The Cruelty of Shooting Flying-foxes in Orchards

Background paper for the Animal Welfare Advisory Committee

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Contents

Figure 1 The four species of flying-foxes shot in orchards in Queensland: Spectacled, Grey-headed, Black and Little red flying-foxes (photographs by Halley Design)

1. Flying-foxes

Four species of flying-foxes are shot under permit in commercial orchards in Queensland: Spectacled (*Pteropus conspicillatus*, listed as vulnerable under the EPBC Act); Grey-headed (*P. poliocephalus,* also listed as vulnerable), Black (*P. alecto*) and Little red flying-foxes (*P. scapulatus*). These four species are shown in Figure 1 above.

Flying-foxes are ecologically important as pollinators and seed dispersers of Australian native trees. Relevantly for the AWAC, flying-foxes are also highly intelligent mammals with complex social lives, including a considerable variety of vocalisations. They are clearly sentient and thus able to suffer pain.

Unfortunately for their welfare and conservation, flying-foxes have a major image problem. These attitudes towards flying-foxes are highly relevant to welfare outcomes. Flying-foxes are reviled by many people and public statements about them often use terms like 'vermin', 'plague' and 'disease-ridden'. For the past 200 years there has been large-scale killing of flying-foxes with methods used or attempted including guns, electric grids, poison, explosives, and gas flares. The local paper in Charters Towers has recently referred to a 1927 report in the same newspaper about a shooting party at the local bat colony (*Northern Miner* 23 June 2006):

> "Shooters assembled in great force at Lissner Park on Saturday afternoon, when a flying fox raid was conducted.
>
> "The city council, it is said, provided some ammunition, and the shooters were pretty generous in their own provision, apparently appreciating that fox shooting is fairly good sport, and being close to home, pretty convenient."
>
> It continues: "It would be difficult to estimate just how many foxes were annihilated, but there could not have been many short of a thousand, and the raid should, for a time at least, have a marked affect on the nocturnal vulpine screechings".

Sadly, there is currently a campaign in the same town to have the local colony dispersed or killed, as there are in a number of other urban areas. Because of their pest status, it was only in 1995 that flying-foxes got the same status as other native wildlife as protected native species in Queensland.

Why is there such bad press for a native animal that performs valuable ecological services and has a fascinating natural history and great charisma? Explanations include the Dracula myth, that they are dark creatures of the night, that they eat fruit from backyards and orchards, that some people find their camps noisy and smelly and, more recently, that they carry diseases feared by people. They are also increasingly used as a political scapegoat with some politicians seek to exploit people's fears and ignorance to gain political advantage.

Flying-foxes are also greatly respected and admired by many people. There is a large contingent of wildlife carers who rehabilitate thousands of orphaned and injured flying-foxes each year. Many members of the public delight in the urban presence of flying-foxes and dusk fly-outs. There is also growing tourism activity around flying-foxes.

2. Flying-foxes and pain perception

With permission, I have taken the following extracts from an affidavit prepared by Dr Len Martin in 2001 for the EPA in a court case involving electric grids (the case did not proceed as the appellant fruit growers withdrew). Here he gives some background on flying-foxes and discusses pain perception (Martin 2001).

3.3.2. *The taxonomy, biology and reproductive biology of flying foxes*

...

3.3.2.3. Flying-foxes are classified a separate suborder of bats - *Megachiroptera*, and do not possess the sophisticated sonar (ultra-sound emission) that is used by the so-called "micro-bats" (suborder *Microchiroptera)* to navigate and catch prey. Nonetheless they have large eyes and good night-vision, excellent hearing, and sense of smell. They are highly intelligent, inquisitive creatures capable of accurate long distance navigation and of remembering specific locations. Radio-tracking research by Eby (Eby, 1991a & b) has demonstrated that individual flying-foxes can return to specific locations after long periods of time, and over long distances. In other words, flying foxes have an excellent spatial sense and spatial memory - maps-in-the-mind as it were. Eby's research gives no support to the theory of many fruit-growers, that specific "scouts" lead other bats into orchards. On the contrary it indicates that all flying foxes are individually capable of locating their own food sources. This does not exclude the possibility of some knowledge sharing or of leadership, but means that orchard attacks are not *dependent* on the hypothetical scouts, as many fruit-growers believe.

3.3.2.4. In captivity, flying-foxes are responsive to, and interact well, with humans. They exhibit a remarkably adaptive behaviour, and substantial capacity for learning, recognition and remembering. In the wild, they are gregarious creatures with complex patterns of social behaviour. Because their brain visual pathway resembles that found otherwise only in primates, Pettigrew *et al* (1985) suggested that flying-foxes are primates, and have evolved separately from the micro-bats. This theory remains controversial. Nevertheless the complexity of flying-fox behaviour is comparable to that of many primates and, other than primates, no mammalian group has the range of vocalisations exhibited by flying-foxes.

3.3.2.5. Flying-foxes have a low reproductive rate, females being capable of raising only one young per year (Martin & McIlwee, 2001; McIlwee & Martin, 2001). There is a heavy investment by females in rearing young: a six month pregnancy followed by a 3-5 month lactation. All species are seasonal breeders, in that each species delivers young at the essentially the same season each year. Little-red flying-foxes deliver young in May-June, but the frequency of parturition in the other three species peaks in October-December on the east coast of Australia, coincident with the fruit harvest season in many areas. Thus many grey-headed, black or spectacled flying foxes which enter orchards at this time are likely to be late-pregnant females or females with dependent young, the latter either being carried by females attached to the maternal nipple, or left in creches in the roost.

