# NSW Flying-fox
# Licensing Review Panel

**Report to**

## Landscapes and Ecosystems Conservation Branch

## NSW Department of Environment and Climate Change

**Panel: Dr. Alice Woodhead, Ed Biel, David O'Shannessy, Dr Len Martin**

**May 10, 2009**

# Executive summary

NSW DECC commissioned an independent review panel to determine whether the current DECC licensing policy for the legal harm (including killing) of flying-foxes in NSW remains valid (environmentally, economically and socially), particularly for the threatened Grey-headed Flying-fox. The Review Panel considered whether:

- The animal welfare issues that result from shooting are acceptable legally and ethically.
- Shooting of the threatened Grey-headed Flying-fox is impacting the viability of the species.
- Shooting is effective in reducing levels of crop damage, in comparison to other available, non-lethal techniques (including full exclusion netting).
- Industry has the capacity to solely rely on netting.

The panel concluded that

- The animal welfare issues that result from shooting as a method of mitigating crop damage caused by flying-foxes are unacceptable ethically and legally.
- It is highly probable that the Grey-headed Flying-fox population is in decline and that any additional mortality can only increase the rate of decline. No matter what the causes, all death, mortalities are additive. Therefore any orchard shooting will hasten decline of the flying fox population, albeit by only a relatively small amount.
- Shooting is ineffective when larger numbers of flying fox visit orchards. Full exclusion netting provides the most effective protection against damage from flying fox.
- The industry could rely solely on exclusion netting, as the means of Grey-headed Flying-fox crop damage mitigation. It is considered unlikely that netting would be erected to any large extent, in the Sydney area, without adequate government grants.

The panel recommends a cessation of the shooting permit system. However, it is important that this be accompanied by financial grants to previous licence-holders to encourage the installation of best practice management netting systems. It is considered unlikely that netting would be erected to any large extent, in the Sydney area, without adequate government grants due to the cost of installing netting and the marginal returns from stone fruit orchards. This could result in the loss of extensive areas of highly productive agricultural land from the Sydney region.

Environmental groups support incentives for farmers to net. Cessation of the licence system, without subsidies, would likely result in a significant increase in illegal shooting. Therefore without subsidies there is likely to be continuing, and possibly greater, animal cruelty issues and detrimental effects on the Grey-headed Flying-fox population decline. Thus there is a very strong case for netting subsidies: they would be good for the orchardists, good for the bats and good for the community and a sustainable future.

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# 1. Introduction

The Department of Environment and Climate Change (DECC) is currently undertaking a review of the NSW licensing regime to harm flying-foxes to mitigate commercial crop damage. DECC established an independent panel to undertake this review. This report discusses the findings of the Review Panel.

## a. DECC's Briefing to the Review Panel

In June 2008, the then Minister for Climate Change and the Environment gave a commitment that the Department of Environment and Climate Change (DECC) would undertake a review of the NSW system to issue licences to harm flying-foxes (generally by shooting) prior to the 2009-2010 fruit-growing season.

This decision was catalysed by calls from groups such as the Humane Society International for NSW to follow Queensland's decision to cease issuing licences to shoot flying-foxes as of 1 September 2008. This decision followed the Queensland Animal Welfare Advisory Committee's finding that shooting flying-foxes as a commercial crop damage mitigation strategy is inhumane. In July 2001 the then Director General of the National Parks and Wildlife Service that following the 2003-2004 fruit-growing season, growers would have to demonstrate that other measures were not available and not workable before applying for a licence. The Humane Society International has foreshadowed legal challenges, on the grounds of animal welfare, should the shooting of flying-foxes continue in NSW.

DECC considers that full exclusion netting is the only reliable method for protecting fruit crops as per the DECC Policy and Procedural Guidelines for the Mitigation of Commercial Crop Damage by Flying-foxes. However, some farmers oppose netting because of perceived expense of erecting and maintaining nets.

DECC is currently undertaking a project in partnership with the Department of Primary Industries to quantify the impact of flying foxes on orchards in the Sydney region (Darkes Forest to Gosford), assess the effectiveness of non-lethal damage mitigation, develop easy methods of estimating damage to orchards that can be applied across NSW and estimate the number of netted and non-netted properties. This project will be completed in early 2009, however, the following issues have already emerged:

- Flying-foxes cause significant damage to stone and pome fruit orchards. The damage in the Sydney region has been heavy recently.
- There are ~50 stone and pome fruit orchards in the Sydney Region with less than 20% of these orchards partially netted and none fully netted.
- The orchardists themselves are generally in their late 40s onwards with little debt. The profit margins are small at around 5% of turnover. They are reluctant to incur debt because it does not add to the value of their properties and will not be recouped because of the large cost of netting.
- Netting these properties can be difficult because the terrain and property boundaries are often uneven and in Bilpin high voltage power lines run through properties making netting unsafe.

- Many of the orchards on the North Coast are netted however industries such as bananas are generally on steep slopes that make netting difficult.

DECC supports the existing NSW Flying-Fox Consultative Committee (FFCC) which includes representatives of the horticulture industry, NSW Farmers' Association, the Department of Primary Industries (DPI), conservation groups, local government and the scientific community.

If a decision is made to change or stop issuing licences, options for dealing with the impact on the horticultural industry should be considered, including transition arrangements to equip orchardists to deal with flying-fox damage without shooting as well as compliance and enforcement arrangements.

## b. Terms of Reference

The Review Panel will provide independent advice and expert opinion to the Director General, DECC and the Minister for Climate Change and the Environment to determine whether the current DECC licensing policy for the legal harm (including killing) of flying-foxes in NSW remains valid (environmentally, economically and socially), particularly for the threatened Grey-headed Flying-fox.

DECC requests that the Review Panel considers whether:

- The animal welfare issues that result from shooting are acceptable legally and ethically.
- Shooting of the threatened Grey-headed Flying-fox is impacting the viability of the species.
- Shooting is effective in reducing levels of crop damage, in comparison to other available, non-lethal techniques (including full exclusion netting).
- Industry has the capacity to solely rely on netting.

## c. Process

**Expert input: Meeting 1 (16th February)**

Flying-fox biology and ecology (Dr Peggy Eby); Grey-headed Flying-fox population viability (Anja Divljan)

Issues for the Horticultural Industry with respect to flying-fox damage, including *Grey-headed Flying-foxes in Orchards* project (Peter Malcolm and Peter Fleming)

Overview of current DECC flying-fox licensing policy and compliance (Ron Haering); On-ground implementation of the policy (Paul Godfrey)

Animal welfare – overview of legislative framework and AWAC considerations (Brendon Neilly;)

**Expert input: Meeting 2 (6th March)**

Horticulturist perspective (John Gough)

Horticulturist perspective (Brian Terrey)

Discussion with representatives of Humane Society International (Nicola Beynon) and Bat Advocacy NSW (Storm Stanford)

Discussion with members of the NSW Flying-fox Consultative Committee (representatives attended from DECC, DPI, Australian Government Department of the Environment, Water, Heritage and the Arts, NSW

Farmers' Association, two horticulturists, scientific community, NSW Nature Conservation Council, Local Government and Shires Association NSW, WWF Australia)

### d. The panel

The panel represents a diversity of interests.

**Dr. Alice Woodhead** is a social scientist with expertise in science policy and critical systems analysis. She advises on a broad range of multi-stakeholder issues in both the corporate and government sectors. Alice worked in agricultural research and science policy for NSW DPI and DAFF Bureau of Rural Sciences.

**David O'Shannessy,**

David OShannessy has been employed by the RSPCA as an Inspector for over 12 years. He is appointed as the Chief Inspector and manager of the RSPCA's Inspectorate.

**Ed Biel**

Ed Biel has been an orchardist in the Sydney Basin for the past 23 years. He has been a member of the Grey-headed Flying-fox consultative committee for 5 years and a member of the Grey-headed Flying-fox National Recovery Plan committee.

**Dr Len Martin**

Dr Len Martin [BSc (Hons I in Zoology), PhD] studied ecology under the eminent ecologist Professor L.C.Birch. Following PhD research on sex-hormone action he researched reproductive biology at The University of Sydney, The Imperial Cancer Research Fund London (heading the Dept. of Hormone Physiology), and the University of Queensland (Dept. of Physiology & Pharmacology) where he began studying flying-fox reproductive biology in 1982. In the course of this he established large, successful, captive breeding colonies. It was knowledge gained from this research that was the foundation for two papers, co-authored with Dr Alan McIlwee, which established the basic characteristics of flying-fox population dynamics. He retired in 1996 as Reader in Physiology at the University of Queensland, but continues to publish. Author of numerous papers in scientific learned journals, he has also refereed many papers for same. He was member, later chairman, of the editorial board of Reproduction Fertility and Development. He is a (founding) Life Member of The Australian Endocrine Society and was inaugural President of the Australasian Bat Society. Since taking up research on flying-foxes he has been deeply involved in many issues affecting their conservation, helping to educate the public about them, and serving as expert witness in three successful court cases against use of electrocution grids in orchards.

# 2. Background

## a. Key stakeholders

- Primary producers (farmers) are a key stakeholder in the Grey-headed Flying-fox issue because of the damage to the crops and consequent impacts on their income.
- Industry associations including NSW Farmers' Association and producer associations have an interest in assisting members to maintain viable agricultural production.
- Non Government Organisations such as animal rights and environmental groups are concerned with the health and welfare of flying-foxes generally as well as effects on the population viability of the Grey-headed Flying-fox.
- NSW Government key agencies are DECC and DPI have legislative and regulatory responsibilities.
- Commonwealth Department of the Environment Water Heritage and the Arts (DEWHA) and the Department of Agriculture, Fisheries and Forestry (DAFF)
- Local communities that live near farms and Grey-headed Flying-fox colonies.

**The culling of FFs is a particularly emotive issue**

Flying-foxes are not the only issue putting pressure on orchardists however feedback indicates that they feel it is an issue that has the potential for resolution

With any complex societal issue, a range of perspectives, often contradictory, exist among key stakeholders groups. Table 1 identifies some of the concerns and perspectives raised in written submissions, by presenters to the panel, and in conversations with a range of stakeholders. The views expressed are not necessarily those of the Review Panel. Some issues raised in these comments are addressed in more detail in the report. Written submissions were received from:

- Australian Veterinary Association
- Bat Advocacy NSW
- Peter Comensoli
- DECC submissions from Ron Haering, Paul Godfrey and Martin Smith
- DPI submissions from Dr Peter Fleming (and Dr Ho Dang) and Dr Peter Malcolm
- Dr Anja Divljan
- Dr Peggy Eby
- Humane Society International
- Nature Conservation Council NSW
- 16 grower submissions

**Table 1** Perspectives of key stakeholders

## Farmers and Producer Associations and individuals

### Shooting

- Low cost option for controlling population
- Shooting enables orchards with low returns to maintain production,
- Effective way to humanely manage Grey-headed Flying-fox, no different to managing other pests, eg. foxes, rabbits.
- What is the impact on the Grey-headed Flying-fox population, dispute that the population is in decline.
- Should be a regular Grey-headed Flying-fox cull, population increasing in Sydney basin
- It is inevitable that some flying foxes are wounded and not killed
- Shooting is effective in circumventing information flow among and between bats regarding the location of food sources in orchards
- Successive Governments have allowed culling of flying foxes and issued growers with licences. If these are removed then compensation similar to fishing industry and buy back of water licences.
- If shooting is taken away then it is inequitable that the farmer be asked to pay the cost (damage to his crop) alone.
- The Grey-headed Flying-fox problem in orchards has increased due to Government Sanctioned development of the eastern seaboard and the removal of forage and habitat. The 'impacter' is Government and the 'Beneficiary' is the community but the orchardist is asked to pay alone.
- The Grey-headed Flying-fox is now permanently in the Sydney area whereas before it was a transitory visitor with only sporadic damage to orchards in the Sydney region.

### Netting

- High cost to install and ongoing maintenance costs. Economic returns from orchards make netting in Sydney region unviable.
- Netting infrastructure can negatively impact on the value of a property
- Difficult to put up nets in some orchards – some state much of Sydney basin not suitable for netting, others state that the majority of properties could be effectively netted
- OH&S, difficult maintaining nets.
- Impacts of nets on crops, disease, pollination of fruit
- Cruelty – some flying- foxes and birds get caught in nets
- Most effective way to manage flying foxes
- Reduces possibility of transmission of disease through the contamination of fruit

## NGO – Environmental and Animal Health

- Inhumane way to kill flying foxes, young stranded in colonies and wounded adults left to die
- Grey-headed Flying-fox is a threatened (vulnerable) species, should not be culled, population in decline
- Do not support shooting, believe no capacity to gain compliance for quotas and not possible to have best practice code for shooting
- Support netting of orchards as humane way to manage production in areas with Grey-headed Flying-fox
- Support for incentive program to encourage netting of orchards

## Community

- Concern about disease and smell from flying fox colonies, especially when close to schools
- Want a cull of flying foxes and to have colonies removed from areas close to urban habitats
- Problem with noise at night from shooting in agricultural production areas - buffer strips between agricultural production in peri-urban areas has decreased over time
- Question safety of using firearms at night in peri-urban areas

### Other issues (all groups)

- Maintain food production close to urban areas to reduce food miles
- Food production in Sydney is no longer commercial. It can be replaced by international imports and production in other regions
- Sydney region Important source of fruit - fills gap in production
- Importance of coastal agriculture, particularly under predicted climate change conditions - increasing water constraints in Murray Darling basin and less impact on rainfall, water resources in coastal areas
- Stress food, orchards provide reserve food source for Grey-headed Flying-fox

## Government

- Grey-headed Flying-fox is the only threatened (vulnerable) species that DECC issues licences to cull
- Other states have banned shooting licences for flying foxes
- DECC - limited capacity to measure compliance of grower quotas – shooting occurs at night
- No code of best practice for shooting – limited data on how growers are shooting flying foxes and managing wounded animals
- Local government – concerns about visual impact of nets in peri-urban landscapes

### b. Data limitations

Data limitations are evident in several areas. In the DECC Background paper it was noted that there was limited or incomplete data on:

- number of current commercial fruit-growers in NSW
- flying foxes population and distribution
- flying fox orchard visiting frequency
- level of shooting licence compliance
- scale and cost of flying fox damage in orchards

### c. Flying-foxes and Fruit production in NSW

The orchard industry in New South Wales is very diverse, both in the crops grown, climatic and agronomic conditions and their locations around the state. There is a long history of flying foxes attacking orchard fruit crops - particularly in Queensland and the North Coast of NSW (Ratcliffe, 1931; Fleming and Robinson, 1987; Loebel and Sanewski, 1987) and Central North Coast of NSW (Palmer 1987). Until relatively recently, the Grey-headed Flying-fox apparently paid only sporadic visits to orchards in the more southern regions of NSW, usually in late spring and summer (Ratcliffe 1931, Comensoli 2002, Biel 2002). They would arrive when native blossom was available and leave when it stopped. They occasionally caused damage to fruit crops in the area, sometimes severe, but mostly relatively slight and infrequent. (Ratcliffe 1931, Comensoli 2002). Shooting on the orchards was available and used as a crop protection measure. This shooting was uncontrolled at first, but then with the legislated protection of the species, under licence. These were issued upon request, once damage was being occasioned.

It is the perception of many growers that, in recent years, there has been a significant increase in the level of damage caused to orchard crops by Grey-headed Flying-fox. Moreover the Grey-headed Flying-fox appears to have changed its behaviour in the Sydney Basin, in that there are permanently occupied camps in at least thee locations, Gordon, Sydney Botanic Gardens and Cabramatta, and other camps that previously emptied in winter are now continuously occupied.

It is interesting to note that the Black Flying Fox (*P alecto*), is now seen with Grey-headed Flying-foxes in the Sydney Botanic Gardens. Previously this species was not known in central coastal New South Wales, it was rarely seen south of the Tweed River. If this species, which shows a preference to fruit over blossom, continues to increase in numbers in this area, damage to crops could become markedly worse. A further reason to install netting. This species extends north, through QLD and across the NT into western Australia. Although once listed as vulnerable in NSW, this is no longer the case and it is unlikely to be listed again because of its extensive northern range and large population base. Its presence in areas previously occupied only by Grey-headed flying-foxes will further complicate the issue of licence compliance because of difficulties of discriminating between the two species at night.

The other species of flying-fox that can cause damage to fruit crops in NSW is the Little-red Flying-fox (*P. scapulatus*) a highly nomadic species whose breeding season is approximately 6 months out of phase with those of the two other species, with births occurring in April-May. The animals only venture south into NSW during the warmer months, sometimes into Victoria. They can occur in huge numbers and their temporary camps can devastate stands of mature trees because of the density of the roosting animals. It is this species that occasionally causes severe damage to orchards in the granite belt, as well as orchards east of the great dividing range, and general dismay in rural communities when they roost in the few remaining trees in the landscape - those in town. Often they will move into camps occupied by Grey-headed flying-foxes, eg., the notorious camp beside the school in Maclean. They usually do not appear in NSW until November and have headed back north by March-April. The public is usually unaware of the differences between the species.

This report is concerned with those areas east of the Great Dividing Range that are the traditional habitat of the Grey-headed Flying-fox, the North Coast (Northern Sector) and the Central Coast and Sydney Basin (Southern Sector).

**Fruit production**

In 2002, NSW produced 16% of the national pome fruit production (465 000 tonnes) (Bureau of Rural Sciences 2003). Similarly, in 2001-2002 NSW produced 20% (32 600 tonnes) of the national stonefruit production (Bureau of Rural Sciences 2003).

In 2006-2007 Australia's horticulture industry comprises fruit, vegetables, nuts, flowers, turf and nursery products. In 2006-2007 it was the second largest agricultural industry in Australia, having a gross value of production of $9.2 billion, ranking behind the meat industry but larger than the drought-impacted grain industry. In 2006-2007, gross value production for bananas was $860m, $590m for apples and pears, $513m for citrus, and $415m for stone fruit (Department of Agriculture, Fisheries and Forestry 2008).

The Northern Sector stone fruit orchards have a total area of 61 ha, with approximately 80 orchard. The Southern Sector orchards have a total area of 300 ha, with approximately 60 orchards (P. Malcolm pers. Com 2009). Data on the area of orchards in the Central sector is not available.

Sydney and the North Coast (Richmond and Tweed) have the highest production (kg) in the state. The Northern sector achieves higher prices ($7kg and $17kg) than the southern sector (between $2.50 and $7/kg), due to the early positioning of fruit in the retail market.

