships. In retrospect, we now know that the fox formed numerous unstable relationships with the mainland fauna, many of which resulted in the extinction or near extinction of the prey. This realisation has only relatively recently come to light, and sadly, only during the last act of a national tragedy that has yet to see the final curtain. In Tasmania, the curtain has been raised, and the first act of another potential tragedy is in progress. It is important that it has a short run.

<sup>13</sup> Anti-predator defenses range from the simple to the complex. A straightforward solution to the fox would be to adopt an arboreal life style and rarely come to ground. Marsupial gliders do this. Other more complex defenses may involve a suite of adaptations. When predators are about, certain lifestyles are untenable because prey would be too vulnerable. For example, before the arrival of the fox, any shady spot to lie up was good enough for a mainland hare-wallaby; it has since disappeared.

In WA, fox control has produced dramatic population recoveries of medium-sized marsupials, and this has led to bouts of surplus killing of rock-wallabies, bettongs, and tammars (pademelon-like wallabies; Short *et al.*, 2002). This seems illogical and wasteful of prey, but apparently, there has been no evolutionary pressure on canids to restrain such behaviour. To avoid such episodes, prey need to possess appropriate anti-predator defenses, which prevent these predators from running amok. Sadly, in relation to the fox, the antipredator defenses of many marsupials are woeful in this regard. Their defenses and lifestyles, which have been honed and fined-tuned in a Gondwanaland setting, are easily breached by this intruder from the northern hemisphere.

### The fox in Australia: A predator turned biocontrol agent

Whenever prey lack appropriate anti-predator defenses, predators can become rampant killers. Mathematical ecologists define such predators as efficient (now and then, mathematicians sometimes forget themselves and use plain english to explain some things). An efficient predator is defined as one that **suppresses** its prey to low numbers including zero — that is, it may drive its prey to extinction. It is able to kill its prey faster than the prey can replace itself regardless of the prey's abundance. An inefficient predator is normally not capable of achieving such ends, a limitation that enables prey and predator to co-exist more or less indefinitely.

Whenever we recognise an efficient predator, we can assign a special name that readily identifies it as such. Efficient predators are in effect, **biocontrol agents** because they are really exercising biological control<sup>14</sup> over some prey<sup>15</sup>.

### The fox as a biocontrol agent

Pest control experts<sup>16</sup> acknowledge that predators can serve as biocontrol agents, but they avoid using them because they tend not to be target specific — that is they not only kill the targeted

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<sup>14</sup> There are many things that control species abundance. Some are environmental e.g., drought, fires, weather. Biological control means that a species (organism) is controlling the abundance of another organism.

<sup>15</sup> Myxomatosis, a virus, is famous for its biocontrol of the rabbit in Australia. It was an outstanding example, especially during the early stages following its release — rabbits disappeared from sight over wide areas. As time passed, both virus and the rabbit evolved attributes that resulted in the virus becoming less efficient. For various reasons this is unlikely to happen in any cases involving the fox and its Australian prey.

<sup>16</sup> Indeed, whenever scientists seek out a biocontrol agent for the purpose of controlling an agricultural pest, they look for those species that have certain properties that make them efficient. Any organism, be

pest species, but kill desirable species as well. The fox on mainland Australia is a classic example, and it's propensity for surplus killing makes it even more efficient. In WA, the fox has been shown to be an indiscriminate, multi-species biocontrol agent of 11 species of marsupials.

### Refuges: a place to hide

By now a question may have come to mind: when faced with a biocontrol agent, what can a vulnerable species do to avoid becoming extinct? The best solution is to retreat to a refuge or safe haven where the predator is denied access and food is nearby. (Another way is to become rare, so rare that the predator switches to some other prey<sup>17</sup> because searching for such a meal becomes unprofitable). In Western Australia, trees, dense vegetation (cover), and rock-piles serve as refuges, but sadly, these safe-havens from foxes do not seem all that secure, because prey numbers are invariably low and recent extinctions are still being recorded. Species that have no access to refuges are doomed to become extinct.

