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Assessing the effectiveness and reliability of a trap alert system for use in wild dog control

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Front cover photo: Trap Alert device attached to wild dog trap and drag (Luke Woodford).

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Summary

The Victorian Department of Primary Industries (DPI) currently undertakes wild dog (feral domestic dogs *Canis familiaris familiaris,* dingoes *Canis lupus dingo* and their hybrids) control in Victoria for the protection of livestock, using an integrated control program involving fencing, trapping and poison baiting. Under an exemption granted by the responsible Minister, wild dog controllers are required to check traps within 72 hours of them being set, rather than 24 hours as required by a regulation under the *Prevention of Cruelty to Animals Act 1986*.

Trap alert systems are a potential aid in managing the requirement to check traps every 24 hours. A trap alert device activates an alarm when a trap is sprung and sends an SMS message and/or email to one or more recipients.

During a wild dog control operation in spring 2010 we trialled three trap alert devices. We also tested devices in summer 2011 at sites in north-eastern Victoria and East Gippsland under controlled conditions in a range of physical and environmental settings.

Although off-the-shelf trap alert systems are available, they require the use of the Global System for Mobile Communications (GSM) network, or expensive and cumbersome UHF repeater stations or on-site modems.

Wildlife and Feral Management Consultancy (Gold Coast, Queensland) developed a system based on a GPS tracking device that allows the device to be used outside the GSM network, is portable and robust and does not require UHF repeater stations or on-site modems.

Two devices were demonstrated using different GPS communication systems to Victorian wild dog controllers and State Government agencies by Wildlife and Feral Management Consultancy in Omeo in October 2010. After considering a range of factors, one device was chosen as a potentially useful tool for DPI wild dog controllers. Three individual devices were then tested in the field at dog trapping sites for 302 device days. They were also tested manually during 45 controlled tests to assess the devices performance within, and outside of, the GSM network. Testing occurred under nine environmental conditions including different terrain, vegetation cover, weather and physical location, e.g. under logs or mounted on tree trunks.

During the live tests the device was triggered eight times, twice by wild dogs and six times by non-target animals. Messages were received on seven of the eight triggering occasions. On the one occasion when a message was not delivered it was found that the batteries in the unit had discharged.

During the controlled tests the trap alert device delivered 87% of possible alert messages, i.e. six failures from 45 tests. The average time taken to deliver the message was just over 32 minutes. Two delivery failures were attributed to the physical location of the device, one was caused by battery failure, and the remaining failures were related to the non-delivery of messages from the manufacturer's server.

The modified trap alert devices performed well under a range of conditions. They are simple, robust and easy to use devices utilising existing technologies, and work within and outside the GSM network in Australia. The failure of the servers to deliver some messages means that there is a risk that notification of trapped animals will go unattended. Whether this is an acceptable risk is beyond the scope of this report. The developers of the trap alert system tested in these trials are investigating further modifications to increase the reliability of the devices.

The trap alert system is a potentially useful tool that could help improve the efficiency of the wild dog trapping program and the welfare outcomes for captured animals in Victoria.

1 Introduction

1.1 Background

Wild dogs (feral domestic dogs *Canis familiaris familiaris,* dingoes *Canis lupus dingo* and their hybrids) attack sheep, cattle and other livestock, causing an estimated $48.5 million damage per annum across Australia (Gong et al. 2009). Wild dogs are listed as an 'established pest animal' under the *Catchment and Land Protection Act 1994* in Victoria. The Victorian Department of Primary Industries (DPI) employs wild dog controllers to actively manage the problem of wild dog attacks on stock. DPI uses several methods to control wild dog numbers, including trapping, poison baiting and shooting.

Trapping involves the use of steel, sprung leg-hold traps with offset rubber padded jaws. These traps are buried in the ground at a location chosen by the wild dog controllers. This is often on the side of a linear feature such as a fence line, track or dirt road. The traps are attached with a chain to a 'drag' consisting of a large piece of wood or a piece of steel. Once an animal springs the trap it can move only a short distance before the 'drag' becomes entangled in vegetation. The trapped animal is then either released (i.e. native species) or euthanised when the wild dog controller next visits the trap site.

There is a potential for as many as 8500 trap nights per month (approximately 12 traps per dog controller × 30 nights × 23 dog controllers (Vaughn Kingston, DPI, pers. comm.) as part of routine field operations in north-eastern Victoria and Gippsland, where most wild dog control occurs. A regulation under the *Protection of Cruelty to Animals Act 1986* requires that all live traps used in Victoria must be inspected no later than 24 hours after being set. However, DPI has an exemption, granted by the relevant Minister that extends this time to 72 hours.

Trap alert systems that notify a trapper of a sprung trap may assist in the strategic use of traps under the 24-hour trap checking regime. There are existing trap alert systems on the market (Table 1) but they operate only within the Global System for Mobile Communications (GSM) network, or emit or change a radio frequency when the trap has been activated and use a repeater station(s) to deliver a signal (Marks 1996), or use a two-way radio system with a very short transmission range (Proudfoot and Jacobs 2001). These systems pose two problems: first, many of the traps deployed in eastern Victoria are outside the mobile GSM network; and second, the use of UHF signals via repeater stations has proven very unreliable in mountainous terrain in previous studies (M. Johnston, DSE pers. comm.).

Table 1. Comparison of current existing off-the-shelf trap alarm technologies.