3.33. *On the nature and perception of pain*

3.3.3.1. Pain is the word given to the conscious sensation experienced by humans when body tissues are stimulated by a noxious factor, ie. are damaged in some way. Damage can be caused by external factors - mechanical, chemical, thermal, electrical, or by internal factors - ischaemia, inflammation, pressure, distension. All readers of this report will have experienced pain in some form or other: the intense lingering pain of a sharp blow to the shin; the sharp pain of a cut, or needleprick to a finger; the intense pain of an abdominal "stitch"; the different intense pain of extremely cold fingers; the (agonising?) pain of an intense muscle cramp; the (agonising?) pain which accompanies every breath in pleurisy; the nauseating disorienting pain of a bad headache; the pain of a twisted joint, of a broken limb; the dull, upsetting continuing ache of bone pain; the continuing unrelenting pain of arthritis; the shocking pain of an electric current; the intense, continuing, and upsetting pain of even quite small burns or scalds.

3.3.3.2.People, in speaking of a "good" death, have in their mind's eye a death without pain. None of us wish for the prolonged, unrelenting deep pain suffered by some cancer patients, pain that despite palliative care and modern analgesics (pain-killers) causes such patients to call on God to end their misery. I make this point in relation to what I describe below, namely flying-foxes carrying gross electrical-burn injuries to wings and limbs, even electrocauterised amputations, consequent upon their contact with an electrified cable or wire, and surviving for hours, even days, without any palliative treatment.

3.3.3.3. Here are some of the words humans associate with pain: discomforting, distressing, suffering, hurt, anguish, agony, torment, excruciating, torture, hell, and so forth. In relation to discussion of the alleged cruelty/ aggravated cruelty of electrocution and electrocutive burns, one may note that: humans envisage(d) the ultimate fate of the wrongdoer to be the eternal fires of hell; witches and heretics were put to death by fire; mediaeval torture frequently involved fire; modern torture allegedly involves burns and electric shocks. I emphasise how humans regard the pain of burns and burning, because so many injuries suffered by flying-foxes are burns, albeit produced electrically.

3.3.3.4. In the normal individual, the sense of pain has adaptive value, in that it warns that tissue damage is occurring. In being conscious of the pain, the individual recognises the circumstance of the damage, and learns to avoid those circumstances.

3.3.4. *The physiology of pain perception*

3.3.4.1. In describing pain in physiological terms, the following passages, in quotation marks, come from the 1993 *Report of the American Veterinary Medical Association Panel on Euthanasia* (AVMAP; Andrews, *et al.,* 1993).

3.3.4.2. “Pain is that sensation (perception) that results from nerve impulses reaching the cerebral cortex via specific nociceptive neural pathways. The term nociceptive is derived from noxious stimuli, which threaten to, or actually do, destroy tissue. The stimuli initiate nerve impulses by acting on a specific set of receptors, called nociceptors. Nociceptors respond to mechanical, thermal, or chemical stimuli. Endogenous chemical substances such as hydrogen ions, serotonin, histamine, bradykinin, and prostaglandins as well as electrical currents are capable of generating nerve impulses by nociceptors. Nerve impulse activity generated by nociceptors is conducted to the spinal cord or the brain-stem via nociceptor primary afferent fibers.”

3.3.4.3. “In the spinal cord or brainstem, nerve impulses are transmitted to two sets of neural networks. One set is related to nociceptive reflexes that are mediated spinally, and the second set consists of ascending pathways to the reticular formation, thalamus, and cerebral cortex for sensory processing... Under certain conditions, both the nociceptive reflexes and the ascending pathways may be suppressed, as, for example, in deep surgical anesthesia. In another set of conditions, nociceptive reflex actions may occur, but the activity in the ascending pathways is suppressed; thus, the noxious stimuli are not perceived as pain, as, for example, in a light plane of surgical anesthesia...”

3.3.4.4. “Pain is divided into two broad categories: (1) sensory-discriminative, which indicates the site of origin and the stimulus giving rise to the pain; and (2) motivational-affective in which the severity of the stimulus is perceived and the animal's response is determined. Sensory-discriminative processing of nociceptive impulses is most likely to be accomplished by subcortical and cortical mechanisms similar to those utilized for processing of other sensory-discriminative input that provides the individual with information about the intensity, duration, location, and quality of the stimulus. Motivational-affective processing involves the ascending reticular formation for behavioral and cortical arousal. It also involves thalamic input to the forebrain and the limbic system for perceptions such as discomfort, fear, anxiety, and depression. The motivational-affective neural networks also have strong inputs to the hypothalamus and the autonomic nervous system for reflex activation of the cardiovascular, pulmonary, and pituitary-adrenal systems. Responses activated by these systems feed back to the forebrain and enhance the perceptions derived via motivational-affective inputs...”

3.3.4.5. “For pain to be experienced, the *cerebral cortex* and subcortical structures must be functional. An unconscious animal cannot experience pain because the cerebral cortex is not functioning. If the cerebral cortex is nonfunctional because of hypoxia, depression by drugs, electric shock, or concussion, pain is not experienced...”

3.3.4.6. “Behavioral and physiologic responses to noxious stimuli include distress vocalization, struggling, attempts to escape, defensive or redirected aggression, salivation, urination, defecation, evacuation of anal sacs, pupillary dilatation, tachycardia, sweating, and reflex skeletal muscle contractions causing shivering, tremors, or other muscular spasms...”.

3.3.5. *The perception of pain in animals*

3.3.5.1. It can be seen that application of a noxious (painful) stimulus to a conscious individual elicits a suite of responses, ranging from immediate (unconscious spinal) reflex-withdrawal of the body part from the source of the stimulus (the withdrawal or nociceptive reflex) to central-nervous-system-mediated and autonomic-nervous-system-mediated effects on hormone secretion, blood pressure, heart rate etc, and behavioural changes - distress vocalizations, fearful behavior, urination, release of certain odors or pheromones and so forth.

