Booderee National Park Camera Trapping Manual

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Acknowledgement of Country

We acknowledge the Traditional Owners of Country throughout Australia and their continuing connection to and stewardship of land, sea and community. We pay our respects to them and their cultures and to their Ancestors, Elders and future leaders. Our Indigenous research partnerships are a valued and respected component of National Environmental Science Program research. We acknowledge the local Wreck Bay Aboriginal Community and people of the Jerringa Community in Jervis Bay.

Foreword: Camera Trapping as a Tool

Camera traps are widely used as a method of surveying introduced and native wildlife (O'Connell *et al.* 2011; Meek *et al.* 2014a; Rovero and Zimmerman 2016). The design of the surveys will vary depending on the project objective, which directly influences the camera trap array, how many and where any camera traps are deployed (Claridge and Paull 2014). Camera trapping is not a one-size-fits-all method and needs to be customised to satisfy the objective, the survey design and the species of interest. Camera traps are a precision tool; care is required to place them in the field and maintain them. This manual provides a guide for describing how camera traps work and how they should be placed to survey for predators and native species in Booderee National Park.

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1. Camera Trap Survey Design

The data collected from monitoring foxes, feral cats and wild dogs are more robust when the camera trap array is based on a track and trail network. This is because these predators selectively use trails to move through the landscape with ease. The array should be spaced at one-kilometre intervals on permanent posts to systematically cover the whole Booderee National Park (‘the Park’). Camera traps should be deployed 24/7 over 12 months to detect seasonal variability in movements and ensure foxes are constantly monitored directly in response to control actions. Strategic placement in the Isthmus at the northern entrance to Booderee National Park will also allow for a rapid response to new incursions

2. Camera Trap Models

The camera trap market is saturated with different manufacturers and models, each with their own specific nuances and advantages. The recommended camera trap model to deploy in Booderee National Park are Reconyx brand camera traps because they are robust, reliable and have good programming versatility. Predator surveys should use Reconyx HP2X camera trap model (Fig 1) and surveys for native wildlife should use Reconyx HP2W white flash. Where funding permits, the Reconyx HP2WSMODGBP should be used for rodent sized mammal surveys because it is designed specifically for small mammal detection.

Figure 1. An image of the Reconyx HP2X camera trap model

3. Camera Trap Naming Conventions and Engraving

Managing camera traps should include keeping a watchful eye on all units and being able to trace their history of service, especially if repairs are required. Each camera trap in the Park should have a unique identifier which does not have to be attributable to a site. This number should be engraved into the top of the camera casing then painted with a UniPaint® marker for permanent recording (Fig 2). A register of the camera trap code should also be kept on file for warranty purposes.

Figure 2. An example of a permanent marking of unique code on each camera trap

4. Camera Trap Components

Different models of camera traps have different features and settings. The preferred camera trap at Booderee is the Reconyx HP2X which has an infrared flash at night. The various components are shown in Figure 3. It is important that the illumination array (flash), the camera lens and the Fresnel lens are kept clean and protected from scratching and damage. Door seals should also be checked for dust and grime.

Figure 3. The components of a Reconyx HP2X. The Fresnel lens and PIR are described here as a PIR Motion Detector. Image courtesy of Reconyx.

5. Camera Trap Settings

The settings can be changed manually using the screen and button array or using software. It is important that the settings are chosen to ensure the data collected will satisfy the requirements of the survey, and that the settings are consistent for each camera in the array. Programming the camera traps as an entire array in one session minimises the chance of error, especially when setting the time.

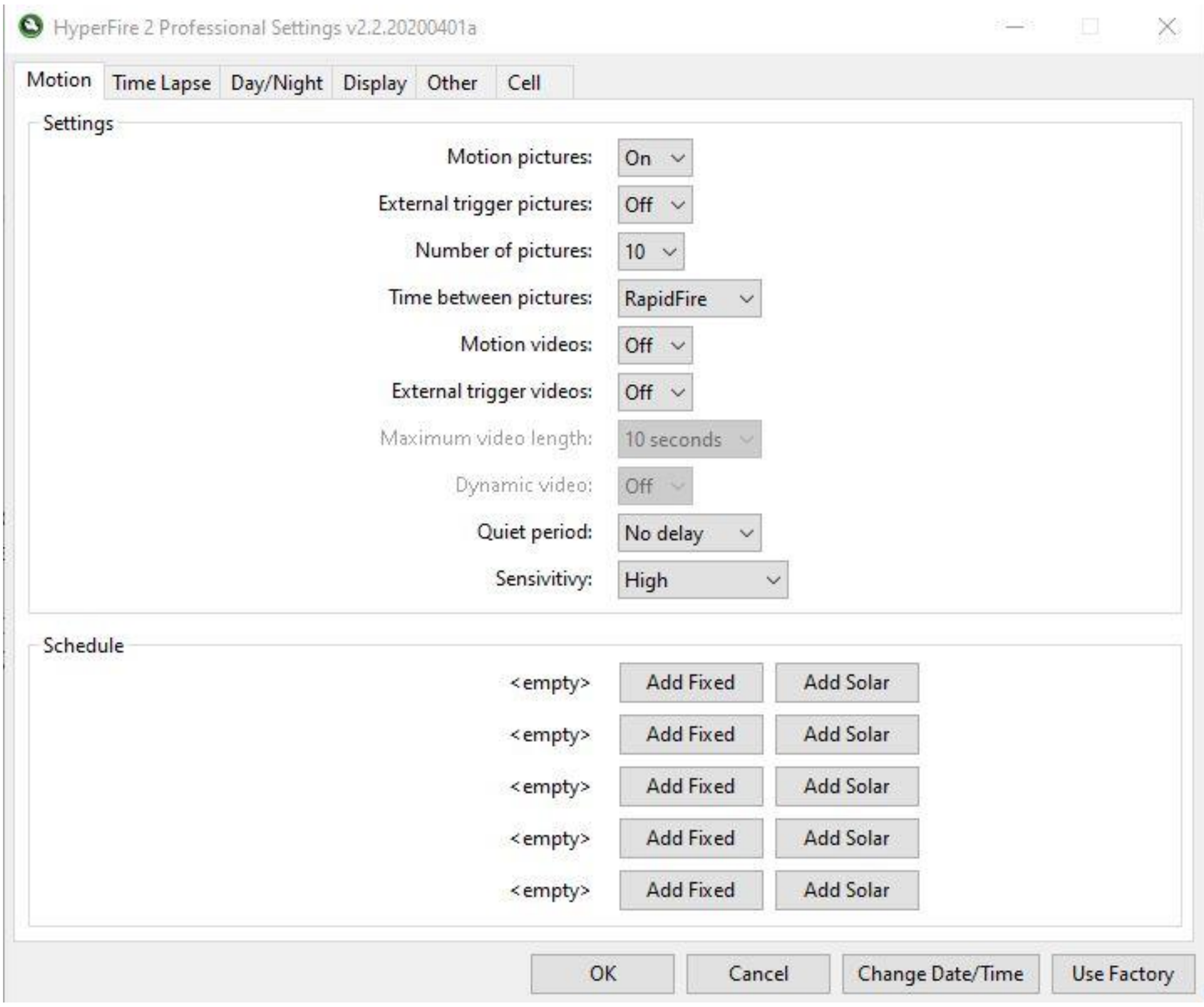
4.1 Predators

Prior to programming the detection settings, all camera traps should have the time and date set using the mobile phone network to ensure all camera taps are synchronised. The Region should be set to “Other”.