Trap alarm	Features	Advantages	Disadvantages	Potential use for Victorian wild dog controllers
Titley™ 'Trap Alert'	SMS messaging, linked to reed switch, low battery warning via SMS	• simple to operate • compact • backed up with expert technical service	• can only be used within GSM network, short battery life (4-5 days)	Possible when within GSM network
Telonics Inc. 'Trapsite' VHF transmitters	continuously operated two-stage VHF transmitter activated by magnet removal	• low cost • long battery life • simple design • allows operator to check unit is functional from a distance	• works on VHF radio signal only so requires the operator to be close to trap i.e. 3.2 km average (Darrow and Shivik 2008)	No
Advanced Telemetry Systems Mammal Trap Monitor M4000	two-stage VHF transmitter with a time elapsed signal change, activated by magnet removal	• low cost • long battery life • simple design	• works on VHF radio signal only so requires the operator to be close to trap i.e. 3.2 km average (Darrow and Shivik 2008)	No

Attempts have been made at developing systems using a range of communication technologies that are not commercially marketed. Some of these systems have proven relatively successful in very specific situations (Nolan 1984, Halstead et. al 1996, Marks 1996, Larkin et. al 2003, Moseby 2003, Neill et. al 2007, Benevides et. al 2008). However, they are generally limited by either terrain, network availability, complexity, bulkiness, fragility, requirement of very specific and often expensive components or, most importantly, their unreliability in either getting a signal out or the operator receiving a signal.

For their day-to-day work, wild dog controllers need to have a reliable, simple, small, robust and relatively inexpensive device that can function outside the GSM network.

Initial trials in Queensland have been successful in developing and modifying existing satellite-linked GPS technologies that connect with the GSM network, allowing the operator to receive an alert via SMS or email. These systems could prove very useful because the devices can be used outside the GSM network (though the message receiver must be within the GSM network or at least have internet access). These devices are also small and robust and have few moving parts.

1.2 Objectives

The objective of this study was to investigate the effectiveness and reliability of two trap alert systems developed by Wildlife and Feral Management Consultancy (Gold Coast, Queensland) for use in monitoring trap status during trapping operations in Victoria. The aims of this work were to:

- Undertake a trial of the two trap alert systems in order to decide which would best suit wild dog controllers in Victoria.
- Trial the preferred device on 'live' wild dog traps and under different climatic and environmental conditions and at different locations.
- Make recommendations regarding the use of the trap alert systems.

2 Trap alert specifications and design

Wildlife and Feral Management Consultancy (Gold Coast, Queensland) developed two systems based on a GPS tracking device that allows the devices to be used outside the GSM network, are portable and robust and do not require UHF repeater stations or on-site modems. The two systems are described below.

2.1 Modified SPOT™ system

The manufacturer of the SPOT device describes it as 'the world's first satellite messenger' (www.findmeSPOT.com). It is intended to be used as a safety device that can advise rescue services (GEOS International Emergency Rescue Coordination Centre) of your exact location. It is a small handheld device that has predetermined buttons that can allow it to send an SOS to emergency services, check in, seek help or assistance, track progress, or send a predetermined custom message. Message recipients may include up to ten contacts. The SPOT device operates as follows:

1. GPS satellites provide a signal.
2. The SPOT messenger's onboard GPS chip determines the GPS location and sends the location and preselected message to a communication satellite.
3. The communication satellite relays the preselected message to specific satellite antennas around the world.
4. Satellite antennas and a global network route the location and message to the appropriate GSM network.
5. The location and messages are delivered according to instructions via email or SMS.

In Australia SPOT devices modified by Wildlife and Feral Management Consultancy use the SPOT server's network in the USA to deliver the alarm messages. The devices (Figure 1) can be connected to a trap and drag via a length of fishing line, and are triggered by an electro-magnetic reed switch (Figure 2). When the trap is sprung the dog's movements releases the reed switch, activating the GPS alarm. No external antenna is needed with the unit, but it does require a clear line of sight to the sky. The reed switch activates the 'custom message' function on the SPOT device, which is pre-programmed with information associated with that particular trap, e.g. the trap number or trap location. The SPOT device, once activated, will attempt to send the predetermined message and GPS location to the SPOT network three times over 20 minutes, although only one email or SMS will actually be sent to the predetermined contacts. However, if no GPS location is found within 20 minutes, the SPOT device will not be able to send the message. The SPOT is claimed to have a '99% probability of successfully sending a single message within 20 minutes' anywhere in Australia.

Figure 1. Modified SPOT trap alert device.

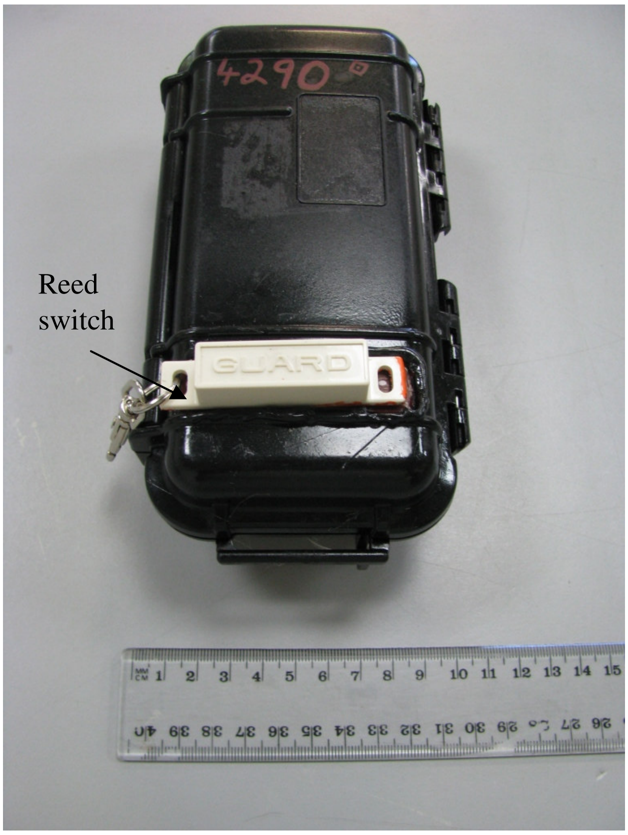

Figure 2. Trap alert device with magnetic reed switch attached.

