Monitoring the humaneness of badger population reduction by controlled shooting

Aim and Objectives

The aim of this project is to collect data to allow an assessment of the humaneness of controlled shooting of free ranging badgers.

To allow the assessment of the humaneness of shooting badgers, the specific objectives are:

1. To determine the time period between the moment of impact of the ammunition until death or irreversible unconsciousness.
2. To determine the proportion of badgers that escape with possible injuries after being shot at with a firearm.
3. To describe the behaviour of badgers after being shot at with a firearm.
4. To determine the location of cutaneous wounds in the badger carcasses recovered from observed and unobserved shootings and compare the location of the entry wound to the shot placement set out in Defra and Natural England's Best Practice Guidance for controlled shooting of badgers[1].
5. To determine the extent of internal firearms injuries observed in recovered badger carcasses.
6. To investigate whether there is any evidence of correlation between the time to death (TTD) and the observed lesions induced by firearms injuries in badger carcasses recovered from observed controlled shootings.
7. To establish if the pattern of injuries in the sample of badgers killed in the presence of field observers is comparable to that detected in unobserved shootings

Policy Rationale

As part of Defra's policy on badger control, two culling techniques will be permitted in licensed areas: controlled shooting (by rifle or shotgun), and cage trapping and shooting using frangible ammunition. It is assumed that controlled shooting is an acceptable method for culling badgers. However, no scientific data are available to either confirm or negate this hypothesis. Controlled shooting is a method already used to control other species such as fox, deer and rabbit. In the best practice guidance, necessary training and competency tests and the types of firearms, ammunition, shooting distances etc are stipulated for the controlled shooting of badgers. This experience and guidance provide a good basis to believe the technique should be humane. However, as controlled shooting of badgers has not been carried out under scientific observation, objective data to judge its relative humaneness is lacking.

Approach – controlled shooting of free ranging badgers

Field observations

Killing techniques that are instantaneous without imposing any stress on the animal are universally accepted as being the ideal and having a low welfare cost. Welfare costs are assessed in two dimensions: duration and intensity of suffering. There is a complex relationship between duration and intensity. We will attempt to measure both, but will prioritise recording the maximum possible duration of suffering. This approach has been used as the basis of research in farm and laboratory animals to assess the relative humaneness of killing techniques. A similar framework has been used in Australia to review some methods of killing wild and feral animals, e.g. ground shooting of foxes and cage trapping and shooting of foxes (FERAL 2010a, b) and rodenticides for rat and mouse control in the UK(PSD 1997).

When animals are shot as set out in the Best Practice Guidance, there are 5 possible outcomes:

1. Death caused directly by the shooting due to severe trauma to vital organs
2. Death caused indirectly by the shooting due to non lethal wounding associated with secondary infections and starvation because of reduced mobility.
3. Non-fatal wounding and recovery
4. Non-fatal wounding with persistent disability
5. Missed shots

[1] http://www.defra.gov.uk/publications/2012/05/03/pb13716-shooting-guidance/

Wild animal species in which time to unconsciousness or death after shooting has been measured are red deer, moose, impala, seals and whales. However, the studies in impala, seals and whales had the brain as the target area; the chest was the target for the moose. The target area for the red deer in one study was not stated but in a second was the chest. The study on moose shooting in Norway that had the chest as the target area, found that no more than 21% of 105 animals died either instantaneously or very quickly, (very quickly not defined) (Oen, 1995, cited in Knudsen 2005). Time to death (TTD) was based on post mortem investigations, testing of the corneal reflexes and behavioural observations. A study on a smaller sample size found that 71% of 31 deer shot by a rifle during daylight, 52% of 21 deer shot by a rifle during darkness collapsed immediately (Cockram et al. 2010). Observations were made by researchers in this study. Ten percent of the daytime shot deer and 43% of the night shot deer collapsed within 50m. Nineteen and 5%, respectively, moved away and did not collapse within 50m. From shooting records of red deer, the number of deer that were not unconscious within 2 minutes was 7.5% with one group of stalkers and 4.5% with a second group (Bradshaw and Bateson 2000). The target area was not reported. Anecdotal reports from deer, moose, black bear and wild boar hunters that aim to place a shot in the heart-lung area, suggest that animals can take over 30 seconds to drop dead or can run for over 100 yards. However, none of these findings have been verified in scientific reports.
There is the possibility that animals that are fatally chest shot, but still conscious prior to death have the possibility of a short period of suffering. However, the extent of suffering will vary depending on which tissues are damaged and the rate of blood loss. During severe haemorrhaging, there is likely to be an increase in respiratory rates (tachypnoea) and hyperventilation, which indicates that there is a sense of breathlessness before the loss of consciousness (Gregory 2004, 2005). If chest shot, animals may be rendered unconscious by the mechanism of shock, if they do not regain consciousness prior to death, they are unlikely to experience distress or pain.
Wild animals that are head shot, show similar responses to domestic animals that are head shot, in that irreversible unconsciousness occurs within 30 seconds (Lewis and others 1997). Badgers restrained in cage traps that were head shot were found to become unconscious within a mean of 30 seconds (range 5 s to 117 s) (Kirkwood 2000).