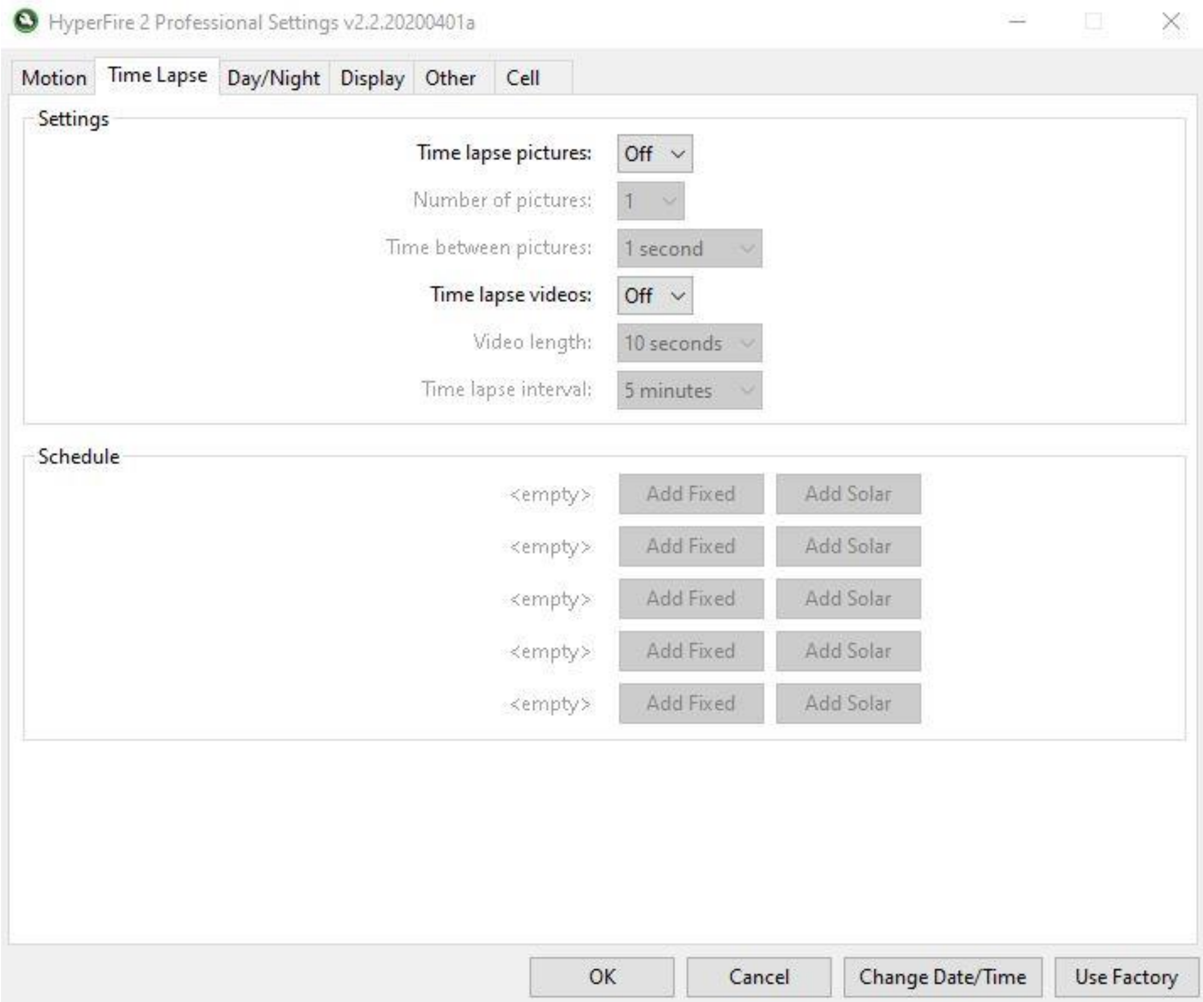
Camera traps should be set to detect all animals passing the camera trap along the road. To ensure optimum identification the camera trap settings should be programmed using the Professional Settings Reconyx software https://www.reconyx.com/software/pro-settings-hf2 downloaded from the Reconyx website. This software expedites the programming process and ensures consistency across all camera traps being programmed. The following settings are recommended.

Programming the camera trap to take 10 photos per trigger gives near video capture of the animal passing and aids identification. Reducing this to 5 images per trigger will reduce the volume of image files while not compromising identification markedly (Sparkes *et al.* 2020). The optimum settings for wildlife research should include the “Rapidfire” and “No Delay” settings that result in a sequence of images (Meek *et al.* 2014b; Sparkes *et al.* 2020).

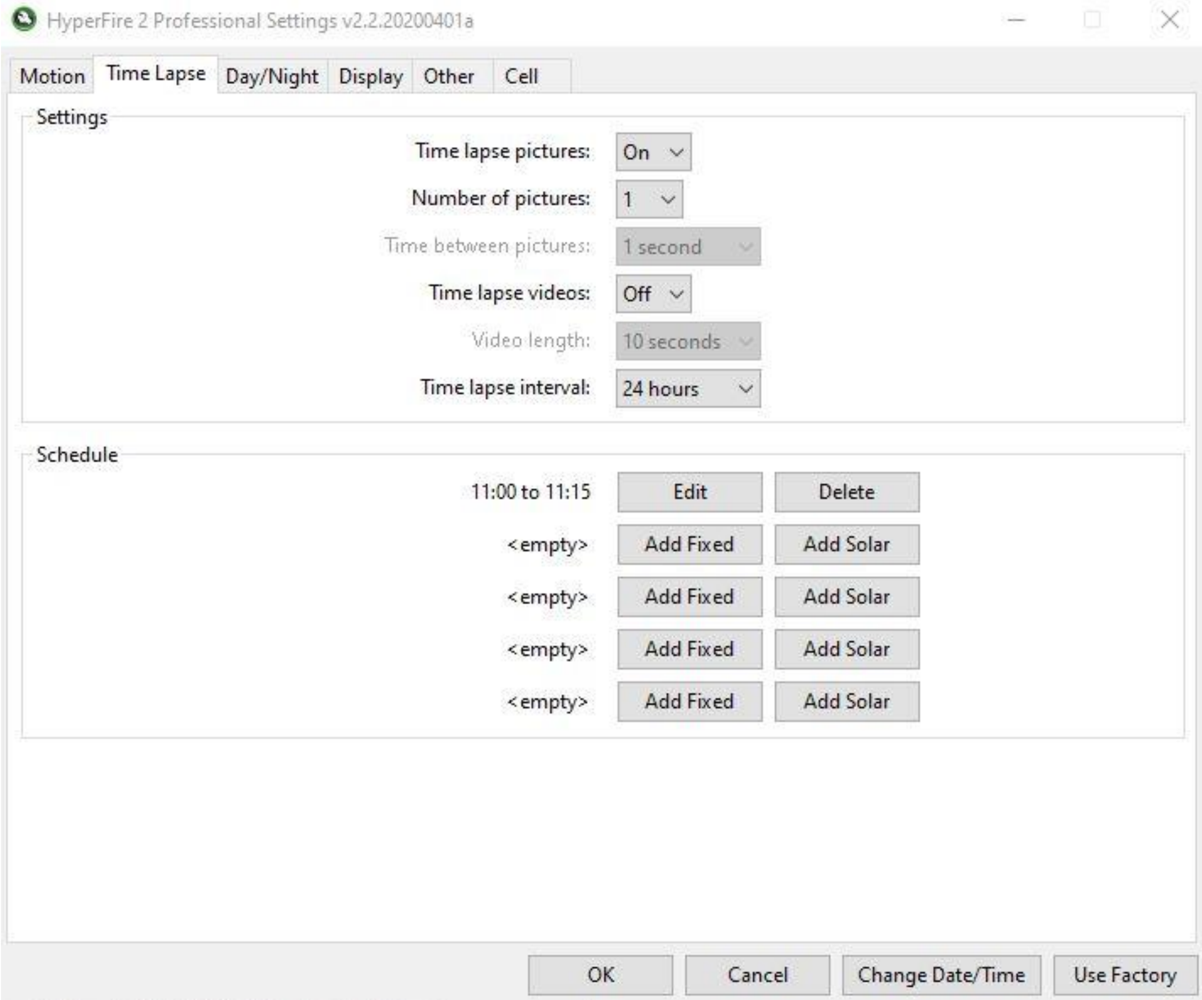
The sensitivity can be adjusted to suit the location of the survey. In areas where false triggers are causing battery drain and/or the premature filling of SD card space from photos of moving vegetation or other triggers, sensitivity can be set to “Low” which reduces the sensitivity of the PIR (Passive Infrared). However, changing to “Low” may result in less detections of animals. The preferred setting is “High” which ensures good PIR sensitivity but may also result in some false triggers from moving vegetation and shadows. The Nil images can be removed using the MegaDetector® software https://github.com/agentmorris/MegaDetector/blob/main/megadetector.md post survey.