A further modification to the SPOT unit is the incorporation of a battery-saving chip that communicates with the GPS. After the devices initial activation via a reed switch the GPS device sends the predetermined message. The chip then shuts the GPS unit down between transmissions into a sleep mode. This allows the unit to have a battery life of around 12 months, although this depends on how many attempts the device has to make in order to find satellites.

The unit has a toggle switch that acts as the on/off switch (Figure 1). To operate the unit, this switch is switched on, the housing is closed and the magnetic reed switch is attached to the closed device in the allocated place (Figure 2). The operator has 30 seconds after the toggle switch is turned on to connect the reed switch. The device has a built in anti-trigger delay of 65 seconds, so that the unit will not send a signal if the reed switch is accidently knocked off during the set up process.

2.2 Modified Pivotel system

Pivotel is one of four mobile telecommunications companies licensed in Australia. It provides services including voice and data communications across Australia. Pivotel's products include the Iridium & Globalstar Satellite network and TracerTrak®, which is a satellite-based asset tracking service. We investigated the TracerTrak service that is used by the Pivotel based trap alert system.

The Pivotel device, called a T1 device (Figure 3), is the link between the trap and the TracerTrak system. The device reports the location and any pre-set parameters e.g. trap status, to the TracerTrak system. The device is triggered in the same fashion as the SPOT system.

The T1 device uses onboard GPS receivers to record its location, which is then sent by either cellular or satellite network back to the TracerTrak servers.

Users can connect to the TracerTrak system via the internet with all the information delivered graphically through their browser, or an SMS can be sent to up to 2000 mobile phones or email accounts.

Figure 3. Pivotel T1 unit including trip wire and reed switch.

2.3 Initial demonstration

A demonstration was held by Wildlife and Feral Management in Omeo, East Gippsland, in October 2010. The demonstration was attended by staff from the Department of Primary Industries (DPI), Parks Victoria (PV) and the Department of Sustainability and Environment (DSE). A presentation of the two trap alert systems was given and a discussion was held as to which system would be preferable for the Victorian environment.

The factors against which the systems were assessed were:

- compatibility with soft-jawed leg-hold traps
- guarantee of trap activation message retrieval
- reliability in the field
- functionality and ease of use
- cost — both initial purchase price and ongoing service charges
- ability to ensure the device is working at the trap location
- availability of components
- compactness and weatherproofing
- security.

Table 2 compares the two systems in relation to these factors. While the Pivotel system has an increased range of functions and inputs compared to the SPOT system, it was agreed that the SPOT system was better suited to the needs of the wild dog controllers. This was mainly due to ease of use, functionality, costs and the ability to determine if the device is working when at a trap site.

Table 2. Comparison of Pivotel and SPOT GPS satellite-based trap alert systems.

Factor	Pivotel	SPOT
Compatibility with soft-jawed leg-hold traps	Yes, via a reed switch. Has 4 inputs so can have 4 triggers if required.	Yes, via a reed switch. Has 2 inputs so can have 2 triggers if required.
Guarantee of trap activation message retrieval	Can never be guaranteed, but Pivotel Globalstar has an established history of satellite communication products and good coverage in Australia. See www.tracertrak.com.au/Coverage.php.	Can never be guaranteed, but the SPOT device uses its own servers or the Pivotel Globalstar network.
Reliability in the field	Battery life of up to 2.5 years if triggered twice daily.	Battery life (using custom message option) of up to about 1 year.
Functionality and ease of use	Fully automated. No display. No buttons. Can alert up to 2000 recipients if activated. Has a 'geo-fence' option.	Simple set up with LED displays and single-button functions. Can alert up to 10 recipients if activated.
Cost — both initial purchase price and ongoing service charges	$700–800 initial purchase price. $400 per year pre-paid fee.	Approx $700–800 initial purchase price. $25 per month pre-paid fee.
Ability to ensure the device is working at the trap location	Cannot determine in the field if device is working as there are no LED lights or any other indicator.	Can determine in the field if device is working by coloured LED illumination.
Availability of components	Only moving part is trip snare device and reed switch, available from hardware stores.	Only moving part is trip snare device and reed switch, available from hardware stores
Weatherproofing	IP66* rated if not used in a case. Can be housed in a Pelican™ case.	IP68 rated if not used in a case. Can be housed in a Pelican case.
Security	Requires no housing and has built in motion sensor. Can be covered in a thin layer of mulch to hide the device.	Compact and can be covered in a thin layer of mulch to hide the device.

* IP is the International Protection rating for weatherproofing properties. First digit is proofing against dust (scale: 1 = low, 6 = high) and second digit is against harmful ingress of water (scale: 1= dripping water, 8 = immersion below 1 metre).

3 Methods

Both of the trap alerts systems were trialled under 'live' tests in the field. The modified SPOT device was also trialled in controlled manual tests under a range of physical and environmental conditions.