**Northern sector**

The North Coast region (Lismore, Ballina and Byron Shire Council regions) fruit is picked from September through to early November. There were some smaller scale stone fruit plantings on the North Coast in the early years of the colony. The main fruits grown in the region were bananas and other tropical and sub-tropical fruit. It was not until the early 1980's with the advent of low-chill varieties of peach and nectarine from the USA, that larger plantings on a commercial scale were undertaken (Gough pers com 2009).

This region produces very early stone fruit for the Australian market. Soon after the industry was established, it became obvious to the industry that very high levels of damage to their crops were being occasioned by Grey-headed Flying-fox which were endemic to this area. Orchard owners invested in full exclusion netting and all northern sector commercial orchards are now 100% netted.

**Central sector**

The central coast is defined as the area between Coffs Harbour and the Hunter and includes Stuarts Point/Grassy Head.

**Southern sector**

The Central Coast and Sydney Basin produces stone fruit once the North Coast has concluded cropping and prior to the more frost prone southern and inland areas. The district commences stonefruit production in October and concludes in early February. Pome fruit commences in January and continues until the end of April. The majority of stonefruit production is in November and December. During the period up to Christmas the Sydney Basin is the major supplier of stonefruit to the Sydney market. Approximately a quarter of the Southern Orchards are netted, with orchardists relying on shooting licences to manage Grey-headed Flying-fox.

The southern region encompasses areas from Newcastle in the north, south to the Illawarra and South Coast, where low, medium and high chill stonefruit are grown, as well as pomefruit and citrus. The fruit growing areas in this region will be referred to as, 'The Southern Sector' and includes, The Central Coast, The Hills District, The Hawkesbury, Bilpin, Macarthur, Wollondilly and The Illawarra/South Coast.

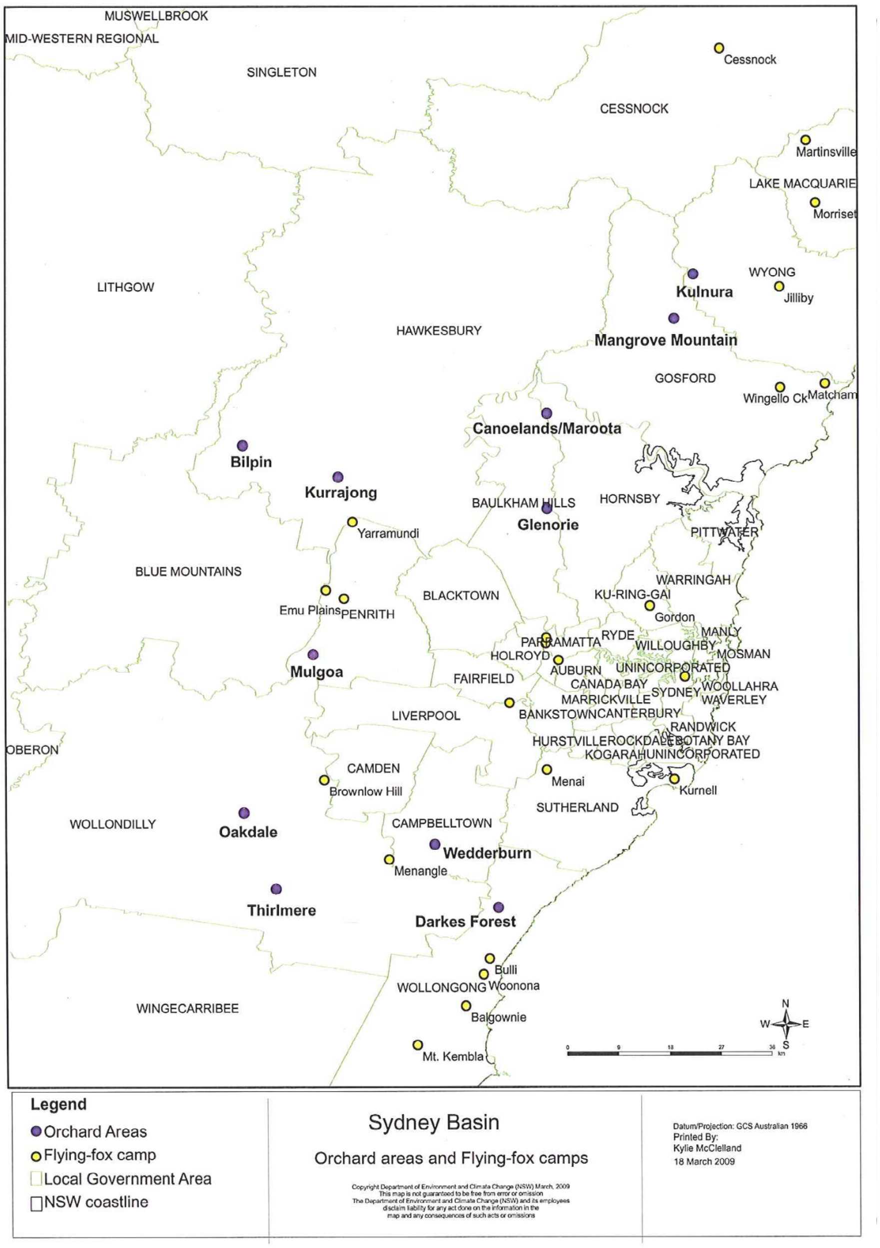


Figure 1 **Map of the Southern Sector orchards**

**Distinguishing characteristics of the stone fruit industry in the Sydney Basin**

It is useful to distinguish the Sydney Basin from the North Coast fruit growing districts. The industry in the Sydney Basin is the oldest exotic fruit growing area in Australia. The first orchards were planted shortly after the arrival of the first fleet. There has been continuous fruit growing in the Sydney Basin ever since. The North-Coast is a relatively young industry having commenced larger scale production in the 1980's.

It has been suggested that, if the stone fruit industry were to disappear from the Sydney area, then the only reliable source of this fruit for Sydney would be imports from other southern hemisphere countries, such as Chile and South Africa. Attempts have been made to grow early stonefruit in northern Victoria and South Australia but due to the occurrence of late frosts in these regions (causing damage to flowers), consistent crops have not been successful.

The pome fruit industry in the Sydney Basin is concentrated in the Bilpin area, with some apple production occurring high on the escarpment in The Illawarra, and in the Wollondilly shire. These areas, because of their altitude, provide enough 'chill hours' (Temperature below 7 degrees C) to set and grow good quality early apple crops.

In conjunction with Stanthorpe (Queensland), the Sydney area provides the first 'new season' apples, on the market. As such, the fruit attracts premium prices. If the Basin production were to disappear, then Sydney would be limited in early season apples. Stored apples, picked the previous season, from other districts could replace these.

Lakesland in the Wollondilly Shire, produced the first cherries in the Sydney market for many years, but commercial production has now ceased, mainly due to losses to flying foxes becoming unsustainable (Fergusson 2009 pers.comm.)

### d. Urban agriculture

There is an appreciation among some members of the community and government of the value of retaining and indeed encouraging agriculture nearby large cities (Gillespie and Mason 2003,Grosskopf 2000). In North America there has been assistance for farmers adjacent to cities, to retain their production and indeed to increase it. Initiatives such as the creation of Transferable Development Rights, grants and taxation concessions have been used to ensure continuation and viability of such farms. (Daniels & Bowers 1997, Grosskopf 2000)

Land values in the Sydney region and coastal NSW are significantly higher than land values in other parts of NSW. Higher land values are limiting the capacity of orchardists to expand operations. Daniels and Bowers (1997) the Cycle of Farmland Conversion, comment *"as the density increases in previously predominantly agricultural areas, the impact upon agricultural operations can exponentially increase. The greatest impact of increasing residential development is not just the potential loss of farmland, but the impact on existing farm operations. An increase in the number of non-farm residences in rural areas can often place greater pressures upon farm operations, making it more difficult for them to continue or expand."*

A range of benefits are attributed to urban agriculture, they include

- Cultural - maintaining traditional farming activities in urban areas close to major cities. Connecting consumers to food production; Education of children about food production

- Landscape - maintaining open spaces for food production as well as for wildlife and parks; farmers can provide effective management of weeds and feral animals.
- Health and nutritional benefits of fresh, local food.
- Environmental – improving resource efficiency by reducing food transportation (food miles). Needs to be tempered with understanding of full life cycle analysis for each crop.

**Emerging markets in urban areas**

Sydney and northern NSW orchards are close to transport networks. An increasing number of growers are taking advantage of their proximity to Sydney and north coast urban areas by selling their fruit directly, either by delivering to retailers, selling at farmers markets, or on farm sale. There has also been an increase in, 'pick your own' operations as well. Growing recognition by consumers, of 'food miles' and 'carbon footprints', in moving food over long distances, is aiding the expansion of consumer interest in locally grown food.

The proliferation of farmers markets in Sydney, the growth of "harvest trails" and the growth of the, "slow food movement", are examples of farmers obtaining far better prices than just supplying the wholesale market with their produce. Smaller growers mainly carry out this type of selling. The larger growers are generally supplying the wholesale sector through the Markets at Flemington.

# 3. Terms of reference

## TOR 1 - Animal Welfare

**The animal welfare issues that result from shooting are acceptable legally and ethically.**

There is no doubt that the issuing of licences to harm Flying foxes to mitigate commercial crop damage is a complex and emotive animal welfare issue with the views of the animal welfare and rights groups being diametrically opposed to those of the orchardists.

The animal welfare and rights groups hold the view that shooting Flying Foxes in an effort to limit crop damage is unacceptable, unethical and inhumane on animal welfare grounds, where a proportion of orchardists at least believe it is a necessary and humane management technique which is essential for the protection of their crops and the survival of un-netted orchards.

While there is general acceptance that there is a requirement and necessity to control and manage vertebrate pest animal species for various environmental and primary production reasons , there is a community expectation that these programs are conducted so that the target species are managed in a manner which causes them no unnecessary pain distress or suffering. This expectation is essentially mandated in the Prevention of Cruelty to Animals Act 1979. (POCTA - 1979)

### a. Legislative Framework.

The objects of the Act (POCTA - 1979) are to prevent cruelty to animals and to promote the welfare of animals by requiring a person in charge of an animal to provide care for the animal, and to treat the animal in a humane manner, and to ensure the welfare of the animal. The legislation recognizes that while certain activities such as hunting, shooting , catching, capturing and destroying animals may be necessary, they must be conducted in a manner that inflicts no unnecessary pain upon the animal, (where pain is defined as distress or suffering). Failure to do so may render an individual or corporation liable to prosecution under the Act for animal cruelty offences where the maximum penalties are 2 years imprisonment and / or $22,000 fine for individuals or fines of up to $110,000 for corporations.

In addition to the provisions of the Prevention of Cruelty to Animals Act, Section 91 of the Threatened Species Conservation Act 1995 and Sections 120 and 121 of the National Parks and Wildlife Act 1974 allows the Director General to issue a general licence to harm any animal that is a protected or threatened species for the welfare of the animal or if there is a threat to life or property. In addition a specific Policy and Procedural Guidelines for the Mitigation of Commercial Crop Damage by Flying-foxes was prepared by the Department of Environment and Climate Change. This document prescribes the procedures for the management of Flying-foxes in commercial fruit crops and underpins the issuing of licences to harm flying-foxes to mitigate commercial crop damage.

With respect to the Section 120 General Licence to harm flying-foxes, there are specific and strict licence conditions that relate to animal welfare. These include conditions;

1. The licensee and other persons authorized under the licence must use a 12 gauge shotgun using number 4 lead shot to shoot flying foxes in accordance with the licence.

4. The total number of Black, Grey-headed and Little Red Flying-foxes harmed under this licence by the Licensee and all other persons authorized under this licence must not exceed the total number for Black, Grey-headed and Little Red Flying-foxes specified. The total maximum number of individual flying foxes of any species harmed under this licence must not exceed the total number specified.

5. The licensee must keep a true and accurate record of all flying-foxes shot utilizing the FFRS provided by NPWS. Each entry must be recorded within 24 hours of the shooting of the animal. The FFRS must be produced for inspection upon request by an officer of the NPWS at any time. A legible copy of the FFRS must be sent and received by the NPWS staff at the office from which the licence was issued no later than 1 week of the expiration date of the licence.

6. The licensee and all other persons authorized under the licence must locate each animal shot and promptly alleviate the suffering of any injured flying fox by gunshot to either the head or thorax of the animal.

9. The licensee must provide reasonable access to the land(s) specified by this licence for inspection by an officer of the NPWS at any time.

The Policy and Procedural Guidelines for the Mitigation of Commercial Crop Damage by Flying-foxes actually states that the DECC will issue licences to property owners to harm a limited number of flying foxes by shooting only. These licences are issued with the understanding that the farmer will shoot to scare and that some incidental harm is likely to result from this activity. This statement is, itself at odds with humane vertebrate pest control procedures and policies in that shooting to scare with incidental harm is unlikely to result in the death of target animal without causing pain or distress. In practice, licences issued “to harm” are actually licences issued “to cull” a specific number of flying foxes.

### b. Humaneness of Culling.

There are a large number of variables which have the potential to influence the effectiveness, efficiency and ultimately the humaneness of culling flying-foxes by firearm. These include the type of firearm, skill, training or experience of the operator, the environment, and the physiology and anatomy of the flying foxes.

Although there are no Standard Operating Procedures specifically for the shooting of flying-foxes, the licence conditions dictate that a 12 gauge shotgun with No. 4 Lead Shot be used. There is however no recommendation as to the choke configuration, (should it be ½, ¾ or full) and the subsequent effective range of the firearm. In addition there are no competency standards, accreditation or skills tests associated with the issue of licences.

While it is unknown what procedures are adopted by individual orchardists within the industry, it is accepted that some are conscious of their animal welfare obligations and adopt procedures designed to reduce adverse animal welfare outcomes. Although not independently assessed or evaluated these procedures are reported to include operations where a shooter and a spot-lighter with a high powered spotlight work co-operatively identifying individual flying fox within a maximum range of 30 metres and shoot using a 12 gauge shotgun with full choke configuration and 32 – 36g No. 4 shot ammunition, in an effort to ensure that they are humanely euthanased and if where individuals are wounded take the appropriate action to ensure that they are euthanased quickly and humanely.

A Standard Operating Procedure and Code of Practice has been developed and published for the Shooting of Pest Birds (Sharp & Saunders – 2005). While the general principles contained in the SOP might be applicable to any shooting operation, due to the inherent differences between birds and flying foxes and the variable conditions and circumstances under which they might be shot, the bird SOP cannot be relied upon for the shooting of bats. The development of specific SOP's for flying-foxes are recommended.

The nocturnal feeding behavior of flying foxes and licence conditions dictate that the shooting has to occur at night and depending upon the shooting procedures adopted it can be inherently more difficult to identify target species, ensure only targeted animals are shot, direct the shot at a moving, small dark colored target and if the animals are not killed outright, search for, locate and humanely euthanase injured animals.

The physiological and anatomical differences between flying foxes and birds of a similar size also have implications for the broad application of the SOP. Flying-foxes in contrast to birds do not possess pneumatised bones or air sacs making them much denser (Booth 2007 & Parsons PhD) this may result in pellets not penetrating a Flying Fox's muscle mass to the same extent and may cause a higher rate of non lethal shots. The body mass to surface area ratio of flying foxes also has implications for the humane destruction of flying foxes in that there is a relatively small target area (for humane euthanasia) and a large wing span. Depending on the accuracy of the shot it may suffer wing membrane damage or an injury that doesn't result in the death of the animal without unnecessary pain distress or suffering.

It is also important to appreciate that it is not only the welfare of the target animals that needs to be considered. Given that the final stages of pregnancy, birthing and rearing coincides with the fruit harvesting season, (Booth 2007; Mcllwee and Martin, 2001; Martin & McIlwee, 2002) it is likely that a high proportion of animals entering the orchards in search of food will be lactating mothers with young attached or left in a crèche at the camp. Therefore in the event of death of injury of the females any attached young and those orphaned at the camp will die of starvation. (L. Martin pers. Comm. Cited in Booth 2007)

### c. Monitoring / Compliance.

The Policy and Procedural Guidelines for the Mitigation of Commercial Crop damage by Flying-foxes' details the Compliance and Monitoring functions which will be performed by DECC Staff. However limited resources and difficulties associated with field inspection causes the existing policy to be essentially unworkable, as crop protection occurs at night when visibility is poor, property access is often limited or restricted, the rostering of staff is complicated and dictated by budget and the necessity to meet other responsibilities or functions within the Region. In addition as shooting operations obviously involve firearms it is desirable that compliance operations are conducted with Police assistance, which rarely occurs due to their limited resources and workload.

The assessment of Flying Fox Record Sheet (FFRS) returns is an area that can be relatively easily managed and monitored. However given that exceeding the permitted number of animals to be harmed is a breach of licence conditions and therefore illegal, the accuracy or reliability of the returns is unknown and impossible to verify. In addition substantial deliberate unlicensed destruction has been reported. (Draft National Recovery Plan - Wahl 1994, Varden and Tidemann 1995, Richards 2000, McLachlan 2002, Waples 2002, Ballard 2004). The unlicensed shooting of flying foxes in orchards is also unlikely to be reported due to fears of reprisal or complacency caused as a result of licensed shooting occurring in the same area at the same time.

### d. Animal welfare research.

Until recently there was very little information available to qualify and quantify the humaneness of shooting as a method of mitigating commercial crop damage caused by flying foxes.

In a recent study (Divljan, Jones and Eby - 2009) a number of Grey Headed Flying Foxes were collected from an orchard following a licensed shooting mitigation program. In the 2007 to 2008 the producer was licensed to harm a total of 110 Grey Headed Flying Foxes and his FFRS return indicated that a total of 105 Flying foxes were harmed. It is alleged that the licensee believed that he was acting within the bounds of normal acceptable practice and gave permission for the bats to be collected. In total, 164 dead or injured bats were observed during the collection process. Of these, 146 dead or injured bats were collected and removed from the orchard in November 2007. Of these bats, 44 were alive at the time of collection and 34 of these were euthanased as a consequence of their injuries. The study also detailed the injuries of a proportion of the dead and injured bats. The fact that several hours after the shooting concluded, 34 bats were retrieved alive and required euthanasia clearly demonstrates that the circumstances under which these animals were shot cannot be viewed as humane or appropriate on animal welfare grounds.

**Conclusion.**

Currently Standard Operating Procedures or Guidelines for the humane culling of Flying Foxes have not been developed or adopted and while a proportion of orchardists may adopt “best practice” procedures, it has been demonstrated that some shooting operations result in unacceptable animal welfare outcomes where injured animals are not promptly shot to alleviate pain distress and suffering.