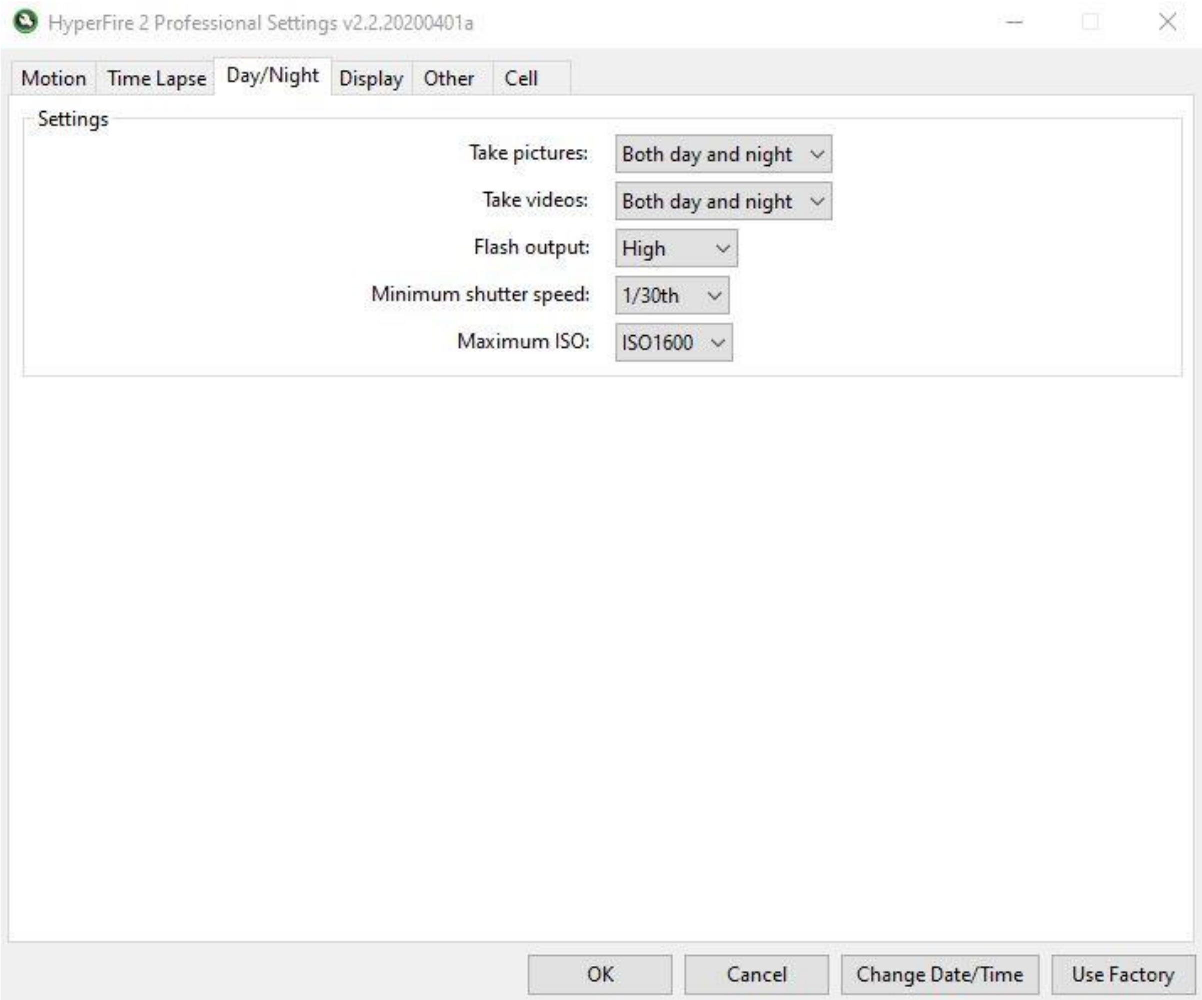
The “Timelapse” setting allows photos to be taken at pre-determined time intervals without the PIR being triggered. This can be programmed through the camera trap screen or using the Professional Settings software. Programming timelapse for a daily photo is recommended because it provides confirmation that the camera has been working, but more importantly it can be used to create a photo point record of habitat change over time. Under the Time Lapse tab switch the camera trap to “On” for photos only, in the software the “Schedule” can be set according to the project requirements.



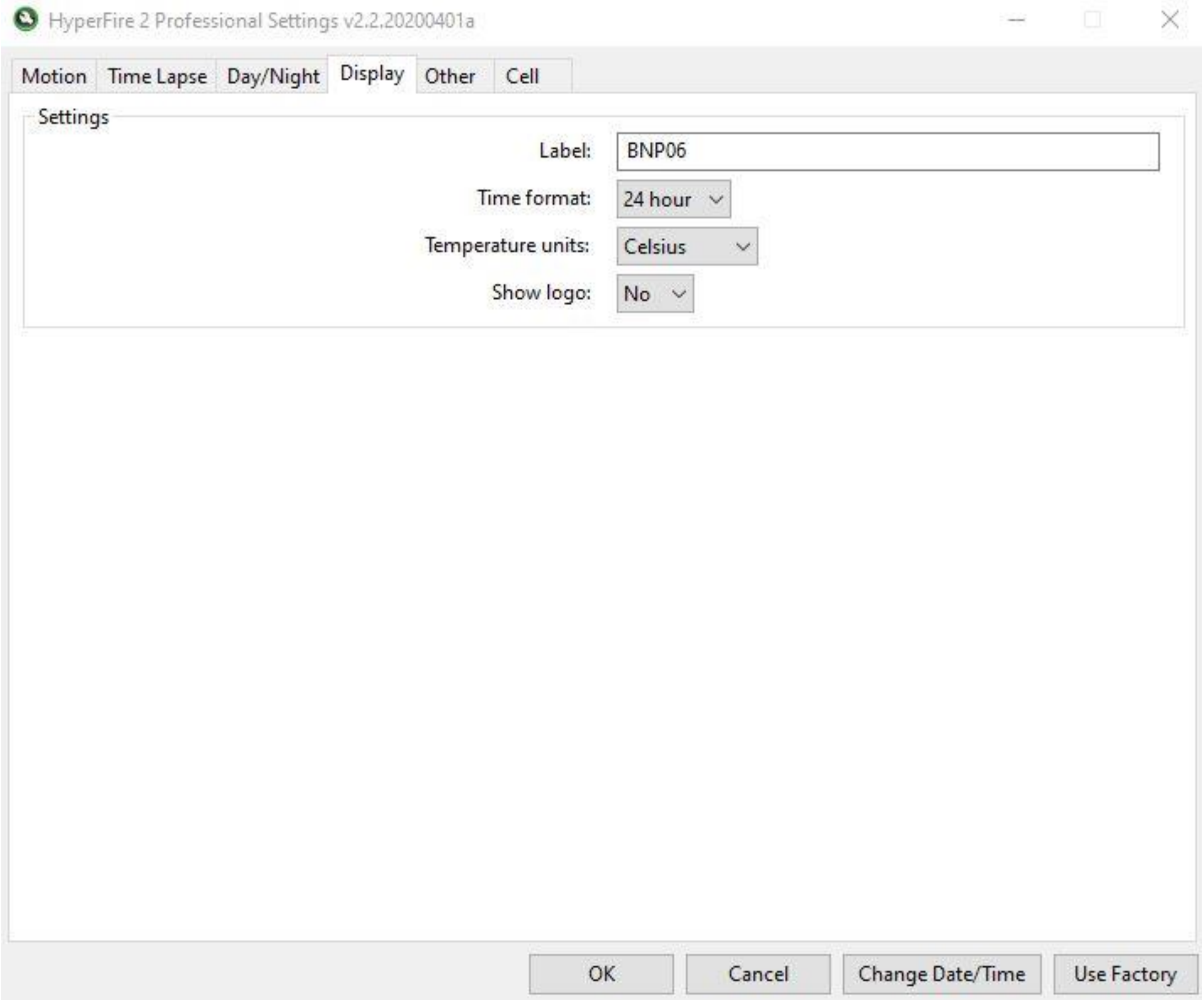
If time-lapse is required, it is recommended that one image is taken at 11:00 hrs each day using the programming software.