Laboratory investigations

The laboratory investigations proposed are radiography and post-mortem examination:

- *Radiography* is an effective method to determine the type of ammunition (rifle, shotgun) as well as the number and location of the bullets, bullet fragments and shotgun pellets. In addition, it is possible to determine bone injury such as damage to the skull, vertebral column, ribs and the long bones of the leg in a relatively short period of time (min/hours). In contrast, it takes considerable time (days/weeks) to dissect and prepare affected bones and their fragments.
- *Post mortem examination (PME)* is the method of choice to assess soft tissue damage (i.e. heart, lung, liver, entry and exit wounds)

Therefore, a combination of radiography and PME is the method of choice for the investigation of firearms injuries (Amanda J 2010; Green 1980;; Keep 1970; Knight and Saukko 2004; Levy and Harcke 2011; Munro and Munro 2011; Munro and Munro 2008).

Objective 1: To determine the time period between the moment of impact of the ammunition until death or irreversible unconsciousness.

Rationale

The time to irreversible unconsciousness (TIU) from when a badger is hit by a bullet will indicate the maximum possible duration which the animal could feel pain or distress. The shorter the TIU, the more humane the killing technique is assumed to be. Assessment of palpebral or corneal reflexes is the recommended method to determine unconsciousness after application of killing techniques in farm animals (Gregory 2004). Some welfare scientists also propose the use of behavioural signs within animal slaughter facilities(Grandin 1994).
In the one previous study where TIU was determined for animals shot in the wild, researchers rather than shooters measured time to irreversible unconsciousness (Lewis and others 1997). In this study they were able to approach the target animals immediately after each shot was fired. To ensure that testing of unconsciousness was possible immediately after a badger had been shot in every observed shooting in the pilot areas would require changes to the Guidance of Best practice for the pilots and therefore would bring the current study under Animals Scientific Procedures Act (1986). A key requirement of the current study is that it is recording the effects of shooting in the field as carried out by private operatives under licence. The collection of data must not influence or interfere with the actions of the shooters. [redacted]

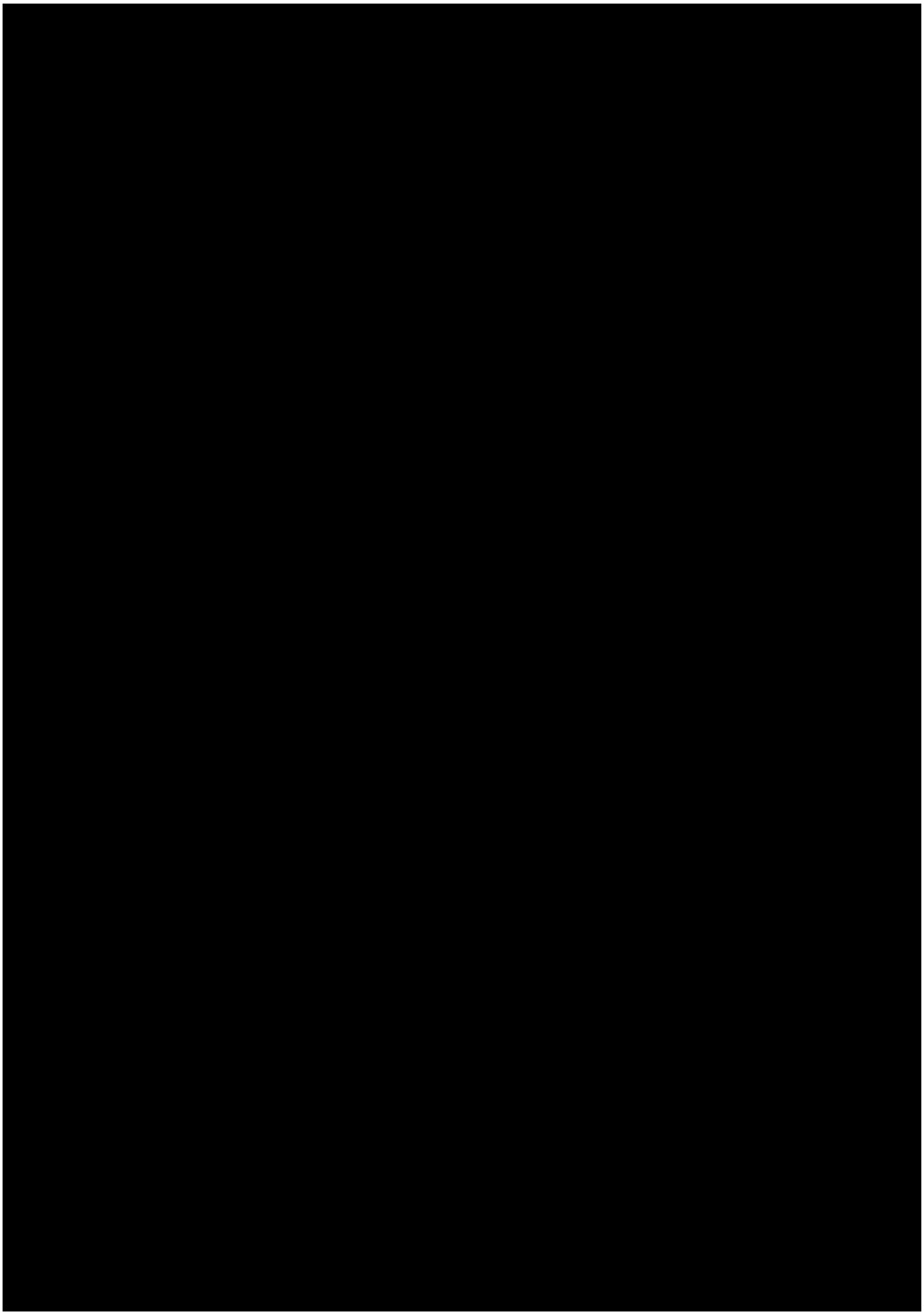
Collection of appropriate data for an assessment of the humaneness of killing methods for wild animals while they are living freely has been extensively discussed in relation to whales (reviewed by Knudsen 2005): In 2003 a paper was presented at the International Whaling Commission Workshop on Whale Killing Methods and Associated Welfare Issues *(IWC/55/WK4 (Evaluating possible indicators of insensibility and death in cetacean)* that proposed the indicators that should be used in the field to determine time of death.
The International Whale Commission agreed that they should use behavioural signs to estimate time to death (TTD), the signs being '…the time taken for the mouth to slacken, the flippers to slacken and all movements to cease'. At sea, veterinary officers used a combination of behaviour, heart and respiration cessation confirmation and post mortem examination to estimate time to death in whales. The post mortem is used to confirm complete destruction of a vital organ in cases where observations of behaviour suggest a very rapid death(Knudsen 2005). Monitoring of the seal cull in Canada uses behavioural indicators such as signs of movement, to estimate time to death. However, there has been much debate over the validity of these signs and they are routinely discussed at the annual IWC meetings.

