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An assessment of animal welfare impacts in wild Norway rat (Rattus norvegicus) management

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Online Resource 1: Part A Impact Scales (continued overleaf). From Sharp and Saunders (2011)

DOMAIN I: WATER DEPRIVATION, FOOD DEPRIVATION, MALNUTRITION		
Impact category	Description of impact	Examples
NO IMPACT	No effect on food/water intake	
MILD IMPACT	Short-term water or food restrictions that are within usual tolerance levels for the species.	An animal has a few hours without water; in shade conditions. Short-term deprivation of food.
MODERATE IMPACT	Water or food restrictions which cause serious short-term or moderate long-term effects on physiological state or body condition, but such effects remain within the capacity of the body to respond to nutritional variations and allow spontaneous recovery after restoration of a good quality diet.	An animal has a few hours without water; in hot, sunny conditions. Deprivation of food long enough to bring about mobilisation of body fat stores.
SEVERE IMPACT	Severe restrictions on food/water intake that lead to significant levels of debility.	An animal has many hours without water. Deprivation of food for many days resulting in severe loss of body weight.
EXTREME IMPACT	Extreme restrictions on food/water intake that would likely result in the animal dying from dehydration or starvation.	An animal has many days without water and /or food and dies from severe dehydration and/or starvation.

DOMAIN 2: ENVIRONMENTAL CHALLENGE

Impact category	Description of impact	Examples
NO IMPACT	Exposure to environmental challenge is not a feature of or consequence of the mode of action.	Exposure to ambient conditions that are within an animals' thermoneutral range.
MILD IMPACT	Short term exposure to environmental conditions which are outside the normal range encountered by the animal but remain within their physiological adaptive capacity.	Exposure to levels of heat or cold which are outside the thermoneutral range, but which do not lead to debility in the long-term.
MODERATE IMPACT	Marked short-term or moderate long-term environmental challenges that elicit body responses beyond the physiological adaptive capacity of the animal, but where the untoward effects are readily reversed by restoration of normal ambient conditions.	Short-term heat stress caused by exposure to high ambient temperatures combined with exercise.
SEVERE IMPACT	Severe environmental challenges that lead to serious physiological compromise or permanent dysfunction, injury or illness.	An animal is exposed to severe heat or cold which could possibly lead to failure of thermoregulation and collapse.
EXTREME IMPACT	Long-term exposure to extremes of heat or cold that bring about the death of the animal from hyper- or hypothermia.	Animals that are left in leg-hold traps, cage traps or yards in extremes of heat or cold and subsequently die from hyper- or hypothermia.

DOMAIN 3: INJURY, DISEASE, FUNCTIONAL IMPAIRMENT

Impact category	Description of impact	Examples
NO IMPACT	Disease, injury or functional impairment is not a feature of or consequence of the mode of action.	
MILD IMPACT	Body responses remain within the homeostatic capacity of the animal to react with no or only minor debility or incapacity.	Minor injuries (e.g. minor skin laceration, oedematous swelling of foot and/or leg, mild mouth injuries). Minor functional impairment (e.g. mild vomiting/retching, diarrhoea).
MODERATE IMPACT	Disease/injury/functional impairment that results in moderately severe debility or incapacity but from which recovery would normally occur spontaneously.	Moderate injuries (e.g. damage to minor tendon or ligament, amputation of a digit, joint haemorrhage, single tooth fracture, major laceration of mouth or tongue, joint dislocation). Moderate or functional impairment (e.g. moderate vomiting/retching, diarrhoea, increased breathing, moderate haemorrhages, convulsions).
SEVERE IMPACT	Injury/disease/functional impairment that result in severe debility or incapacity and serious physiological compromise and would normally cause permanent disability. Includes injuries that are likely to reduce survival if the animal were to be released.	Severe injuries (e.g. deep and wide lacerations, severed tendons, broken foot and leg bones below elbow or stifle, joint dislocations, amputations). Severe or functional impairment (e.g. severe vomiting/retching, diarrhoea, abnormal breathing, severe haemorrhages, convulsions).
EXTREME IMPACT	Injury/disease/functional impairment that result in very severe debility or incapacity due to the effects of traumatic injury, infectious agent or toxin.	Extreme injuries (e.g. death caused by excessive blood loss or shock, spinal chord injury, severe internal bleeding, fractures of more than one limb, severe jaw fracture, fractures of limbs above elbow or stifle). Extreme or functional impairment (e.g. extreme persistent vomiting/retching, diarrhoea, laboured breathing, convulsions, blindness, immobility/prostration, excessive and prolonged haemorrhaging).