3.1 Live field trials

Three trap alert devices were trialled over five months in a regular wild dog trapping program in East Gippsland and north-eastern Victoria. The devices were placed *in situ* attached to dog traps and were periodically moved around as determined by the wild dog controller using the device. Two Reconyx RapidFire™ ProPC90 heat-in-motion activated digital cameras (Reconyx, Wisconsin, USA) were placed at each of the two SPOT devices to determine the exact moment that a trap was triggered using the cameras time and date stamp function. This was then cross-referenced to the date and time of the trap alert message. The trap alert device was lightly covered in forest litter to camouflage the devices and help protect against theft.

3.2 Controlled field trials

The SPOT device was trialled at sites representing nine different environmental and physical conditions — steep gully, broad valley, open clear, dense vegetation, medium vegetation, device under debris in open cover, under debris in closed cover, vertical mounted in open cover, vertical mounted in closed cover — at seven sites in mountainous parts of eastern Victoria (Appendix 1). Sites were chosen to encompass a variety of different topographical features and vegetation types.

Each test was repeated five times within each of the nine conditions. Each trigger of the device needed to be undertaken individually, and the next test was not undertaken until a message had been received or two hours had elapsed. This was because it was found in earlier trials that the device often only sent some of the alert messages when the tests were grouped together, i.e. the message needed to be received or not (in the case of a failure) before the next test could be undertaken. This is likely because the device attempts to send a message three times over 20 minutes and there may be too much overlap when they are grouped close together (Cameron Fels, Wildlife and Feral Management, pers. comm.). Twenty-four of the 45 tests were within the GSM network and 21 were outside of the GSM network.

The devices were deployed in the field as normal but were not connected to dog traps. Devices were also trialled vertically in a tree as this may be an option to reduce the likelihood of an accidental trigger. A one centimetre layer of leaves was placed on top of the device set on the ground as camouflage to protect against theft. In all tests the reed switch was manually activated.

The time taken to send the message following triggering was recorded directly from the SPOT device *in situ* (a green LED lights up once the message is sent). The time of message delivery was recorded from the 'message sent' list on a mobile phone and the email heading, which provides both time and date. The time of triggering and the arrival time of both the SMS and email message were recorded once within the GSM network.

Six variables were recorded during each test. Vegetation type was recorded for each site. The percentage lateral cover above the device was calculated from digital images recorded *in situ* looking upwards. Photoshop® (Adobe Systems, USA) was used to determine the percentage of pixels in the image containing vertical foliage cover. The dilution of precision (DOP) was also recorded for each test. DOP is an indicator of the quality of satellite constellation geometry (usually used to navigate to a position). Higher values, typically above 3, will usually result in poorer measurement results. The DOP takes into consideration the amount of available GPS satellites in the sky, which is usually from 5 (poor) to 11 (good). Weather conditions were assigned as clear, overcast, partly cloudy, or thick cloud, as well as if it was raining at the time of the test. The amount and type of cover over the device was also recorded, including the depth of debris and proportion of the device that was visible.

3.3 Strength and ruggedness tests

Both the SPOT and Pivotel devices can be housed in a Pelican case which is rated at IP68 for weather resistance. A dummy device was left within easy reach of a dog trap to provide information on the damage that a trapped dog might do to the device.

4 Results

4.1 Live field trials

The three trap alert devices (two SPOT and one Pivotel) were set up in the field on live wild dog traps for a total of 302 trap days (Table 3). The devices were triggered eight times by animals, including two dogs that were caught during the trial. Messages were received from six of the eight triggering events. On two occasions batteries were found to have been discharged and no signal sent. During tests of one of the SPOT units, an email alert was sent only on the day the device was triggered, with the corresponding SMS to mobile telephones not sent until the following day.

Five alerts were set off by non-target species either triggering the trap or knocking the reed switch off the device. On one occasion a falling branch triggered an alert.

On six occasions we manually triggered the SPOT devices, and on each occasion a signal was received on average 4.5 minutes after triggering. On three of the occasions non-target species triggered an alert, cameras identified the trigger time. On these occasions the average time to message reception was 22 minutes.

4.2 Controlled field trials

Overall 87% (range 3-5) of messages were successfully received during the controlled field trials (Table 4). Six messages (13%) were not received. One failure was in a steep gully, one in open cover under debris, four in closed cover (two under debris and two mounted vertically). Devices placed under debris in open forest took longer to have their message sent (10.5 minutes) and received (100 minutes) than any of the other physical or environmental conditions tested (Table 4). Batteries lasted through all of the 45 tests undertaken without replacement required. Percentage view of the sky at sites where the alert signal failed to be received was no different than other sites (failed = 34% ± SD 22% compared to 54% ± SD 30%). Failures also occurred on sunny days, days with clear sky, partly and completely cloudy days. There was also no apparent correlation with failure and vegetation type, with failures occurring in burnt mixed forest, open Snow Gum woodland, riparian tea-tree thicket, Mountain Ash forest, and thick riparian foothill forest. Satellite geometry as measured by the DOP was not different between failed (2.4) and successful (2.65) signals. Initiation of the signal from within or outside the GSM network also did not appear to influence the time a signal was received, although five of the six failures were initialised outside the GSM network (Table 5).

Five of the six alert signals were not registered on the SPOT website, indicating that the message was either not received by the server or not stored on the server correctly. The sixth signal was recorded on the website and an email was received, but no SMS text alert was received. This device was vertically mounted in closed cover Mountain Ash forest with 21% view of the sky on a cloud-covered day (Appendix 2).

Table 5 shows the overall performance of the trap alert device in delivering an alert message within and outside the GSM network for each trigger during manual tests.