In spite of these concerns, the detection of behavioural signs in conjunction with clinical assessment and post-mortem examination appears to be the most robust approach available to assess the humaneness of controlled shooting of badgers in the current study. A similar approach to that used to determine 'time to death' (TTD) in whales is therefore proposed for the current study.
The mechanism of death for brain shot and chest shot animals is significantly different and therefore it is thought that the behavioural indicators identified for observing whales and outlined in IWC/55/WK4, may not be appropriate for chest shot badgers. There are no published studies on chest shot animals and therefore held a workshop, with relevant experts to investigate potential indicators of death for chest shot badgers. This workshop is described in Annex E of this document.

There are many factors that may influence the accuracy and effect of a shot and consequently the TTD. No shooter will have prior experience of shooting badgers and, therefore, as time progresses experience in this factor will accrue, and this may have an impact on shooting performance. As the number of badgers removed from the environment increases, the opportunities available to kill and shoot badgers are expected to decrease and shooters may attempt shots under less than ideal conditions and outside the recommended range. The weather conditions, habitat and range may all be factors that influence TTD. As all shooters will have been trained and assessed and therefore they should all meet the minimum skill level to ensure an accurate within range shot, we will not assess the proficiency of individual operators. However, we will collect data on other factors that could conceivably influence performance (listed below).

Data collection

[redacted]



[redacted]

Objective 2: To determine the proportion of badgers that escape with possible injuries after being shot at with a firearm.

Rationale

It is likely that not all shots will result in retrieval of a badger carcass. Some shots may completely miss the animal whereas others may cause injuries which either result in recovery or in death at a later time. Some badgers hit with a non-lethal shot may be killed by a subsequent shot (see objective 1), but some may escape again. There is no established method to assess in unrestrained animals the proportion of individuals in which this occurs. We do not know if shots where a badger's death is confirmed will provide environmental evidence, such as detectable blood spots, of the shot hitting the target animal. Therefore environmental evidence such as detectable blood spots may not be a reliable method for distinguishing between shots that completely miss and those that cause injuries. Those animals that receive non-lethal injuries and recover may be killed (and their carcasses recovered) at a later stage of the cull. [redacted]

Data collection

[redacted]

Data collation and presentation.

[redacted]

Objective 3: To describe the behaviour of badgers after being shot at with a firearm.

Rationale

Observation of a shot animal's behaviour and vocalisations is the only method available to determine the degree of pain that may be experienced during the dying process after application of a killing technique, and has been undertaken in laboratory and farm animals for this purpose (Gregory 2004; PSD 1997).

Data collection

[redacted]

Data collation and presentation

[redacted]

Objective 4: To determine the location of cutaneous wounds in the badger carcasses recovered from observed and unobserved shootings

Rationale

The location of the firearm wounds will convey where the animal was hit. Therefore, it may be possible to infer from this the extent to which shooting is occurring in line with the Best Practice Guidance (DEFRA 2011), i.e. that shooters are aiming for the chest region of the badger. This guidance on shot placement has been drafted with the aim of ensuring that the shooter is confident of an accurate and humane shot.

Data collection

[redacted]

Data collation and presentation

[redacted]

Objective 5: To determine the extent of internal firearms injuries observed in recovered badger carcasses.

Rationale

During firearms injuries, some or all of the kinetic energy of the missile has to be absorbed by the target tissues, where it dissipates as heat, noise and mechanical disruption (Knight and Saukko 2004). Depending on the type of ammunition used as well as of the trajectory and velocity of the missile, the character of the tissue damage varies from a simple wound track in a non-vital tissue to complete destruction of the targeted body part. By carrying out radiography and PME, it will be possible to determine the extent of damage to vital and non vital organs.
Lack of visible damage does not rule out a short period to time of unconsciousness or time of death. An example would be sudden death due to functional heart disease. On the other hand, it is fair to assume that extensive destruction of a vital organ such as brain, heart or aorta will have resulted in a relatively short TTD, even assuming that shock does not result in rapid loss of consciousness (Beverland and Rutherford 1983; Campbell and others 1997; Parmley and others 1958a; Parmley and others 1958b; Svendsen and others 2008).