The current monitoring and audit activities are ineffective in assessing compliance with licence conditions. Nor does it provide any measure or detail on the animal welfare issues which result from shooting.

In addition, despite the best efforts of orchardists, a proportion of young flying foxes will ultimately be orphaned at the camp and die of starvation as a consequence of shooting.

The animal welfare issues that result from shooting as a method of mitigating crop damage caused by flying-foxes as they are currently undertaken are unacceptable ethically and legally.

## TOR 2 - Species Viability

**Shooting of the threatened Grey-headed Flying-fox is impacting the viability of the species.**

### a. Flying-fox biology in relation to orchard "culling"

***1.1 Introduction***

It is clear that many fruit-growers (see growers' submissions) regard Grey-headed Flying-foxes as being in "plague proportions" and think that their numbers are increasing (see full treatment of this aspect below).

It is important, therefore, in any panel recommendation, that it is emphasised that the animals' limited reproductive potential (one young per year; three years before sexual maturity) does not allow the population to increase rapidly (see Appendix 4), and that the large numbers of animals that appear at irregular intervals to cause severe damage to orchard crops reflect animals moving into an area, often from long distances, because their natural food is in short supply (See Appendix 1; McIlwee & Martin, 2002; Martin & McIlwee, 2002; Eby personal communication).

The corollary to this is, that when large numbers of animals ***do*** appear in orchards, shooting is unlikely to reduce the local flying-fox population - other animals will simply replace them by migrating into the area - furthermore, when such large scale attacks occur, there seems to be consensus among growers that shooting is ineffective in preventing damage .

***1.2 Increasing Damage to Sydney Basin Orchards from Grey-headed Flying-foxes***

Reports of flying-foxes attacking orchard fruit in the Sydney area go back to the early days of the colony. Nevertheless, growers in the Sydney Basin report flying foxes as an increasing problem (growers submission) - something that gives foundation to their views on flying-fox numbers and increasing population size. It appears that growers see the time frame over which this increase has occurred as the last 15-20 years. Despite the accepted difficulty in quantifying flying-fox damage to orchard fruit crops, there are good reasons to accept that such increases in damage are real.

There is a general consensus that severe flying fox attacks on orchard crops occur when there is a failure of the animals' natural food supply - notably low or zero nectar flow in the eucalypt forests on which the animals feed. There is continuing diminution of the animals' natural food supply (see below) and this is likely to be exacerbated by climate change, irrespective of whether climate change is man-made or not. The southern extension of the Black flying-fox into the Sydney area is also likely to put more pressure on natural food resources and thus more pressure on Grey-headed Flying-foxes to enter orchards. Needless to say, eventually, Black Flying-foxes will be in there doing damage with the Grey-headeds, making shooting of the latter (vulnerable) species even more problematical - identification before shooting - compliance etc.

Another contributing factor may be the increasing numbers of flying-foxes that are roosting in urban sites, such as Gordon and the Sydney Botanic Gardens. Furthermore, some camps that previously emptied during winter, now remain occupied throughout the year (Eby, personal communication). Guaranteed food supplies from backyard blossom and fruit, and minimal persecution, are thought to underlie this trend. It may be that increasing sub-urbanisation in the Sydney basin is bringing foraging paths (many km/ night) closer to what previously were exclusively rural orchards. Nonetheless, there are no firm data to support this hypothesis.

***1.3 Conclusion***

There is the likelihood of a future with frequent and ever-increasing flying-fox incursions into orchards to levels at which shooting is ineffective in protecting crops, and increasingly impracticable.

## b. Protecting orchard crops by methods other than expensive netting

Despite the success of properly erected exclusion netting elsewhere in NSW & QLD, Sydney Basin growers have expressed many concerns about its use - most of which (cost apart) are not justified, or are easily remedied. In particular, bats and birds do ***not*** become entangled in ***properly erected exclusion netting***. This must be emphasised because at least one grower has suggested that if shooting is banned, and properly erected exclusion netting is so expensive, growers would be likely to use loose drape nets - and these ***do*** raise major cruelty issues because of the horrendous manner in which flying-foxes become entangled and severely injured (L. Martin, personal communication).

Growers are understandably disappointed that there has not been more money put into research on chemical and other deterrents that might prove to be much cheaper than netting. However, what little that has been done, largely in Queensland, does not appear to offer any great hope, let alone any rapid solution.

Three Queensland reports (Greimel; Rigden, 2008; *Flying fox control methods research findings,* QLD DPI) detail the general effectiveness and benefits of exclusion netting in protecting orchard fruit, and discuss the ineffectiveness of alternative methods of protection. One method which has received some attention is re-using the now-banned "humane" flying-fox electrocution grids in a non-lethal form - an idea which on the face of it has some merit. Unfortunately the design of many existing grids virtually guarantees their ineffectiveness as deterrents (see Appendix 2). That is not to say that ***properly designed deterrent grids*** would not be effective.

## c. Do orchards serve as an essential food source for grey headed flying fox? Would netting (by reducing food supplies) impact the Grey-headed Flying-fox population

These questions cannot be answered with any certainty, but probably the answers are negative to both. The newly received report of Dang and Jarvis (2009) includes analyses flying-fox faeces (Brooks 2008) which show that the major food sources are natural and orchard minimal [though these analyses were not made during a "bad" flying-fox season]. Lack of access to orchards might increase the probability of

***some*** flying-foxes dieing; shooting in orchards ***guarantees*** that some will die - and possibly many. In the long term it is essential that there are sufficient natural food sources available for the species survival. In times of blossom failure, orchardists could perhaps market substandard fruit to DECC to place for starving animals to feed on. During a 1990 flying-fox food crisis in SE Queensland animals were found dead on out-side cages of captive flying-foxes at the University of Queensland's farm at Pinjarra Hills as they tried to get to buckets of fruit inside. Wild animals were caught simply by hanging food buckets in empty cages with the doors open!

## d. Is shooting of the threatened grey headed flying fox in orchards impacting on the viability of the species?

***4.1 Evidence from Population Counts***

As discussed above, fruit growers are sceptical of claims that the Grey-headed flying-fox (Grey-headed Flying-fox) population is in decline. Some question the accuracy/veracity of the annual population counts made from 1998 to 2005, and it has been suggested (see grower submissions) that counts were stopped after 2005 because they showed that the population was increasing! The difficulties attendant on gaining accurate counts of the Grey-headed Flying-fox population are well known and this panel member (LM) is satisfied that the high 2005 value resulted from employment of inexperienced observers plus the inclusion of data from previously undiscovered camps. Nonetheless there is no denying the fact that these data ***do not*** demonstrate a systematic decline in numbers over the period of study.

| | |
|---|---|
| 1998 | 400,000 |
| 1999 | 355,000 |
| 2001 | 320,000 |
| 2003 | 435,000\ |
| 2004 | 425,000 |
| 2005 | 674,000 |

Apropos the high 2005 count, some simple sums demonstrate that the species does ***not*** have the capacity to increase from 425,000 to 674,000 in one year ***by reproduction alone***.

***4.2 Evidence from Studies of Population dynamics of Flying-foxes***

Much has been made of a submission by Dr Anja Divljan that purports to demonstrate a rapidly declining Grey-headed Flying-fox population. However, there are flaws in the calculations that invalidates this conclusion, though in itself, the predicted decline is not unreasonable. In particular, Dr Divljan has used a "Standing Age distribution" as though it represents "Age-specific mortality". This is only correct if the population is stationary. Since there is no evidence that this is the case - indeed the author uses the data to "demonstrate" that the population is in decline - the calculations are not valid.

In order to deal fully with the problems that this raises, theoretical modelling of flying fox population dynamics is detailed in Appendix 3.

As Dang & Jarvis (2009, p.29) emphasise, "**In order for the Government policy on sustainable management of this animal** [to] **withstand legal scrutiny, the scientific evidence of the population decline and the cause for the declination should be provided. The shooting of flying foxes in orchards might not be the major factors** [*sic*] **causing decline (if any decline at all). Other mortality factors have not been studied and carefully considered in the national population count**".

### *4.3 Comparison of the impact of various factors, including orchard shooting, on the Grey-headed Flying-fox population*

In discussing putative effects of NSW orchard shooting on the Grey-headed Flying-fox population it is important to recognise that the species is naturally long-lived and has a low reproductive rate. Thus increased mortality impacts much more severely on the population than decreases in breeding success.(McIlwee & Martin, 2002; Martin & McIlwee, 2002).

***Any*** anthropogenic mortality (like orchard shooting) will impact negatively on the population - adding to "natural" mortality and speeding any population decline.

It also needs to be recognised that for such a wide-ranging animal, any action in NSW impacts on the whole Australian Grey-headed Flying-fox population - the NSW Grey-headed Flying-fox population does not exist in isolation - it is part of a dynamic continuum running from Victoria to Queensland.

On the basis of flying foxess' fecundity, "natural" life span, and age-to-sexual maturity McIlwee & Martin (2002) found that an annual breeding success of 80% with an annual age-independent mortality of 20% would give a stationary population (See also Appendix 3). They argued that such figures reflected the "natural" levels operative during the animals' evolution and that, prior to European settlement, flying fox populations would have experienced an average per annum mortality of about 20%.

Present day “natural” mortality experienced by flying foxes is likely to be significantly higher as a result of habitat destruction, reduced food sources and roost sites, augmented by a significant level of human-imposed mortality: electrocution on power lines; entanglement on barbed-wire fences/ in loose netting; shooting; maternity-roost disturbance and destruction, plus an increasing frequency of massive heat death events associated with increasing temperatures (Alexander, et al., 2007; Chambers. & Griffiths, 2008).

Given the lack of any recent definitive data on the rate of decline of the NSW Grey-headed Flying-fox population, we must consider scenarios based on ***likely population size*** and contributing factors such as:

*average breeding success*;

*disease;*

*diminution of natural food resources*;

*loss and degradation of optimal roosting habitat*;

*increased mass heat-death events*;

*competition from the Black flying-fox (Pteropus alecto)*

*likely numbers of Grey-headed Flying-foxes being shot in orchards.*

### *4.3.1 Average breeding success*

Eby's data over 11 years, with 6-8 camps per year, gives a mean breeding success rate of 73.7% (s.e. = 2.6, n = 78). With an annual age-independent mortality of 20% (the hypothetical "natural" rate) a breeding success of 70% produces a population in slow decline. Thus it may be argued that virtually ***any*** human-imposed mortality, or human-imposed decline in breeding success can only produce an increased rate of population decline.

### *4.3.2 Disease*

Historically there are no reports of massive deaths of flying foxes associated with disease. The recent discoveries of Hendra virus and Australian Bat Lyssa virus have led to concerns among growers as well as the general public. The recently promulgated theory that ecological stress increases the incidence of disease in flying foxes appears to have no firm foundation.

***Hendra virus*** is endemic in Australian flying foxes and does not appear to cause any serious disease in the animals. It is important to note that it is not transmitted directly to humans, ie., bat to human transmission does not occur. Prior to the discovery of ***Hendra*** there had, over decades, been many thousands of flying fox-human contact hours without incident, and a sample of over a hundred flying fox carers and investigators, this panel member (LM) included, showed no immunological signs of infection with the virus. The only human cases have resulted from infection via infected horses - and the way in which the latter become infected remains a mystery. Apparently, in a recent ABC *Catalyst* program on ***Hendra***, it was stated that an attempt to artificially infect a horse with the virus had failed! It should be noted that exclusion netting prevents/ minimises contamination of fruit with flying fox faeces and urine.

***Australian Bat Lyssa virus*** (***ABLV***) is a form of ***Rabies*** and sufficiently closely related to "***Classic Rabies***" that humans are protected against it by vaccination with standard anti-rabies vaccine. It was discovered in the course of the search for the natural host of ***Hendra*** virus in the late 1990s. Infection can ***only*** occur via a bite or bat-saliva contaminated scratch; infection ***cannot*** occur via contact with, or ingestion of, flying fox faeces or urine.

***ABLV*** seems also to have been long present in Oceania. "Oceania" rather than "Australia" because of the pre-discovery epidemiology - a complete absence of any previous cases among the carer-investigator community - a situation which remains altered by retrospective (searching back through medical records) studies.

The first human ***ABLV*** death was attributed to a flying fox bite but later investigation showed it to have resulted from a micro-bat bite. It is now known that there are two distinct strains of ***ABLV*** - one characteristic of flying foxes, one characteristic of micro-bats - the main evidence that it has been around a long time in these animals. Martin (2003) discusses these aspects in more detail. In view of the pre-discovery epidemiology, it is suggested that ABLV may have been endemic to northern Australia and only spread into southern regions recently, or even that it has only moved into Australia recently. To LM's knowledge There appear to be no data relating to ***ABLV*** mortality rates in Grey-headed Flying-foxes.

### *4.3.3 Competition from the Black flying-fox (Pteropus alecto)*

This is a much greater threatening process than any one anticipated at the time the listing of the Grey-headed Flying-fox was being discussed. Blacks are moving south very rapidly and in increasing numbers. Grey-headed Flying-foxes are not competing successfully.)

### *4.3.4 Diminution of natural food resources*

At the time the Grey-headed Flying-fox was listed as vulnerable there had been massive clearance (on private land) of major food resources. Subsequently clearing rates have dropped but clearing continues. All vegetation communities that are important winter (pregnancy)/ spring (birth and lactation) food sources for Grey-headed Flying-fox are classed as "endangered ecological communities" in that only 30% remain (Eby, personal communication). The vegetation types that provide winter food sources are largely on privately owned land, poorly represented in conservation reserves. It has now been established that in years of severe food shortage, body weight in many individuals drops below a sustainable level - the animals cannot fly out sufficient distances to feed. Loss of native vegetation continues in the few areas in the range of Grey-headed Flying-foxes where such things are monitored – such as SEQ. Coastal lowlands will continue to be particularly affected by development. Therefore, ***key winter feeding habitats*** will continue to be particularly affected. Perhaps most significantly, there is direct evidence that Grey-headed Flying-foxes continue to experience winter food shortages. The last wide-spread and intense event was in winter 2007. Reduced natural food sources (reductions in nectar flow and rainforest fruit production) are accepted by the scientific community as inevitable outcomes of climate change.

### *4.3.5 Loss and degradation of optimal roosting (camp) habitat*

Loss and degradation of roosting habitat continues, though the number of sanctioned dispersals from camps has diminished. However, ***optimal*** roosting habitat has not been conserved. Recent experiences in the Tweed, where the vegetation of three camps has been illegally cleared or poisoned in the past four years, confirms that roosting habitat is not being protected. These are not the only examples. Thus the camp at Moorland was felled this summer to widen the Pacific Highway. There is ongoing conflict with humans at camps – the list of current points of conflict in NSW is long. Loss of ***optimal*** maternity roost sites must reduce breeding success as well as exacerbate the effects of extreme high temperatures.

### *4.3.6 Increased mass heat-death events*

Natural catastrophic events, such as droughts and heat waves were cited by Ratcliffe (1931) as having the potential to cause heavy mortality, but appear to have been rare with only two documented incidents prior to 1994 (Ratcliffe, 1932). Over recent years such events seemed to have increased in frequency. Environmental stress may also disrupt reproduction in that late-pregnant flying-foxes are highly prone to abort (Dukelow *et al.,* 1990). Hall (personal communication, 2000) observed mass abortions in camps of these species in SE Queensland; 2,000 out of 12,000 females aborted near-term foetuses in Beenleigh (QLD) in 1978. He also observed large numbers of aborted foetuses in the Indooroopilly (QLD) camp in 1983, and numerous bats were found dead, and foetuses were aborted, during a winter failure of blossom in 1990 (Hall *et al*., 1991).

There is consistent evidence that Grey-headed flying foxes begin to die at ambient temperatures >40°C and that rates of mortality increase steeply at temperatures >43°C. Recent increases in Australian average summer temperatures, with concomitant increase in frequency of extreme high temperature events (>42°C) are now well documented (Alexander, *et al*., 2007; Chambers& Griffiths, 2008), and are associated with increased frequency of Grey-headed Flying-fox heat-death events. Dr Divljan discusses the issue extensively in her thesis using Dr Eby's data, but also provides evidence of the high death rates that can occur from extreme hail events.

Dr Eby supplied details of these events plus contour maps of maximum temperatures (Australian Bureau of Meteorology) for the past seven years. Six cover the entire range of Grey-headed Flying-foxes and are compilations for 12 month periods. Thus they show maximum temperatures reached during one complete summer. In summary Eby states that:

"*A substantial number of heat-related deaths were recorded in five of the past seven summers. There was only one summer when no deaths were recorded, although... there were deaths in the Melbourne camp that year.*"

"*In each year, few occupied camps were checked and the counts I've given you are underestimates. I predict that >4,000 animals died in four of the past seven summers and that total deaths exceeded 8,000 in at least one year… you can imagine searching for bodies in and around a camp - during and after one of these situations. It is an imprecise process at best. The numbers I have given you are all underestimates of the numbers that died in the camps that were checked. I know that they are still finding bodies in Melbourne this year - and the same was the case for months after the Bellingen event in 2004.*".

Since we do not have data from so many camps that have experienced heat-death events it is difficult to estimate the effects on the ***total*** population, we can only use estimates. Thus, with a putative population of 320,000 - 5000 heat deaths per year gives a mortality rate of 1.56% which, added to the "natural" rate, gives a total annual mortality of 21.56% - though as discussed in the next section the ***actual*** population may be larger and the ***actual*** heat-death mortality rate lower (1.29% & total 21.29%).

### *4.3.7 Other evidence of population decline*

The highly anomalous *standing age distributions* in the *Divljan* thesis and shooting report may indicate excessive mortality among younger animals. Most standing age distributions decline monotonically. Despite the different times and different sources of the samples, all distributions show marked deficiencies in younger age groups - this panel member (LM) does not have the expertise to make any authoritative statement on this. Nevertheless there may be a time trend here. In the 1999-2007 "found dead around the Sydney Basin" sample, the greatest age-class deficit (relative to older age classes) is 2 yr olds then 1 yr olds - there is ***no*** major deficit in 3 yr olds. In the February 2006 - April 2007 "lived trapped in the Sydney Botanic Gardens",sample the major deficit is 2 yr olds ***then*** 3 yr olds. In the November 2007 "shot in an orchard" sample ***the outstandingly major deficit is 3 yr olds*** then 2 yr olds then 1 yr olds. Could this reflect a pattern of recently increasing cataclysmic losses of young from extreme heat? The data warrant further analysis. Yes, it could all be down to sampling errors, movements of young in and out of camps/ orchards, but it could also be an indication of large and sporadic deaths of young from heat and/or hail.