4.3 Strength and ruggedness tests

On one occasion when a dog was caught, the dummy device was chewed very slightly, with the lid remaining intact. On another occasion the lid of a real device was flipped open but the device was not chewed. There may be a need to secure the lid when deployed in the field. This could be as simple as strapping a cable tie around the device once it is set.

Table 3. Live trials of three trap alert devices in a regular wild dog trapping program.

Location	Time message sent (GMT)	Time message received (GMT)	Time taken (min)	Comments
SPOT device				
3 km north of Dargo, East Gippsland	n.a.	13:32	n.a.	Reed switch knocked by unknown animal.
3 km north of Dargo, East Gippsland	23:15	23:31	16	Triggered by deer stepping in dog trap.
3 km north of Dargo, East Gippsland	22:52	00:28	36	Triggered by deer stepping in dog trap. Device removed.
Rosewhite, NE Victoria	n.a.	n.a.	n.a.	Device removed after dog caught but batteries were depleted. Reed switch lost.
Bairnsdale – Bruthen Rd, East Gippsland	23:22	23:37	15	Wombat triggered alarm.
Bairnsdale – Bruthen Rd, East Gippsland	15:09	15:14	5	Manual Test.
Rosewhite, NE Victoria	15:37	15:42	5	Manual Test.
Rosewhite, NE Victoria	11:01 – 1:31	11:05 – 11:37	4 6	Manual Tests. – 6 email only messages.
Rosewhite, NE Victoria	11:01 – 11:31	11:43 – 12:10	n.a.	Manual Tests. – 6 SMS messages only but same alerts as day before arriving to phones 24 hours later.
3 km north of Dargo, East Gippsland	n.a.	n.a.	n.a.	Manual Test. Trap moved to new location – failed due to battery failure.
3 km north of Dargo, East Gippsland	13.25	13:32	7	Manual Test – worked after battery replacement.
3 km north of Dargo, East Gippsland	13:41	13:46	5	Manual Test.
Pivotel device				
Mt Delusion Rd near Omeo, East Gippsland	n.a.	19:18	n.a.	Motion sensor only – falling branch in high wind. Motion sensor then deactivated by trapper.
Mt Delusion Rd near Omeo, East Gippsland	n.a.	11:53	n.a.	Wombat triggered device by pulling reed switch.
Mt Delusion Rd near Omeo, East Gippsland	n.a.	1:09	n.a.	Dog capture.
Mt Delusion Rd near Omeo, East Gippsland	n.a.	9:36	n.a.	Unknown animal triggered device.
Mt Delusion Rd near Omeo, East Gippsland	n.a.	13:34	n.a.	Device and trap removed.

Table 4. Trap alert performance in a variety of physical and environmental conditions.

Location	Number of alerts received from 5 triggers	Median time (mins) taken to send incl. 65 second trigger delay (range)	Median time (mins) taken to receive alert (range)
Steep gully	4	7 (3-14)	76 (3-82)
Broad valley trial	5	3 (2-5)	12 (3-26)
Open clear country trial	5	3 (2-3)	41 (12-63)
Thick vegetation trial	5	5 (3-10)	11 (3-16)
Medium vegetation trial	5	4 (3-7)	24 (3-42)
Under debris trial in open cover	4	10.5 (8-24)	100 (91-122)
Under debris trial in closed cover	3	4 (3-8)	17 (4-17)
Vertical mounting in open cover	5	6 (3-9)	9 (4-31)
Vertical mounting in closed cover	3	6 (4-9)	5 (4-42)

Table 5. The overall performance of the trap alert devices during controlled tests.

GSN Network	Number of tests	Number messages received	Median time (mins) taken to receive (range)
Inside GSM	24	23	31 (3-122)
Outside GSM	21	16	11.5 (3-82)

5 Discussion

The modified SPOT trap alerts are simple, robust and easy to use devices utilising existing technologies to work both inside and outside of the GSM network in Australia. The devices generally performed well. However, they did not prove to be 100% reliable when tested in the field. In our trials we failed to receive a message from a triggered trap on six occasions. Two of these failures were due to the device being placed too far under a log and another due to battery failure. The remaining failures relate to the delivery of the messages from the SPOT servers after an alert has been triggered. All messages that were sent and received during tests were registered on the SPOT website, while those messages that were sent but not received were not registered on the SPOT website. The units we tested are being further modified by the manufacturer, and investigations into the failure of the SPOT server system to forward a sent message are underway.

In 2012, Wildlife and Feral Management will be switching to TracerTrak software and servers that allow users to register and manage their SPOT devices. Further testing once that occurs would be desirable.

In our trials there was a 6% chance that an activated trap alert message was not received. The degree to which this represents an unacceptable ethical risk to animal welfare is beyond the scope of this report; however, this is clearly an issue that needs to be resolved, both in terms of the reliability of the trap alert system and the public policy position on this issue.

The average time taken to receive a message was 32 minutes. However, the majority of messages that did arrive (80%), arrived within 30 minutes. On some days the messages took longer to arrive than on others. This is likely to be related to high traffic on the SPOT servers on those days (Cameron Fels, pers. comm.). On one occasion an email was not received but an SMS was, and on two other occasions the SMS arrived the day after the email was received. Overall, 91% of messages were sent from the trap alert device within ten minutes.

Physical conditions that may affect the transmission of a signal once a device has been deployed in the field were minimal. Vegetation coverage did not affect signal reception. During the manual field tests all signals were sent when the device was placed under thick vegetation cover. Even when the view of the sky was as little as 14% an alert message was received. This included both at a tree canopy level and at a shrub layer level. The thin layer of litter placed on top of the units (except those mounted on a tree) had no effect on the delivery of an alert message.