3.3.5.2. Although humans routinely euthanase injured domestic animals to “put them out of their misery” and many humans believe intuitively that “animals feel pain like us”, it is unlikely that it will ever be possible to “prove” that non-human mammals perceive pain qualitatively in the same way as humans, or to the same level of intensity. Nevertheless a body of objectively verifiable knowledge supports the view that all mammals perceive pain in essentially the same way. Thus the chemical and cellular (neuronal) basis of pain generation and perception is essentially the same in all mammals, and specific noxious stimuli elicit the same suite of measurable physiologic and behavioural responses in a wide variety of species. It also seems that for “pain” to be of adaptive value it is essential that it be a consciously perceived sensation. Only thus can an individual animal recognise and remember the circumstances of the pain, and take the appropriate action to avoid them in the future. Thus, the accepted scientific view is that all mammals perceive pain in essentially the same way and to the same degree as humans. The National Health and Medical Research Council's guidelines for experiments on animals are predicated on this view, as is the AVMAP report on animal euthanasia, and for example, the NSW PREVENTION OF CRUELTY TO ANIMALS ACT.

3.3.8. *Neonatal flying-foxes: deaths and injuries resulting from electrocution of mothers*

3.3.8.1. For the first few weeks of life, neonatal flying-foxes are carried everywhere by the mother. They grip firmly to the mothers abdominal skin by their well-developed horny hind-claws, and are attached firmly to one or other of the axillary nipples by strongly recurved milk teeth (Martin, 1998). In this position the neonates are unlikely to receive a major electric current flow resulting in cardiac fibrillation and death. …

3.3.8.2. The birth season of Black, Spectacled and Grey-headed flying-foxes corresponds to or overlaps the harvest season for many fruit crops grown in eastern Australia (McIlwee and Martin, 2001). Thus it is likely that 50% or more of bats killed on orchard grids are lactating females with young attached, or left in a creche. In the event of electrocution of females with young attached, many of the latter survive, albeit with the injuries described above to die slowly of trauma and starvation, and in considerable pain. Orphaned young in the creche simply die by starvation.

3. Humaneness issues

Categories of suffering

There are two main categories of welfare problems arising from the shooting of flying-foxes for crop protection in orchards: (1) the suffering of animals which die slowly of injuries rather than instantly and (2) the suffering of young dependent flying-foxes who starve to death after their mother is killed in an orchard.

Numbers of flying-foxes shot in orchards & problems with DMPs

It is unknown how many flying-foxes are shot each year in orchards in Queensland. There is the *legal* figure—those that are shot under damage mitigation permit—and the *illegal* figure—the necessarily unknown number that are shot without a permit or in exceedance of permit numbers. The current total quota for flying-foxes permitted to be taken under DMPs in Queensland is more than 10,000. Below is a table extracted from the *EPA Guideline for Damage Mitigation Permits for Flying-foxes* showing how many flying-foxes were killed under DMPs for the 2000 to 2003 fruit seasons (EPA 2004).

Table 2: Summary of DMP statistics for the 2000 to 2003 fruit growing seasons

Species	No of permits issued				No of animals taken			
	2000/01	**2001/02**	**2002/03**	**2003/04**	**2000/01**	**2001/02**	**2002/03**	**2003/04**
P.scapulatus (LRFF)	59	22	26	42	4205	1360	1549	1695
P. alecto (BFF)	112	65	62	57	3463	2557	2425	2282
P. poliocephalus (GHFF)	21	5	19	29	1227	65	220	345
P. conspicillatus (SFF)	48	20	27	18	3180	1402	1018	425
Total	**112**	**112**	**129**	**146**	**12075**	**5384**	**5107**	**4747**

- **Note:** *Permits issued in 2000 include taking by shooting and electric grids.*

Figure 2 Extract from EPA (2004), as per table heading.

The number of flying-foxes killed illegally is likely to far exceed those killed legally. This was the case even when the EPA prior to 2001 liberally issued DMPs (permitting individual growers to kill up to 500 flying-foxes a month) and had no quotas. For example, flying-fox researcher Patrina Birt (2000), based on discussions with fruit-growers, reported that culling usually exceeded the permissible take by 5 to 6-fold. My own investigations in 2000, focused on grids, found evidence that on 7 out of 10 orchards visited there had been killing of flying foxes without a permit or in exceedance of permit numbers.

Although the total number of flying-foxes now being killed is likely to be much less than a few years ago because of the ban on the use of electric grids, which were large-scale killers,[1] and the move by many growers to netting, it is likely that the proportion of 'illegally killed' to 'killed under DMPs' is still high. This is because the number permitted to be shot on each orchard is now very small, e.g. 15 Spectacled flying-foxes a month, which allows on average one flying-fox to be shot every second night. In the views of many orchardists the numbers on the permit do not suffice for crop protection. And there is extremely low risk of being caught if they do exceed permit numbers. No fruit grower has ever been prosecuted for illegal shooting of flying-foxes. (Note that only one person ever has been prosecuted for illegally killing flying-foxes, a 17-year-old who shot at least 48.) To catch someone would be virtually impossible for the EPA as they have no legal capacity to go on to a property to monitor shooting. In the past 6 years I have found a significant number of growers illegally electrocuting flying-foxes, which has been my investigation focus, so I strongly suspect that there is a similarly significant rate of illegal shooting. Note that

[1] The Federal Court decided in *Booth v Bosworth* that probably 18,000 Spectacled flying-foxes had been killed in just one season on the Bosworth orchard on electric grids.

numbers of flying-foxes killed under DMP do not include the dependent young who die because of the death of their mother.

While stopping the issuance of DMPs for shooting flying-foxes won't directly stop all illegal shooting, it will make it easier to enforce the Nature Conservation Act as any evidence of shooting would then suggest illegal activity, potentially providing a basis for EPA officers to apply for a search warrant. The unavailability of DMPs for shooting would also increase the pressure on growers to move to other systems of crop protection, as has been the case since the ban on the use of lethal electric grids.