### *4.3.8 Likely numbers of Grey-headed Flying-foxes being shot in orchards.*

This question relates to the whole Grey-headed Flying-fox population, not just that in the Sydney Basin, so it is whole-of-state orchard shooting that must concern us (as well as what might be happening in Victoria & Queensland). But it is the NSW Grey-headed Flying-fox population that is critical - because, at the time that orchard shooting is taking place, the bulk of the Australian National Grey-headed Flying-fox population is in NSW, ie., ***the shooting of Grey-headed Flying-foxes in NSW orchards is a National problem.***

The NSW quota allows 3040 bats to be shot per year (with "20% held in reserve"). This is based on that minimal population estimate of 320,000 bats and theoretically constitutes 1.5% of the population. However the population may be higher - the mean count for 1998-2005 being 434,833. However, that includes the suspect 2005 high value. If that is excluded the mean becomes 387,000 - still higher than the figure on which the quota is based. Thus it may be argued that the quota is ***actually*** less than 1.5%, and the numbers of bats ***actually*** shot an even lower percentage of the population. Again there is a numbers problem. How many Grey-headed Flying-foxes are ***actually*** shot each year? How accurate are the growers' returns? How much illegal shooting is occurring?

From growers' returns for 2001-2007 an average of 1,536 bats/year were shot; a nominal 0.48% of the population. However there is great difficulty in policing compliance. It is often difficult for growers to get licences at short notice, ie., when they may urgently need them, and human nature being what it is - particularly when one's livelihood is at stake - who knows what might go on. And yes, there are, apparently, frequent reports of illegal shooting. As well as intentional under-reporting - and from LM's experience with QLD growers licenced to kill flying foxes - this can be gross (see Dr Booth's submission on this subject). In support of this view the number of bats shot in the NSW orchard involved in the report on gunshot injuries to Grey-headed Flying-foxes seem to be inconsistent with the returns for that area in that year. Additionally, from what the panel has heard about orchard shooting, it seems likely that a grower who valiantly attempts to do all the right things in euthanasing bats, keeping accurate records etc., is likely to underestimate the number of animals actually killed because of those that fly away injured and die outside the orchard. So that in attempting to estimate of numbers actually killed, it is not unreasonable to feed in a variety of "correction" factors - x2, x4, x5, x10. These give respectively 3072, 6144, 7680 and 15,360 killed per year and shooting mortality rates of 0.96%, 1.92%, 2.4%, 4.8%, or using the larger population size 0.79%, 1.59%, 1.98%, 3.97%. Our x 2 added to the natural+heat-death mortalities = 22.52% or 22.08%. Our x 4 added to the natural+heat-death = 23.48% or 22.88% and so on. What is a reasonable figure?

*Table 1. Mortality, life expectancy, female reproductive rate and population doubling/ halving time.* It is assumed that: no bats survive beyond their 15th year and mortality remains constant across the adult life-time (age □ 3 years); the no. females born/ adult female/ year remains constant over a female's adult life and that adults have, 100, 90 or 70% breeding success (respectively 0.5, 0.45 or 0.35 females born/ female/ year). Doubling/halving times were calculated on basis that 20% of 2-year-olds bear young. So too was $\Sigma l_x.m_x$.

| **Mortality (%/yr) yrs 1/2/3-15** | **Life expectancy (years) ($\Sigma l_x$)** | **Females/adult female/year ($m_x$)** | **Total females /female life-time ($\Sigma l_x.m_x$)** | **Doubling (+$T_d$) halving (-$T_d$) time (years)** |
|---|---|---|---|---|
| 20/20/20 | 4.9 | 0.45 | 1.15 | +34 |
| 2020/20 | 4.9 | 0.35 | 0.91 | -52 |
| 25/25/25 | 3.0 | 0.35 | 0.63 | -10 |
| 30/30/30 | 3.3 | 0.35 | 0.45 | -5.4 |

Table 1 (complete version in Appendix 4) demonstrates that annual mortalities greater than 20% together with reproductive sucess of about 70% produce a declining population. Reference to Figure 2 in Appendix 4 graphically demonstrates this trend.

***4.3.9. Summary Conclusion*** There are no accurate data on the rate of change in the Grey-headed Flying-fox population - the thesis calculations (Divljan 2008) purporting to demonstrate decline do not appear to be valid. Population modelling based on the well-established reproductive characteristics of the animals suggest that pre-settlement age-independent mortalities of ~20% per annum coupled with a reproductive success of ~80% would produce a stationary population. There are now excellent data, based on multiple counts from multiple camps over eleven years, that demonstrate that ***recent average breeding success*** is only 73.7%. If annual mortality ***had*** remained at the "natural" pre-settlement rate of 20%, such reproductive success would place the population close to slow decline. However it is likely that mortality rates have ***increased*** in recent times due to decline in natural food resources, destruction of optimal maternal roost sites, power-line electrocution, barbed-wire & net entanglements, plus increased mortality from increasingly frequent extreme weather events such as heat & hail (and competition with Black Flying-foxes). Thus it is highly probable that the Grey-headed Flying-fox population ***is*** in decline and that ***any additional*** mortality can only increase the rate of decline. ***No matter what the causes the death, mortalities are additive***. Therefore ***any*** orchard shooting will hasten decline of the Grey-headed Flying-fox population, albeit by only a relatively small amount.

## TOR 3 - Shooting vs non-lethal techniques

**Shooting is effective in reducing levels of crop damage, in comparison to other available, non-lethal techniques (including full exclusion netting).**

There are various methods for controlling flying fox. In addition to full exclusion netting, which provides a total barrier to flying foxes visiting fruit trees, noise, smell, taste and light have been trialed, as mentioned under Tor 2. These methods have proven to be ineffective over time (Greimel QPWS 2008). Fleming and Dang (presentation to the panel) cited recent survey results on control efficacy indicating that:

- Netting effective: 100%
- Shooting effective: 60%
- Scaring devices: 7-16%

A number of sources note that that Grey-headed Flying-fox tend to ignore non-lethal measures in times of food shortage. Even as far back as 1931 the oft quoted ecologist, Francis Noble Ratcliffe wrote– "Thus most methods employed to scare them (Flying Fox) away from orchards, by noise, lights, hanging cloths etc have proved unsuccessful after the first night or so." (Ratcliffe 1931,p.16). Given the low level of effectiveness of other non-lethal devices, TOR 3 addresses shooting vs full exclusion bat netting.

This section does not discuss bird or hail netting.

### a. Effectiveness of Shooting

Shooting may be effective during the hours permitted under the shooting licence, but flying-fox can visit the orchard after shooting stops. The threshold number of flying-fox that can be controlled by shooting has not been established. Shooting is said to be effective when 'small' numbers of Grey-headed Flying-fox are present in an orchard (Rogers 2002, Comensoli 2002).

Fruit growers have long argued the notion of conscious communication between individual flying-foxes, such that discoveries of new feeding grounds by so-called 'scouts', are communicated to other flying-foxes in the camps (Ratcliffe 1931, 1932). Thus if a grower can get in early and shoot the scouts this reduces the numbers of flying foxes finding the orchard. This view has been challenged by Martin (2009) on the basis that repeated killing of flying foxes on electrocution grids in QLD did not reduce the flow of bats into orchards or prevent damage. However, in these cases large numbers of bats were entering the orchards and it is generally agreed that killing (by shooting) is ineffective when large numbers of bats are involved (Draft National Recovery Plan , Comensoli 2002, Teagle 2002) and it is likely that the same is true for electrocution grids.

Ratcliffe (1932) suggested that individuals whose food source is beginning to fail may simply follow others who are flying straight to a previously discovered feeding ground. He noted that in addition to the main column, or columns, of flying-foxes exiting a camp "usually at a considerable height, and in a most purposeful manner", a large number of individuals ("scouts") flying at much lower altitude "fan out in all directions", to explore the area for resources.

Tidemann *et al.* (1997) proposed that, as an intelligent animal, there is a strong likelihood that Grey-headed Flying-foxes, like honeybees, learn about food resources from the behaviour of others in the colony. As such, all individuals may at any point in time play the role of communicator, facilitating the flow of information on the location of available food resources to other flying-foxes. While the exact mechanisms of how flying-foxes exchange such information are unknown, a good spatial (and perhaps temporal) memory and an effective means of communication enable flying-foxes to track changes in food resource availability and migrate accordingly (P. Eby pers. comm. 2009). The mobility of flying-foxes and high turnover of individuals in any one camp facilitates the transfer of vast amounts of information regarding food availability over a large geographic scale (P. Eby pers. comm. 2009).

Flying is an energetically expensive activity, particularly for a flying-fox given its small, but relatively dense, body size, and the often considerable flying distances for foraging. Effective communication between individuals in camps regarding food availability enables individuals to maximise energy intake with minimal expenditure searching for resources that are patchily distributed across the landscape. Radio- and satellite-tracking studies have shown that flying-fox movements are very directed and purposeful, rather than random (P. Eby pers. comm. 2009; B. Roberts unpublished).

It follows that removal of individuals that have identified a food source, in this case an orchard, precludes them conveying this information to others – the theory is that it stops the flow of information and thereby reduces crop damage - but the question is still open as to its effectiveness in reducing levels of crop damage. Also the threshold number of flying-foxes that can be controlled by such shooting has not been established.

It is generally agreed that, when large numbers of bats are involved, shooting is ineffective, and that even when shooting is uncontrolled, the possibility of shooting all animals is remote. Dang *et al* (2009) reported counting up to 1000 flying fox per hour entering one orchard. Licences are issued for a maximum of 50 animals per licence. Thus, licenced shooting, when numbers are high, cannot by itself effectively reduce damage.

Given that farmers argue that they are observing an increase in Grey-headed Flying-fox populations in the Sydney Sector, shooting is likely to become less effective at limiting the damage in orchards. Shooting has considerable social and environmental imposts. As identified in TOR 1, many groups actively oppose shooting on humane grounds. Further, considerable community concern exists about the noise and risks of being shot accidentally. Community complaints include finding dead foxes and wounded foxes in backyards.

The cost of shooting (Dang and Jarvis unpublished) is estimated at $8700 per orchard, per season (see Appendix 5).

"Beside the monetary cost, shooting cost growers more in term of mental health and physical exhaustion. During the fruit season, a growers might have to work on average 12 to 14 hours a day. Instead of having time to rest before going to bed, they have to shoot Grey-headed Flying-fox. Their exhaustion and anxiety would further reduce their productivity and the cost of reduced productivity during their day work is hard to quantify, but is real cost."

### b. Full exclusion bat netting

With regard to non-lethal deterrence it would appear that the only consistently reliable deterrent that prevents fruit damage is full exclusion netting. Netting is

- not impacted on by any increase or decrease in the size of the flying fox population
- 100% effective 24 / 7 at excluding flying fox from orchards, providing the nets are properly maintained.

Two types of netting systems are commonly used by growers[1]:

1. Full canopy netting—The net is flat canopy over the entire orchard, held permanently in place by a grid of wires or steel cables supported and tensioned at the perimeter by poles and anchors. There are many possible variations of net type, structure materials and design.
2. Tunnel netting—A series of light frames connected by wires are erected at intervals along the row to support the net and hold it away from the tree. Orchard row spacing has to be wide enough to allow tractor access with structure in place. The nets are placed over the frame only when the fruit approaches maturity and are taken down after harvest. Picking, summer pruning and spraying operations may be affected.

Picture 1 Hooped frame tunnel nets on stone fruit (the net is looped round from one row the next to avoid cutting). Picture 2 Full exclusion bat netting

1 Full details of structures, netting types and costs are given in ***To net or not to net,*** 3rd edition (2008) by Peter Rigden, QLD Government Department of Primary Industries and Fisheries and freely available from the web at: http://www.dpi.qld.gov.au/cps/rde/dpi/hs.xsl/16_12622_ENA_HTML.htm

A comparison of tunnel and canopy netting systems (from Rigden 2008)

| Factor | Full canopy netting | Tunnel netting |
|---|---|---|
| Capital cost | High cost, upwards of $23 000 per hectare. | Moderate cost, from $17 000 per hectare. |
| Support structure | Needs to be strong and durable and is therefore relatively expensive. | Can be made from lightweight and relatively low-cost materials. |
| Net quality and cost | Nets are permanently exposed to the elements so good quality, more expensive nets need to be used. | Nets are on the trees for only +/– 2 months per year, so cheap light weight nets can be used. |
| Quantity of net | Nets cover only the top and sides of the whole orchard, reducing the area of net needed per tree. | Nets cover the top and the two sides of each tree row, increasing the area of net needed per tree. |
| Recurrent costs | No recurrent costs putting out and recovering the nets. | The cost of putting out and recovering the nets each season is significant over the life of the orchard. |
| Maintenance | Repairs to net and structure will be required from time to time, depending on quality of materials used and weather events. | Frames need to be smooth to minimise net damage during application and removal. Store nets in vermin-proof containers. |

The netting advocated for installation in this report is *bat netting* with a mesh size of 20-40mm. This mesh-size excludes most birds as well as bats, and the animals do not become entangled when it is properly erected. With this mesh size there are no major micro-climate or light reduction problems and bees are not excluded. It is available in a variety of colours. It does *not* protect against hail. Hail netting has a much denser mesh, is far more expensive and can be associated with micro-climate problems. In the present report, all costs and proposed subsidies are based on the installation of bat netting, not hail netting.

Dang *et al.* (2009) asserts that damage is reduced to zero when full exclusion netting is used to cover susceptible crops. Properly constructed and maintained full-exclusion netting provides a barrier, which prevents the animals from entering the cropped area, thus totally eliminating the damage. However some bats do get caught in the nets, for instance, if the nets are not properly maintained the net sides may become loose. This has OH&S implications for farmers. flying fox are carriers of diseases, so any person who comes in contact with them must have vaccinations.

Full exclusion bat netting has the added economic benefit of reducing bird damage, but it does not reduce hail. Anecdotal evidence from northern sector orchards indicates that birds can cause major damage, at certain times, e.g. during times of food shortages.

**In conclusion, shooting is ineffective when larger numbers of Grey-headed Flying-fox visit orchards. Full exclusion netting provides the most effective protection against damage from Grey-headed Flying-foxes.**

## TOR 4 - Industry capacity

### Industry has the capacity to solely rely on netting.

The Northern Sector stone fruit orchards rely totally on netting. The stone fruit sector is 100% netted (61Ha) (Malcolm submission to panel). No shooting licences for flying fox have been issued in the Northern Sector since the 04-05 season The Central and Southern sector have some netted properties and use shooting to manage flying fox.

In the Southern sector, about 23%, of the estimated 450Ha (300Ha stone fruit &150Ha apples), is under net. A survey (Sydney Basin grower survey (*n*= 27/31) Fleming and Dang (2009) of orchards provides an indication of the size distribution of orchards. Orchards were divided into three acreage categories:

- 22% Small (2 - 4ha)
- 59% Medium (5 - 16ha)
- 18% Large (20 - 30ha)

Of these orchards, 88.3ha were netted (=32.3%) and 185.2ha were un-netted.

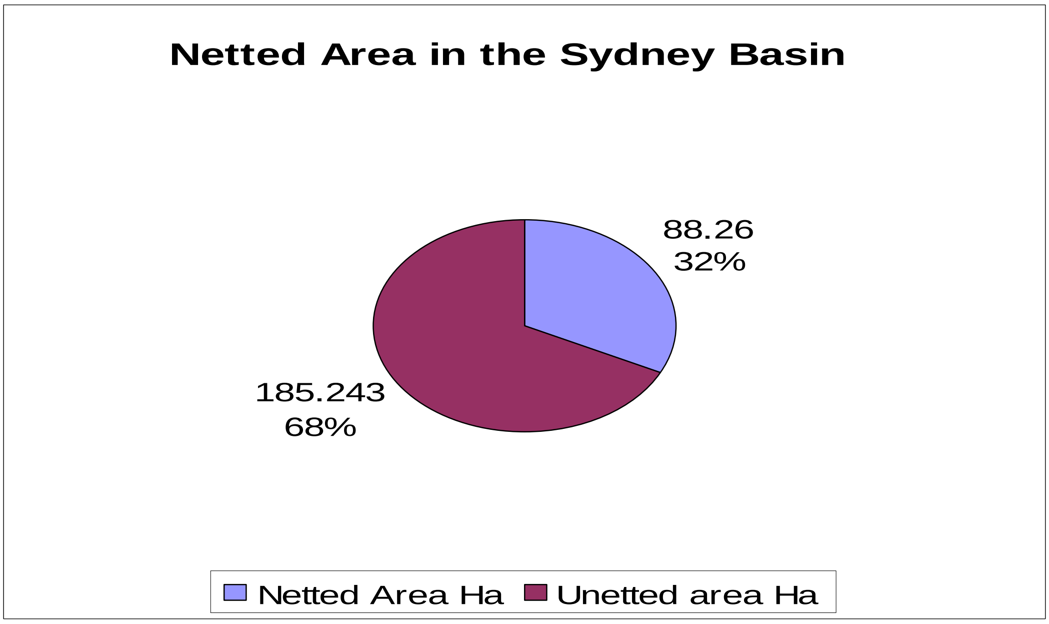


Fig. 4: Acreage of netted and un-netted orchards in the Sydney basin.

When the **Northern Sector** was established in the 1980s the industry initially relied on shooting to cull flying foxes. The change to full exclusion netting was due to two factors

- orchardists found shooting and other techniques ineffective given the numbers of flying fox visits

- netting infrastructure investment provided financial returns given the terms of trade[2] for Northern sector stone fruit. New growers' factored in the cost of netting for establishing new orchards.

Total exclusion netting applies primarily to the stone fruit sector. Other small industries such as lychee, mango, custard apple, blueberry etc, have some netted areas, and are either not being attacked by flying fox or not interested in netting. The banana industry has not netted mainly due to constraints of topography. They have used bags to protect bunches from damage.