Micro-site placement of the device may have had some impact on the likelihood of the device being able to send a message. During one trial a message was not sent from a device positioned under a large log with only 25% of the antenna showing to the sky. The antenna of the GPS is at one end of the trap alert device, and when deployed in the field this end should be placed to obtain the broadest possible view of the sky. During another trial with 50% of the antenna end of the device showing from under a log, an alert message was received (Appendix 1).

An option for deployment in the field is to mount the device on a tree horizontally, with the fishing line running vertically up the side of the tree. This may result in fewer false triggers by non-target animals. Vertical mounting was trialled 10 times with the GPS antenna pointing skyward. A signal was sent and received each time the device was triggered. However, the magnetic reed switch connection needs modifying to allow attachment and easy removal should the device be triggered. Wildlife and Feral Management is currently investigating mercury movement switches as an alternative triggering mechanism and this would likely work if the device was vertically mounted.

The weather also played no part in the likelihood of an alert message being received. The device was tested in a variety of different weather conditions and none of these affected whether a message was sent from the device or not (Appendix 1). This included when tested in very thick and drizzly cloud above 1200 metres.

DOP results at the time of the devices being activated were collected and showed no difference in the likelihood and indeed, the length of time that was required for a message to be sent. On the five occasions that the DOP was above three, all of those five messages were sent and received. At most times during a 24 hour period there are between eight and eleven satellites available on the GNSS (Global Navigation Satellite System) for use by GPS devices (www.CalSky.com). However, there are periods in the day when this may be as low as five satellites. Although this increased the DOP it did not affect the performance of the SPOT based trap alert devices.

The trap alert devices would require an information management system to be established when multiple units are deployed in the field. More than one mobile telephone and email should be linked to the devices in order to ensure more than just one operator receives the message. It is not possible to test each deployment prior to setting the trap outside of the GSM network as a message requires to be received before the device can be reset. This would require the operator to travel to within the GSM network in order to receive the message. This is very impracticable or even unfeasible unless there is a coordinator to facilitate both live and occasional test messages. Tests of each device should be undertaken periodically to ensure the batteries are functioning or at each trap site if the site is within the GSM network.

The SPOT based trap alert has many advantages when used in the field. In our trials they proved to be reliable. Failure to receive a message was related to an earlier model having older style batteries that became depleted. The SPOT units run on lithium batteries which have a much longer life. Failure was also associated with the device being placed to far under heavy forest debris or for unknown reasons related to the SPOT servers. The units have inexpensive and easy to access components for on-going maintenance; they are easy to set up, with a simple LED based interface that allows the operator to see if the device is working *in-situ*.

The SPOT trap alert devices are yet to be fully costed by Wildlife and Feral Management. However, the initial cost estimate is $700–800 per unit. There is a $25 per month fee for each device using the SPOT service. There is also the option of using SPOT through the TracerTrack server system which would be a pre-paid fee of approximately $35 per month for each device. However, using the SPOT devices through the TracerTrack network has not yet been tested.

The Pivotel system also has an initial purchase price of approximately $700–800 per unit, with an ongoing pre-paid fee to the service provider of $400 per year. Wildlife and Feral Management are currently also considering the possibility of leasing the devices, but details of this are still yet to be confirmed.

During the live performance tests the reed switch appeared to work well. However, as the fishing line runs horizontally along the ground for several metres or so, there were a few occasions when it was pulled by a passing animal and the trap was activated, giving a false alarm. On one occasion the magnetic reed switch was lost after a dog had been caught in a trap and had moved away from the trap location. There is clearly a need to improve this aspect of the trap alert system.

6 Recommendations

Should the modified SPOT trap alert device be deployed in wild dog control in Victoria, the following should be considered:

- Undertake further testing once the devices have been switched to TracerTrack, to see if reliability can be improved further.
- Include multiple custom message recipients for each trap alert device deployed, and have a facilitator manage the test and live alert messages.
- Deploy the devices as far as practicable from the dog trap in order to minimise damage caused by the trapped animal. This may include mounting the device up a tree if feasible. The unit should be cable-tied once set to ensure that it cannot be opened and exposed to the elements.
- The device should be placed with no more than 50% of the unit hidden under logs, rocks, etc., and the GPS antenna end of the device should be placed with the broadest possible view of the sky.
- Improve the triggering mechanism to reduce the possibility of false triggering.

Other alternatives to the modified SPOT trap alert devices should be investigated. One such option would be investigating the use of remote sensing cameras that can send images to a computer or hand-held device. These can be set up to capture and send an image at a pre-programmed time. This would eliminate any doubt as to whether a trap had triggered and should also provide the operator with a clear idea as to what is in the trap. This technology is becoming more available but is limited by the high cost (over $1200 per unit) and the need for a modem in the field (see www.faunatech.com.au). There are also camera image systems available that use UHF repeater stations, similar to existing trap alert technologies. Like most of the other trap alert systems available, this technology is expensive and requires access to UHF repeater stations and is somewhat impracticable and cumbersome. Although these technologies have their limitations, they are improving rapidly and may soon become more practical and cost-effective.

References

Benevides, F.L., Hansen, H. and Hess. S.C. (2008) Design and evaluation of a simple signalling device for live traps. The Journal of Wildlife Management **72** (6), 1434–1436.

Darrow, P.A. and Shivik, J.A. (2008) A pilot evaluation of trap monitors by the USDA Wildlife Services Operational Program. Pages 213–217 In: Proceedings of the 23rd Vertebrate Pest Conference. (University of California: Davis, USA).