<u>Queensland Ombudsman views</u>
The Queensland Ombudsman has recently identified problems with the DMP system and the shooting of flying-foxes. Reporting on the results of an Ombudsman investigation of a complaint I made, the deputy Ombudsman said in a recent letter (I have bolded the most relevant comments):

> **6.2 Long term viability of the DMP system**
>
> The Ombudsman's report made a number of recommendations to improve the effectiveness of the existing DMP system. Specifically, he indicated the ongoing viability of the scheme needs to be addressed having regard to the following factors:
>
> - the confirmed reduction in the numbers of growers participating in the system;
> - the small number of protected animals permitted to be taken under DMPs (including under an agreement with the Commonwealth for some species);
> - **the improbability that taking small numbers under DMPs offers effective crop protection;**
> - **the difficulty in killing animals the size of flying foxes by shooting them;**
> - **concerns about the suffering of animals not killed outright by shooting; and**
> - **the impracticality of enforcing compliance with the terms of the permits issued**.
>
> The Ombudsman suggested it may be appropriate for the QPWS to consider phasing out the system over time.

4. Suffering due to injuries from shooting

<u>What humaneness requires</u>
To prevent suffering of the shot animal, a shot must result in instant brain death. To call shooting 'humane' requires that a large proportion, close to 100%, of shot animals is killed instantly. The likelihood of this depends on a range of variables, including:

- Size of target
- Distance of target
- Speed at which target is moving
- Skill and attitude of the shooter
- Type of firearm
- Conditions such as visibility

Here I briefly look at each of these variables with respect to flying-foxes and orchards.

Relative size of flying-fox target

Weighing at most about 1 kg, flying-foxes are relatively small animals, although with a wingspan of up to more than 1 metre. Their brain, the target, encased in the skull, if presented to the shooter with its largest surface area visible, makes for a very small shooting target—at most only about 7 sq cm (approx 25mm x 30 mm). From many angles, the size of the target is much smaller. For example, if aiming at the back of a flying-fox, which is most likely as the flying-fox flees from disturbance, the area of head in view would range from 0 to 6 sq cm, depending upon the angle and height of the flying-fox in relation to the shooter. In most cases it is likely that there is no clear shot to the head as the flying-fox would be above the shooter and heading up and away, thus presenting only the back of their body and wings to the shooter as a target.

Studies of the wounding rates in duck hunting have found that the critical feature is the ratio of the 'vital' areas—the brain, heart and lungs—to the rest of the animal. X-ray sampling studies have found that the larger the duck the greater proportion of them have embedded pellets. For example, an Australian study of 40,000 ducks found that 9 per cent of the relatively small grey teal had embedded pellets while 19 per cent of the larger mountain ducks had pellets (Norman 1976). The relative ratio for flying foxes would fall within this range. The image below shows the anatomy of the flying-fox and the relative size of the target for instant death—the size of the cranium is only about 0.8 per cent of the surface area of the flying-fox (Dave Pinson pers. comm.).

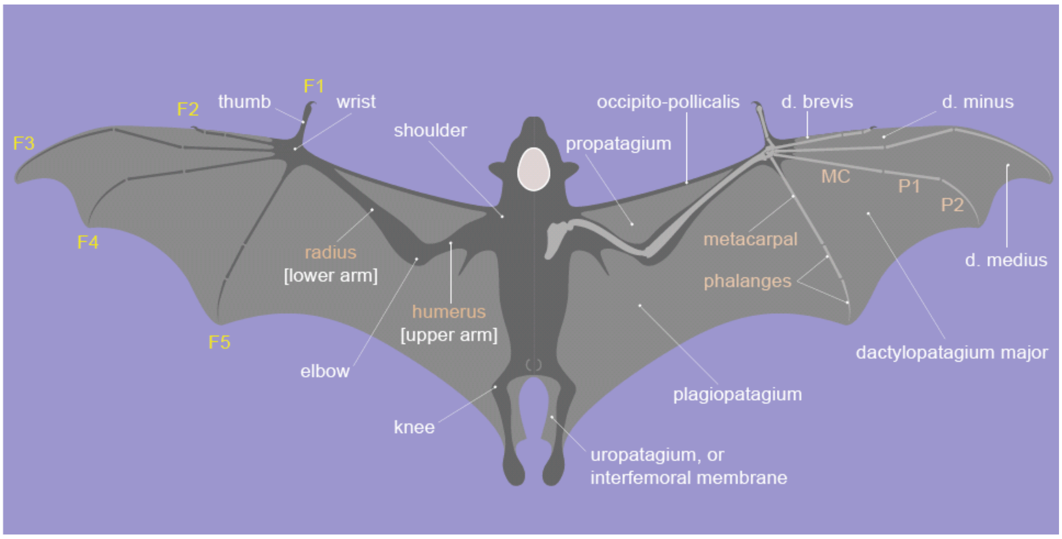

Figure 3 Flying-fox anatomy showing the relative size of the shooting target, just 0.8% of the body surface area (image from Pinson 2006)

Distance of target

Orchardists would shoot flying-foxes in a variety of circumstances: as they fly over the orchard or as they leave or enter a fruit tree. In an orchard where there is shooting, flying-foxes would be exceedingly wary and flee at the slightest noise. Thus, shooters are unlikely to be able to get close. At most, I speculate, they would be lucky to get within 20 m of a flying-fox, probably often no closer than 30 m (flying-foxes have good hearing). Below is a table defining the effective ranges for various types of choke for a 12 gauge shotgun from 18 to 37 m. In many cases, the distance to a fleeing flying-fox would be at or beyond the effective limit of the shotgun, decreasing the likelihood of death, but increasing the likelihood of injury because of the spreading pattern of shotgun pellets.