With a few exceptions, orchards in the **Southern Sector** have remained un-netted (Malcolm pers com 2009). Southern Sector orchardists argue that netting has not been erected, to any large extent, in the Southern Sector because it is expensive (Commensoli 2001, Biel 2001, Tidemann et al 1997, Ratcliffe 1931, Malcolm P, 2009 presentation to panel) and that:

- Legal shooting was available as an option for flying fox damage mitigation. It has been effective with the number of flying fox visits, damage was infrequent and irregular. This damage has gradually increased over the last 15-20 years.
- Capital to erect netting, their orchards are established, and they have limited financial capacity to factor in netting given their terms of trade for Southern sector stone fruit
- Ability to repay loans for netting. The current 'low interest loans' through the Rural Assistance Authority have not generally been taken up.
- Commercial benefit of netting for greater yield perceived as less than licensed culling to limit flying fox damage.
- Micro-climate issues with hail net
- Age of farmer population. Orchardists have grown older and are reluctant to spend money on netting that may be needed for their retirement.
- Value of property. Netting is seen by some as a liability, as an impairment to the sale of a property.

There are some Southern Sector growers who assert they would be unable to net due to terrain or other problems, such as powerlines passing over the orchard blocks. Most of the terrain around the Sydney Basin lends itself to the installation of netting (according to a panel member). Nets can be installed on

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2 **Terms of trade**, the relative price of producing crops to the farm gate returns, declined in the Southern Sector partly as a result of the entry of the Northern Sector into the market place, thereby taking the 'early market' spot. However, over the past 20 years, both Sectors have seen an ongoing lowering of terms of trade, or the profitability of agriculture.

irregular shaped blocks and all farmable slopes, without affecting installation costs to any large extent. The major factor to affect netting cost are:

- The presence of rock at or below the ground, which requires extra excavation cost.
- Very steep slopes, which restrict the movement of tractors and are not farmable, are also cost prohibitive (Grigson J. JAG Trading Co Pty Ltd pers.comm. 2009). According to a panel member there are no such slopes in the Sydney basin that are used for orchard production.
- Burying the lines underground, or re-routing them could resolve the issue of private power lines. Publicly owned power lines require easements over land on which they are located. These easements restrict activities that can be carried out beneath them. Some growers from Bilpin have netted under public power lines and they state that the power company will accept a gap of 5 metres (Tadrosse & Saliba pers. comm. 2009).

There may be councils that will restrict netting for visual or amenity reasons in the more closely settled 'residential zones'. See Appendix 6 for council response to questions on netting policy. This eventuality is considered unlikely, as commercial orchards are generally located in 'rural zones'. Such zones permit crop protection structures to be erected. To our knowledge, this has not been tested in the Land and Environment Court.

## a. Types of nets and maintenance issues

Netting underwent a number of changes; from the initial 100mm mesh loose nets that entrapped animals and birds to 44mm, 25mm and smaller taut nets in use today.

Some growers raised issues with netting causing excessive rots, diminished fruit colour, bat or bird entanglement and insect problems. (Terrey, Ramm *et al* 2009 pers.comm.) The use of bat/bird net with an open mesh size of 20 - 40mm, stretched taught over a properly constructed structure, allows airflow to pass through, minimizing moisture caused rots, allows the passage of pollinating bees, diminishes shading effects and does not entangle bats or birds. Netting does prevent birds from entering the orchards, which can cause some insect populations to become problematic. However, if required netting can be constructed with roll up sides that can allow entry for birds during non harvest periods.

Netting costs $18,000- $52,000 per ha (Fleming and Dang 2009 presentation to panel). The panel has received a quote of $42,300 for the supply and erection of 2Ha of 20mm bat net. This represents a cost of $21,150 per Ha. (Grigson J. JAG Trading Co Pty Ltd. 2009).

Tunnel netting; where Poly Pipe or PVC hoops are fixed into the ground and then net is drawn over the structure and tensioned to ground wires just prior to harvest have been suggested as an alternative to those who may have rock on site or dislike the more permanent structure. This type of net is effective against damage from flying fox's but does cause inconvenience and extra cost each year during deployment and harvest.

**Maintenance**

Nets require ongoing maintenance. They can become stretched and tear when overhanging trees drop branches and from tractors throwing objects onto the nets. If nets are not of sufficiently small mesh size and are not kept taught they could entrap birds and bats. Cutting the net to remove trapped birds and bats weakens the nets. Hail and strong winds can cause considerable damage, if nets tear, the nets can become very tangled in strong winds. Cherry pickers are required to maintain nets. This can have OH&S issues, because working at height with large areas of loose, heavy and damaged nets can be quite dangerous.

Northern and Southern sector farmers paid on average $11,000 p/ha to repair hail nets after a 2008 hail storm. Applications for grants to repair the nets were refused.

## b. Economic returns from netting vs orchards without netting

According to a panel member, fruit growers in the Sydney Basin mostly receive adequate prices in the wholesale sector to remain viable. This is especially true in the earlier months of both the stone fruit and the apple season, as supply is limited and prices buoyant. Prices diminish later, when fruit from the inland and other states enters the market.

While profits have been adequate to sustain the industry in the past, they have not been sufficient to accrue the capital required to net. Revenue in the Sydney Basin is much less per hectare than that received on the north-coast (Malcolm 2009 pers.comm, Gough 2009 pers.comm. Ramm 2009 pers.comm).

There has been a movement over recent years, to plant varieties that supply the market when fruit from other areas are not present and prices are higher. According to a panel member, this would no doubt continue if widespread netting were to occur. The coastal districts of NSW, including the Sydney Basin, receive reliable rainfall, unlike the Murray Darling Basin and other fruit growing areas. Consequently, given adequate crop protection from Grey-headed Flying-fox and other pest species by netting, proximity to markets, adequate water resources and a desirable product, the sustainability of fruit production in the Sydney Basin, could be assured.

**Orchards without netting**

Yield losses in orchards without netting ranged from 13 to 34 percent during the 2006-07 and 2007-08 seasons (Dang and Jarvis 2009 unpublished data). Damage in orchards (Fleming and Dang 2009 presentation to panel) is variable between years, regions, seasons, orchards and nights. flying fox damage without nets 2007 & 2008 (growers said low to moderate damage year):

- 13 - 34% (fruit loss)
- 0 - 50% (growers estimates)

Dang and Jarvis (2009) unpublished results indicate damage for 2006-07 and 2007-08 yield losses in orchards without netting range from 13 to 34 percent. 2009 damage range from 1 to 3%. “The loss is quite significant economic loss as the profit margin of the fruit industries is rather low in the Southern sector." Ullio (2002) in Fleming and Dang (2009), presentation to panel, found that netting is not economically viable when gross market return are less than $8 per tray (4kg [*sic*] 5kg tray) with the required return in capital investment for netting is greater than 5% and crop loss from 15 to 30% annually.

**Returns from netted orchards**

Fleming and Dang 2009 (presentation to panel) found that yields were always higher with netting. Their analysis indicates that netting provides a positive cash flow and ensures a long term commercially viable business.

> "At whatever level of yield gained and price, netted orchard provides higher Cost/Benefit Ratio, indicating that a businessman, grower with netted orchard withstands price instability and damage caused by pests better than one without netting." Fleming and Dang 2009 (presentation to panel).

See Appendix 7 for Investment return of netting in 3ha orchard and 20ha orchards. Returns for netting in Southern orchards (Fleming and Dang 2009 presentation to panel):

- Small orchards
  - Worst case (low yield gain, low prices 2$ per kg): 18.5 years to break even
  - Best case (high yield gain, high prices ($3 per kg): 7 years
- Large orchards
  - Worst case: 15 years
  - Best case: 4.5 years

If a property is purchased for another use other than orchards, netting is regarded by some growers as a liability. Removal of netting is expensive for the buyer and therefore does not add value to the land, rather it can de-value the land. Few orchards have been sold as going concerns in the Sydney Basin in recent years, partly because of high land prices and low returns on investment. There are a range of possible future scenarios for the industry:

- The current status quo of approximately 50 farmers is maintained
- Land value increases and the terms of trade continue to deteriorate. The exit trend from the industry increases.
- Netted orchards are seen to become profitable in the longer term they could be sold as ongoing businesses, thereby achieving a premium over land value for other uses. Some growers believe that children may remain on existing orchards, if they are netted. The parents, or grandparents,

incomes will be seen to rise (see returns from netted orchards below), (approx due to increased production. Prices may remain buoyant as the market acceptance and consequent demand for local produce increases.

Some growers believe that children of orchardists are reluctant to enter the industry and take over the orchards, partly because they are aware that flying fox attacks are becoming a greater impost on production and therefore long-term viability (Fergusson 2009 pers. comm.)

**In conclusion**, the industry could rely solely on exclusion netting, as the only means of Grey-headed Flying-fox crop damage mitigation. However, nets can be expensive to maintain in the event of a major storm. It is considered unlikely that netting would be erected to any large extent, in the Sydney area, without adequate government grants.

# 4. Policy implications and options

This section discusses the underpinning social and economic data and the policy options for the future management of the Grey-headed Flying-fox in NSW orchards.

## a. Socio-economics

What is a viable orchard? Farm viability depends on a range of factors including, market access, terms of trade, level of debt and lifestyle. The value of land is also important. In the last 15 years there have been no commercial buyouts (Malcolm 2009 pers. comm), rather properties were sold to lifestyle peri-urban dwellers. A similar scenario exists on the north coast, with many orchards changing ownership to life style farmers. The value of the land in these peri-urban agricultural areas has become too valuable, and therefore impacts on the capacity of landowners to expand their operations, or to enter the industry. As noted by Daniels and Bowers (1997), this trend ultimately leads to the conversion of land to other uses. Over the last 15 years there has been a consistent downward trend in the number of orchards in both the Northern and Southern sectors. There are now approximately 50 orchards in the Sydney area, this is down from approximately 150 orchards 10 years ago.

To survive changing societal and economic conditions, farmers have undertaken a range of business management strategies. Farmers can be broadly viewed in three groups:

- Farmers who have off farm income

Some of the 50 farmers in the Sydney basin have off farm income and use the orchard's income to supplement their income.

- Farmers who rely solely on farm income with no debt

These farmers tend to live very economically; many do not have netting and are not in the position to incur debt - a significant proportion are elderly.

- Farmers who rely on farm income to service debt

They rely on on-farm income (and maybe some off-farm income) to service debt and could be forced to sell should anything impact on their capacity to earn on farm income.

Farmers with debt and those who are relying solely on farm income are most financially vulnerable to changes in the shooting license regulations. Given the age of farmers (many over 60 with limited signs of intergenerational management), likelihood of increases in farm input costs (fertilizer, sprays) and decline in commercial returns – terms of trade, it is likely, given the current trend, that some farmers will exit the industry voluntarily over the next 10 years.

## b. Policy options

Best Management Practices (BMPs) are production methods which aim to improve agricultural practices, by preventing or reducing the impact of agricultural farm management practices on the environment. BMP's also provide broader social and environmental benefits, by addressing ethical and socially responsible management of scarce and fragile resources (wildlife, biodiversity, water quality protection or soil erosion), while balancing the need for effective, profitable and economic production of food, forestry or fish stocks.

BMP's are based on agreed standards for management of resources within natural and economic limitations. There are two management practices that have been identified under the Terms of Reference, shooting and full exclusion netting. This section assesses the BMP options for improving the management of flying foxes in orchards, and likely outcomes and cost of shooting vs netting. There has been limited uptake from industry of the low interest loans. The panel has therefore not advocated this option.

**Option 1 Maintain shooting licences**

**Option 1.1 Maintain current status:** Maintain current status, shooting licences are issued without any code of best management practice and limited surveillance of levels of compliance.

Likely outcomes and risks:

- Environmental groups will provide strong resistance to this option. They have indicated that they will challenge DECC's legislative power to cull a threatened species.
- Animal welfare and rights groups will contest this outcome – could mount legal cases against DECC and orchardists
- Compliance officers in DECC will regard this outcome as beyond compliance and un-manageable
- Limited Industry support

**Option 1.2 Code of Best Practice for shooting flying foxes:** Develop a Code of Best Practice and DECC to increase surveillance of orchards compliance to best practice standards.

Likely outcomes and risks:

- Environmental groups will provide strong resistance to this option. They have indicated that they will challenge DECC's legislative power to cull a threatened species.
- Animal welfare and rights groups will contest this outcome – could mount legal cases against DECC and orchardists.
- Compliance officers in DECC will regard this outcome as beyond compliance and un-manageable
- May have stronger community support than Option 1.2
- Strong industry support

- Southern sector farmers would support this outcome.

**Option 2 Stop issuing shooting licences**

**Option 2.1 Zero grants:** Stop issuing licences with no grants or subsidies to farmers.

Likely outcomes and risks

- Likely increase in illegal shooting – continuing animal welfare issues and adverse pressure on a vulnerable species
- Requirement for increased resources for monitoring illegal shooting
- Opposition by Industry and reduction in fruit grown in the area, and decrease in fruit quality
- Poor uptake of netting
- Environmental group support

**Option 2.2 – Grants for farmers to net based on hectare payments:** Stop issuing licences after May 2010* (One season) and provide grants to farmers ($20,000/planted ha) to net orchards or sections of orchards that are not currently netted with full exclusion netting for Grey-headed Flying-fox

Conditions.

i. Only for current growers - not those entering the industry.
ii. Retrospective to the Grey-headed Flying-fox's threatened species listing for farmers who have been issued a shooting licence since the 2001-02 season
iii. To net areas of the orchard not currently netted with full exclusion bat netting (best practice: taut hoop netting; taut, flat-roofed permanent netting with fixed or roll-up sides)
iv. Part payment upon signing of contract to install netting; final payment upon completion of installation
v. Government one-off contribution. No on-going responsibility.
vi. Grower pays for anything above the full exclusion bat netting (as defined above).
vii. Indemnified against claims for ongoing maintenance, insurance or replacement.
viii. Amount $20,000 /ha for netting of un-netted areas
ix. Best practice shooting guidelines to be developed for interim period

*Providing netting companies can serve demand and the decision is made prior to the commencement of the 2009 fruit season (August 2009).

Likely outcomes and risks

- Industry and environmental support
- Large cost to government, interim shooting compliance and netting
- Supporting local industry
- Community support for maintaining local jobs/industry;
- Community opposition for payments for exit strategies for high-value land (Government money being channeled from other sources)

- Industry fails to adopt best practice shooting.

**Option 2.3 – Grants for all farmers to net or leave the industry based on hectare payments**

As Option 2.2, but inclusive of all farmers whether netting ($20,000/planted ha) or exiting the industry ($10,000/planted ha). This will allow farmers to either exit the industry (sell their property at current market value) or self insure against the risk of future flying fox damage.

Conditions.

i. Only for current growers - not those entering the industry.
ii. Retrospective to the Grey-headed Flying-fox's threatened species listing for farmers who have been issued a shooting licence since the 2001-02 season
iii. To net areas of the orchard not currently netted with full exclusion bat netting (best practice: taut hoop netting; taut, flat-roofed permanent netting with fixed or roll-up sides)
iv. Part payment upon signing of contract to install netting; final payment upon completion of installation
v. Government one-off contribution. No on-going responsibility.
vi. Grower pays for anything above the full exclusion bat netting (as defined above).
vii. Indemnified against claims for ongoing maintenance, insurance or replacement.
viii. Amount $20,000 /ha for netting of un netted areas
ix. Best practice shooting guidelines to be developed for interim period

<u>Likely outcomes and risks</u>

- Industry and environmental support
- Large cost to government, interim shooting compliance and netting
- Supporting local industry
- Community support for maintaining local jobs/industry;
- Community opposition for payments for exit strategies for high-value land (Government money being channeled from other sources)
- Industry fails to adopt best practice shooting.
- Large cost to government

**Option 2.4 – Grants for farmers to net based on 50:50 payments.** Stop issuing licences after May 2010* (one season) and provide grants to farmers to net orchards or sections of orchards that are not currently netted with full exclusion netting for Grey-headed Flying-fox. Farmers pay 50% of the cost of netting.

Conditions.

i. Only for current growers - not those entering the industry.
ii. Retrospective to the Grey-headed Flying-fox's threatened species listing for farmers who have been issued a shooting licence since the 2001-02 season

iii. To net areas of the orchard not currently netted with full exclusion bat netting (best practice: taut hoop netting; taut, flat-roofed permanent netting with fixed or roll-up sides)
iv. Part payment upon signing of contract to install netting; final payment upon completion of installation
v. Government one-off contribution. No on-going responsibility.
vi. Grower pays for anything above the full exclusion bat netting (as defined above).
vii. Indemnified against claims for ongoing maintenance, insurance or replacement.
viii. Three netting quotes required.
ix. Ceiling of $15,000 /ha government contribution for netting un-netted area

*Providing netting companies can serve demand and the decision is made prior to the commencement of the 2009 fruit season (August 2009).

Likely outcomes and risks:

- Industry and environmental support
- Moderate cost to government, interim shooting compliance and netting
- Supporting local industry
- Community support for maintaining local jobs/industry
- Community opposition for payments for exit strategies for high-value land (Government money being channeled from other sources)
- Industry fails to adopt best practice shooting.

## c. Cost analysis

The cost to Government for each option is difficult to assess accurately given available data. Therefore the likely costs are provided below for full compliance of Code of Best Practice for shooting flying fox vs the Financial Assistance Package options.

**Cost of full compliance over 5 years to BMP Shooting**

The cost of managing full compliance of shooting licences over 5 years is estimated at between $500,000 and $1,000,000 (source: NSW DECC, Economic Division). This does not include the probable costs of responding to legal actions by environmental groups.

**Cost of Financial Assistance Packages for BMP Netting and funding options**

The cost of supporting the transition to BMP netting are estimated below. The following data has informed the costing:

- Approximately 92 different licensees have been issued with licences since Grey-headed Flying-fox was listed as vulnerable in May 2001.

- The estimated area and likely farmer uptake for potential netting in Sydney sector (Growers Survey, Biel 2009) is ~250 hectares

- Cost of netting on an average property $20,000 – $27,000 (Peter Comensoli, 2009)

Northern sector farmers have netted their properties (100%). There are three potential outcomes for Central and Southern Sector farmers, they will

- use the package to net their properties and increase their commercial investment;
- exit the industry; Some farmers view netting as a barrier to the sale of their property and do not intend staying in the industry long term.
- maintain their orchards without nets and accept the reduced yields due to flying fox damage, until they are ready to exit the industry.

Results from a growers survey (Appendix 8) indicate that the majority of farmers will net their properties if Option 2.2 or 2.3 is offered. The response to Option 2.4 was not assessed in the survey.