Gong, W., Sinden, J., Braysher, M. and Jones, R. (2009) 'The Economic Impacts of Vertebrate Pests in Australia.' (Invasive Animal Cooperative Research Centre: Canberra).

Halstead, T.D., Gruver, K.S. and Phillips, R.E. (1996) Using telemetry equipment for monitoring traps and snares. Eds: Masters, R.E., Huggins, J.G. Pages 121 – 123 In: Proceedings of 12th Great Plains Wildlife Damage Control Workshop, The Noble Foundation, Ardmore, OK.

Johnston, M. (2004) Trap alert review. Unpublished Report for the Keith Turnbull Research Institute, Department of Primary Industries, Frankston.

Larkin, R.P., Vandeelan, T.R., Sabick, R.M., Gosselink, T.E., and Warner, R.E. (2003) Electronic signalling for prompt removal of an animal from a trap. Wildlife Society Bulletin **31**(2), 392–398.

Marks, C. (1996) A radiotelemetry system for monitoring the treadle snare in programmes for wild Canids. Wildlife Research **23**, 381–386.

Marks, C. (2008) Review: Welfare outcomes of leg-hold trap use in Victoria. (Nocturnal Wildlife Research Pty Ltd, East Malvern).

Moseby, K. (2003) The Arid Recovery Project, Roxby Downs — A 6000 ha fence, eradication and maintenance program together with a demonstration of trapping techniques. In: Proceedings of a feral cat control seminar on Kangaroo Island (unpublished).

Neill, L.O., Jongh, A.D., Ozolins, J., Jong, T.D. and Rochford, J. (2007) Minimizing leg-hold trapping trauma for Otters with mobile phone technology. The Journal of Wildlife Management **71**(8), 2776–2780.

Nolan, J.W. (1984) Transmitters for monitoring Aldrich snares set for Grizzly Bears. The Journal of Wildlife Management **48**(3), 942–945.

Proudfoot, G.A. and Jacobs, E.A. (2001) Bow net equipped with radio alarm. Wildlife Society Bulletin **29**(2), 543–545.

Appendix 1. Description of physical conditions under which controlled field trials were conducted.

Category	Description
Steep gully	tests were conducted in three different creek systems, from broader to narrower sides.
Broad valley	tests were undertaken in two valleys, one with scattered trees and one with a mostly open canopy cover.
Thick vegetation	tests were conducted at three locations in rainforest canopy, riparian cover and one under low and thick shrubs.
Medium vegetation	tests were undertaken at two different locations, both in foothill forest, one in wet forest and one in drier forest.
Open clear country	tests were undertaken at one location in subalpine clear country.
Under debris with open canopy	tests were undertaken at one location under a log with different levels of the device showing to the sky in foothill forest. A thin layer of leaf litter was placed on the device.
Under debris with closed canopy	tests were undertaken at one location under a pile of sticks with different levels of the device showing the sky in a Tea-tree thicket. A thin layer of leaf litter was placed on the device.
Vertically mounted under closed canopy	tests were undertaken at three locations in riparian, mountain forest and dense mid slope forest. The device was mounted at chest height up a tree.
Vertically mounted under open canopy	tests were undertaken at three locations in a clearing in tall wet forest, under scattered trees and in burnt mid slope mixed forest. The device was mounted at chest height up a tree.

Appendix 2. Results of the trap alert trials conducted under controlled conditions using the SPOT system.

	Time taken to send incl. 65 second trigger delay (mins)	Time taken to receive message (mins)	Inside / Outside GSM	Email received (Yes/No)	Registered on SPOT website (Yes/No)	Vegetation Type	Actual view of sky	Weather	Debris type and % of unit exposed	DOP
Steep gully trial										
Acheron Way	10	77	No	Yes	Yes	Tall wet forest	97%	Clear sky	NA	2.43
Acheron Way	7	82	No	Yes	Yes	Tall wet forest	97%	Clear sky	NA	2.43
Acheron Way	14	75	No	Yes	Yes	Tall wet forest	97%	Clear sky	NA	2.51
Mt Disappointment SF	3	3	No	Yes	Yes	Burnt mixed forest	73%	Overcast	NA	2.3
Mt Disappointment SF	3	Did not receive	No	No	No	Burnt mixed forest	77%	Sunny	NA	2.29
Broad valley trial										
Acheron Way	3	8	Yes	Yes	Yes	Riparian forest	64%	Partly cloudy	NA	2.3
Acheron Way	2	12	Yes	Yes	Yes	Riparian forest	64%	Partly cloudy	NA	2.52
Acheron Way	5	19	Yes	No	Yes	Riparian forest	64%	Partly cloudy	NA	2.52
Dartmouth	3	3	No	Yes (took 12 hrs)	Yes	Foothill forest	23%	clear sky	NA	2.21
Dartmouth	3	26	No	Yes (took 12 hrs)	Yes	Foothill forest	23%	clear sky	NA	2.21
Open clear country trial										
Mt Donna Buang	3	12	Yes	Yes	Yes	None	100%	Thick cloud, drizzle	NA	2.38