To summarise, the fox in Australia is not functioning as a typical predator in regards to many species of Australian wildlife — instead, it has assumed the role of biocontrol agent. However, this does not mean it is a super predator, for there is no evidence that it has improved its skills as a predator since its release into Australia. For example it is still a very ordinary everyday predator of rabbits. What has happened is that it has landed in country full of hapless “dodos”<sup>18</sup> with the result they end up as fox meat.

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it a microbe, insect, fox or whatever, that restricts another species to low numbers can be considered to be a biocontrol agent. They are all doing the same thing.

<sup>17</sup> This is a poor strategy because rarity makes a species liable to extinction from other causes.

<sup>18</sup> Hapless dodos only because of ineffective antipredator defenses with respect to the fox, but otherwise Australia's mammals are superbly adapted to their environment.

## **Appendix 2- What if eradication fails? Some consequences.**

The following quotation, which was made in reference to invading foreign species in general, describes the Australian mainland scene with respect to the fox with uncanny accuracy:

'Essentially, after an invading species becomes established the ecological 'rules' or processes which operated in a given system change. ... the 'rules' or processes permitting the coexistence of a species complex are drastically altered leading to extinction of native species' (Mooney and Drake, 1989, p.492).

In Tasmania, should the fox become established, we can likewise expect that the existing ecological rules that operate would be drastically altered with tragic consequences. Medium-sized mammals<sup>19</sup> would decline in abundance and distribution, and some would become extinct. Surviving species would be restricted to refuges<sup>20</sup> but their numbers would be low. Most species would disappear from agricultural regions. Ground-nesting/dwelling birds in open country would decline and disappear. More specific predictions follow:

1. During the early phase of establishment when foxes become conspicuous, bouts of surplus killings will be encountered involving prey species that aggregate. Victims will be partly consumed or not at all.
2. It is highly probable that the bettong and the barred bandicoot would be driven to extinction.
3. Populations of pademelons, long-nose potoroos, and southern brown bandicoots would crash; populations would be fragmented, and limited to sites serving as refuges; numbers would be low.
4. Brushtail and ringtail possums would decline and their distribution would become fragmented and limited to woodlands, forests, and treed urban areas. Ground sightings of possums would be uncommon. A closed canopy would promote survival

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<sup>19</sup> In 1989, Burbidge and McKenzie discovered an association between a species average weight and its inability to survive and prosper in post-colonial Australia. They found that species, whose weight ranged between 35 grams and 5.5 kg, were poor survivors. These species were designated as Critical Weight Range species (CWR). Interestingly, the CWR relationship did not apply to Tasmanian mammals. The authors listed several possible causes for the poor survivorship including predation, but it was not emphasised because they believed other factors to be more important at the time. Nowadays predation is recognised as a major cause, but not the sole cause in every case.

<sup>20</sup> Refuges are discussed in Appendix 1.

of ringtails, because this habitat allows movement at the canopy level thus avoiding foxes.

5. Quolls: likely to decline, possibly due to both fox predation, and competition with the fox for food. WA's quoll is of similar size to the eastern quoll, and it has increased when foxes are controlled.
6. Adult devils are not likely to be depredated by foxes (the young, possibly), but are likely to be deprived of food resources e.g., carrion, native fauna. It may decline for this reason. It may also switch to other food sources of agricultural origin.
7. Echidna: will probably decline appreciably, but will persist over a wide area. In WA, echidnas have increased significantly at some sites under fox control.
8. Red-necked Wallaby: because of its size, it should persist in reasonable numbers, but large pouched young and young-at-heel may be depredated. The jury is still out on this species. It has persisted in England in the presence of foxes.
9. Forest Kangaroo: No concern here; too big for foxes. Interestingly, on the mainland, female eastern grey kangaroos with large pouch young are known to be harassed by foxes, which causes the female to eject it's young thus providing a tender meal.
10. Lamb survival will decrease by 2-10 percent — at times more.
11. Business enterprises dependent on fauna-based tourism would be severely impacted. Bankruptcies would follow.
12. Hunters will be deprived of game. New laws will be passed that forbid hunting of some former game species.