It is imperative to have the camera trap programmed to operate in day and night as foxes and other predators are active throughout the day although mostly at night. The illumination should remain on high to ensure animals are highlighted greater than 6 metres from the camera trap. Adjusting the shutter speed and ISO can be done although no research has been published on how this effects detection and identification of animals in images.



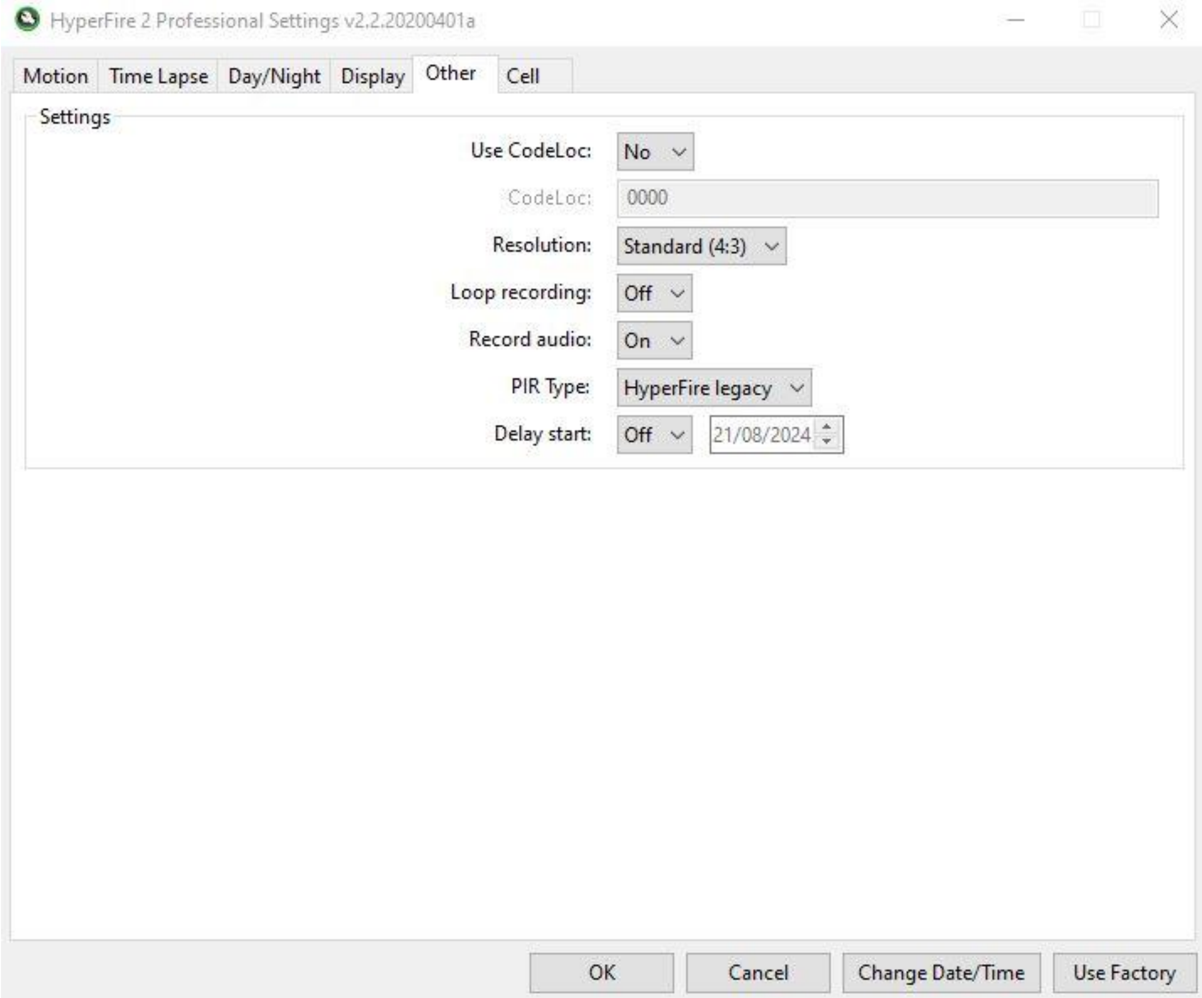
In the display screen there is an opportunity to add a user label to the camera, this code should coincide with the site code and the code marked on the SD card. The camera code may be different if necessary for operational purposes. A 24-hr time format reduces the chances of interpretation error when using am and pm, using Celsius is consistent with Australian standards and excluding the logo precludes the need to remove that part of an image if used in publications. Further, if the images are likely to be used for artificial intelligence algorithm development, it is better to not have a logo.