[redacted]

Data collection

[redacted]

Data collation and presentation

[redacted]

[redacted]

[redacted]

Objective 6: To investigate whether there is any evidence of correlation between the visually estimated (field-observed) TTD and the firearms injuries in badger carcasses recovered from observed controlled shootings.

Rationale.

Lesion classification and lesion profiling is a useful tool, because it allows the summarisation of complex data. In the field of human medicine, this technique has been developed over several years to produce lesion scores to assess survival/mortality rates from firearm wounds and blast injuries (Beverland and Rutherford 1983; Gugala and Lindsey 2003; Yelveton 1996).

It is generally accepted that a well placed chest shot results in a relatively rapid death. [redacted]

Data collection.

[redacted]

[redacted]

[redacted]

[redacted]

Data collation and presentation

[redacted]

Objective 7: To establish if the skin lesions and injuries in the sample of badgers killed in the presence of field observers is comparable to that detected in unobserved shootings.

Rationale

Shooters may behave differently when they are being observed by the scientists, and therefore the TTD and wounding rate data gathered from the observed population may not be representative of all badgers shot.

[redacted]

Data collection.

[redacted]

Data collation and presentation

[redacted]

Communication and delivery of reports

In addition to the daily reports described later in this document (under ethical conflicts, study level), an initial report on the basic results from objective 1 will be delivered to Defra within 2 weeks of the end of the cull. A full report that will contain all the statistical analysis and post mortem results will be delivered to Defra within 25 working days of the end of the cull. The report concerning objectives 4, 5, 6 and 7 is going to include descriptive pathology data and the statistical analysis as detailed at the end of each objective.

[redacted]

Immediate communication with DEFRA will take place if any concerns regarding safety to staff and property as well as animal welfare are identified.

Potential ethical conflicts between field observation protocol and animal welfare

1. Individual researcher level

While observing the behaviour of badgers [redacted] after they have been shot at, the scientists may potentially observe the badger getting to its feet and moving slowly away from the target site or displaying signs of consciousness. The Guidance document recommends that shooters should take a second shot if there is any indication that the animal is still alive. However, we cannot guarantee that shooters will continue to observe such animals, or take the appropriate action.

If alerted to the movement of the badger by the scientist the shooter may have the opportunity to fire a second shot at the badger. In the protocol issued to researchers, we will make explicit that the shooters have to behave as if the scientists were not present, and under normal circumstances that the scientists cannot interfere with the actions of the shooter.

However, to avoid creating a potential ethical dilemma for the researcher, we propose to advise researchers that if they believe there are signs of consciousness but judge that the shooter does not indicate an intention to take a second shot, they are permitted to alert the shooter to these signs of consciousness. [redacted]

It is recommended that rules for when action should be taken by researchers and/or Defra officials are agreed before culling commences, so that field scientists are not required to make a judgement on appropriate action whilst in the field.

[redacted]

2. Study level

It is possible that data accumulated on either the level of non-lethal shots or the TTD may indicate an unacceptable level of humaneness before the end of the 6 week cull. A decision could be taken on the acceptability of the technique at this point that either the cull in its entirety or the use of certain methods should be suspended. Any such decision would need to be based on a robust sample size.

[redacted]

Potential risks to the study

1. Problems with Post mortem examinations.

[redacted]Laboratory capacity to carry out post mortem examinations may be exceeded. [redacted]

- Equipment failure – radiography, downdraught tables, respirators, (camera). All equipment will be either new or checked prior to commencement of the cull to try and avoid equipment failures.

A contingency plan is being developed by organisation B.

2. Risk to personal safety and damage to property due to public interruption.

Likelihood: Medium
Impact: High
Action: Project leader will liaise with security experts and devise appropriate guidelines for use by field staff. [redacted]

3. Insufficient staff in institution A to carryout field observations.

Likelihood: Medium
Impact: Medium

[redacted]

5. Insufficient replicates and bias in data collected.

[redacted]

[redacted]

6. Large number of non-lethal shots.

Not all gunshot wounds are lethal (Munro and Munro 2008) and potentially injured badgers may therefore not be retrieved. The potential ethical implications of this have been discussed elsewhere in this paper (Potential ethical conflicts between field observation protocol and animal welfare, 2. Study level, page 13). Calculations of current estimates of likely outcome will be communicated to Defra on a daily basis, so that ministers are aware of any welfare issues and if deemed necessary could halt the cull. However, there is also the risk of loss of data and introduction of potential biases.

Likelihood; low,
Impact: high.
Action: Only shooters that have attended the training course and passed a practical assessment will be licensed to shoot badgers. The primary aim of the training program is to try and ensure that non-lethal shots are not fired.

7. Transport and handling of infectious material including *Mycobacterium* sp infected carcasses.

Likelihood: high,
Impact: High.
Action: All procedures will be carried out according to the required H&S standards for handling potentially mycobacterium-infected badgers and many of the required risk assessments are already in place or can be used following minor amendments.

8. Study ended prematurely due to ethical conflicts

Likelihood: medium
Impact: High.

