Perangkap Kamera (*Camera Trap*) *Dalam Survei Mamalia*





Generalities about wildlife monitoring



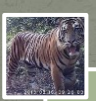
Wildlife survei:

- mengukur kehadiran satwa liar (dan jika memungkinkan status dan kelimpahannya) pada suatu lokasi tertentu dan pada waktu tertentu



Wildlife monitoring

- survei yang dilakukan secara berulang terhadap spesies satwa liar pada suatu area tertentu untuk mengetahui perubahan populasi secara temporal



Wildlife management

- usaha untuk menyeimbangkan antara apa yang diperlukan untuk menjaga populasi satwa liar tetap sehat dengan apa yang diperlukan oleh manusia

- Banyak metodologi penelitian satwaliar telah dikembangkan dan telah banyak literatur yang membahas mengenai hal ini (misal White & Edward, 2000, Bennun et al., 2002, Long et al., 2008; O'Connell et al., 2011 dll).
- Secara umum, metode dipilih berdasarkan kondisi lingkungan, kelompok spesies yang menjadi target penelitian, tujuan penelitian dan batasan lain yang melekat pada proyek penelitian (misalnya ketersediaan sumber daya manusia dan dana)
- **Metode invasif**: berdampak langsung terhadap hewan yang menjadi target penelitian (*live trapping, killing for speciment* dll) sedangkan metode **non-invasif** tidak perlu menangkap dan menangani hewan secara langsung (misalnya survei transek, survei berdasarkan tanda-tanda kehadiran hewan dan ***camera trapping***)

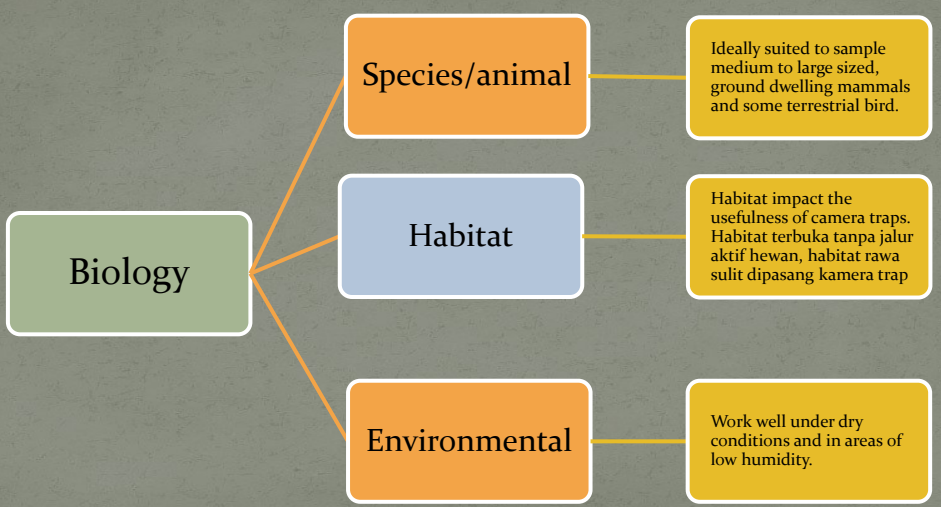
Dua alasan utama bagi ilmuwan dan pengelola satwa liar merupakan tantangan dalam mempelajari hewan di hutan tropis:

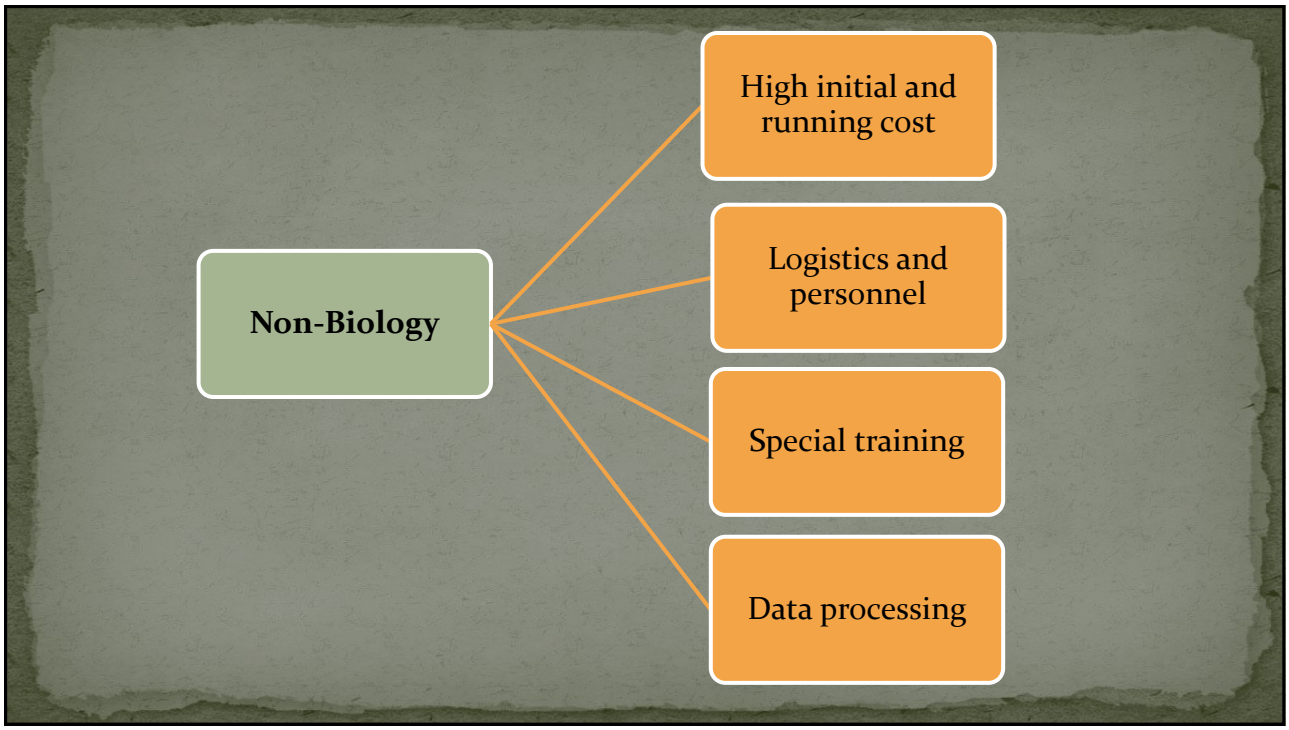
- **Animal ecology**: spesies hewan hutan tropis umumnya "pemalu", dan tersembunyi di alam, dan sangat sulit untuk mengamati di alam liar. Komunitas hewan di daerah hutan tropis dan equator tersebar luas dan agak komplek untuk dipelajari
- **Environmental variables**: secara umum visibility di dalam hutan rendah, lingkungan dan kondisi iklim kadang-kadang ekstrim, daerah yang menjadi interest biasanya jauh dan memiliki infrastruktur yang terbatas