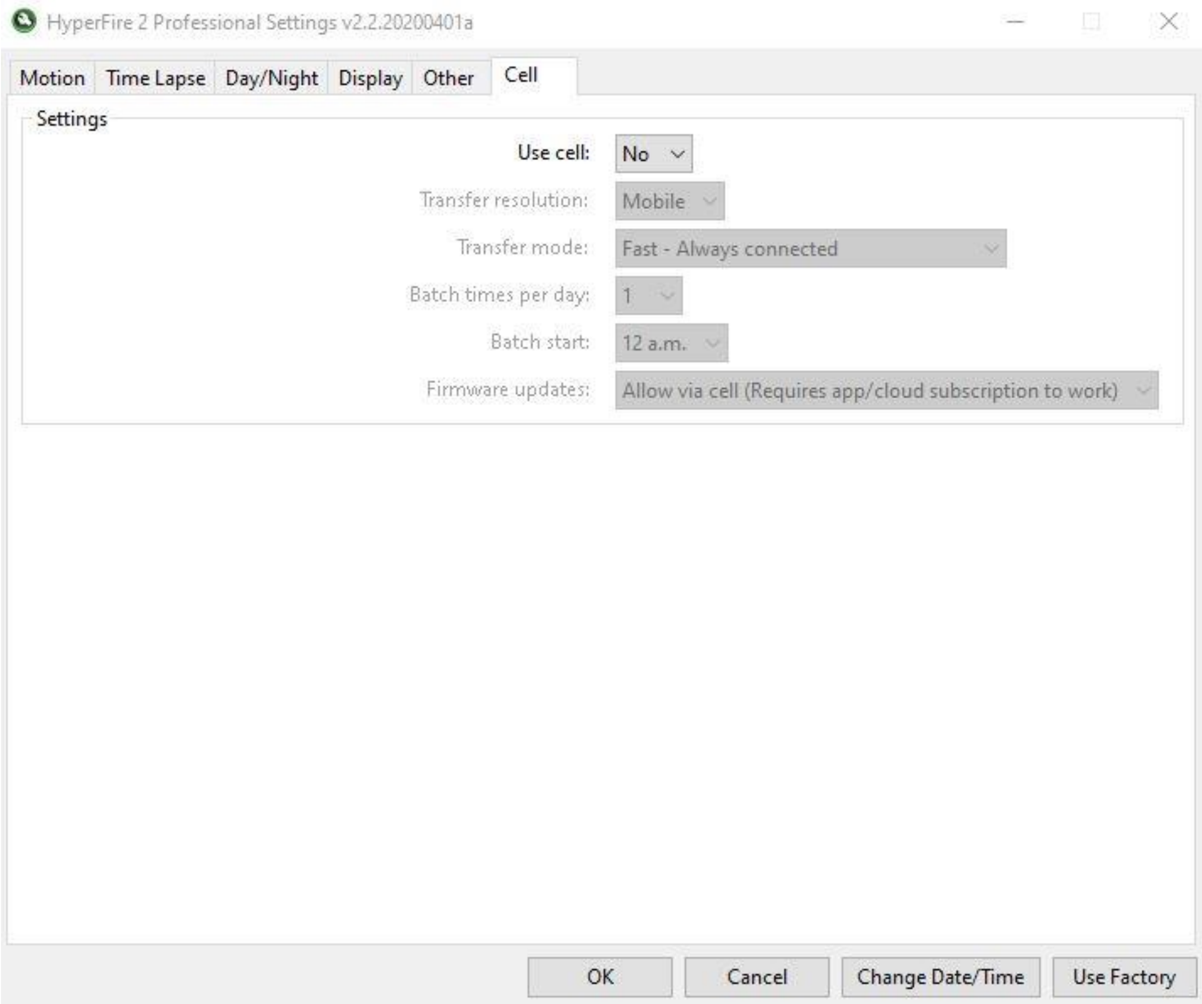
Using a Codeloc can make it more difficult for would be thieves to reuse a camera trap that they steal, however if the camera trap experiences a power surge or drop and the camera restarts, when Codeloc is set, the camera trap will not arm. As such the use of Codeloc is not advocated, especially if a security post is being used.

There are two resolution settings: “Wide” and “Standard”. Set the resolution to standard to ensure full image capture. Moreover, the placement method that is recommended in this manual will only be useable if the “Standard” setting is programmed.

The Passive Infrared (PIR) type should be set to “Long Range” to enable comparisons in detections with contemporary data collected at Booderee NP. The new HP2X model default setting is “Long Range” although there have not been any published investigations to compare detection accuracy between the “Legacy” and “Long Range” setting. It is noteworthy that historical data was collected using HC600 which uses the “Legacy” detection zone, and this difference should be recognised in comparing historic with contemporary data. The third setting is High Frequency which should be set when targeting small mammals like rodents and *Antechinus*.

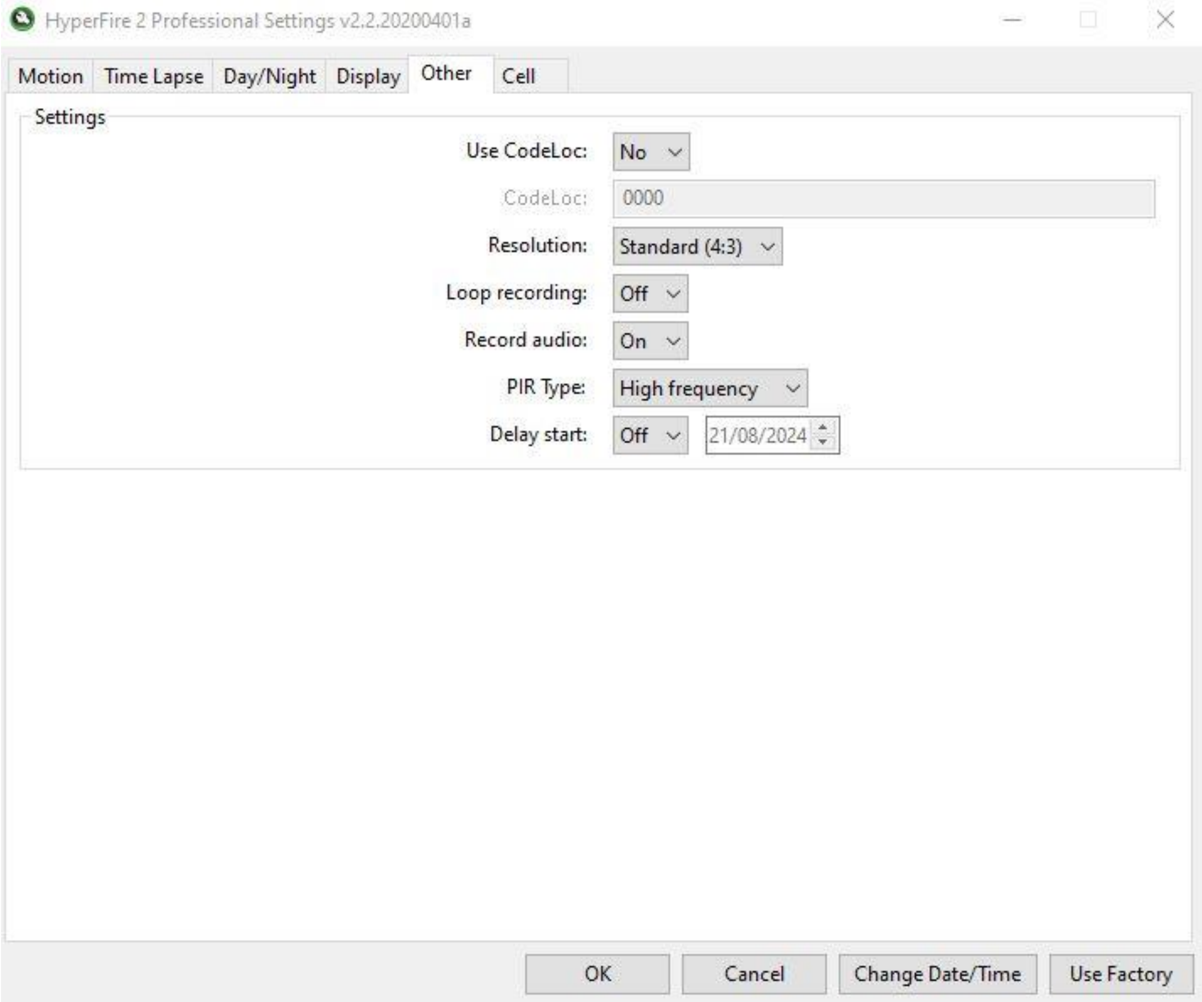


The Cell setting should be turned off as this is not a function available in Australia or with the HP2X model.