Table of shotgun chokes for a 12 gauge shotgun using lead shot

Constriction (inches)	Constriction (micrometres)	American Name	percentage of shot in a 30 in (76 cm) circle at 40 yd (37 m)	Total spread at 40 yds (in)	Total spread at 37 m (cm)	Effective range (yd)	Effective range (m)
0.000	0	Cylinder	40	59	150	20	18
0.005	127	Skeet	45	52	132	23	21
0.010	254	Improved Cylinder	50	49	124	25	23
0.015	381	Light Modified					
0.020	508	Modified	60	46	117	35	32
0.025	635	Improved Modified					
0.030	762	Light Full		43	109		
0.035	889	Full	70			40	37
0.045	1143	Extra Full					
0.050	1270	Super Full					

Figure 4 12 gauge shotgun range (Wikipedia Encyclopedia)

<u>Speed of flying-fox flight</u>
Flying-foxes can fly at 25-30 km/hour (Hall & Richards 2000, 26), up to 60 km/hour with a wind behind them. They would usually be flying slower than that close to landing or soon after take-off in an orchard. Nonetheless, it is likely that they are travelling at up to 15-20 km/h when being shot at, that is, while moving 4.2–5.5 m/sec. An animal moving at this speed makes a difficult target. Furthermore, flapping wings would obscure the brain target and distract the shooter.

<u>Skill & attitude of the shooter</u>
Primary producers are able to obtain a firearms licence simply because of their line of business. To get a firearms licence there is no requirement for a skills test. Thus, there is no guarantee that a fruit grower licensed to shoot flying-foxes has the skills to do so.

A shooter's attitudes towards an animal is also likely to affect the outcome of shooting—respect for an animal is likely to motivate attention to accurate shooting and follow-up to ensure that a downed animal has been killed rather than wounded. Many fruit-growers express hatred for flying-foxes—attitudes prevalent in submissions, letters to newspapers, and letters to politicians. For example, in a document submitted to the EPA one fruit-grower has this to say about flying foxes (Thomas 2005):

> Fruit bats are disease ridden vermin that can transmit at least 3 fatal viruses to humans. For some unknown reason they are protected by law and have been for about the last decade….Farmers have managed to continue operating ('sanctioned culling' and rubber counting) by conceding some of their civil rights. This scenario of course leaves orchard viability and productivity at the whim of the EPA.

With such attitudes common, there is not likely to be much concern for wounded flying-foxes.

Note also that studies of duck hunters have found that they are highly unreliable in reporting their own rates of kill. A 1987 Canadian study involved firstly asking hunters to estimate their cripple rate and then, from concealed hides, observing those same hunters and estimating cripple rates. The Canadian Wildlife Service staff observers counted 5 to 8 cripples for every 10 birds bagged (which also includes wounded), but hunters admitted to only about 2 cripples for 10 bagged (Geoff Russell citing Nieman).

Type of firearms

Orchardists would typically use either a .22 calibre rifle or a shotgun, most often the latter, because a rifle requires accuracy that would be exceedingly difficult in an orchard at night. Following is a description of shotgun ballistics, provided by Dave Pinson:

> shotgun shells are plastic tubes with a brass base containing the primer cap. The plastic tube is filled with gunpowder and dozens of tiny lead shot. Powder and shot are separated by a piece of plastic wadding material. When the hammer hits the primer it ignites the gunpowder, producing rapidly expanding gases which propel wadding and shot towards the target. Unlike a single bullet, this mass of shot is propelled in such a way that as distance to target increases, the shot spreads out in an ever-widening pattern. This means it is much easier to hit a flying animal such as a duck [or flying-fox], because the sheer force of numbers from a pattern of multiple shot requires much less accuracy in aiming (Pinson 2006).

As the distance to target increases, there is less chance of shotgun pellets hitting the small target area and greater chance of injury rather than death. Even if only one or two pellets actually penetrate the flying-fox and cause only minor injury they will nonetheless usually cause death by infection.

Conditions

The conditions for shooting are very far from ideal: at night, so in the dark, and with both the shooter and the flying-fox likely to be on the move. Furthermore, some shooters spend many hours patrolling their orchards and so would be tired when shooting. Shots would have to be made quickly because the target would usually be quickly moving away from the shooter.

In sum, it is exceedingly difficult for a shooter, even a very good shooter, to shoot and instantly kill flying-foxes in an orchard at night, and there is little incentive for them to do so. It is likely that a very large proportion is not killed instantly but die slowly from their wounds or infection or, if they're fortunate, they are more quickly eaten by a predator.

Suffering involved

Here is a description of how pellets or bullets injure:

> As the projectile impacts and enters, it punches out a small plug of skin and fur, carrying it deep into the wound ahead of itself. As the projectile progresses through tissue, it creates a rapidly expanding temporary cavity, which continues to expand after entry, creating a negative pressure that sucks more contaminated material into the wound through entry, and/or exit wounds. Once pressure equalizes again, any skin or tissue forced out from entry and exit holes [but still attached to wound edges] snaps back into the wound like a piece of elastic. Projectile deceleration [as it is increasingly slowed by passing through various layers of tissue] can also create great damage, as this kinetic energy is transferred to surrounding tissue and bone like a high-pressure shockwave. Wound severity depends upon a number of factors such as mass of projectile, impact velocity, residual velocity, tissue reaction, tissue elasticity, and tissue density, but ultimately, it is tissue absorption of transferred kinetic energy shed by the projectile on deceleration that determines wound severity, and not the kinetic energy actually possessed by the projectile itself. Gunshot wounds are described as either "penetrating" - where projectile has entered the body, but not exited again [remaining inside the body], or "perforating" - where the projectile has sufficient velocity and energy to exit the body from another location. (Pinson 2006)

There are numerous ways in which a wounded flying-fox would suffer, including the following:

- Pain from penetration of projectile
- Pain from wounds, such as shattered bones and torn/burnt flesh
- Infection – high temperatures, swelling, pain
- Inability to fly, feed or drink, therefore suffering from starvation and thirst
- Psychological suffering, including fear, due to being unable to fly and function

Below is an x-ray image of a flying-fox rescued with a paralysed leg, caused by a pellet lodged near the spine. After treatment, the flying-fox recovered and was released (Suzanne Grzegorski, pers. comm.). If it had not been rescued it would have eventually died of starvation. Note from the image how thin the wing bones are. They are very fragile and thus susceptible to breakage from pellets, which would condemn a flying-fox to a slow death. It may take weeks for a flying-fox to die from infected wounds or starvation/thirst. Alternatively, a flying-fox on the ground may be preyed upon by a dog, cat, pig, goanna, which would cause its own suffering, but would at least result in a quicker death.