Keuntungan camera trap

- Penggunaan paling sederhana camera trap adalah untuk mendokumentasikan kehadiran spesies pada suatu area tertentu
- Pola aktivitas dan beberapa aspek perilaku spesies juga dengan mudah dipelajari
- Jika lokasi camera trap diketahui, data yang dihasilkan dapat digunakan untuk analysis spatial patterns of species occurence
- Sampling yang dilakukan secara kontinyu dapat dibagi ke dalam periode waktu tertentu pada setiap camera site, dapat digunakan untuk mengetahui **pola okupansi spesies hewan**
- Untuk spesies yang dapat dikenali berdasarkan tanda di tubuhnya (spots atau stripes, atau tanda artificial), hasil kamera traps dapat digunakaan untuk memperkirakan jumlah dan kepadatan populasi dengan model capture-recapture
- Foto/video hasil camera trap dapat digunakan sebagai bahan kampanye untuk meningkatkan kepedulian masyarakat umum terhadap konservasi

The constraints of camera-traps





Sejarah Perkembangan Camera Trap

- Kamera pertama untuk menangkap satwa liar bebas dari kehadiran manusia yang digunakan pada akhir 1890 oleh pelopor fotografi George Shiras dengan menggunakan kabel yang dihubungkan dengan bohlam lampu kilat untuk menangkap hewan di film; foto-foto itu akhirnya diterbitkan di majalah National Geographic.
- Penggunaan camera trap untuk penelitian ilmiah pertama pada tahun 1920, ketika *Frank M. Chapman* mengamati spesies besar di Barro Colorado, Pulau di Panama dengan menggunakan kamera trap perjalanan-kawat.

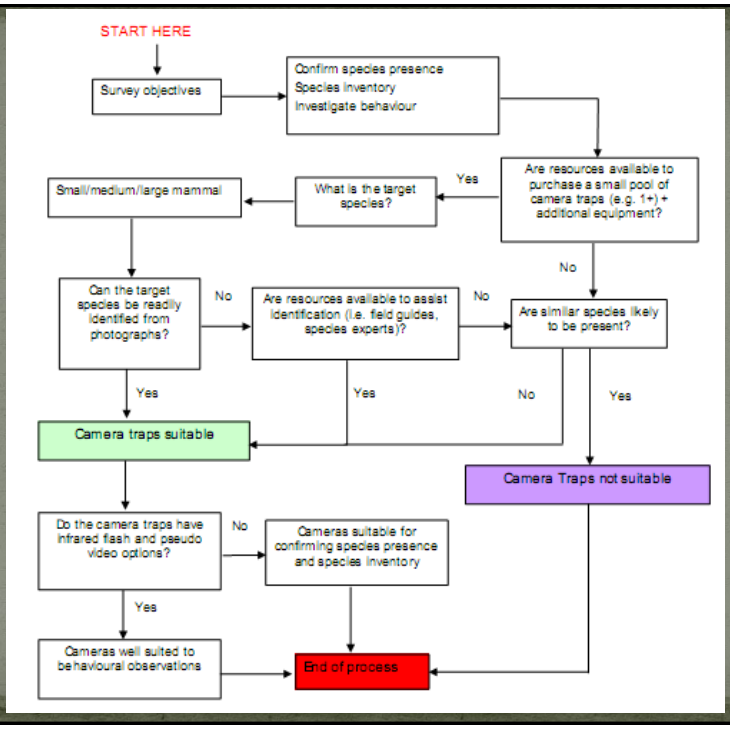
- Penggunaan “camera trap” untuk satwa liar dipelopori oleh fotografer satwa liar George Shiras III pada akhir tahun 1890.
- Terdiri dari kamera besar dan kawat/kabel yang terhubung dengan aki mobil. Ketika hewan tersandung kawat, baterai akan memicu bubuk flash menciptakan ledakan cahaya, memicu kamera bekerja.
- Berhasil mendokumentasikan gambar rusa dari alam liar: beberapa rusa berlari menjauh dari flash terang ke gelap malam.



Photograph by George Shiras III, 1906. Copyright National Geographic.
http://osaconservation.org/2013/08/capturing-the-wild/

- Dengan berkembangnya teknologi, kamera dan flash berukuran semakin kecil dan tidak mencolok.
- Flash serbuk digantikan dengan lampu, dan kabel perangkap berbasis tekanan digantikan dengan inframerah atau sensor panas.
- Saat ini, beberapa kamera menggunakan inframerah yang tidak terlihat oleh hewan tetapi hanya dapat menghasilkan gambar hitam-putih.
- Light flashes, menghasilkan foto berwarna, tetapi beresiko menakuti hewan atau bahkan menyebabkan hewan marah (gajah, harimau, beruang dll).
- In 2006, **George Steinmetz** merupakan fotografer pertama yang menggunakan kamera trap digital untuk mendapatkan foto satwaliar di alam-mendapatkan foto singa gunung di dekat sumber air di padang pasir Arizona.