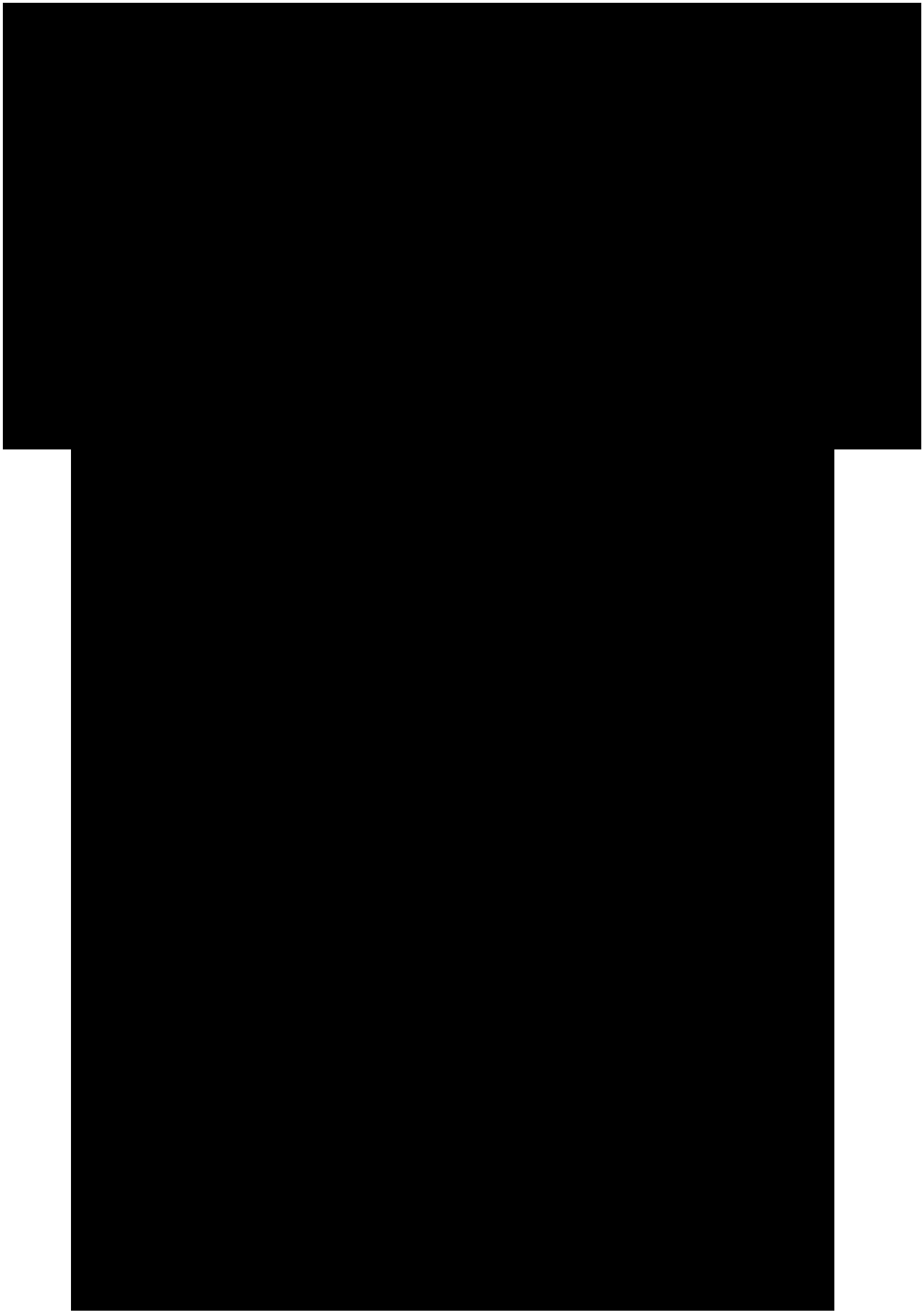
Action: Data analysis will only be carried out if sufficient data are available.

Annexes

Annex A: Logistics of the field observations:

[redacted]

Anatomical units (AU)



[redacted]