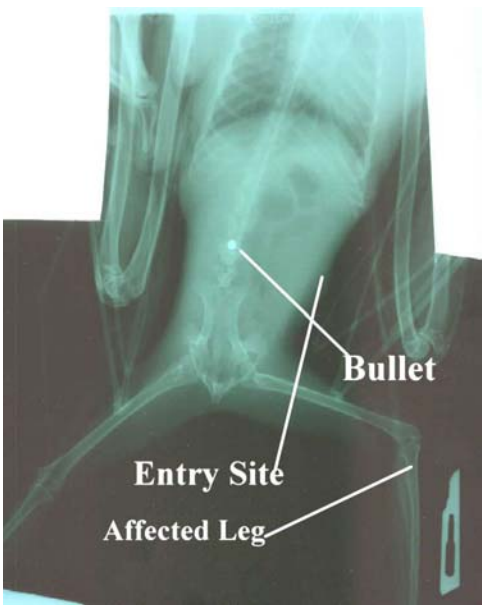

Figure 4 X-ray of flying-fox with paralysed leg showing location of a shotgun pellet (provided by Suzanne & Henry Grzegorski).

Young flying-foxes

For up to the first 6 weeks of life, young flying-foxes are carried by their mother, hanging on to her fur and teat. The birth season for Spectacled, Black and Grey-headed flying-foxes coincides with the ripening and harvest of a considerable amount of fruit, particularly lychees. Therefore, the young carried on mothers shot in orchards would also be victims of the shooting. They would die instantly if a bullet penetrated their brain (an even smaller target than that of an adult) but only slowly from wounds or starvation or predation, a more likely outcome given their size and location.

A comparison with duck shooting

It is very difficult to obtain evidence of the impacts of shooting on orchards. EPA has no capacity under their legislation to enter properties for the purpose of monitoring. Thus, it is necessary to infer from other similar activities the likely welfare impacts of shooting flying-foxes. There is considerable evidence for duck shooting, with which the AWAC would be very familiar having considered the issue and provide advice that it is inhumane. In the table below I identify in what ways duck-hunting and shooting of flying-foxes would be similar and dissimilar.

Similarities	**Differences**
Target size: The size of the target (the brain) is similarly small for both ducks and flying-foxes.	*Body size*: The surface area of a flying fox (with wingspans >1 metre) is larger than that of most ducks, so there is greater probability of flying foxes being wounded than ducks, other things being equal.
Firearms: Similar firearms would be used for both.	*Conditions*: Flying-foxes are shot at night in contrast to ducks being shot during daylight, so there is greater probability of a flying-fox being wounded due to poor visibility, other things being equal.
Retrieval: Like ducks which escape being bagged by the hunter, many wounded flying-foxes would fly out of the orchard and therefore provide no opportunity for the shooter to 'finish them off' (even if there was an incentive for the grower to do so).	*Retrieval*: The hunting 'ethic' promotes the retrieval of the body of a shot duck prior to further shooting and there is incentive for the duck hunter to recover bodies, and therefore kill any wounded ducks that can be retrieved. However, growers who shoot flying-foxes are likely to leave bodies where they fall, as there is no incentive for retrieval and it would be difficult in the dark. Therefore, there is likely to be a greater proportion of flying-foxes which are left to die from wounds.
	Angle: Ducks are often shot from the side giving a shooter a clear shot at the head. However, flying-foxes would often be shot from behind as they flee from disturbance in an orchard, which reduces the probability of a shot to the brain.
	Young: Flying-foxes carry very young babies with them while feeding, which will also die (most likely from wounds or starvation) when the mother is shot.

Therefore, while there is no direct evidence by which to estimate the wounding rate for shot flying-foxes, there is strong justification for inferring that the wounding rate would be higher than that for ducks.

There is considerable evidence that wounding rates in duck hunting are very high (as documented by Geoff Russell n.d.). For example, to cite one of many studies, US shot shell makers with the US Bureau of Sport Fisheries and Wildlife test steel shot as an alternative to lead shot by tying 2000 live ducks to inverted J poles. They were shot with electrically aimed guns and the rates of killing and wounding assessed. At 40 yards with US #4 lead, only 66 per cent of ducks were instantly killed (Russell n.d., citing Andrews and Longcore). Russell has carried out computer simulations to demonstrate likely wounding rates under various conditions. Below is one such simulation with parameters that might apply to shooting flying-foxes, showing a 99 per cent wounding rate with 2 shots per duck. In fact, the assumptions used for this simulation are conservative for ducks, and would be even more conservative if applied to flying-foxes.