Tabel. 1. Kelebihan dan kekurangan penggunaan "Camera Trap"

Kelebihan	Kekurangan
○ Bias rendah	○ Biaya mahal
○ Bisa digunakan dengan umpan atau tanpa umpan	○ Peralatan yang rumit
○ Dapt mengidentifikasi spesies dengan pasti	○ Alat tidak berfungsi/kamera rusak
○ Mampu mendeteksi berbagai jenis spesies	○ Dibatasi kapasitas batrai dan film
○ Foto berperan sebagai catatan permanen	○ Teknologi berubah dengan sangat cepat
○ Menghasilkan berbagai jenis informasi (misalnya: umur, perilaku dan waktu)	○ Rawan terhadap pencurian
○ Bisa meminimalkan tenaga kerja (tergantung frekuensi checking kamera)	○ Identifikasi individu dapat dilakukan hanya pada spesies yang memiliki ciri atau bulu khusus



Foto: PKHS/STT-TNWK-2013



Foto: PKHS/STT-TNWK-2013

Bagaimana camera trap bekerja ?

- Camera trap semakin populer digunakan untuk mempelajari satwa liar.
- Meskipun ada beberapa jenis camera trap, semua model memiliki prinsip dasar yang sama: foto (dan / atau video) kamera dilindungi oleh semacam rumah pelindung (dari cuaca), ditambah dengan mekanisme yang memungkinkan kamera menjadi pemicu otomatis ketika hewan bergerak di depannya.
- Ada dua jenis utama kamera perangkap yaitu: analog dan digital.

- Camera trap digital menjadi semakin populer dibandingkan dengan film negatif. Camera trap digital modern biasanya tidak memiliki unit kamera terpisah, tetapi merekam foto-foto digital ke kartu memori. Selain itu, beberapa camera trap memiliki kemampuan untuk merekam video.
- Camera trap dapat bersifat pasif (panas dalam sensor gerak) atau aktif (sinar infra-merah yang memotong jalur hewan potensial).
- Di daerah tropis basah dan medan yang sulit, sistem pasif umumnya lebih disukai di atas yang aktif. Beberapa pro dan kontra dari masing-masing jenis

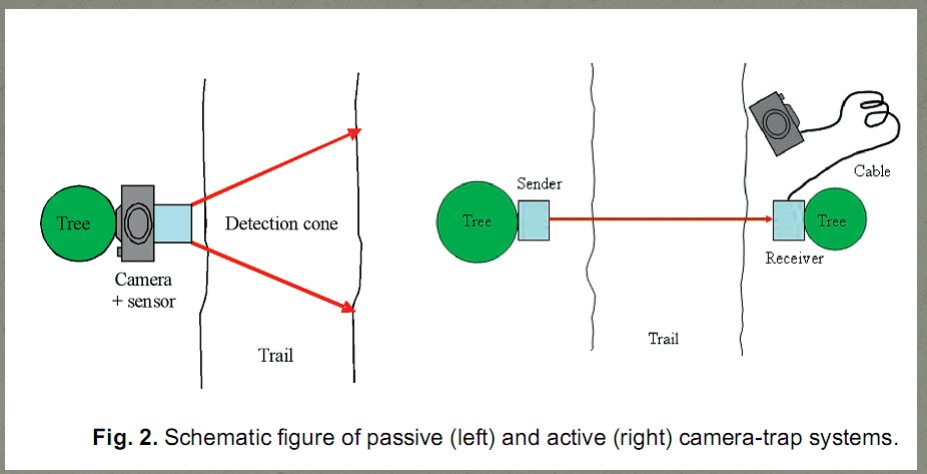
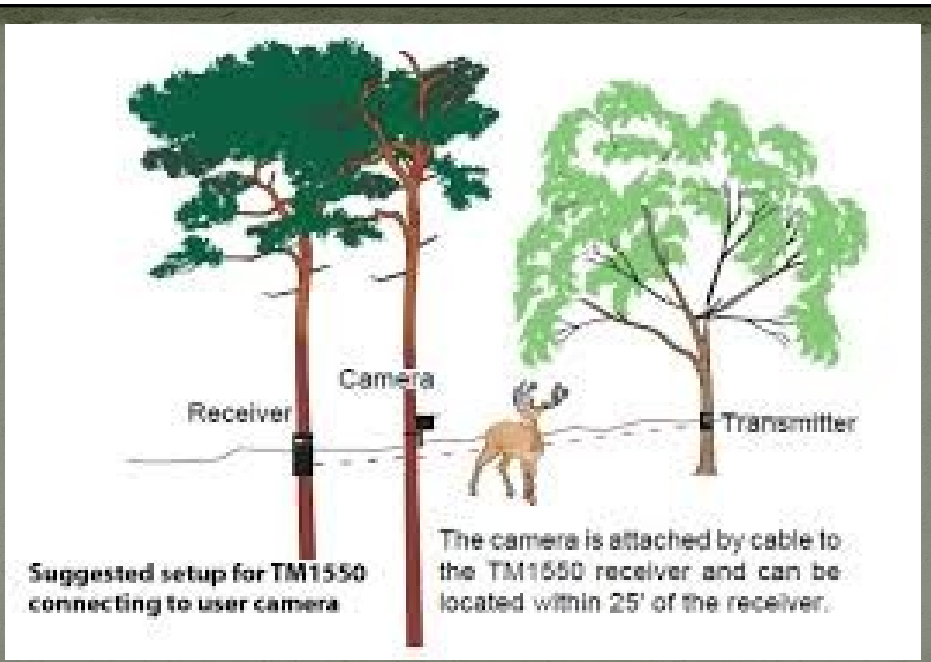


Fig. 2. Schematic figure of passive (left) and active (right) camera-trap systems.