4.2 Native Species

The same settings can be used for native species detections as predators, with the exception of the PIR Type which can be changed to 'High Frequency'. This setting is designed to detect smaller heat signatures in animals like native rodents and *Antechinus* species. The Long Range or Legacy setting can be used for quoll, bandicoots and macropods sized animals.


HyperFire 2 Professional Settings v2.2.20200401a
Motion
Time Lapse
Day/Night
Display
Other
Cell
Settings
Use CodeLoc:
No
CodeLoc:
0000
Resolution:
Standard (4:3)
Loop recording:
Off
Record audio:
On
PIR Type:
High frequency
Delay start:
Off
21/08/2024
OK
Cancel
Change Date/Time
Use Factory

6. Batteries and Chargers

It is recommended by the manufacturer that alkaline batteries should never be used in Reconyx camera traps because they do not provide enough power for the camera trap to operate, specifically the illuminators. This can result in poor detection and low-quality images at night. Alkaline battery performance is also affected by weather extremes. Environmentally, using alkaline batteries in place of rechargeable batteries in studies where lots of camera traps are deployed produces waste: rechargeable batteries are preferred.

The 2 best options are lithium batteries and NiMH batteries.

Lithium maintain their charge better than NiMH batteries in extreme weather. However, lithium batteries are expensive, and they only have one use, after which they must be disposed of properly. In large programs where servicing is continuous the best option is to use rechargeable NiMH batteries. Preferably, each camera should have exactly the same AA battery brand and power (1.3 v/2450 mAh). The Eneloop 16 cell battery charger provides the ability to charge and occasionally completely discharge before charging which can improve longevity of batteries.

7. SD Cards

The preferred SD cards are SanDisk Ultra 32 GB 90 MB/second. These cards have the best upload speed which reduces the delay between trigger and image capture. Using 32 GB cards also reduces the chance of cards filling up even with triggers from moving vegetation and shadows.

Figure 4. The preferred SD cards are SanDisk Ultra 32 GB 90 MB/second.

8. Site Naming conventions and labelling

Each camera site should have two sets of SD cards, with a permanent label and site code name denoted on the SD card. Two sets of SD cards (A and B) should be allocated per site e.g. BNP6A and BNP6B.

9. How do camera traps work?

Camera traps are a precision tool that use a sensor called a Passive Infrared (PIR) sensor. This sensor detects heat-in-motion, in the form of radiant heat, of an animal against a background temperature that is cooler or hotter than the animal (Meek *et al.* 2012; Meek *et al.* 2015; Welbourne *et al.* 2016). This difference in temperature is called a temperature differential, and in order for the camera trap to trigger and take a photo, there must be a difference between the background and animal temperature (Fig 5).

Figure 5. A human and dog showing red (23-29°C) where there is a heat signature different to the blue and black background temperature (<19.5°C), showing how a camera trap detects an animal.

The PIR is assisted in detecting heat by the Fresnel lens (Fig 3) which usually is positioned under the camera trap lens and is a soft plastic that needs to be protected from damage.

10. Camera Trapping Deployment Pipeline

Establishing a pipeline process for using camera traps and servicing the camera trap array is a fundamental requirement of all research and monitoring programs. Having a process that all staff understand reduces the chance of errors in surveys and means that there is less opportunity for issues to arise when the data is analysed and interpreted. It is critical that potential bias and errors are minimised during data collection.

Battery charging and storage

A battery charger rack should be set up in the office on a bench for ease of processing batteries. Enough batteries need to be charged for one deployment. Carry cases should be purchased for storing charged batteries, each compartment stores 12 batteries, enough for one camera (Fig 6).

Figure 6. AA battery storage box, 12 batteries can be stored in each compartment.

SD card storage

SD card storage boxes (Fig 7) should be used to keep SD cards clean and in order. When using in a servicing activity, card B should replace card A in the camera trap and card A should be placed backwards in the storage case to ensure cards are not accidentally reused.

Figure 7. SD card should be stored safely, for instance in Elephant brand storage cases.

Preparation for deployment

Prior to heading out into the field to service the camera trap arrays, staff need to do a complete check to ensure everything required is in the vehicle.

Camera traps

All camera traps should be checked to ensure that the settings including the date and time (set to EST, not daylight saving) are correct and working. Spare camera traps should be kept in the servicing kit in the event of a camera fault or damage.

SD Cards

Either A set or B set cards should be placed in the elephant case in order of servicing by the team. If two or more teams conduct the servicing, then more cases will be required. SD cards should be kept clean as they gather dust and grime and can damage the camera trap and cause faults in the camera trap and in data upload.

Equipment for servicing

1. Locks or security spanners for the camera traps
2. Spare cameras
3. SD cards in cases
4. Enough batteries to replace camera trap array with some spares
5. Spray water bottle to clean cameras in the field
6. Brush for cleaning camera lens and Fresnel lens
7. Insect spray for security post treatment
8. Over the Ute tray battery basket with an internal canvas bag for easy removal (Fig 8). Figure 8 is a 32L Rapidplas Fence Feeder, available from farm supply stores.

9. Stationary and SD card stickers in case of change over in equipment

Figure 8. Over the ute tray battery basket. This is a Rapidplas Fence Feeder.

10. Data sheet or phone application to track servicing and record issues
11. Brushcutter, PPE, cord and fuel
12. Chainsaw, PPE, field and service kit
13. Secateurs
14. Field computer

11. Track-based Predator Surveys

Camera trap surveys for foxes, dogs and feral cats should be undertaken on tracks and roads (Ballard *et al.* 2014). The placement of the camera trap in relation to the road is critical (Meek *et al.* 2024). This poses a risk of theft and damage so each camera trap should be installed in one of two security post designs (Meek *et al.* 2022). If security boxes are not used, camera traps must be placed on posts not on trees. This is because trees are not uniform in location in relation to the track and the passage of the animal, and, as such, this introduces a detection bias.

Placement

On main roads where there is public access and a high risk of theft, the Zorro security post should be deployed (Fig 9). At sites where there is less risk of theft and damage the lesser robust Rose Valley security post should be used (Fig 10).

Figure 9. Zorro security post.

Figure 10. Rose Valley security post.

The secondary benefit of using security posts is that the site becomes a permanent monitoring site and eliminates variability in camera trap deployment (i.e. alignment) between surveys. Once the camera trap is set properly with the detection zone accurately placed, and the security post is concreted in place, regardless of who services the camera trap it will always be accurately and consistently placed.

Camera trap post installation should follow the HODD Method (Meek et al submitted,) which ensures that the camera trap is accurately placed at the right height, orientation, direction and distance ('HODD') from the roadside. The Fresnel lens should be approximately 50 cm above the ground, the centroid of the detection zone should focus 5-6 m from the camera into the middle of the track, where possible facing approximately 23° to the track and where possible away from the sun (Fig 11).