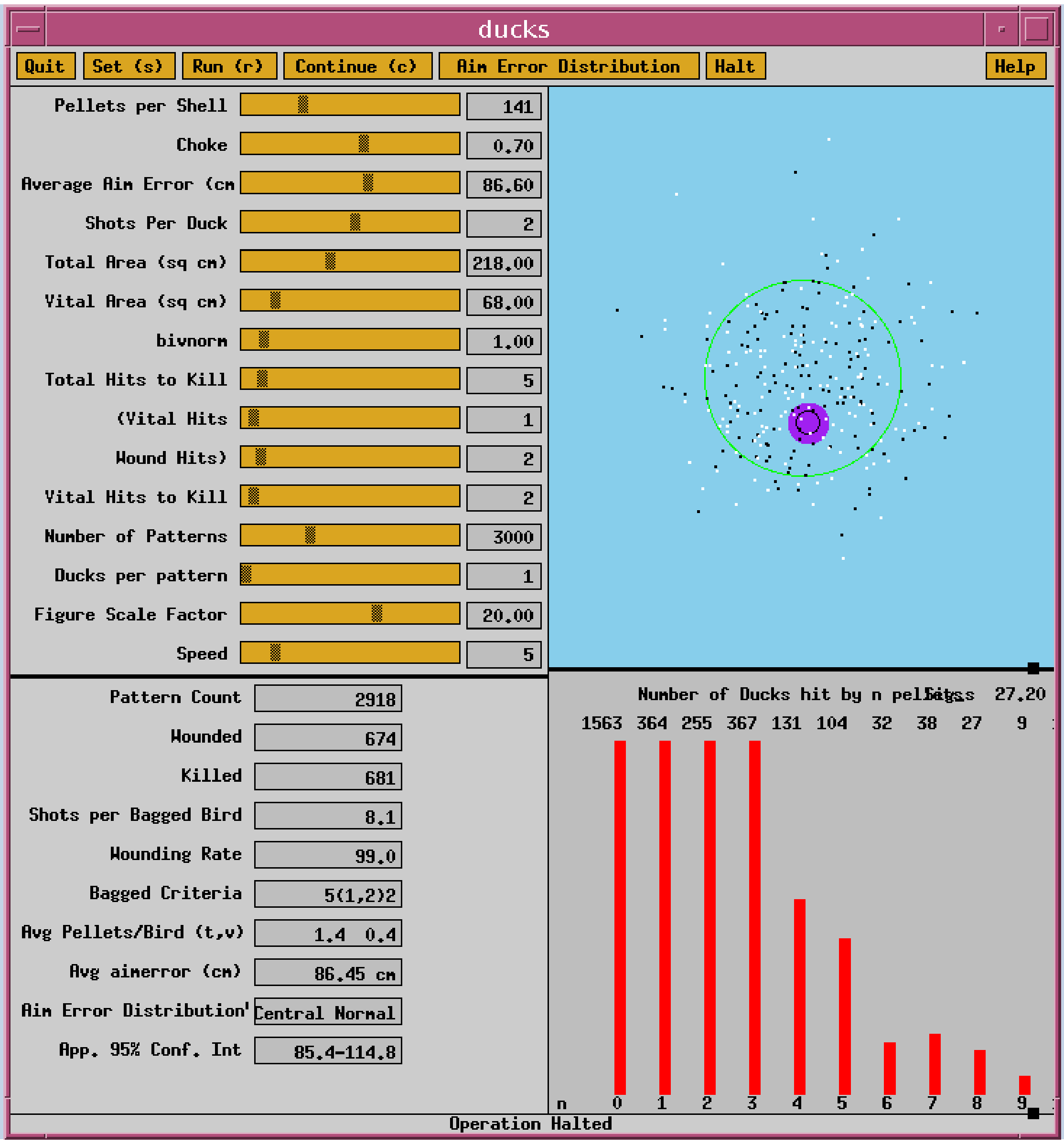

Figure 5 Computer similation of duck-shooting (by Geoff Russell 2001 <http://www.animalliberation.org.au/computer.php>).

In conclusion, it is reasonable to infer that wounding rates for shot flying foxes are higher than wounding rates for ducks; that is, the majority of shot flying-foxes would be wounded rather than instantly killed.

5. Suffering due to starvation of orphaned young

Much of the shooting of flying-foxes in Queensland orchards takes place during the birth season of flying-foxes. Three of the targeted species give birth primarily from September to December and young are dependent on maternal milk for 3 to 5 months and maternal care for even longer. Most shooting occurs November–January, with the ripening of lychees and mangoes.

Suffering involved with starvation
Without food, the body uses up available carbohydrates and fats and then starts to break down and feed upon its protein. Failure of vital organs results. Some idea of the suffering involved can be gained from the clinical signs of malnutrition, which include some or all of the following:

- the animal is significantly underweight for its size
- significant loss of muscle mass [as muscle is sometimes broken down and utilized to feed the body before fat reserves], - leaving ribs prominent and visible [may actually be more obvious on the back than the chest]
- sternum visible and prominent, with no "meat covering the bones" [in extreme cases the sternum will be sticking out like a razor blade]. Scientists and field biologists actually grade this flesh cover from 1 - 5.
- sunken eyes [due to body survival mechanisms using up protein layers surrounding the eye ball]. Note dehydration produces the same sign
- skin stretched tight over face - giving the face an angular look - compared to the normal well rounded features
- lips - dry and shrunken - giving the animal a skeletal grin; lips peeled back revealing teeth
- skeletal wasted appearance to whole body [depending upon severity]
- dull - dry looking fur, or fur loss
- general pallor: pale mucous membranes or signs of anaemia
- incorrect body temperature - can go either way [hypothermic or feverish]
- sore and/or swollen painful joints - oedema [fluid build up in the body, caused by low serum protein in the blood], which may present as puffy areas around the joints [finger joints, knees, and puffy feet]
- reluctance to eat - which is ironic considering the animal is starving [can also be caused by sore mouth, inflamed gums, loose teeth, or sore throat]
- rapid breathing or respiratory distress
- pulmonary oedema [fluid in the lungs - difficulty in breathing - which can be heard as rasping breath or a clicking sound] - caused by low serum protein
- general body weakness: listlessness, apathy - unresponsive or disinterested in external stimuli such as noise and movement
- signs of hypovolaemic shock
- signs of hypoglycaemia: lethargy, limpness and loss of consciousness as the condition reaches near fatal levels. As the condition worsens the animal will drift in and out of consciousness, then coma - progressing to death (Pinson 2006)

Evidence from wildlife carers suggests that orphaned young flying-foxes may take up to 2 weeks to die from starvation. For example, carer Dave Pinson (pers. comm.) rescued a 10-week old orphan which survived 7 days of starvation in very hot conditions after a heat wave killed its mother. Carer Louise Saunders rescued a 4-week-old which had survived at least 6 days, but died from kidney and liver failure (pers. comm). The 12-week-old flying-fox pictured below had probably not fed for 10-14 days, most likely due to the death of his mother (Dave Pinson, pers. comm.).