Camera trap dengan cara kerja aktif



Camera trap dengan cara kerja pasif

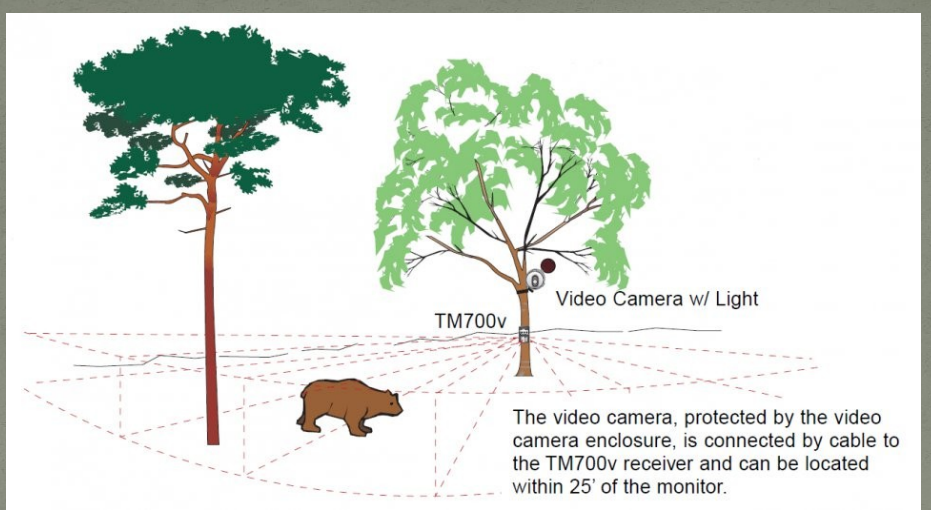




Figure 5. Diagram of a Reconyx HC600 showing the various components that are fairly standard in all camera traps (courtesy of Reconyx).



A



C

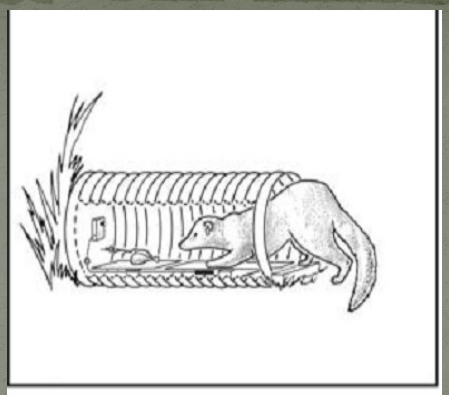


B

Figure 5.1. (A) Unbaited trail set using paired (PIR) cameras to simultaneously photograph (B, C) both sides of an ocelot for individual identification. Illustration by P. Kernan; photos from Belize, courtesy of the Wildlife Conservation Society Great Cats Program.

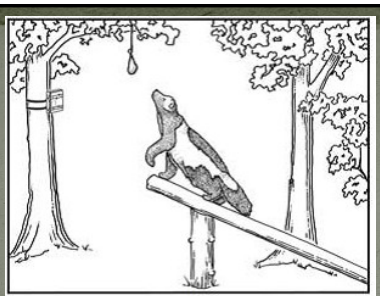


B



A

Figure 5.2. (A) Baited cubby set triggered by a pressure pad (illustration by P. Kernan). This particular set is designed to capture photos of the ear tags on (B) a marked fisher. Photo from northern California by J. Thompson; research described in Thompson (2007).

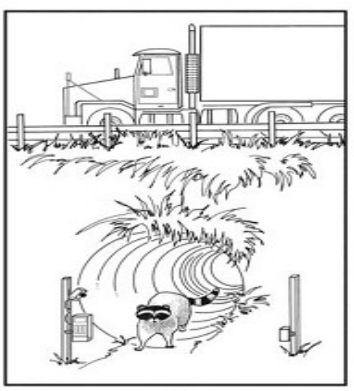


A



B

Figure 5.3. (A) Camera (PIR) set with hanging bait, intended to capture the unique gular color patch on (B) wolverines when animals look up at bait. Illustration by P. Kernan. Photo from northern Ontario by A. Magoun; research described in Magoun et al. (2005).



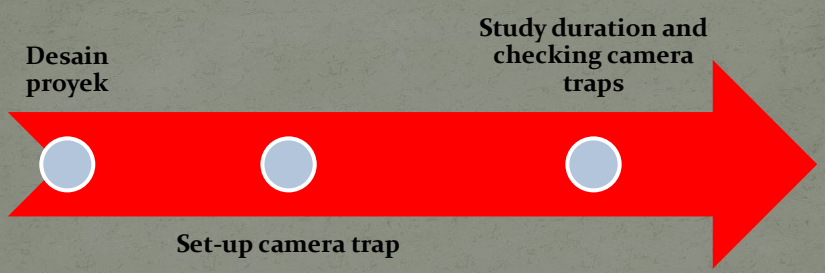
A



B

Figure 5.4. (A) Unbaited (AIR) set designed to detect animals, such as this (B) raccoon, moving through a culvert under an interstate. Illustration by P. Kernan. Photo from Adirondack Park, New York, by R. Kays; research described in LaPoint et al. (2003).

SOP Penggunaan Camera Trap



Perencanaan Proyek

- Camera-traps bisa digunakan untuk mengumpulkan data berbagai aspek ekologi hewan, konservasi dan perilaku.
- Perencanaan proyek merupakan hal yang sangat penting untuk menjamin bahwa kita mengumpulkan data yang benar yang diinginkan untuk menjawab tujuan dari penelitian atau pertanyaan-pertanyaan untuk pengelolaan dan termasuk perencanaan pada berbagai tingkatan.