AHVLA
Animal Health and Veterinary Laboratories Agency

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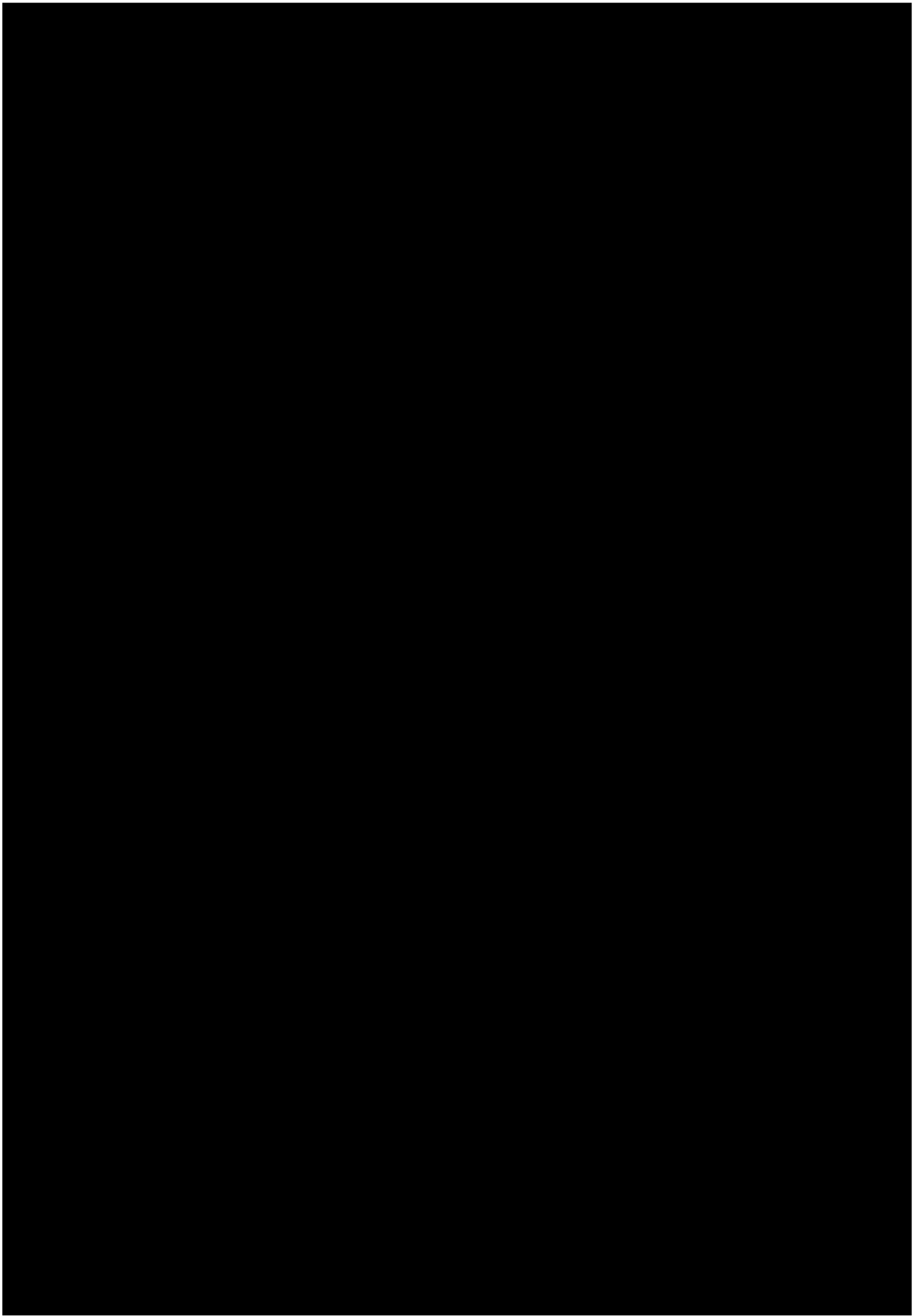
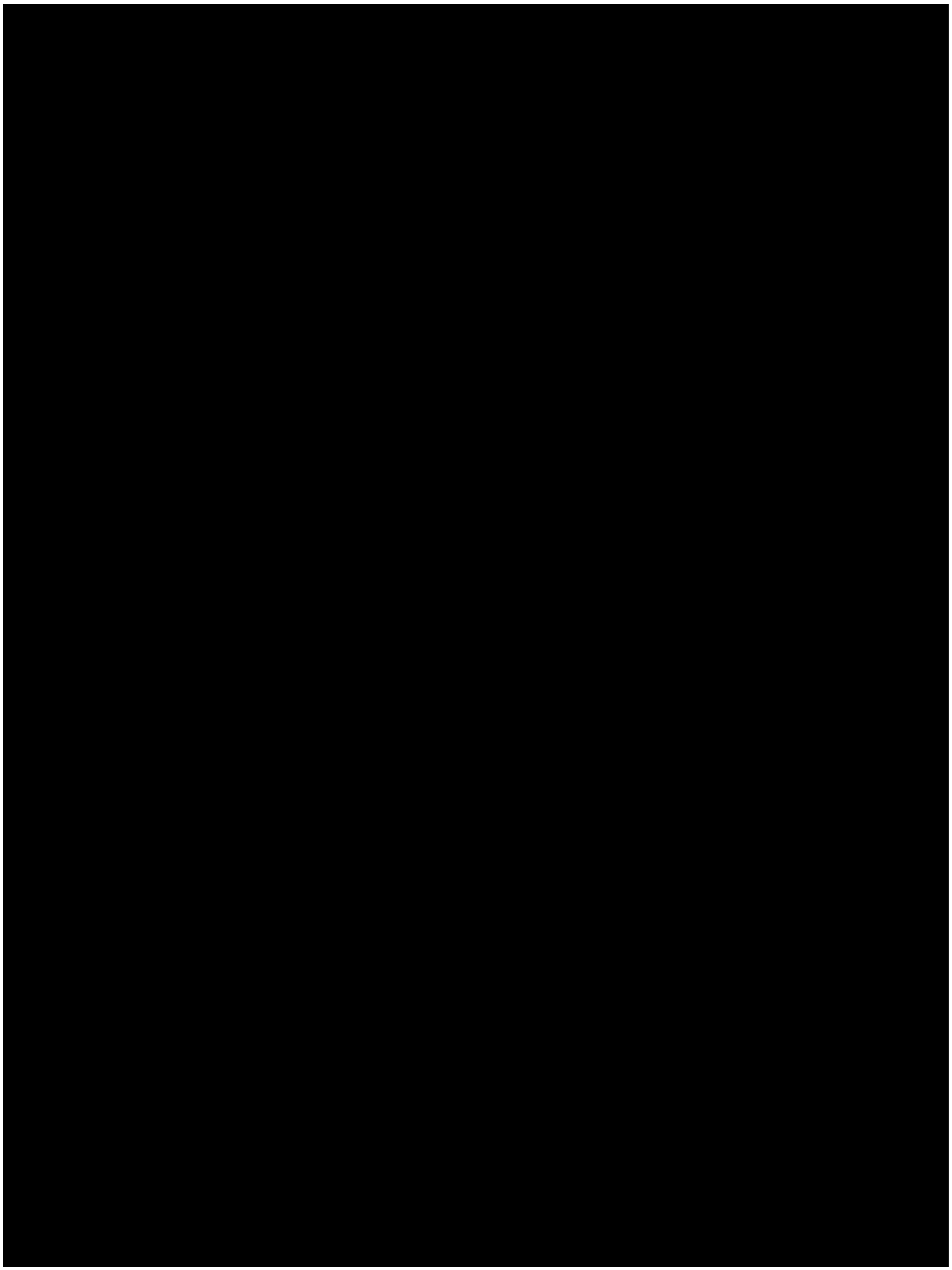
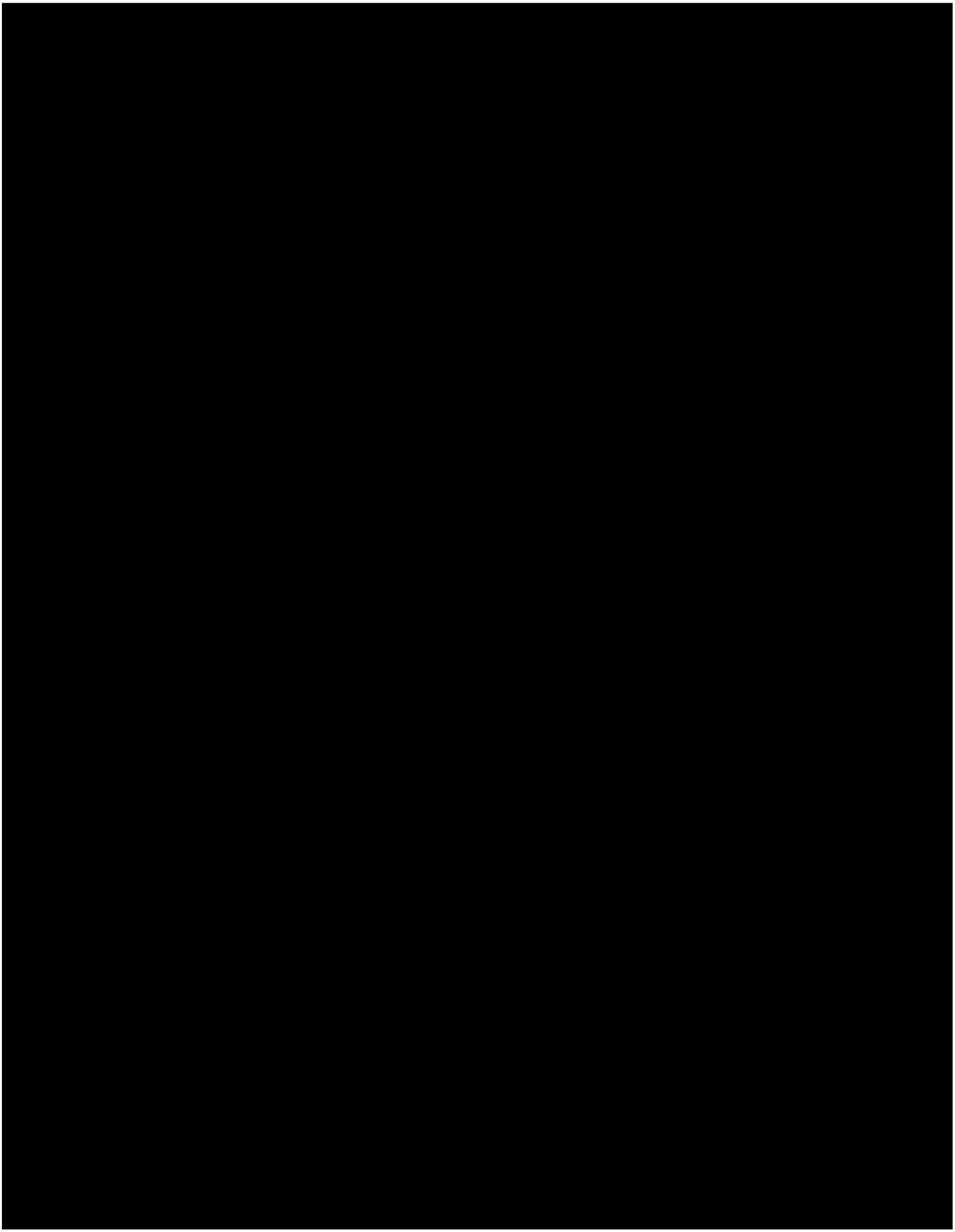