Option 2.2 – Grants for farmers to net based on hectare payments

- Estimated cost between $5,000,000 and $6,000,000

Option 2.3 – Grants for all farmers to net or leave the industry based on hectare payments

- Estimated cost between $6,000,000 and $9,000,000

Option 2.4 –Grants for farmers to net based on 50:50 payments

- Estimated cost between $2,000,000 and $6,000,000

### d. Funding sources

Consideration of the flying fox issue included consideration of funding for netting. Funding sources considered included industry restructuring and exceptional circumstance programs. These funding options were not considered to be closely aligned to the policy issue under consideration, that is effectively managing flying foxes and fruit production. Funding for better management practices – that is funding to move from bad management practices (practices that are having a negative impact on the society and/or environment – eg. flying fox population) to better management practice (reduce the impact of fruit production on the flying fox population and improve the viability, accountability and profitability of farms by netting) was considered the most relevant.

'Caring for our country' was identified as a likely source because the funding supports groups that are moving towards sustainable and better management practices. The program supports sustainable farming practices that:

> "… maintain or improve Australia's capacity to produce food and fibre while enhancing the capacity of agricultural lands to deliver other ecosystem services, such as clean air and water, healthy soils and biodiversity conservation.

“Good farm management can be good for farm productivity and good for the environment. Farm systems and land management practices continue to evolve to adjust to the Australian environment while still improving productivity and Caring for our Country is seeking to support farmers to continue their work to balance production and the environment.
Source: Caring for our country: http://www.nrm.gov.au/publications/factsheets/target-info-sheet-landmanagement.html

# 5. Summary of findings and recommendations

The panel reviewed the Terms of Reference and concluded that

- The animal welfare issues that result from shooting as a method of mitigating crop damage caused by flying-foxes are in no way acceptable ethically or legally.
- It is highly probable that the Grey-headed Flying-fox population is in decline and that any additional mortality can only increase the rate of decline. No matter what the causes, all death, mortalities are additive. Therefore any orchard shooting will hasten decline of the Grey-headed Flying-fox population, albeit by only a relatively small amount.
- Shooting is ineffective when larger numbers of Grey-headed Flying-fox visit orchards. Full exclusion netting provides the most effective protection against damage from Grey-headed Flying-foxes.
- The industry could rely on exclusion netting, as the only means of Grey-headed Flying-fox crop damage mitigation.

A significant negative financial, cultural and social impost will be incurred by some orchards should shooting licences be banned without reasonable adjustment time. If an assistance program was implemented, we consider that a minimum of 12 months would be required for all those who wish to net to arrange contractors and complete the projects.

The panel finds that the following issues are important considerations for the government:

- It is important to reduce the adverse pressures on a vulnerable species, the Grey-headed Flying-fox, while at the same time maintaining food production and encouraging sustainable farm business.
- Maintaining orchards in NSW and in particular in urban areas such as Northern NSW and the Sydney Basin is important because farming:
    - provides coastal areas with locally grown food; food grown close to major urban centers requires less transport and increases urban areas food security. Over 4 million people live along the NSW coast.
    - has broader societal and environmental benefits, including landscape management, maintaining open spaces and rural practices and culture in urban areas.
- Future climate change events are likely to favor coastal agriculture– inland areas that are currently growing fruit may not be able to sustain production due to water constraints. The soils and climatic conditions in coastal areas are excellent for orchards.

- Farming industry needs to commit to working towards higher social and environmental standards in collaboration with the government, through the adoption of agreed best practice management standards, such as netting orchards.

- Farmers need incentives to net (taut netting) and to stop shooting due to the low returns from stone fruit. Netting will increase the viability of the orchards and help to maintain orchards in coastal NSW and particularly Sydney.

It is unlikely that netting will be erected to any large extent, in the Sydney area, without some form of government support. Considerable concern is evident in the farming population that changes to the Licensing policy could place farmers in a position where they are unable to maintain orchard production due to the capital investment required to net and force farmers to sell during an economic downturn.

The flying fox review panel recommends that:

1. Shooting be phased out after one fruit-growing season, providing netting companies can serve demand and the decision is made prior to the commencement of the 2009 fruit season (August 2009).

2. BMP guidelines and Standard Operating Procedures are developed for shooting during a transition period to May 2011 and that there are procedures for the industry to engage with government in managing compliance including DPI Shooting Code of Practice, RSPCA POCTA offences, DECC – best practice SOP's for compliance with shooting licences.

3. Netting BMP guidelines are developed for all existing and new orchards in NSW.

4. Government provides assistance to farmers to net their properties. There has been limited uptake from industry to the existing low interest loans. The panel does not advocate this option. The panel supports these options in this order of priority:

   i. Option 2.2 – Grants for farmers to net based on hectare payments: Stop issuing licences after May 2011 and provide grants to farmers ($20,000/planted ha) to net orchards or sections of orchards that are not currently netted with full exclusion netting for Grey-headed Flying-fox

      Then equal priority to

   ii. Option 2.3 – Grants for all farmers to net or leave the industry based on hectare payments. As Option 2.2, but inclusive of all farmers whether netting ($20 000/planted ha) or exiting the industry ($10,000/planted ha).

   iii. Option 2.4 –Grants for farmers to net based on 50:50 payments for netting

The panel notes that environmental groups indicated support for financial incentive for farmers to move to BMP netting systems. Netting provides farmers with economic advantages including reduced risk through improved yield and fruit quality. Netting also provides farmers with improved environmental and societal performance – the negative impact of shooting on flying fox population is removed, as are other adverse impacts, noise and animal welfare issues. Industry has indicated strong support and will:

- Work with government to enforce best practice shooting procedures during the interim period (development of SOP's, raising awareness, training, and enforcement);
- Identify illegal shooting or bad practice shooting, during the interim period;
- Identify illegal shooting once licences are terminated;
- Support farmers who net orchards in the adoption of best practice management standards for fruit production in the Sydney basin and NSW to ensure the ongoing economic, social and environmental viability of the industry.

**In conclusion**, the panel recommends a cessation of the shooting permit system. However, it is important that this be accompanied by sufficient financial grants to previous licence-holders to encourage the installation of netting systems. The industry could rely solely on exclusion netting, as the only means of Grey-headed Flying-fox crop damage mitigation, but, it is considered unlikely that netting would be erected to any large extent, in the Sydney area, without adequate government grants due to the cost of installing netting and the marginal returns from stone fruit orchards. This would result in the loss of extensive areas of highly productive agricultural land from the Sydney region. Environmental groups support incentive to maintain agriculture, as does the D*raft National Recovery Plan for the Grey-headed Flying-fox* which advocates "the use of environmental incentive schemes and equitable cost sharing arrangements".

Cessation of the licence system, without subsidies, would likely result in a significant increase in illegal shooting. Therefore without subsidies there is likely to be continuing, and possibly greater, animal cruelty issues and detrimental effects on the Grey-headed Flying-fox population decline. Thus there is a very strong case for netting subsidies: they would be good for the orchardists, good for the bats and good for the community and a sustainable future.

# Appendices

## Appendix 1 Implications of the mobility and large home range of flying-foxes from Martin (2009, in press)

"Flying-foxes can move many kilometres to food sources; Pierson and Rainey (1992) emphasise that, "Foraging areas are almost always separated from roosting areas. On large land masses, animals may travel 40-60km". Indeed they may do so every night. Thus bats attacking a given orchard cannot be regarded as an isolated population. Indeed, Tidemann (2000) arguing that electrocution of *P. conspicillatus* in a lychee orchard would not have significant adverse effects, stated that, "In any event, a localised reduction in numbers of spectacled flying-foxes is likely to be counterbalanced by individuals flying in from elsewhere... satellite tracking studies of grey-headed flying-foxes... have revealed one individual that flew 500 kilometres in less than a week. It is not known if spectacled flying-foxes have a comparable capacity for long-distance flight, but it is known that they are highly mobile animals".

If there is a good food source, flying-foxes may move from distant roost sites to ones closer to that food source. If the bats in the latter are being killed, bats from more distant areas will move in to replace those that are killed. The ecological term for such movement into a cull site is "source-sink dispersal" (Pulliam, 1996); the site of culling is the "sink" into which animals move from surrounding "source" areas. To a grower killing the animals, there will be a perception of "millions" of animals - a never-ending supply - and the misconception that the bats breed like rats and mice.

Thus, any orchard culling of a perceived "local" population will not only fail to stop the problem damage, but will simply drag animals in from far afield. In describing this, the image of a pteropucidal "black hole" and its irresistible gravitational force sweeping everything into its maw is a not unreasonable metaphor. Culling produces a local vacancy, bats move into it from further afield, and are killed, so producing a local vacancy which... Thus localised culling can effect a flying-fox population over its whole range. On these bases, I consider that continuing flying-fox culling by orchard electrocution grids is not sustainable and is likely to cause population declines of a magnitude as to put the species at risk."

## Appendix 2 Evidence that electrocution grids are relatively ineffective in protecting fruit from Martin (2009, in press)

"The affidavit from the respondent in the Federal Court case states, "*Since 1986 I have... maintained electric fences... There are now... 14 erected electric fences... and consist of 20 verticle [sic] wires from 4.4 metres to 9 metres in height. The total length of fences is 6.4km... The fences are operated during the harvesting season only...*" Having on many ocasions observed flying-foxes approaching food trees in suburbs close to the Indooroopilly flying-fox camp, and noting the precision with which individuals approach chosen food trees, I am not surprised that electrocution grids are ineffective. Indeed, to anyone familiar with the aerial and sensory abilities of flying-foxes it is the geometry and spacing of electrocution grid-lines that is the most damning aspect regarding their supposed protective efficiency. How many of us may have envisaged grids as enclosing an orchard like exclusion netting. They do not. The 6.4km North Queensland electrocution grid has 14 vertical arrays of parallel horizontal wires ***spaced ~100 metres apart!*** The Rockhampton Appellants operated a ***single*** 9.3-metre-high electrocution grid-line, of the type described above, "*approximately 200 metres long **in a straight line through the middle of**... a lychee orchard with the dimensions of approximately 300 metres long and 80 metres wide.*". They stated that, "*Since 1994 we have spent approximately $9,100 on protective netting to drape over the lychee trees... The nets offer reasonable protection from attacks by small numbers of flying-foxes, but are unsatisfactory for an attack by a large number of flying-foxes. The reasons for this is that the lychee fruit hang on the exterior of the canopy of the tree and as the net sits immediately over the tree, flying-foxes **and rainbow lorikeets** can simply land on the tree and* *attack/eat the fruit through the net"* [my emphases]. One must ask, given the behaviour of flying-foxes in relation to trees under nets, ***how a single grid line in the middle of an orchard could protect the surrounding trees or deter flying foxes from them*** or how ***how grid-lines spaced 100 metres apart protect the trees in between?*** Is the primary purpose of the grids to protect the crops or simply to cull flying-foxes?"

## Appendix 3 Modeling how flying-fox populations increase and decline

What follows is taken largely from McIlwee & Martin 2002 and Martin & McIlwee 2002. In simplest terms, population change is governed by birth-rate and death-rate: fecundity versus mortality. When births exceed deaths, the population grows. When deaths exceed births, the population declines. Viability of a population depends on size and productivity (fecundity) of the female population. This will depend on the number of young a female can bear per year, how soon a female matures sexually, and how long a female is likely to live (life expectancy). Since a polygamous (male-with-harem) system is the rule rather than the exception for flying foxes, the ratio of adult males to adult females in the wild is unlikely to have a major effect on female productivity unless the proportion of males in a population becomes excessively low. The ratio of males to females in my successful captive breeding colonies was about 1:5.

***Fecundity***

The most offspring a female flying fox can deliver per year is one. It is only females that count in our calculations, since only they provide the next generation. As the sex-ratio at birth is one, the birth of 1 young per year is equivalent to 0.5 females per year; 0.5 designates the ***maximum annual birth rate of females***. Since Grey-headed Flying-foxes are seasonal breeders, females effectively give birth around the time of their own birthday. In the light of pregnancy rates observed in the wild and in my captive colonies, we assume that: (a) all females are capable of producing 1 pup per year from their third birthday onwards; (b) that after a female reaches 3 yr, ***potential*** productivity remains constant for the rest of her life (ie. it is age-independent). Nevertheless, the proportion of females that ***actually*** deliver young (breeding success), will vary with environmental conditions. If only 90%, 80% or 70% of adult females deliver young, the corresponding number of females born per female per year are, respectively, 0.45, 0.4 and 0.35. We have used these levels of breeding success in our modelling, along with the theoretical but unrealistic maximum of 0.5.

***Patterns of mortality***

For a ***complete*** description of a population one needs to know the ***age-specific fecundity*** and the ***age - specific mortality*** - the number of young/female for each age class and the number of animals that die for each age class. In relation to the former it is not unreasonable to extrapolate from what occurs in captive breeding colonies. In relation to the latter it is not - and this is where most studies of populations in the wild meet difficulties - as described in detail by Caughley (1975) a subject we shall return to below.

In our modelling (McIlwee & Martin 2002 and Martin & McIlwee 2002) we assumed that <u>no</u> female survived beyond her 15th year. In the simplest calculations we also assumed that a constant proportion of females die each year from the time of birth until the 16th year, when all surviving females die (death rate is age-independent). We also examined the effects of high death-rates among new-born and juveniles but these aspects are not dealt with here.

***Basic calculations***

In our calculations we denote the proportion of females surviving to a given age (***x***) as ($l_x$) and the number of females born per surviving female of age (***x***) as ($m_x$). The maximum mx is 0.5; $m_x$ = 0 for age 1 year, 0.1 for age 2 years, and remains constant thereafter to age 15 years, at values ranging from 0.5 - 0.35 (respectively 100% - 70% of females delivering 1 young each year). It is assumed that all surviving females die on completing year 15. Since flying foxes are seasonal breeders and births occur close to each maternal birthday, the values of ***x*** refer to the end of each successive year of life.

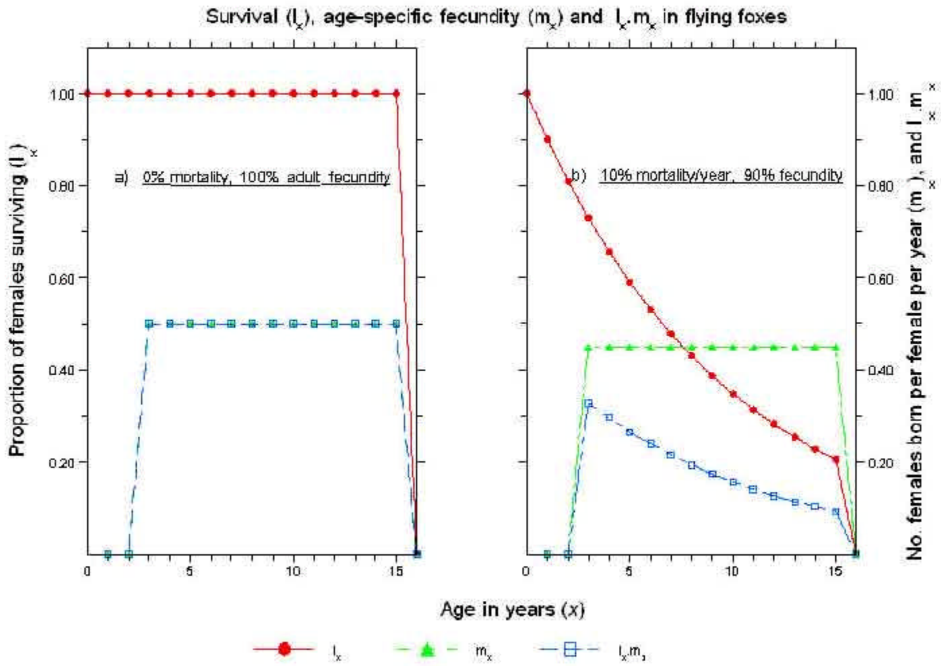



***Figure 1*** shows examples of the basic calculations involving survival of females and their breeding success. The left hand graph shows the theoretical, upper-limit case - a set of circumstances that could never happen in the wild. Females are born at time zero; none survive beyond year 15, but ***none die before year 16*** - annual mortality is zero. We have assumed that all adult females deliver 0.5 females/ year (100% reproductive success) every year including their 15th.

The left axis scale ($l_x$) shows the proportion of females surviving (the subscript refers to the age ***x***, bottom axis). Since none die until the 16th year, the proportion surviving remains at 1 for fifteen years, Adding up (?) the proportion surviving each year gives the *life expectancy* - 16 years (?$l_x$ = 16). The scale of the right axis ($m_x$) shows female fecundity as the number of female young/per female/per year, equal, in the left-hand graph, to the theoretical maximum of 0.5. The right hand scale also shows the number of female young/ surviving female/ year - obtained by multiplying the proportion of females surviving each year by the number of females born/ female/ year (***$l_x$. $m_x$***). Adding up the number of females/ surviving female/ year gives the total number females produced/ female life-time (***$\sum l_x$. $m_x$***). For the left hand graph, this equals 6.6 females. From such data we can calculate the time it takes for a population to double or halve. In this case the doubling time (***$T_d$***) is 3.1 yr. It is worth emphasising that Grey-headed Flying-fox populations cannot increase faster than this, and that the real-world maximum is much less.

***The effects of decreased fecundity and increased mortality***

The right hand graph shows such a scenario. Here the population suffers a moderate mortality, with 10% of females dieing each year, and the proportion surviving declining progressively. Here, *life expectancy* is 8.2 years. We assume that most (90%) of surviving adult females produce 0.5 female/ year, throughout their life to age 15. The total females produced/ female lifetime (***$\sum l_x.m_x$***) is 2.5. The population increases, but ***$T_d$*** is 5.7 years.

In order for a population to be maintained or grow, the number of females produced per female lifetime (***$\sum l_x.m_x$***) must be greater than 1 - each female must survive long enough in each generation to produce at least 1 female replacement, which must survive long enough in each generation to produce at least 1 female... and so on. When ***$\sum l_x.m_x$*** is greater than 1, the population will increase. When ***$\sum l_x.m_x$*** = 1 the population will remain ***stationary*** (constant number, neither increasing or decreasing). When ***$\sum l_x.m_x$*** is less than 1 the population declines.