Tipe studi	Tujuan	Desain survei
Inventarisasi spesies	**Mendapatkan daftar lengkap spesies dari sejumlah kelompok taksonomi dalam area studi.**	**Single camera traps are set up throughout the study areas. No requirement on minimum distance between camera traps or total survey area to be covered**
Studi okupansi	**Occupancy is defined as the proportion of area, patches or sites occupied by a species (MacKenzie *et al., 2006), and MacKenzie et al. (2002) developed a model to estimate site occupancy and detection probability based on repeated presence-absence surveys of multiple sites.***	**When carrying out an occupancy study camera traps should be set out in a regular grid with approximately equal distances between cameras. They should cover all habitat types of interest and the number of camera traps in each habitat type must be sufficiently large to allow for analysis. If possible the distance between camera traps should be larger then the diameter of the average home range of the species of interest, to avoid spatial auto-correlation. If the homerange diameter of a species is much larger than the distance between camera traps the results should be interpreted as the percentage of area used by a species during the survey period instead of the percentage of an area occupied (Tobler *et al., 2009*).**
Aplikasi lain	**differences in activity patterns between sympatric species**	**Single camera traps are set up throughout the study areas.**

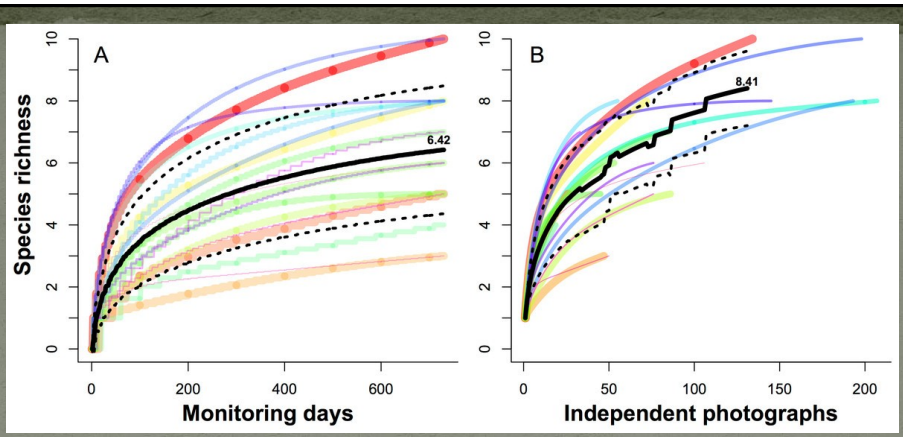
Summary of sampling designs and camera features

Stydy type	Number of camera sites	Camera-days	Placement	Camera features
Fisrs assessment, inventory	bervariasi	1000-2000 untuk daerah tropis	Tidak diperlukan, memaksimalkan capture,	White flash, high sensitivity if small species are targeted, large detection zone, fast trigger speed
Occupancy (Okupansi)	>60 but depending on the detection probability (p) of target species	Enough to reach sufficient p for target species	Reguler grid, spacing with larger home range, more sites will ensure more species with p>0,1-0,2	IR flash, sensitivity tuned to species size

Density estimation though CMR	**Trade-of between trap density and size of the sampled area: 10-30 individuals exposed with a trap sites density of at least 2-4 per smallest home range.**	**As short as possible to assume demographic closure but long enough to have enough recapture (>60)**	**Sampled areas maximizing the area-to-perimeter ratio, 2 camera trap at each site, for carnivores optimal placements along trails**	**Xenon white flash with distance setting, short delay between consecutive pictures, high sensitivity if small target species, fast trigger speed, either two xenon white flash camera trap per site.**
Random Encounter Model (REM)	>50	Depending on target species, enough to obtain 50 independent event	Random relative to animal movement, grid preferred, avoid multiple captures of same individual, area coverage important for abundance estimation	IR flash, high sensitivity if small species are targeted, fast trigger speed, bursts of photo.

Distances between camera trap positions

	Wide ranging species	High density species
Trapping area size (km^2)	Minimum of 4x average home range	Small area due to small home range sizes (MMDM)
Minimum trapping effort/area (days)	Density – ensure do not violate assumptions of closed population so 40-60 days (all cameras active) Diversity – depends on rate of increase of species accumulation curve	Recommended 250-300 camera days
Number of trap sites	Large carnivores - ≥160 Large herbivores – probably less but will be species dependant	High number/density of traps
Distance between cameras	Large carnivores: 1-2km Small carnivores: 500m-1km Large herbivores: 1km	Small herbivores/rodents: 500m Specific natural locations: not fixed distance
Cameras paired?	Yes if you need to identify individuals	Yes if you need to identify individuals
Analysis methods	Depends on what your question is and if you can identify each individual	Mean camera trapping rates, variety of methods can be applied
Location	Depends on survey objective	Depends on the survey objectives



Site	Number of species (proportion of total)	Trap effort (camera days)	Source
Emas National Park, Brazil	16 (57%)	1035	(Silveira *et al.*, 2003)
Atlantic forest, Brazil	17 (81%)	1849	(Srbek-Araujo & Garcia, 2005)
Udzungwa Mountains, Tanzania	44 (80%)	3400	(Rovero & De Luca, 2007)
Los Amigos, Peru	21-24 (75-86%)	1440-2340	(Tobler *et al.*, 2008a)
Bakhuis Mountains, Suriname	27 (100%)	49589	J. Sanderson (in preparation)

Table 1. Efficiency of camera trapping for inventorying medium to large mammals at different sites. Camera days are defined as the number of cameras multiplied by the number of days they were functioning.

- **Field equipment:**
  - ✓ GPS units
  - ✓ Notebooks or data sheets and pens/pencils (pencils are better in the rain)
  - ✓ Spare batteries in battery boxes (batteries discharge if they touch each other)
  - ✓ Card readers or spare memory cards. Spare memory cards are the better option. If the data are all downloaded in the field and the memory cards formatted, the only copy of those data are on the card reader until the team return to base camp. Card readers can, and do, malfunction
  - ✓ Silica gel in suitable containers (film canisters with tiny holes drilled in work well if there is room in the camera case)
  - ✓ Umbrella to keep the cameras dry during checking in the rain
  - ✓ Cloth to dry the unit before opening and to clean the lens if needed
  - ✓ Watch (some cameras need the date and time re-setting if the batteries run out, alternatively use the time on the GPS)
  - ✓ Vegetation cutters/parangs to re-clear the area in front of the cameras
  - ✓ Specific equipment to open the cameras: e.g. spanners, screwdrivers, padlock keys
  - ✓ Spare camera-traps, if possible to replace damaged or broken units
  - ✓ Equipment to re-locate a camera-trap if necessary e.g. mallet, spare screws, wire
  - ✓ Camping equipment (if needed)

- **"Office" equipment:**
  - ✓ Laminated map of the study area showing camera-traps
  - ✓ Laptop/PC and suitable software
  - ✓ Data storage facilities e.g. external hard drives and **backup copies**
  - ✓ Battery chargers if rechargeable batteries are used (rechargeable tend to be cheaper over the long term, but have a higher initial cost, they also do not last as long in the field)

11. Lembar data/buku monitoring camera trap

THE CAMERAS

1) Check time (am/pm), date (MM/DD), year and test
2) Check angle of camera to trail/location to ensure photo capture is good and full angle of photo is clear
3) Set cameras across the trail but not too close. Ensure that the cameras have a maximum angle of capture.
4) Select video and photo mode or photo only.
5) Advantages of video are that more behaviour can be captured but this will take up more space on the SD card. Also, if the camera takes a photo before the video and the capture rate is fast enough (e.g. 5s or less) then the video mode is less useful for scientific analysis and is more useful for media. One advantage of video is that it may improve the chances of catching additional individual if the study species is travelling along the trail as a group.