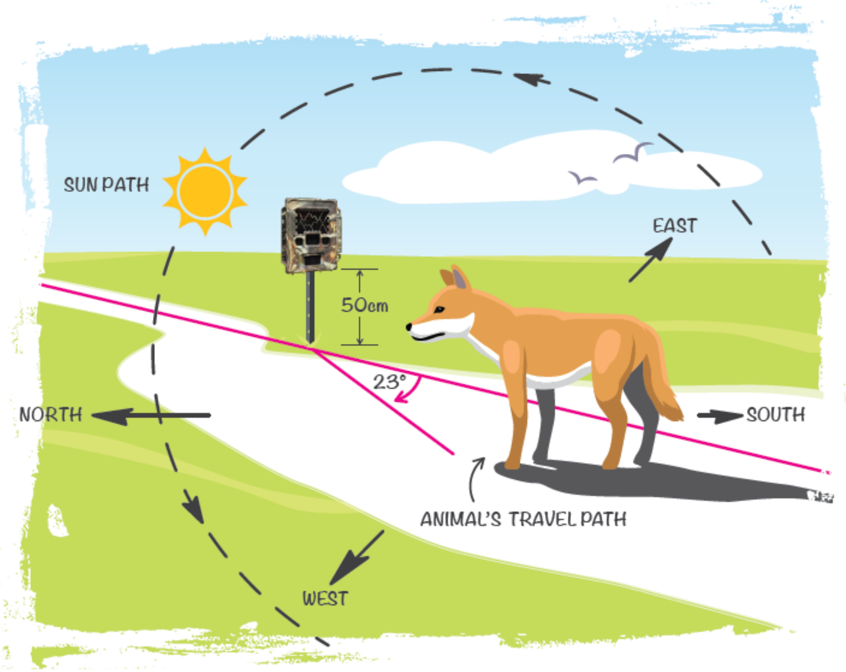


Figure 11. The HODD method showing how the camera trap should be placed with the correct height, orientation, direction and distance (HODD). Image courtesy of NSWDPI.

Once the specific location of the camera trap array is decided, all cameras should try and face the same direction. Using the HODD method the camera trap can be precisely placed to suit each site condition. This is best done by setting the camera trap by eye considering how the PIR detects heat-in-motion (Fig 12), and by triggering the camera trap by someone in your team physically crawling past the device at a height as close to the fox as possible. Then using Irfranview®, open the first detection of the crawling human and overlay the detection zone .jpg as a watermark and see if the alignment is accurate. If not, repeat the method until the camera is detecting the human well before they reach the centre of the image and the PIR watermark is aligned properly (Meek *et al.* 2024).

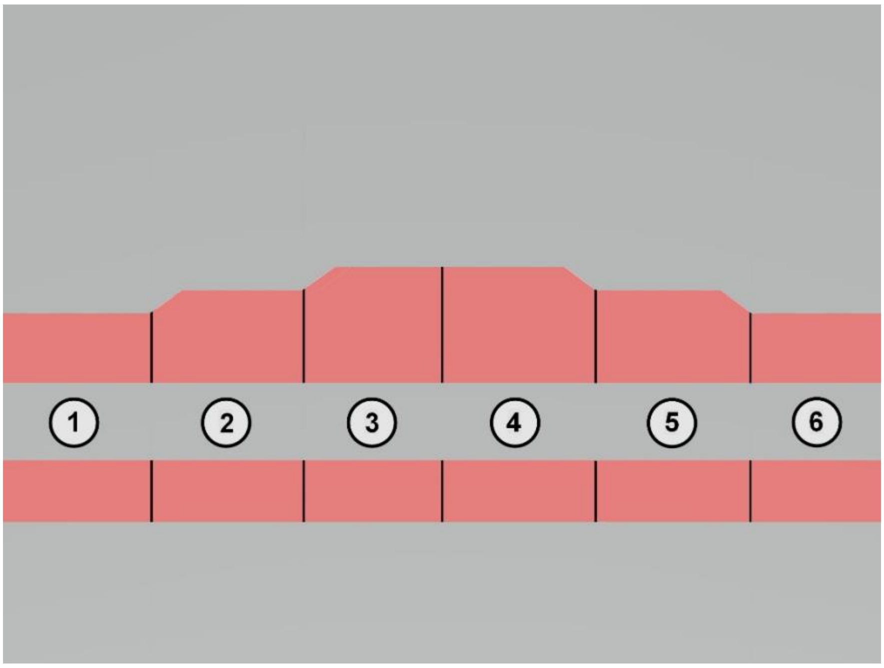


Figure 12. The Reconyx PIR watermark showing the detection zones where animals must pass through (pink) for heat-in-motion to be detected. Image courtesy of Reconyx.

Security posts should be off the road grading edge and away from road drains but as close to the road edge as possible e.g. <300 mm.

Site preparation

It is crucial to use a brush cutter to remove the vegetation in front of the security post to avoid the camera trap from being triggered by swaying vegetation, this includes removing overhanging branches. Once the post point has been decided and the hole is being dug, the vegetation should be removed so that you don't have any swaying vegetation in the detection zone when setting up the camera trap.

12. Off-Trail Native Animal Survey

The placement of camera traps for small mammals – like quolls, bandicoots and native rodents – needs to be different to trail-based predator surveys. The target species are much smaller and as such their heat signature is much more difficult for the camera trap to detect. It is also common for an attractant to be used (such as a lure or bait) to attract the animal in front of the camera and cause them to move about, ensuring the PIR triggers.

Placement

Because small-medium sized native species have a small heat signature, it is important to try and create a temperature differential between the animal and the background. This can be done by placing the bait station and the camera trap in front of a fallen log or tree (Fig 13) that will inherently have a cooler temperature than the animal.

Figure 13. A bait station in front of a log is the best placement method for detecting small mammals on camera trap.

Alternatively, when logs are unavailable, a backdrop can be created by using a cork board on a peg and placing the bait station and camera trap facing the cork board (Fig 14). This method is a modified version of the COAT (camera overhead augmented temperature) method for reptiles (Welbourne 2013).

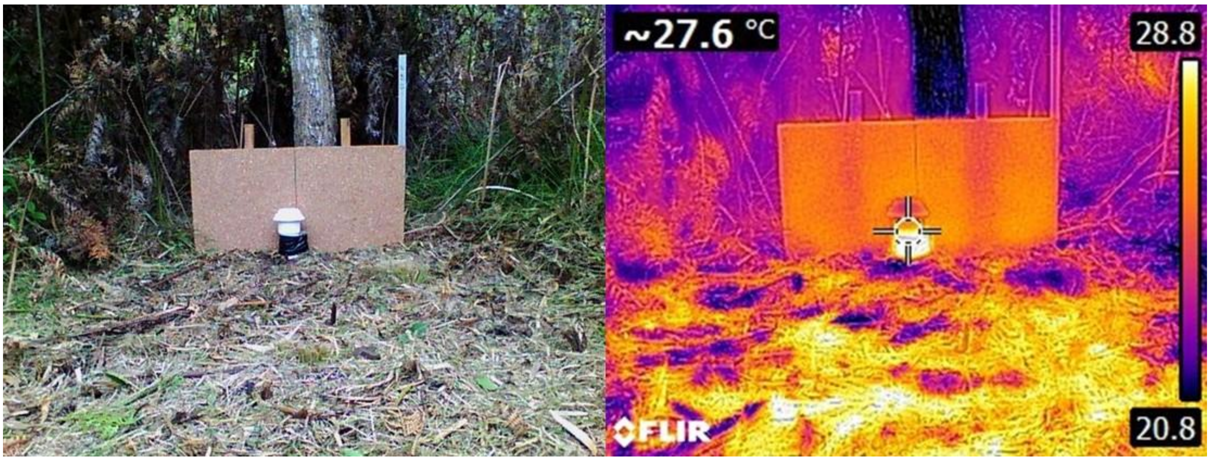


Figure 14. A small mammal bait station with a cork tile background where a natural log was not available.

Because small mammals have a smaller heat signature, the height of the camera trap can be reduced to 30 to 40 cm above the ground. If you go closer to the bait station you will miss visits by other species, but if identification is necessary, you can place the camera trap two metres from the bait station. Using the placement method described in the predator setup, the precise alignment of the camera is even more important. Using the water-mark alignment method ensures optimal placement (Fig 15).