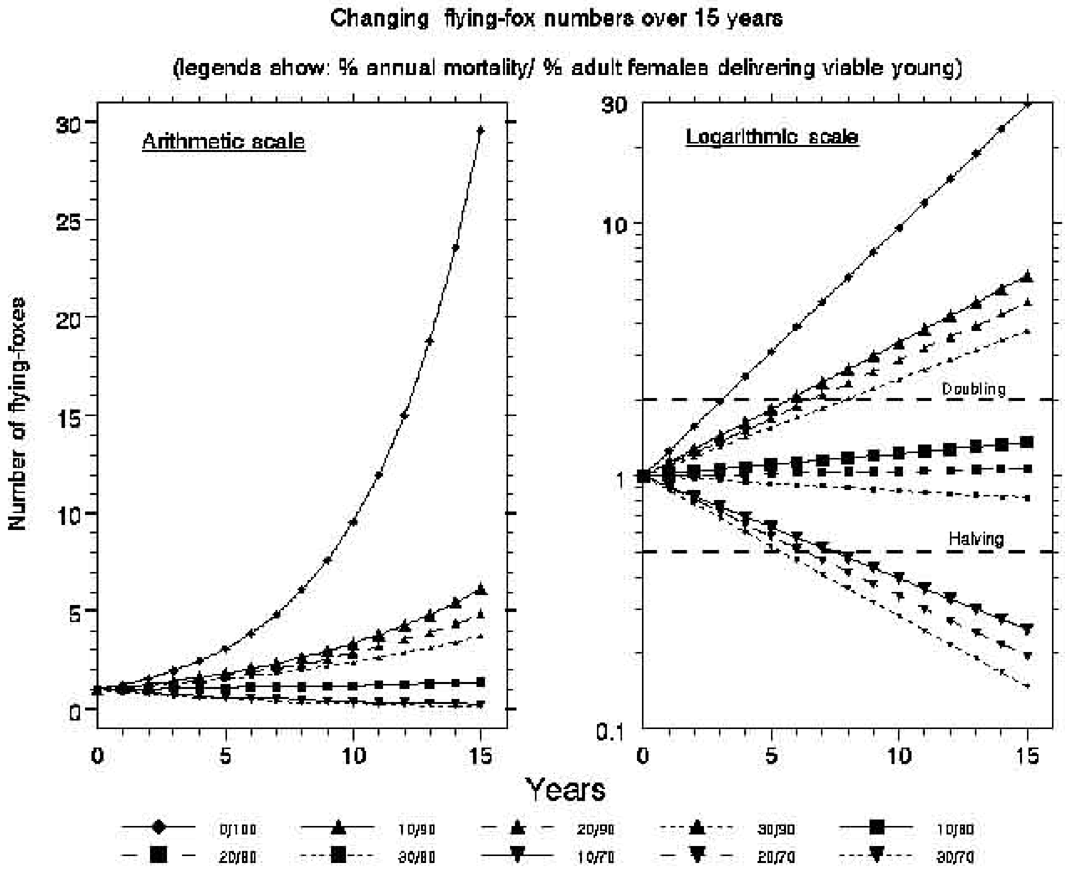
*Table 1. Mortality, life expectancy, female reproductive rate and population doubling/ halving time.* It is assumed that: no bats survive beyond their 15th year and mortality remains constant across the adult life-time (age $\geq$ 3 years); the no. females born/ adult female/ year remains constant over a female's adult life and that adults have, 100, 90 or 70% breeding success (respectively 0.5, 0.45 or 0.35 females born/ female/ year). Doubling/halving times were calculated on basis that 20% of 2-year-olds bear young. So too was $\sum l_x.m_x$.

| Mortality (%/yr) yrs 1/2/3-15 | Life expectancy (years) ($\sum l_x$) | Females/ adult female/year ($m_x$) | Total females /female life-time ($\sum l_x.m_x$) | Doubling ($+T_d$) halving ($-T_d$) time (years) |
|---|---|---|---|---|
| 0/0/0 | 16.0 | 0.50 | 6.6 | +3.1 |
| 10/10/10 | 8.1 | 0.45 | 2.53 | +5.7 |
| 10/10/10 | 8.1 | 0.35 | 1.98 | +7.9 |
| 20/20/20 | **4.9** | 0.45 | 1.15 | +34 |
| 2020/20 | 4.9 | 0.35 | 0.91 | -52 |
| 25/25/25 | 3.0 | 0.45 | 0.8 | -20 |
| 25/25/25 | 3.0 | 0.35 | 0.63 | -10 |
| 30/30/30 | 3.3 | 0.45 | 0.56 | -7.4 |
| 30/30/30 | 3.3 | 0.35 | 0.45 | -5.4 |

**Table 1** shows how increased mortality decreases life-expectancy and the total number of female offspring produced per female lifetime. Decreased female breeding success also reduces $\sum l_x.m_x$. As $\sum l_x.m_x$ diminishes, so populations swing from increase to decline - as shown by the doubling ($+T_d$) and halving ($-T_d$) times in the final column.

***Expansion and decline of Grey-headed Flying-fox populations under various conditions***

**Figure 2** shows, how population numbers change over time for various death and birth rates. On the left, in an arithmetical plot, the top line shows that, under zero mortality and 100% reproductive success, the population numbers increase to give a line with an ever increasing upwards slope - characteristic of exponential increase. Population size starts at 1 in year 0, doubling every 3.1 years, to increase ~ 32-fold by year 15.




This is an unrealistic rate that would never occur in the wild. When 10% of bats die annually and 90% of surviving females rear young to independence each year, the doubling time extends to about 6 years.

In this graph, all of the other cases are crowded below and difficult to distinguish. In the right graph, the same numbers have been plotted on a logarithmic [geometric] scale to produce straight lines which show declining populations to better effect. Horizontal drawn lines enable one to read off doubling and halving times. The top line again shows population growth where animals have 100% survival and breeding success. Below, three groups of lines correspond respectively to age-independent annual mortality rates of 10, 20 & 30%. Within each group, successively lower lines represent, respectively, 90, 80 and 70% breeding success. Clearly it is the mortality of females that has the greatest influence on the dynamics of flying fox populations, in the sense that a 10% increase in mortality has a much greater effect than a 10% decline in breeding success. The figure shows that when annual breeding success averages 80%, and annual mortality rate across all age classes averages 20%, then the population is near-stationary. McIlwee & Martin (2002) suggested that these are therefore likely to be close to the "natural" rates that applied to Australian flying fox populations prior to European settlement. It should be noted that Eby's recent data show the average breeding success of Grey-headed Flying-foxes in NSW to be ~70%.

***Calculation of a population's intrinsic capacity for increase ($r_m$)***

As shown above, one can calculate, from female fecundity & mortality rates, how a population will behave over time. The basic principles, fully described in Andrewartha and Birch (1954), are as follows. The total number of females produced per female lifetime ($\Sigma l_x.m_x$) is the *net reproduction rate* $R_0$, and is the capacity of the species to multiply in one generation time ***T*** - defined as *"the mean period elapsing from birth of parents to birth of offspring"* and which may be calculated as:

$$T = \Sigma l_x.m_x.x/\Sigma l_x.m_x$$

In unvarying favourable environmental conditions in which a population of animals can breed without restraint, and birth-rate exceeds death-rate, the population will increase at a constant exponential rate as,

$$N_t = N_0.e^{r_m.t}$$

where $N_0$ is the number of animals at time 0, $N_t$ the number of animals at time ***t***, ***e*** the base of natural logarithms, and $r_m$ the "rate constant" - the ***intrinisic (or "innate") capacity for increase in numbers***. It is this relationship which is illustrated for various conditions in figure 2, in which $r_m$ is the slope of the straight-line plots. If death-rate exceeds birth-rate, all other factors remaining constant, population numbers will decline at a constant exponential rate and $r_m$ is negative. In an exponentially growing or diminishing population:

$$R_0 = e^{r_m.T}$$

where ***T*** is the generation time, and

$$r_m = \log_e.R_0/T$$

which is the expression we first used to calculate $r_m$. We describe it here because it is a relatively transparent calculation for those who find mathematics to be unintuitive. Andrewartha and Birch (1954) state that this method gives approximate values of $r_m$ (though usually within 10% of the true value) as it does not consider the ***stable age distribution*** of the population. In ***Figure 2*** the left hand graph is a plot of $N_t = N_0.e^{r_m.t}$. Both plots are based on precise calculation of $r_m$.

***The importance of the age structure of a population***

If environmental conditions, and $l_x$ and $m_x$, remain constant over time, then a population will reach a characteristic ***stable age-distribution*** associated with its particular mortality and fecundity.

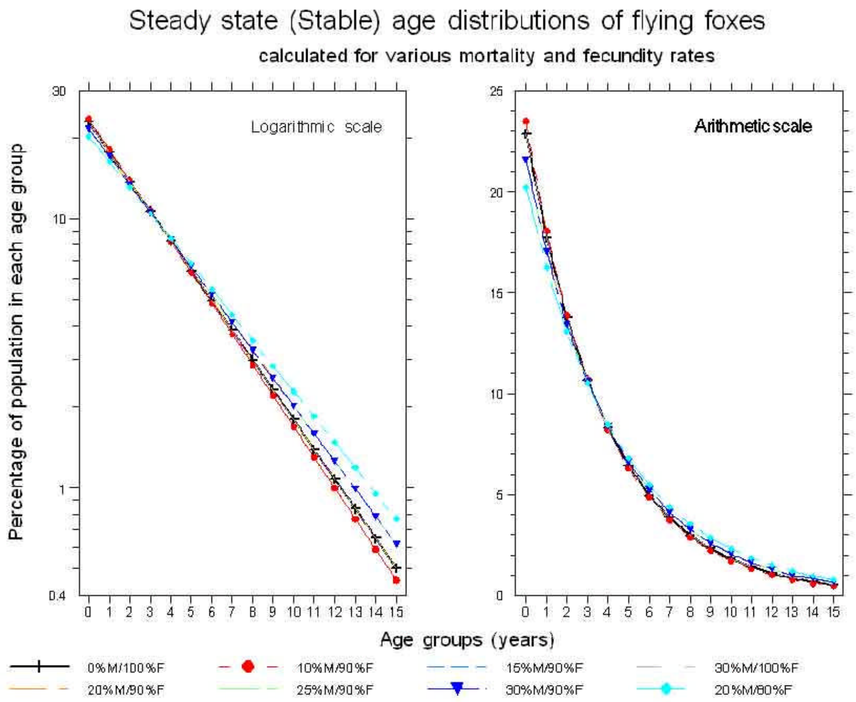



**Figure 3** shows the stable age-distributions for a range of Grey-headed Flying-fox population mortalities/ fecundities. When age-independent mortality and fecundity both change there is effectively no change in the age-distribution. Changing mortality while fecundity remains constant, produces minor changes, as does changing fecundity, as mortality remains constant. When these distributions are plotted on a logarithmic scale, all follow a straight line - effectively each follows a negative exponential. This, perhaps surprisingly, includes the upper limit case where all females have 100% breeding success, and none die before the fifteenth year. Clearly, in this case, the progressively smaller proportion of older females in the population is not due to progressively older females dying, but to dilution of the population with young, and the young of young etc. "***We note, however, that random samples taken from any of these populations could well lead un-informed researchers to conclude that the animals had a relatively short life-span"*** (McIlwee & Martin, 2002). It is on the issue of age distributions and their use in determining age-specific mortalities, that the *Divljan Thesis* modelling comes to grief. This panel member (LM) has consulted with an overseas colleague, who has confirmed the criticisms expressed below. He wishes to remain anonymous, but his reports are available if required.

## Appendix 4 Flaws in the population modelling methodology of the Divljan Thesis

Ideally age-specific mortality rates are determined by following the survival of a cohort of animals all born at the same time, and a life-table constructed with columns for age-class (***x***), number in each age-class (frequency, $f_x$), survival ($l_x$) etc. However this is usually not possible for populations in the wild, and, "real cohorts are seldom studied, mortality rates calculated indirectly are applied to imaginary cohorts" (Caughley, 1977).

Any series of animals collected from the wild (either by trapping, or simply found dead, as in the Divljan Thesis) and then placed into age groups will provide a ***standing age distribution***. As Caughley (1977) states:

"Two kinds of age distribution must not be confused: the temporal age distribution of a cohort gives the proportion surviving to each age; the standing age distribution of a population gives the number of animals, relative to the number of newborn, in each age class at a particular time. In only one case are these two distributions congruent. When a population's exponential rate of increase is zero, and when it has been zero for some time, and when the survival and fecundity schedules have remained constant for some time, the standing age distribution is the same as the temporal age distribution of the cohorts that collectively constitute the population. **In all other cases the standing age distribution differs from the cohort age distribution**". **[my emphases]**. The following effectively paraphrases Caughley's section on the use of standing age distributions.

An age distribution is convenienlty expressed as the number of animals in an age class relative to the number of new-born. This age-distribution $S_x$ is defined as $S_x = F_x/F_0$. $S_x$ is usually estimated from a sample by $S_x = f_x/f_0$ where $f_x$ and $f_0$ are the sampling frequencies.

When a populations rate of increase (or decrease) has been constant for some time (***stable age distribution***) $S_x$ is related to survival $l_x$ as

$$l_x = S_x e^{rx} \text{ and } S_x = l_x e^{-rx}$$

Caughley (1977) presented a table illustrating five ***different*** $S_x$ distributions derived from the ***same*** survival schedule, but with differing $r$s. Only when $r = 0$ does $S_x = l_x$.

Caughley (1977) also discussed the implications of methods of sampling, and some of his criticisms are probably applicable to the *Divljan* methodology, but will not be dealt with here. In the thesis the age distribution obtained from recovered dead bats and captured live bats (***Thesis figure 6.3***) shows large anomalies. Also the author makes a number of assumptions about the data, arguing among other things that the apparent agreement between the two sets of data is evidence of a steady state.

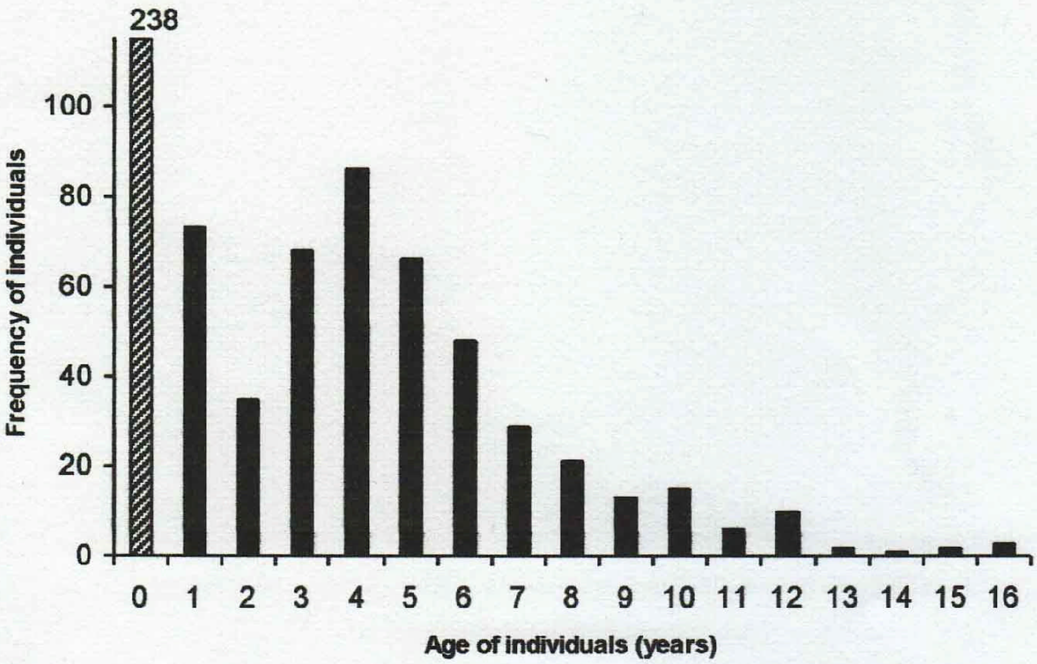



**Figure 6.3** Combined age distribution (≥1 year old, $n$ = 478) for two independent Grey-headed Flying-fox samples (dead individuals collected between 1999–2007, and live individuals trapped during 2006/07 season). Young of the year (39 dead and 199 live), and animals between 1 and 3 years of age are under-represented because of sampling bias.

The author then ignores the anomalous groups (under representation of 1-3 year olds) and fits the line shown in ***Thesis figure 6.5***, stating that this is an "exponential decay function with the equation $S_x = 347.28e^{-0.3482x}$"....Then The age-specific survivorship ($l_x$, proportion of females surviving to given age $x$) were then calculated using the equation $l_x = S_x / S_0$ where $S_x$ is the observed frequency at age $x$". **This is completely erroneous because the population is not stationary**. Moreover the author uses these calculations to demonstrate that the population is in decline. Note that Caughley (1977) commented that "A common mistake is to assume that if an age distribution did not change during a study, the rate of increase was zero over this period". This seems to be the case for the thesis as the following quotation from pages 184-5 would indicate.

"Typically populations do not have ***a stable age-structure***, as they are subject to a variety of factors that can affect reproductive and/or survival rates. Therefore, the principal criticism of using the vertical life table approach is the validity of this assumption (Menkens and Boyce, 1993), which is also difficult to test given a single data set (Caughley, 1966). Combining the information provided by multiple sources of vertical age-structured data can allow one to relax the otherwise required assumption (Udevitz and Ballachey, 1998). In this study, I used the Kolmogorov-Smirnov test to compare the two age frequency distributions (Quinn and Keough, 2002). Both dead and live samples had low numbers of individuals younger than 4 years old, but no statistical difference ($D$ = 0.3077, $P$ = 0.489) in the age distributions of the samples was found, ***suggesting a stable population structure of the sample***. To improve the sample size in the subsequent calculations, the two data sets were combined (Figure 6.3)... I opted for a more conservative approach, and under the assumptions of equal sex ratios, and equal age distributions for both sexes, treated all individuals as females to improve the sample sizes (predominantly in the older age classes).

One of the main limitations remaining for ***the combined stationary age distribution*** was that the observed age frequencies were not monotonically decreasing, implying that mortality rates for some ages are negative – a biological impossibility (Caughley, 1977). The numbers of individuals <4 years old were particularly low, possibly due to changes in the population vital rates, ***resulting in a non-stable age-structure*** and low recruitment four years prior to and during the sampling period. (Alternatively, older individuals might have been born during a series of years with favourable environmental conditions, which is unlikely given the irregular and unpredictable flowering patterns of plants that flying-foxes feed on (Eby, 1996).)".