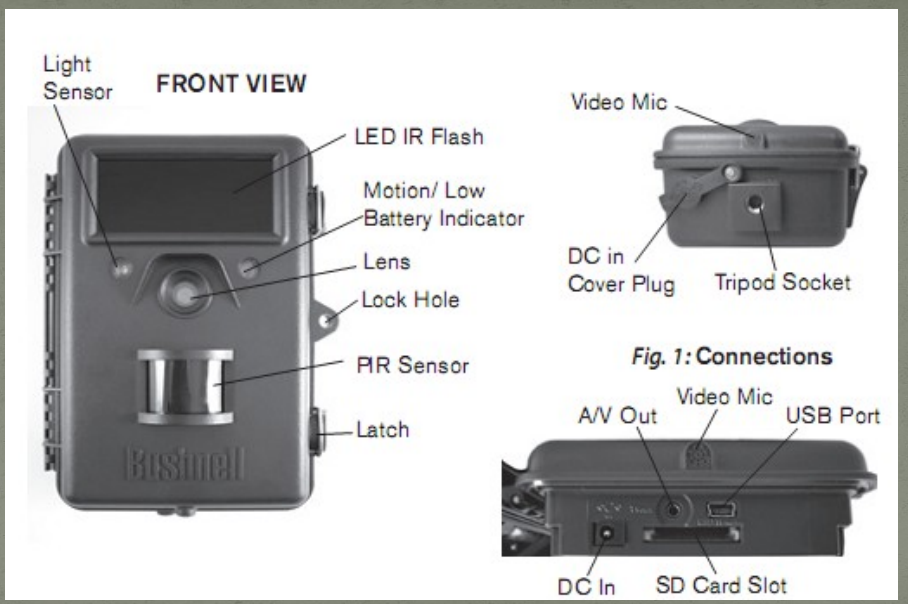


Fig. 1: **Connections**

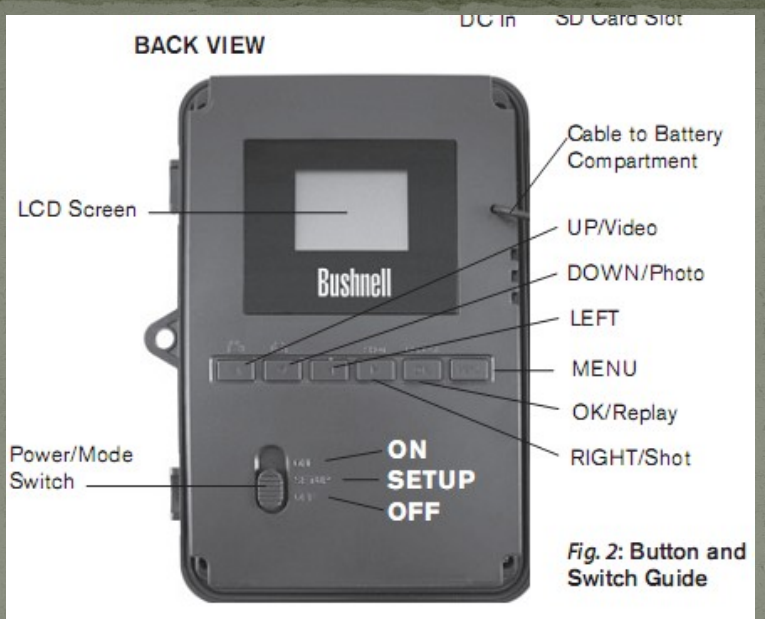
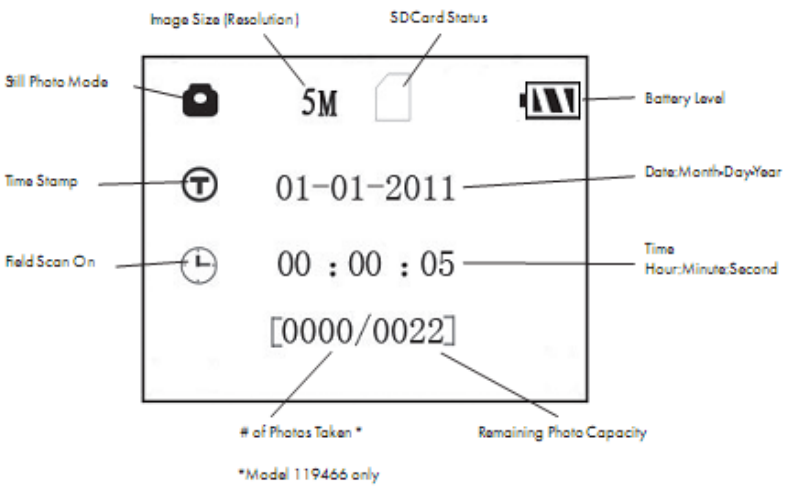