Tasmania could blunt the impact of the fox at refuge sites. Costly baiting of refuges and surrounds, where possible, would enable refuge populations to maintain populations at acceptable densities. Fencing may be the only option in some situations — a very costly one.

Broad scale, wide area fox control by aerial baiting of farmland is not an option, and aerial baiting of wilderness areas would presumably jeopardise native carnivores. Baiting would be labour intensive and limited to laying buried baits in and around nature reserves. Baiting is not a solution, it should be seen as a holding operation designed to prevent species from becoming extinct in the hope that some day, biological control of the fox will be achieved

### **Appendix 3- Scepticism about the fox threat: opposing arguments**

When publications identifying the fox as a threat first appeared, scepticism prevailed, but as more evidence was published, acceptance has taken hold. Nonetheless opposition still exists. Opposing arguments tended to focus on environmental damage resulting from European settlement as being responsible for faunal losses on the mainland. It is argued that European settlement produced an Australian landscape so altered and so degraded that is now incapable of supporting much of its original mammal fauna. Other arguments are based on ecological concepts, theories, and/or models that are largely unproven.

#### **The pristine argument**

In essence, the above argument implies that many Australian mammals require near-pristine habitats. Clearly this argument does not hold in Tasmania. It has a comparable history of settlement and disturbance of the original landscape, yet today, Tasmania's mammal fauna is largely intact. Moreover, the degradation argument is further weakened because some Tasmanian marsupials are so abundant they are regarded as pests. The mainland lacks such pests because of the fox is exercising biological control over many species.

#### **The niche argument: sorry no vacancies**

An ecological argument is based on this assumption: there is supposed to be no niches available for foxes in Tasmania because the existing predators namely, devils and the two quolls, already occupy the niches available to predators. In other words, there is supposed to be **no room** for foxes because native predators would competitively exclude the fox.

#### **The saved by the devil argument**

In a similar vein, there is speculation that devils could prevent the establishment of foxes by seeking out fox dens and killing the cubs. An intriguing point indeed, which might be so, but it is pure speculation again.

#### **The Gondwana anti-predator defence system**

Another argument is based on the anti-predator defenses possessed by Tasmania's prey species in response to their native predators, the devil and the two quolls. These home-grown anti-predator defenses are suppose to be transferable, thus enabling native prey species to cope with

the fox. This has not been the case on the mainland, and moreover it does not take into account predator differences.

### The Walt Disney argument: predators are good for prey

Still another argument treats predators as constructive and beneficial agents that help biological communities function smoothly. Predators prevent their prey from becoming too numerous, which if unchecked, would cause prey to exhaust their food supply. Predators are supposed to only cull the oldies and the sick — its nature's way of keeping the prey fit and healthy and to make room for new blood. Walt Disney nature films emphasise this role — nature in the raw is cruel, but sometimes nature has to be cruel to be kind — not to mention the gripping viewing associated with the pursuit and the kill.

Some studies actually have shown that predators apparently take prey that are destined to die anyway — the so-called “doomed surplus”. This surplus is comprised of those individuals that are destined to become that part of a population, which are dispensable and which make no contribution to population growth. In such cases, it does not seem to make any difference to the prey population if predators are present or not (for an Australian example involving foxes and bush rats, see Banks, 1999). However, things do get out hand whenever a predator, such as the fox, becomes a biocontrol agent; it not only takes the doomed surplus, it tends to take the whole lot.

### Summary and recommendations

My expert opinion about these arguments can be summarised succinctly — ignore them! It would be great bonus if these **assumptions and speculations** were indeed true, and if so, nothing would be lost by ignoring them, as they would be helping to eradicate foxes. However, if you base the eradication strategy on any of the above unproven arguments, you stand to fail totally, and absolutely. Procedures based on speculation should not be part of the eradication strategy.