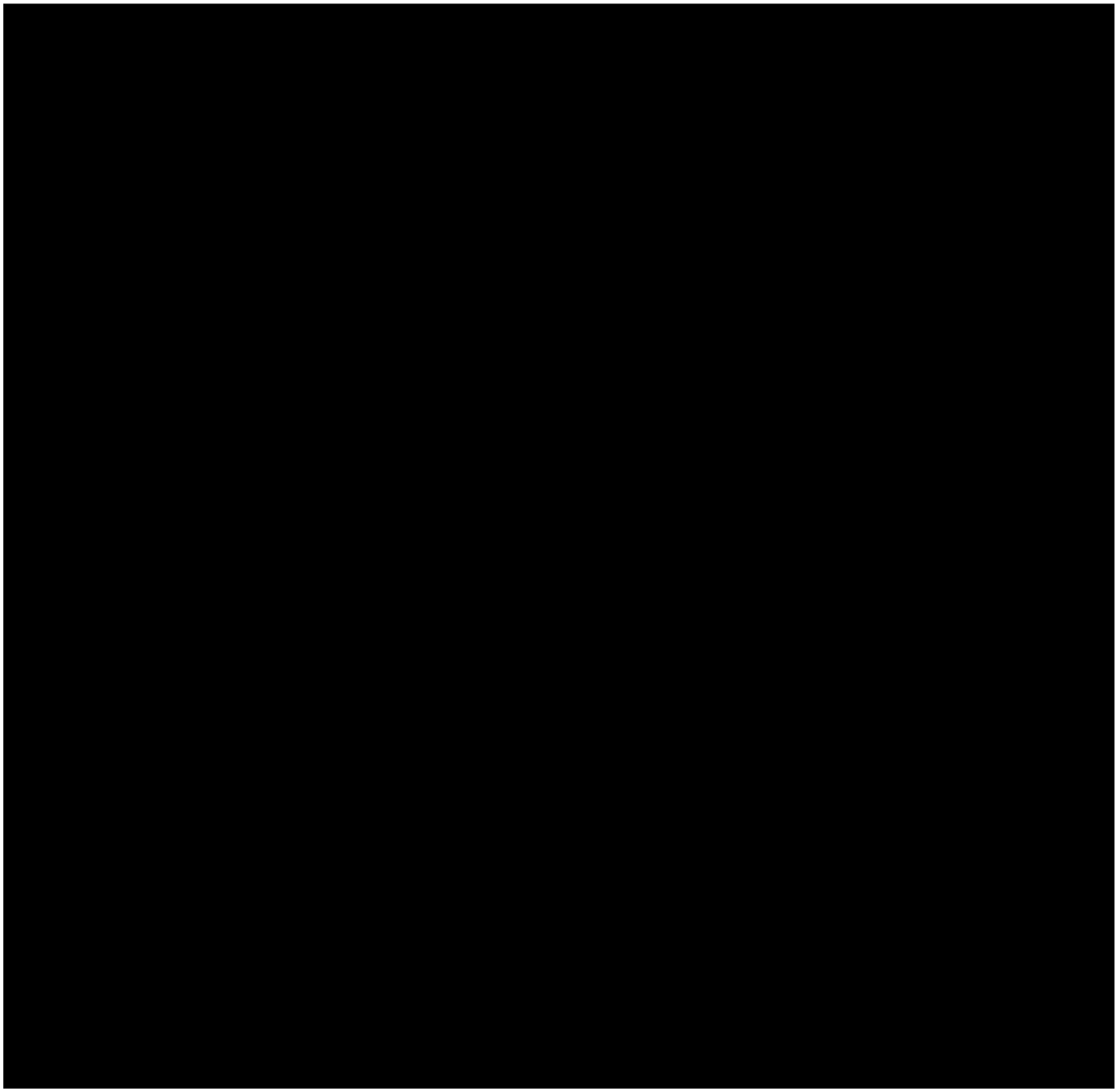




Annex D Detailed Statistics

Three basic statistical tasks will be undertaken in this study which will be used to either assign resources to observations, and/or provide evidence about the humaneness of control, and to explore relations between some of the factors which describe how control is undertaken and our observations.

[redacted]



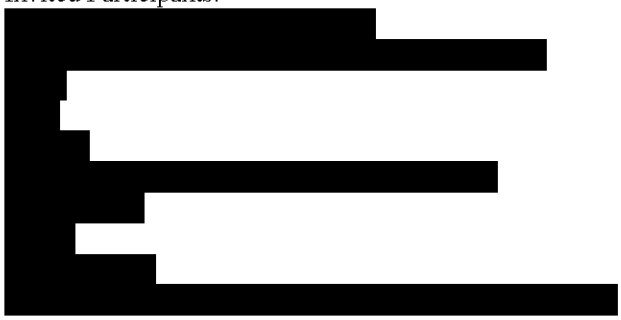
Annex E: Workshop

Title: Behavioural indicators to use during the monitoring of pilot badger culls.

Background: There is a paucity of literature on the behavioural responses of animals that have been chest shot. The brain is the target area when domestic animals are killed using a firearm. Three published studies on free shooting of wild animals all targeted the brain rather than the chest. These studies on whales, seals and impala indicated that death in many cases was instantaneous. In the case of whales and seals, a workshop was held to determine the most appropriate indicators of death to use in the field. However due to the mechanism of death being significantly different between head shot and chest shot animals, it is uncertain whether the outcome of that workshop is applicable in the proposed study. The behavioural responses of animals to destruction of the brain by a bullet have been documented, e.g. collapse and muscular contractions (Gregory, 2004) Behavioural responses to chest shots have been described by several hunting organisations, but no objective study of these has occurred. Some anecdotal accounts suggest that deer can continue to graze after receiving a lethal chest shot, before dropping unconscious some time later. Could such behaviour be used to indicate that the animal was not experiencing pain and suffering during this time? There may be other behaviours that occur that could be used in a similar manor. Videos of chest shot foxes show them collapsing and muscular contractions occurring instantaneously.

Objectives: To identify indicators of a) death and b) intensity of pain before death in chest shot free living wild badgers.
To determine which of these indicators can be measured under the field conditions of the pilot badger culls, without interfering with the actions of the shooters.

Invited Participants:



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