Fig. 2: **Button and Switch Guide**

Fig. 3: **SETUP Information Screen** *(standard display model shown)*



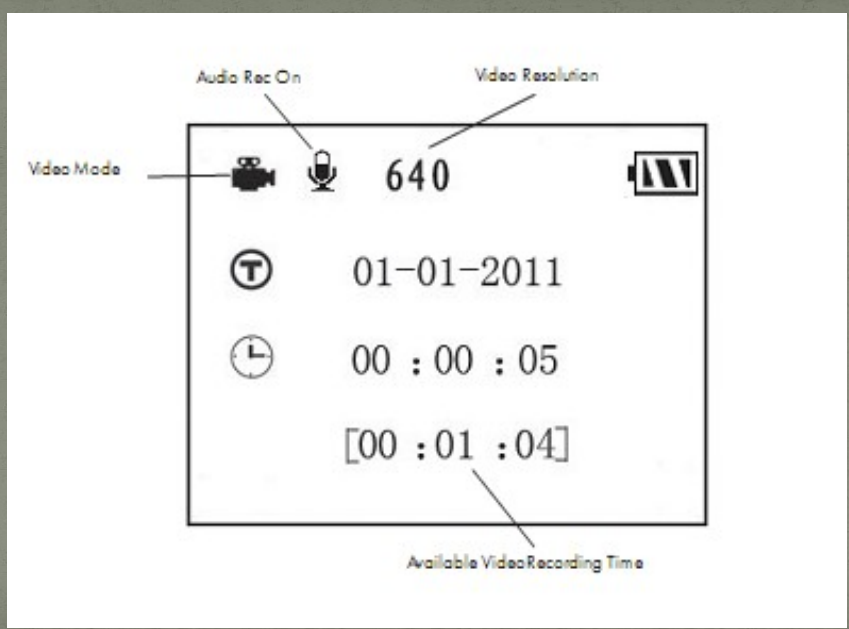
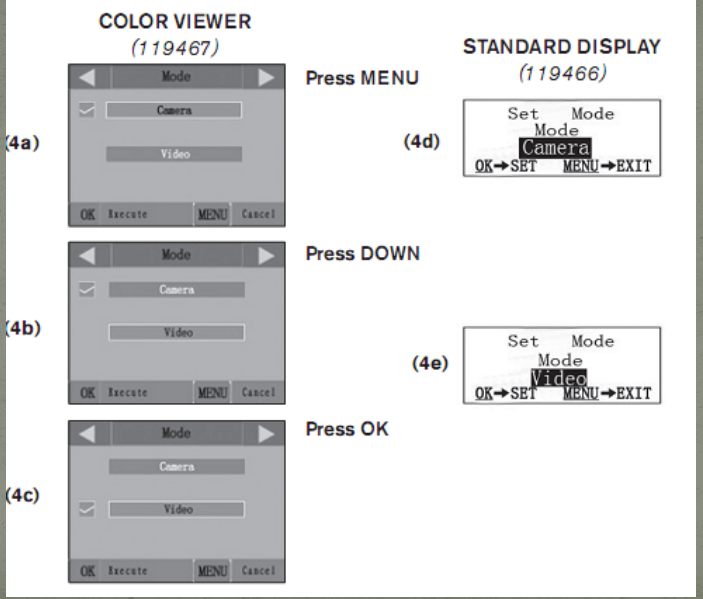


Fig. 4: Selecting Parameter Settings



Camera trap position

- Camera height
- Camera angle
- Distance from trail
- Camera position
- Paired camera
- Light
- Vegetation clearing



Text Box 10: Paired camera set-up for capture-recapture approach.

- Species that have patterned coats are marked asymmetrically, therefore in order to identify individuals accurately it is necessary to photograph both flanks simultaneously
- To achieve this, a pair of cameras needs to be set up with one camera on either side of the trail or road, facing each other
- It may be necessary to angle the camera slightly away from each other to prevent the flashes interfering with each other



Example of a leopard cat captured with a paired camera set-up.



Figure IV. *When vegetation is not cut back sufficiently, or cameras are not checked frequently animals can be obscured in the photograph.*

LOCATION SET-UP

1) Choose ridges, trails, fallen logs, mud gaps/open areas and anywhere there are animal signs.
2) Clear all vegetation between both camera, and if possible sweep the trial in each direction from the camera
3) Lay a bed of fresh large leaves on the ground in front of cameras to prevent mud splash obscuring the lens or sensor.
4) Use vegetation to block pathways behind the cameras, to encourage the animals to walk in front of the cameras and not go around.
5) Place camera about 50cm from the ground but check the view by taking a test photo so always have a digital camera to check the photos.
6) When putting a camera near a stream of river that is likely to flood put the camera higher than usual and try to make the field of view a bit larger.
7) Make test-shots by crawling in front of the camera at approximately the same speed as the target species to ensure detection by the camera and to test field of view.

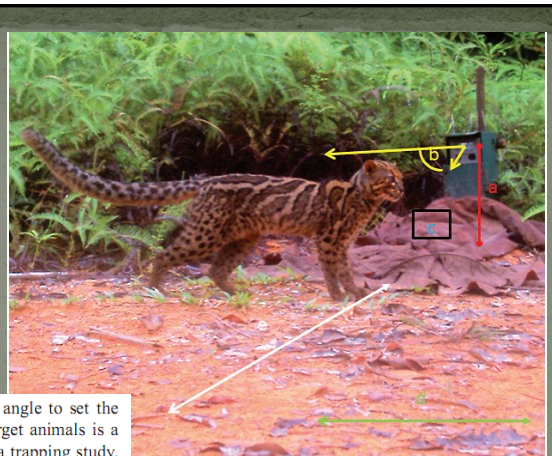


Fig. 1. Careful selection of the site, height, and angle to set the camera trap considering the characteristics of target animals is a key factor in determining the success of a camera trapping study. The present example shows a two-camera set-up for individual identification: a) height of 30–40 cm designed for small to medium-sized carnivores; b) camera angle that is not directly facing the other camera at the same station; c) pile of leaves to protect against splashing mud in heavy rain; d) placement along old logging road when applicable to increase the probability of detection; and e) vegetation clearing to ensure clear picture of the animal and avoid misfiring. (Photograph by: Wilting, Mohamed, Sabah Wildlife Department & Sabah Forestry Department).