Figure 6 A starving Black flying-fox brought into care at 12-weeks-old (left) and after care (right) (photos by Dave Pinson)

Responsibility for impacts on young

Shooting lactating females in orchards has a direct causal link with the death by starvation or predation of their young. If the young are with their mother on the orchard then the humane expectation would be that the baby is killed along with the mother. After all, the humane killing of joeys is meant to be a requirement in the shooting of kangaroos. However, after about 6 weeks of age, the baby is not with the mother for killing, but back at the flying-fox camp. The only difference between the circumstance where it would be expected of the shooter to ensure a humane death for the young and the circumstance for most flying-fox young is the distance between mother and young. Therefore, the shooter is directly responsible for the death of young flying-foxes but cannot ensure that death is humane.

6. Implications of a finding that shooting is inhumane

The *Queensland Nature Conservation Regulation* 1994, s 281(e), requires that DMPs be issued only if the chief executive is satisfied that, amongst other things, the proposed way of taking the animal is humane and not likely to cause unnecessary suffering to the animal. With the AWAC a recognised expert body on humanness, the EPA would no longer issue DMPs for shooting if the AWAC advised it was inhumane.

In 2001, in response to advice provided by the RSPCA that the use of lethal electric grids was inhumane, the EPA decided that no more permits for electrocution would be issued. Since then a proportion of those who used electrocution as a method of crop protection have moved to netting. Below is a photograph of one of those orchards.

With the listing of 2 of the targeted species of flying-foxes under the EPBC Act in 2001, the state government in negotiations with the federal government developed a quota system for issuance of DMPs for lethal take of flying-foxes. In Queensland during the past four fruit harvesting seasons, each fruit grower has been able to apply for a permit to shoot up to:

- 15 spectacled flying foxes/month (total Queensland quota of 1800)
- 20 grey-headed flying foxes/month (total Queensland quota of 1280)
- 30 black flying foxes/month (total Queensland quota of 3500)
- 30 little red flying foxes/month (total Queensland quota of 4000)

Figure 7 Use of nets on a property with electric grids on the Atherton Tableland.

Fruit-growers have non-lethal options for crop protection. These options are outlined in documents such as DPI's *To Net or Not to Net* (ref) and EPA's survey of more than a dozen methods of crop protection (Greimel 2005). Full exclusion netting is the method recommended as it is 100 per cent effective. Other methods used by growers include light and noise but these are less effective in most situations as flying-foxes become habituated to these disturbances.

With the current low numbers permitted to be shot, the unavailability of lethal DMPs would make very little difference to a fruit grower's productivity. I have estimated that flying foxes legally killed (for example, 15 Spectacled or 20 Grey-headed flying-foxes) could eat no more than about 1 per cent of lychees in an orchard of minimum viable size, making the cull pointless.[2]

Many fruit growers claim that they focus on killing flying-fox 'scouts' and that for this reason they need to kill only a few flying-foxes for effective crop protection. The scout theory is not regarded as credible amongst flying-fox researchers, as Dr Len Martin (2001) explains:

> **3.2.2.** *Do grids selectively cull flying-fox "scouts"?*
>
> 3.2.2.1. It is often asserted that grids are effective in protecting fruit because they selectively kill "the scouts" - a specific category of animals that are alleged to guide the main body of "ordinary' bats to the orchard, and without which, said ordinary bats would not find and attack the orchard. Furthermore, such culling of scouts is believed to have the benefit of reducing the total cull. Thus, on p.46 of the Queensland Department of Primary Industries publication, *To Net or Not to Net? Flying Fox Control in Orchards Through Netting Protection*, (Rigden *et*

[2] Let's say a grower kills the permitted 15 spectacleds the first hour of the first night of the month and that each of those flying foxes would have eaten their own weight in lychees each night for the rest of the month had they not been killed. Thus the permitted cull that month would have saved at most 450 kilograms of fruit, assuming extravagantly that each of the flying-foxes would have eaten/damaged 1kg of fruit each night. With an average yield of 7.7 tonnes of lychees per hectare, on a 7 hectare orchard[2], killing those flying foxes would have saved the grower about 1% of the crop.

al., 2000), , the text relating to a North Queensland rambutan grower reads, ***"The grids are switched on as soon as the fruit starts to colour up about 8 weeks before picking, this policy ensures that any scouts entering the orchard are culled. Culling the scouts ensures that other flying foxes are not led to the orchard, thus the total cull of flying foxes is reduced. If grids are switched on too late 50% losses can occur, when the system is used to its optimum effect losses are reduced to 2%"***.

3.2.2.2. To my knowledge there is no scientific evidence for a specific category of scouts. Unfortunately, a perennial problem in evaluating the efficacy of anti-flying-fox fruit-protection systems is the year-to-year variability in the pressure on flying-foxes to attack fruit crops. It is generally accepted that "bad" flying-fox years for growers are associated with failure of the animals' natural food resources. Thus a grower may switch a grid on early in a "good" year, when relatively few flying-foxes are driven into orchards, and late in a "bad" year, and attribute the apparent success of early switch-on to selective killing of scouts.

3.2.2.3. Flying-foxes have large eyes, excellent hearing and sense of smell, and good night vision, but lack the sophisticated sonar (ultra-sound emission) used by the so-called "micro-bats" to navigate and catch prey. They are highly intelligent, inquisitive creatures capable of accurate long-distance navigation and of remembering specific locations. Radio-tracking research by Eby (Eby, 1991, 1996) has demonstrated that individual flying-foxes can return precisely to specific locations, after long periods of time, and over long distances. In other words, flying foxes have an excellent spatial sense and spatial memory - maps-in-the-mind, as it were. Eby's research gives no support to the theory that specific "scouts" lead other bats into orchards. On the contrary it indicates that all flying-foxes are individually capable of locating their own food sources. This does not exclude the possibility of some knowledge sharing, or of some leadership, but it means that orchard attacks are not *dependent* on the hypothetical scouts, as many fruit-growers seem to believe.

In sum, a ban on lethal DMPs for flying-foxes would not greatly affect the viability of fruit growers as (a) currently permitted numbers for take are very low and (b) fruit-growers have other, much more effective, options for crop protection.

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