	Time taken to send incl. 65 second trigger delay (mins)	Time taken to receive message (mins)	Inside / Outside GSM	Email received (Yes/No)	Registered on SPOT website (Yes/No)	Vegetation Type	Actual view of sky	Weather	Debris type and % of unit exposed	DOP
Mt Donna Buang	3	41	Yes	Yes	Yes	None	100%	Thick cloud, drizzle	NA	2.38
Mt Donna Buang	3	31	Yes	Yes	Yes	None	100%	Thick cloud, drizzle	NA	2.52
Mt Donna Buang	2	49	Yes	Yes	Yes	None	100%	Thick cloud, drizzle	NA	2.52
Mt Donna Buang	2	63	Yes	Yes	Yes	None	100%	Thick cloud, drizzle	NA	2.52
Thick vegetation trial										
Nr Mitta Mitta	5	12	No	Yes	Yes	Tea-tree, Riparian	38%	Clear sky	NA	2.14
Mount Disappointment SF	8	16	No	Yes	Yes	Burnt Riparian forest	14%	Overcast	NA	4.89
Mount Disappointment SF	10	11	No	Yes	Yes	Burnt Riparian forest	14%	Overcast	NA	2.58
Mount Disappointment SF	3	3	No	Yes	Yes	Burnt Mixed forest	18%	Sunny	NA	2.57
Mount Disappointment SF	3	3	No	Yes	Yes	Burnt Mixed forest	18%	Sunny	NA	2.57
Medium vegetation trial										
Warburton	3	13	Yes	Yes	Yes	Tall wet forest	76%	Partly cloudy	NA	2.14
Warburton	7	42	Yes	Yes	Yes	Tall wet forest	76%	Partly cloudy	NA	2.14
Warburton	4	33	Yes	Yes	Yes	Tall wet forest	76%	Partly cloudy	NA	2.33
Warburton	4	24	Yes	Yes	Yes	Tall wet forest	76%	Partly cloudy	NA	2.33

	Time taken to send incl. 65 second trigger delay (mins)	Time taken to receive message (mins)	Inside / Outside GSM	Email received (Yes/No)	Registered on SPOT website (Yes/No)	Vegetation Type	Actual view of sky	Weather	Debris type and % of unit exposed	DOP
Mount Disappointment SF	3	3	No	Yes	Yes	Burnt mixed forest	59%	Overcast, drizzle	NA	2.53
Under debris trial in open cover										
Mount Donna Buang	Would not send - no satellites	Did not receive	Yes	No	No	Open, edge of snow gums	25%	Thick cloud	Log 25%	2.52
Mount Donna Buang	11	96	Yes	Yes	Yes	Open, edge of snow gums	25%	Thick cloud	Log 75%	2.29
Mount Donna Buang	10	104	Yes	Yes	Yes	Open, edge of snow gums	25%	Thick cloud	Log 75%	2.29
Mount Donna Buang	8	122	Yes	Yes	Yes	Open, edge of snow gums	25%	Thick cloud	Log 75%	2.29
Mount Donna Buang	24	91	Yes	Yes	Yes	Open, edge of snow gums	25%	Thick cloud	Log 50%	2.29
Under debris trial in closed cover										
Mitta Mitta	8	Did not receive	No	No	No	Ti tree, Riparian	34%	Partly cloudy	Sticks & leaf litter 20%	1.99
Mitta Mitta	5	17	No	Yes	Yes	Ti tree, Riparian	34%	Partly cloudy	Sticks & leaf litter 20%	3.86
Mitta Mitta	4	Did not receive	No	No	No	Ti tree, Riparian	34%	Partly cloudy	Sticks & leaf litter 30%	2.47

	Time taken to send incl. 65 second trigger delay (mins)	Time taken to receive message (mins)	Inside / Outside GSM	Email received (Yes/No)	Registered on SPOT website (Yes/No)	Vegetation Type	Actual view of sky	Weather	Debris type and % of unit exposed	DOP
Mitta Mitta	3	4	No	Yes	Yes	Ti tree, Riparian	34%	Partly cloudy	Sticks & leaf litter 30%	2.46
Mitta Mitta	3	17	No	Yes	Yes	Ti tree, Riparian	34%	Partly cloudy	Sticks & leaf litter 30%	2.46
Vertical mounting in open cover										
Acheron Way	6	31	Yes	Yes	Yes	Tall wet forest, Riparian	61%	Partly cloudy	NA	2.52
Mitta Mitta	3	5	Yes	Yes	Yes	Scattered trees in paddock	58%	Partly cloudy	NA	2.78
Mitta Mitta	6	16	Yes	Yes	Yes	Scattered trees in paddock	58%	Partly cloudy	NA	2.78
Mitta Mitta	9	9	Yes	Yes	Yes	Scattered trees in paddock	58%	Partly cloudy	NA	2.14
Mount Disappointment SF	3	4	No	Yes	Yes	Burnt mixed forest	28%	Overcast	NA	4.89
Vertical mounting in closed cover										
Acheron Way	8	Did not receive	No	Yes	Yes	Mountain Ash	21%	Thick cloud	NA	2.59
Mitta Mitta	5	4	Yes	Yes	Yes	Mid-slope forest,	20%	Scattered cloud	NA	3.7

	Time taken to send incl. 65 second trigger delay (mins)	Time taken to receive message (mins)	Inside / Outside GSM	Email received (Yes/No)	Registered on SPOT website (Yes/No)	Vegetation Type	Actual view of sky	Weather	Debris type and % of unit exposed	DOP
						peppermint				
Mitta Mitta	4	5	Yes	Yes	Yes	Mid-slope forest, peppermint	20%	Scattered cloud	NA	3.7
Mitta Mitta	9	42	Yes	Yes	Yes	Mid-slope forest, peppermint	20%	Scattered cloud	NA	2.78
Dartmouth	4	Did not receive	No	No	No	Thick Riparian, foothill forest	15%	Clear sky	NA	2.54

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