8) Place cameras approximately 1km apart (1-2km depending on the size of the study species). When selecting the actual trap location it is important to find the best possible spot to maximise the probability of photographing your animal. It is therefore possible to move some distance away from your theoretical location – quite how far is dependent on the size of your study species. In our studies we tend to allow ±c.100m but in other studies they have allowed up to ±500m. The two most important considerations are (1st) that the best possible location is selected and (2nd) that no gaps are present in your array of traps.it is important that no holes are present in your array.
9) GPS each location of cameras and re-name the waypoint. Ensure all GPS units set up the same e.g. taking data in UTM and all units same.
10) If covering 160km^2 cameras will likely cross different habitat types so accurate recording of camera locations is crucial.
Take data on

- location e.g. ridge, trail, stream, burnt area/disturbed area
- altitude
- SD card number
- Camera numbers

11) Write everything down in case of GPS failure.
12) Try to use established trails rather than cutting new ones.

Informasi ekologi apa yang didapat ?

7.1. Types of camera trap surveys

Presence/Absence

One of the simplest measures that camera traps are used is detecting the presence or absence of species. It is often reported as the total number of events of a species over a set period of time and number of camera traps (trap nights).

Detection rate is one of the simplest methods of measuring animals that are photographed at camera trap sets (Kays et al 2009), which provides a general index of abundance, and is recorded as:

Detection Rate = Total number of events of a species/Deployment time

If each camera trap is queried separately, a probability of detection per site can be derived by calculating the detection of each species by each camera each day (Kays et al 2009).

Population trends

Measuring the performance, success or failure of management actions or trends on wildlife populations can be measured with camera traps (O'Connell et al 2011). This can be done by measuring visitation to poison baits by target species as a proof of concept (see Zewe et al submitted), or by monitoring fledgling success (eg Malleefowl and Little Terns following predator population intervention). In the case of pest animals, camera traps may be set to measure the success of a baiting program on carnivores using activity indices as described below (Diment 2010; Ballard et al unpublished data).

The use of camera trap data to measure population status over time and as an early detection system has been advocated by O'Brien (2011) and adopted by organisations across multiple countries (O'Brien et al 2010; Ahumada et al 2011; TEAM Network 2011). The measure of change is based on occupancy and uses the approach described above in the WPI (O'Brien et al 2010). These forms of monitoring networks require sound survey designs, detailed manuals and guidelines, good equipment, reliable personnel, effective data management systems and long-term commitment. The following sections describe the range of metrics used in camera trapping for measuring populations and population trends.

Animal activity, abundance and density

Activity indices are generally considered to be a poor option in population measures (O'Brien 2011), but they do have a useful role in pest monitoring, particularly when the targets are cryptic. The Passive Activity Index (PAI) is one of the most common activity indices (Allen et al 1996; Engeman 2005). In recent times, PAI sand pads have been commonly been replaced with camera traps (eg wild dog activity surveys before and after management interventions). The technique required to effectively sample a predator population is the subject of a long-term research program by NSW DPI and the IA CRC (the authors of this document). Specific outcomes relating to camera traps will encompass camera type, settings and positioning as well as sample size, deployment period and how to interpret of records and events.

Camera traps have been widely used for estimating animal abundance for large species, mostly big cats (Karanth and Nichols 1998), where markings enable accurate identification of individuals. In Australia it is possible to use individual markings for some species, such as quolls (Juczscak et al unpublished data), to estimate abundance. Occupancy is commonly used as a metric for estimating species' occurrence and is a function of abundance (MacKenzie et al 2003; O'Connell and Bailey 2011) as it concerns the probability of a particular animal being in a given site or patch. This method can be misused by only reporting on detection sites and ignoring non-detection sites, thereby failing to calculate the detection probability (O'Connell and Bailey 2011). The software program PRESENCE can be used for calculating occupancy.

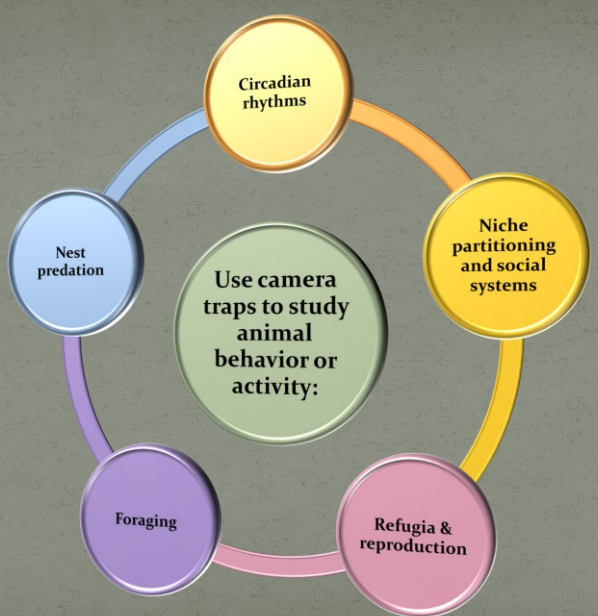
Estimating animal density can be difficult with camera traps but is possible if designed accordingly (Kays et al 2009). A detailed overview and methodology for estimating density using camera traps is described by O'Brien et al (2010).

The use of capture-recapture methods using camera trap datasets requires the ability to uniquely identify all individuals captured, a method developed for large cats (Karanth and Nichols 1998). Some researchers have attempted to use paints and markers to automatically tag animals (J. Mulder, personal communication, 2011) to aid density estimation but this method requires more refinement. The Random Encounter Model (REM) (Rowcliffe et al 2008) uses a gas model approach to overcome this requirement based on the rate of contact between animals and camera traps.

Animal behaviour

Camera trapping has increased our ability to study the behaviours of animals under 'natural' conditions (Kays et al 2009; Bridges and Noss 2011). The ability to set the devices in such a way that unbiased data are gathered on how animals behave during their daily cycles is unprecedented. Using camera traps, Bridges and Noss (2011) sorted behavioural and activity patterns into six categories:

- circadian rhythms
- nest predation
- foraging
- niche partitioning and social systems
- habitat use and refugia
- reproduction.



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