Site preparation

Similar to the predator camera trap site preparation, all vegetation between the camera trap and the bait station must be groomed to reduce the false triggering of the camera trap by moving vegetation. Further, the lower you place the camera, the more horizontal it needs to be to ensure the detection zone is not set on the ground in front of the camera trap and redundant.

Figure 15. Using the watermark method to align the camera trap on a bait station allows precision alignment, in this case allowing for detection on the log, on the approach and at the bait station.

Bait station

Various bait devices are used in small mammal camera trap studies (Fig 15 and Fig 16). Figure 15 is a pipe bait station used for quoll surveys and Figure 16 is a bait station used for small mammal surveys (Claridge *et al.* 2010; Meek *et al.* 2012). A primary focus should be on being able to pin the device to the site so animals can't move the device, and to ensure that flies and other bigger insects are excluded to slow the deterioration process of the bait. The bait device in Figure 16 comprise a septic tank pipe breather vent attached to a short piece of pipe and a cap. The vent has a rain proof lid which keeps the bait dry and a wire mesh opening which allows the scent of the lure out but stops fly invasion.

Figure 16. Camera trap bait station for small mammals.

Bait

The bait chosen will depend on the target species and their diet preferences. Predators like quolls are most often attracted to protein baits like chicken necks and wings. Small mammals like native rodents and bandicoots are attracted to mammal mix (peanut paste, oats and honey) and lures like truffle oil.

Servicing Procedure

Depending on the survey objectives, camera traps should be serviced before the battery levels reduce to half to ensure optimum power and therefore optimum detection. Predator surveys that are away from main roads where cars will trigger the camera trap can have a servicing period of 8 to 12 weeks depending on activity. It is important that each service includes a full replacement of all 12 batteries and the SD card. In dusty areas the camera trap lens should be cleaned either using a soft brush or by spraying water on the camera trap front with an atomiser to remove grime. In some locations insects like ants can invade the camera trap so using a surface spray insecticide may be needed to discourage insect occupation. Where security posts are used, insect spray will be necessary as spiders often reside inside and can cover the camera lens with cobwebs causing false triggers and battery drain.

Used batteries can be stored in a field bag and returned to the office, however SD cards must be put into the storage cases (Figure 7) for protection.

Where roadside vegetation has grown and branches may be hanging in the detection zone, a brush cutter should be used in a triangle formation from the camera trap out for 6 m to reduce false triggers by low lying vegetation. Branches should be removed using secateurs or a saw.

Data sheets should be used to record details of each service and to provide a maintenance record, including comments on issues or replacements that were required. If possible, developing a phone based recording system with software like ArcGIS Field Maps https://www.esri.com/en-us/arcgis/products/arcgis-field-maps/overview for automating the recording of servicing data is preferred.

13. Survey Completion

When the field servicing is completed, it is important that all equipment is returned to the designated officer and data sheets provided as evidence of completion.

Batteries

All batteries should be put into the battery chargers and recharged preferably a few days prior to the next servicing to ensure they are fully charged. Stored batteries will lose charge over time. Once charged they should be placed in the recommended battery cases ready for field deployment. Please recycle batteries that can no longer hold a charge.

SD Cards

When returning from the field, SD card cases should be provided immediately to the designated officer. As soon as feasibly possible, raw data should be uploaded to a safe storage system and a backup system.

14. Camera Trap Terms

Alignment	Term used to describe the placement of a camera and the cardinal direction, it can be two dimensional thus a horizontal (standard placement – lens perpendicular to the ground) or vertical (lens facing downwards at the ground) alignment as well as a horizontal-cardinal direction.
Burst mode	A camera trap setting that allows continuous images to be taken following a trigger event, see also Rapidfire.
Camera trap	A term used to describe a camera that captures images of wildlife using heat-in-motion sensing, time lapse, mechanical, seismic sensors or an active infrared sensor system.
Camera trap set	Connotation of a foot-hold trap 'set' which describes the immediate area where camera/s are placed, can be more than one camera per set.
Camera trap array	The number of camera traps set in a certain pattern and defined location, referring to more than one camera trap at a study area.
CF card	The acronym for Compact Flash cards, a mass storage device used by older camera traps, virtually all new models (at the time of publication) now use SD cards.
Covert surveillance	Use of cameras set to catch illegal actions by people.
Delay	A program function available on some models. This setting has many forms but typically allows the user to set a period of time where the camera trap is inactive or 'hibernating' before or between images.
Depth of field	This refers to the aperture setting and its effect on the focus of objects in the front and rear of the image. Not often adjustable in camera traps.
Detection zone	The area in which a camera trap is able to detect the heat signature and motion of a target.
Event	The period of time between independent triggers of distinct individuals, regardless of the number of images, to the last image in a sequence.

False Positive	Incorrectly detecting an animal or species when none is present.
False Negative	Failure to detect an animal or species when in fact it is present.
Focal point	Usually the centre of the image (if the image is composed correctly), the subject of interest, the lure, pathway or track centre or bait device.
Field of view	The area captured in an image, usually between 35 and 45 degrees.
Fresnel lens	A lens used by camera traps to direct infrared energy onto the passive infrared (PIR) sensor. These lenses are commonly seen in lighthouses and cause refraction of light.
Incandescent	A white flash (xenon) used by some camera traps, now mostly superseded by white LED.
LED	An abbreviation for light-emitting diode, a form of light source used in modern white flash cameras.
Lures	A generic term referring to an attractant used to encourage animals to investigate a specific point within the detection zone. Lures may be auditory, olfactory, visual, or some combination of these in nature.
Night Mode	This setting is available in some camera traps and allows the device to be set to maximise clarity at night by reducing the illumination power and increasing the speed of the shutter, thus reducing blur.
PIR sensor	Passive detectors of infrared light.
Rapidfire	A camera trap setting that allows images to be taken continuously following a trigger event - see also burst mode.
SD card	The acronym for Secure Digital cards. A removable digital storage medium that is currently the standard in camera traps.
Sensitivity	A setting, often adjustable, that reflects the camera’s response to heat in motion for PIR sensors. Higher sensitivity is associated with more images, and lower sensitivity with fewer images. Increased sensitivity, however, does not guarantee detection of a target.

Sequence	A series of still images or video taken in rapid succession but separated by a time interval less than the set independence interval and forming an animated record of a triggering event.
Time lapse	A program function available on some camera traps. The time-lapse function, or similar function, typically allows a user to prescribe times of day and/or night when the camera is inactive, regardless of activity within the detection zone. Some time-lapse cameras do not have a PIR and, instead, capture images at prescribed times or intervals.
Time lapse camera	Camera traps that do not have a PIR sensor and can be programmed to take images at predetermined times throughout the day regardless of any triggers.
Time to first trigger	The speed of the camera from detection by the PIR sensor to the first image captured.
Trigger or Capture speed	The time difference between detecting heat in motion and capturing an image. Also known as response time. Slower trigger speed (i.e. more time elapsing between trigger and image capture) may decrease the likelihood of capturing a target.
Walk test	A program function available on some camera traps. Walk test, or similar, can be used to identify where a camera will respond to heat in motion. Consequently, it can be used to 'focus' the camera's detection zone, as desired.
White LED	A white flash consisting of white LED's in an array similar to an infrared array that illuminates the subject at night in full colour and is faster than xenon flash technology.
Xenon flash	An incandescent or white flash that illuminates the subject at night in full colour.
Synonyms for camera traps	Remote camera, remotely activated monitoring camera, trail camera, spy camera, wildlife camera, camera trap, remote-sensing camera, sensor camera, remote sensing camera, remotely-triggered camera, game camera, photo-trapping, sensor camera, heat-and-motion sensing camera.

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