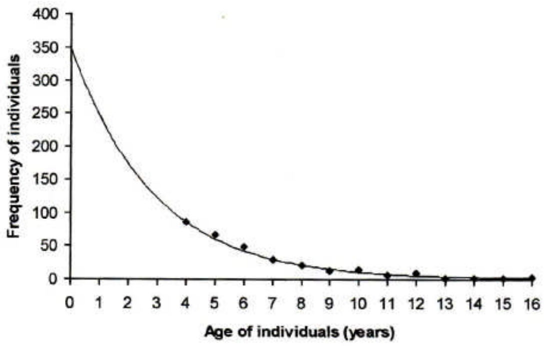



**Figure 6.5** Projected age distribution of flying-foxes based on frequencies of individuals aged 4–16 years from the two combined, independently collected samples. The fitted curve is the exponential decay function with the equation: $S_x = 347.28e^{-0.3482x}$.

It is also evident that the highly anomalous nature of the combined ***standing age distribution*** makes it highly unlikely that it is based on a stable age distribution (on which an accurate estimation of $r_m$ is predicated) nor is it based on a stationary one.

Some aspects of the thesis are puzzling and confusing - so many mortality rates!. For example, the statement(s) on p195 of the Thesis under **6.4.3 Life table analyses**. In particular,it is intriguing that one can obtain an "instantaneous mortality estimate" from "the gradient of the age versus natural log of the frequency of individuals". No details are given other than a reference.

The full statement reads as follows: "The standard model life-history table is summarised in [Thesis] Table 6.3, showing ***variable survival rates across age classes***, with ***mortality ranging from 15% to as high as 40%***. However, the ***instantaneous mortality estimate taken as the gradient of the age versus natural log of the frequency of individuals*** (Fox, 2006) was 35%, estimating the annual mortality rate (= $1-e^{-0.35}$) for the population at 30%." [**panel member's emphases**]

**Table 6.3** Life table for female Grey-headed Flying-foxes based on the adjusted frequency sample (standard model). $x$ is the age of an individual, $S_x$ is the smoothed number of individuals observed, $m_x$ is the average number of female offspring per female, $l_x$ is survivorship (i.e. probability of an individual surviving from birth to age $x$). The entries for the Leslie matrix are also provided with $i$ annotating the age class, $P_i$ is the survival probability of an individual in age class $i$ from time $t$ to $t$+1, and $F_i$ is the fecundity.

| Life table | | | | | | Matrix parameters | | |
|---|---|---|---|---|---|---|---|---|
| $x$ | $S_x$ | $m_x$ | $l_x$ | $l_x m_x$ | $l_x m_x x$ | $i$ | $P_i = l(i)/l(i-1)$ | $F_i = m(i)P_i$ |
| 0 | 347 | 0.00 | 1.000 | 0.000 | 0.000 | | | |
| 1 | 245 | 0.00 | 0.706 | 0.000 | 0.000 | 1 | 0.706 | 0.000 |
| 2 | 173 | 0.09 | 0.499 | 0.045 | 0.091 | 2 | 0.706 | 0.064 |
| 3 | 122 | 0.35 | 0.352 | 0.122 | 0.366 | 3 | 0.705 | 0.245 |
| 4 | 86 | 0.44 | 0.248 | 0.108 | 0.432 | 4 | 0.705 | 0.307 |
| 5 | 66 | 0.45 | 0.190 | 0.086 | 0.431 | 5 | 0.767 | 0.348 |
| 6 | 48 | 0.45 | 0.138 | 0.062 | 0.373 | 6 | 0.727 | 0.327 |
| 7 | 29 | 0.45 | 0.084 | 0.038 | 0.263 | 7 | 0.604 | 0.272 |
| 8 | 21 | 0.45 | 0.061 | 0.027 | 0.218 | 8 | 0.724 | 0.326 |
| 9 | 13 | 0.45 | 0.037 | 0.017 | 0.152 | 9 | 0.619 | 0.279 |
| 10 | 11 | 0.45 | 0.032 | 0.014 | 0.143 | 10 | 0.846 | 0.381 |
| 11 | 8 | 0.45 | 0.023 | 0.010 | 0.114 | 11 | 0.727 | 0.327 |
| 12 | 5 | 0.45 | 0.014 | 0.006 | 0.078 | 12 | 0.625 | 0.281 |
| 13 | 4 | 0.45 | 0.012 | 0.005 | 0.067 | 13 | 0.800 | 0.360 |
| 14 | 3 | 0.45 | 0.009 | 0.004 | 0.054 | 14 | 0.750 | 0.338 |
| 15 | 2 | 0.45 | 0.006 | 0.003 | 0.039 | 15 | 0.667 | 0.300 |
| 16 | 1 | 0.45 | 0.003 | 0.001 | 0.021 | 16 | 0.500 | 0.225 |
| 17 | 0 | 0.00 | 0.000 | 0.000 | 0.000 | | | |
| Total | 1184 | | | 0.5 | 2.8 | | | |

The statement on page 196 is puzzling, "The life table analyses of all four models are summarised in [Thesis] Figure 6.6. It is apparent that the population is exponentially decreasing under the standard model, and only 20% of the animals born at time 0 will remain alive by the time they are 5 years old, making the life expectancy for the this model *Σlx* = 3.4 years ([Thesis] Figure 6.6 a). As expected, the figure is a close approximation to the estimate from a previous model with a constant female mortality rate of 30% until year 16, when all remaining females die (Martin and McIlwee, 2002)". **Fig 6.6** shows $l_x$, $m_x$ and $l_x.m_x$. Thesis ***Fig 6.6a*** does ***not*** show that "the population is exponentially decreasing".

On p33 of the thesis the author makes a strange statement, viz.

"The limited information on the effects of mortality on *P. poliocephalus* suggests that active shooting of bats is one of the main factors responsible for the species decline (together with habitat loss and degradation; Wahl, 1994, Parry-Jones, 2000)".

Evidence of unconscious bias?

There are sufficient anomalies in the author's data, and in many of her statements (some of them detailed above) that put the validity of the calculated rate of population decline into doubt

*4.3.9 Conclusion* The calculations are flawed and the estimated rate of decline in the population is not valid.

That is not to say that the population is ***not*** declining - it probably is, although the recent (admittedly flawed) population counts do not show any such decline.

## Appendix 5 Cost of shooting

Text from Dang and Jarvis unpublished
"Ammunition $130.00 per 250 rounds. Observations with grower's practice on many occasions revealed that 250 rounds could be used in one night. The shooters are sometimes paid employee or the growers themselves. On average, shooting time is about four hour per night.

"For an average orchard in Sydney Basin, the shooting period for a season should be about six weeks from the first ripe crop to the latest, if only stone fruits are grown. If stone fruits and apple are grown, the period could be 10 weeks or more depend on what varieties are grown.

"Shooting requires two people and on average three nights per week so as to reduce damage significantly. Thus the cost involved shooting could be estimated per season as below:

(1) Stone fruits only:

1.a. Labour:

2 (employees) X 4 hr X $20 (per hr) X 3 (night/week) X 6 (weeks) = $ 2880.00

1.b. Ammunition:

$ 130 (per night) X 3 (night/week) X 6 (weeks) = $ 2340.00

Total: $5220.00

(2) Stone fruits and apple:

1.a. Labour:

2 (employees) X 4 hr X $20 (per hr) X 3 (night/week) X 10 (weeks) = $ 4800.00

1.b. Ammunition:

$ 130 (per night) X 3 (night/week) X 6 (weeks) = $ 3900.00

Total: $8700.00

## Appendix 6 Local government responses to netting questions

Response from Kirsty McIntyre, Senior Policy Officer - Natural Resource Management, Local Government Association of NSW and Shires Association of NSW. You may wish to look at the state policy which was only recently been gazetted. My understanding depending on the zone is the structure would not require approval under this policy. Council response to following:

- Are there any councils that require orchardists to submit a DA when they are seeking to net their orchards?
- Do any councils have guidelines or standards for erecting nets or for the colour of nets?

No councils have come forward to say that they require a DA. Hawkesbury Nepean have mentioned that the state Environmental Planning Policy (exempt and complying development codes) 2008 - Subdivision 16 Farm Buildings and structures outlines where these structures do not require any approval. It seems that approval would depend on the zone but might be useful to review too.

The councils I spoke to all agreed that guidelines on netting which they could provide to the community would be a useful resource.

Responses received include:

**Randwick**
Randwick does not have any issue with them as agricultural pests but were involved in a survey done by the Botanic Gardens on their behaviour and roosting locations to inform their strategy for relocation of the Sydney Botanic Garden's colony of Flying Foxes.

**Ku-ring-gai Council**
We don't have a policy on nettings and DA's etc as we don't have orchards but we have worked with the KCBS and used their early brochure on netting fruit trees safely. This has now been superseded by the DECC guidelines

**Tumut Shire**
Tumut Shire has a large horticultural industry, mainly apple trees at Batlow. Netting is common to protect the trees and fruit from hail, not so much from birds or flying foxes. Given that hail netting is common in the shire' protecting a major industry, Council does not require approval, nor does it have any guidelines.

**Shoalhaven**
In relation to the questions below I can report that Shoalhaven City Council does not require a DA for the netting of orchards and does not have any guidelines or standards for erecting nets or for the colour of nets. The Shoalhaven is not a big orchard area though their are a number of vineyards and a few stonefruit orchards. Council has produced a "sharing your space" brochure, which is aimed at urban and rural residents rather than orchardists, and it contains basic information and photos on how to net fruit trees and the consequences of putting nets loosely over fruit trees. The brochure goes out with occupation certificates to new home owners but is also distributed by local wildlife carers and council officers.

**Shellharbour**

I checked with our Development people and we do not require orchardists to submit a DA when they are seeking to net their orchards. We also do not have any guidelines or standards for erecting nets or for the colour of nets.

**Hawkesbury City Council**

The provisions of state Environmental Planning Policy (exempt and complying development codes) 2008 Subdivision 16 Farm Buildings and structures outlines where these structures do not require any approval.

## Appendix 7 Investment return of netting in small (3ha) and large (20ha) orchard

The results of investment return for small and large orchard at different damage levels (or level of yield gained by netting) and fruit price (Dang and Jarvis 2009 unpublished data).

Table 1: Investment return of netting in small orchard (3ha) with different situation[1]

| Farm situation | Price and yield gained through netting | | | | Investment return factor | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Price | | Yield gained | | No. of year to gain positive cash flow | | Benefit/ Cost Ration | | Annual return (in 1000$) | |
| | 2 $/kg | 3$ /kg | 30% | 50% | Netted | Un-netted | Netted | Un-netted | Netted | Un-netted |
| A | Y | | | Y | 15 | >20 | 1.11 | 0.91 | 15361 | -9869 |
| B | Y | | Y | | 18.5 | >20 | 1.02 | 0.91 | 1988 | -9869 |
| C | | Y | | Y | 7 | 11 | 1.57 | 1.29 | 80627 | 33641 |
| D | | Y | Y | | 8.5 | 10.5 | 1.44 | 1.29 | 58552 | 33641 |

1/ A: 30 %yield gained (YG)/low price (LP-2$/kg); B: 50% YG/LP; C: 30%YG/high price(HP-3$/kg) 30%(YG)/high price(HP-3$/kg) and D: 50%YG/HP

Table 2: Investment return of netting in small orchard (20ha) with different situation[1]

| Farm situation | Price and yield gained through netting | | | | Investment return factor | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Price | | Yield gained | | No. of year to gain positive cash flow | | Benefit/ Cost Ration | | Annual return (in 1000$) | |
| | 2$/ kg | 3$/ kg | 30% | 50% | Netted | Un-netted | Netted | Un-netted | Netted | Un-netted |
| A | Y | | | Y | 10.5 | >20 | 1.19 | 0.97 | 167241 | -19356 |
| B | Y | | Y | | 15 | >20 | 1.09 | 0.97 | 73317 | -19356 |
| C | | Y | | Y | 5 | 6.5 | 1.77 | 1.45 | 680881 | 335047 |
| D | | Y | Y | | 4.5 | 6 | 1.75 | 1.45 | 676563 | 335047 |

1/ A: 30 %yield gained (YG)/low price (LP-2$/kg); B: 50% YG/LP; C: 30%YG/high price(HP-3$/kg) 30%(YG)/high price(HP-3$/kg) and D: 50%YG/ HP

## Appendix 8 Growers Survey of farmers in the Sydney Basin (Ed Biel 2009)

| | Grower | Location | Postcode | Contact No | Crops | Orchard Area | Already Netted | Stay in Industry: 1 year | Stay in Industry: 1-5 years | Stay in Industry: 5 years plus | Previous Licences: Yes | Previous Licences: No | If Granted $20000: Net | If Granted $20000: Self - Insure | If Granted $20000: Leave Industry | Area will net |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | Wedderburn | 2560 | | Peaches | 16 | 0 | | | 1 | 1 | | 1 | | | 16 |
| 2 | | South Maroota | 2756 | | Stonefruit | 2 | 0 | | | 1 | | | 1 | | | 2 |
| 3 | | Darkes Forest | 2508 | | Stonefruit and Apples | 26 | 18 | | | 1 | 1 | | 1 | | | 6 |
| 4 | | Gross Vale | 2753 | | Stonefruit | 11 | 0 | | | | 1 | | | | 1 | 0 |
| 5 | | Canoelands | 2157 | | Peaches Nectarines | 13 | 0 | | | 1 | 1 | | 1 | | | 13 |
| 6 | | Canoelands | 2157 | | Peaches Nectarines | 20 | 18 | | | 1 | 1 | | 1 | | | 2 |
| 7 | | Canoelands | 2157 | | Peaches Nectarines | 20 | 0 | | | 1 | 1 | | | 1 | | 0 |
| 8 | | Canoelands | 2157 | | Nectarine Plums | 15 | 10 | | | 1 | 1 | | 1 | | | 5 |
| 9 | | Canoelands | 2157 | | Peaches Nectarines | 8 | 5 | | 1 | | 1 | | | | 1 | 0 |
| 10 | | Arcadia | | | Peaches Nectarines | 5 | 0 | | | 1 | 1 | | 1 | | | 5 |
| 11 | | Mangrove Mountain | 2250 | | Stonefruit | 10 | 0 | | | 1 | | | 1 | | | 10 |
| 12 | | Kulnura | 2250 | | Stonefruit | 3 | 0 | | | 1 | 1 | | 1 | | | 3 |
| 13 | | Kulnura | 2250 | | Stonefruit | 5 | 0 | | | 1 | 1 | | 1 | | | 5 |
| 14 | | Central Mangrove | 2250 | | Stonefruit Apples | 25 | 0 | | | 1 | 1 | | | 1 | | 0 |
| 15 | | Kulnura | 2250 | | Stonefruit | 3 | 0 | | | 1 | 1 | | 1 | | | 3 |
| 16 | | Bilpin | 2758 | | Stonefruit and Apples | 12 | 6 | | | 1 | 1 | | 1 | | | 6 |
| 17 | | Kulnura | 2250 | | Stonefruit Pomefruit | 12 | 0 | | | 1 | 1 | | 1 | | | 12 |
| 18 | | Bilpin | 2758 | | Stonefruit Apples | 28 | 10 | | | 1 | 1 | | 1 | | | 10 |
| 19 | | Thirlmere | 2572 | | Stonefruit Apples Persimmons | 27 | 8 | | | 1 | 1 | | 1 | | | 10 |
| 20 | | Lakesland | 2572 | | Stonefruit Apples | 5 | 0 | | 1 | | 1 | | | 1 | | 0 |
| 21 | | Oakdale | 2570 | | Stonefruit | 5 | 2 | | | 1 | 1 | | 1 | | | 3 |
| 22 | | Cobbity | 2570 | | Persimmons | 10 | 0 | | | 1 | 1 | | 1 | | | 10 |
| 23 | | Mulgoa | 2745 | | Stonefruit | 12 | 10 | | | 1 | | 1 | | 1 | | 0 |
| 24 | | Mulgoa | 2745 | | Stonefruit | 9 | 2.5 | | 1 | | | 1 | 1 | | | 2 |
| 25 | | Lakesland | 2572 | | Stone and Pomefruit | 2 | 0 | | | 1 | | 1 | 1 | | | 2 |
| 26 | | Lakesland | 2572 | | Stonefruit Pomefruit | 8 | 0 | | | 1 | 1 | | 1 | | | 8 |
| 27 | | Kulnurra | 2250 | | Plums | 2 | 0 | | | 1 | | | | 1 | | 0 |
| 28 | | Mangrove Mountain | 2250 | | Stonefruit | 5 | 2 | | | 1 | | 1 | | 1 | | 0 |
| 29 | | Maroota | 2756 | | Stonefruit | 2 | 0 | | | 1 | 1 | | 1 | | | 2 |
| 30 | | Maroota | 2756 | | Stonefruit | 9 | 0 | | | 1 | 1 | | 1 | | | 9 |
| 31 | | Glenorie | 2757 | | Stonefruit | 4 | 0 | | | 1 | 1 | | | 1 | | 0 |
| 32 | | Maroota | 2756 | | Stonefruit | 15 | | | | 1 | | 1 | | 1 | | 15 |
| 33 | | Wedderburn | 2560 | | Stonefruit & Pomefruit | 20 | 0 | | | 1 | 1 | | 1 | | | 8 |
| 34 | | Bilpin | 2758 | | Stonefruit & Pomefruit | 12 | 0 | | | 1 | 1 | | 1 | | | 12 |
| 35 | | Lakesland | 2572 | | Stonefruit | 2.5 | 0 | | 1 | | 1 | | | 1 | | 0 |
| 35 | | **Remaining** | | | | | | | | | | | | | | |
| 36 | 6 growers | B ilpin (Estimate) | | | | 20 | | | | | | | | | | |
| 37 | 10 growers | Rest (Estimate) | | | | 30 | | | | | | | | | | 21 |
| 38 | 5 growers | ewarts Point (Estimate) | | | | 20 | | | | | | | | | | 20 |
| 39 | 5 growers | Araluen (Estimate) | | | | 40 | | | | | | | | | | 28 |
| 40 | 2 growers | Milton (Estimate) | | | | 5 | | | | | | | | | | 3 |
| | 28 growers | Total Estimated | 115 | | | 498.5 | 91.5 | 0 | 4 | 30 | 27 | 5 | 24 | 9 | 2 | 251 |

| | | | |
|---|---|---|---|
| **Total Cost** | $8,140,000 | Total Estimated area | 115 |
| **% of total area will be Netted** | 75 % | Estimated extra net | 85.93 |
| | | Total netted area after grants (est) | 336.93 |

| | | |
|---|---|---|
| 30 of 34 want to stay >5 years | 85.71 | percent |
| Previously held licences | 77.14 | percent |
| 22 will net all or part of orchard | 68.57 | percent |
| 9 will self insure | 25.71 | percent |
| 2 will leave industry | 5.88 | percent |

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