DOMAIN 4: BEHAVIOURAL, INTERACTIVE RESTRICTION

Impact category	Description of impact	Examples
NO IMPACT	No interference with the behavioural needs of an animal (an animal's behavioural needs being those activities which when thwarted produce untoward physiological or psychological effects).	
MILD IMPACT	Mild interference with the behavioural needs of an animal.	Mild and short-term physical restraint resulting in minor behavioural or interactive restriction.
MODERATE IMPACT	Moderate interference with the behavioural needs of an animal resulting in negative physiological or psychological effects which are readily reversed after restoration of normal conditions.	Restraint that results in agitation from not being able to perform natural behaviour that the animal is highly motivated to perform e.g. feeding, moving, resting, grooming, mating, caring for young.
SEVERE IMPACT	Marked interference with the behavioural needs of an animal leading to physiological or psychological compromise that may cause long-term or permanent negative effects.	Severe abnormal self-directed behaviour e.g. chewing/biting of feet and limbs when restrained. Normal defensive and/or escape reactions to visibility of or presence of predators are prevented.
EXTREME IMPACT	Extreme interference with the behavioural needs of individuals or groups of animals leading to psychotic-like behaviour or to agonistic interactions that result in very severe injury or death.	Restraint that results in extreme abnormal self-directed behaviour, excessive aggression, stereotypy (e.g. severe fighting among incompatible social groups, unfamiliar individuals that are in close proximity). Inability to escape attack by a predator.

DOMAIN 5: ANXIETY, FEAR, PAIN, DISTRESS, THIRST, HUNGER ETC.

Impact category	Description of impact	Examples
NO IMPACT	Anxiety, fear, pain, sickness, breathlessness, nausea, lethargy/ weakness, dizziness, greater than normal thirst and/or hunger or other negative affective experiences causing distress are not a feature or consequence of the method.	
MILD IMPACT	Mild anxiety, fear, pain, sickness, breathlessness, nausea, lethargy/ weakness, dizziness, unsatisfied thirst and/or hunger or other negative affective experience causing distress.	Limited human contact with no physical handling.
MODERATE IMPACT	Moderate anxiety, fear, pain, sickness, breathlessness, nausea, lethargy/ weakness, dizziness, unsatisfied thirst and/or hunger or other negative affective experience causing distress.	Moderate level of human contact with minimum of physical handling.
SEVERE IMPACT	Severe anxiety, fear, pain, sickness, breathlessness, nausea, lethargy/ weakness, dizziness, unsatisfied thirst and/or hunger or other negative affective experience causing distress.	High level of human contact with a degree of physical handling.
EXTREME IMPACT	Extreme inescapable or unrelieved anxiety, fear, pain, sickness, breathlessness, nausea, lethargy/ weakness, dizziness, unsatisfied thirst and/or hunger or other negative affective experience causing distress which is judged to be at or beyond the limits of reasonable endurance and results in the death of the animal.	Excitement, fear and distress in struggling restrained animals that result in death from capture myopathy.

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Online Resource 2: Part B Impact Scales (continued overleaf). From Sharp and Saunders (2011)

Impact category	Description of impact	Examples
NO SUFFERING	<p>No suffering before death. There is immediate death or immediate loss of consciousness lasting until death.</p> <p><i>Note that components of suffering include (but are not limited to) fear, anxiety, pain, distress, apprehension, sickness, fatigue, thirst, hunger.</i></p> <p><i>Aversion refers to the avoidance or attempted avoidance of unpleasant, noxious stimuli and distressing stimuli</i></p>	<p>Direct destruction/concussion of brain tissue resulting in rapid unconsciousness e.g. accurate shooting in the head.</p> <p>Inhaled vapour with no irritant effect that induces unconsciousness without pain or discernable discomfort.</p> <p>Does not involve physical handling or restraint</p>
MILD SUFFERING	<p>Loss of consciousness is not immediate and there is no or only minimal aversion and no or only mild suffering before death.</p>	<p>Inhaled vapour causing mild irritancy and mild pain and/or distress.</p> <p>Mild dyspnoea (breathlessness).</p> <p>Mild degree of sickness e.g. vomiting/retching, diarrhoea, lethargy/weakness etc.</p> <p>Does not involve physical handling or restraint.</p>
MODERATE SUFFERING	<p>Loss of consciousness is not immediate and there is moderate aversion and suffering before death.</p>	<p>Inhaled vapour causing moderate irritancy and moderate pain and/or distress.</p> <p>Moderate degree of sickness e.g. vomiting/retching, diarrhoea, lethargy/weakness etc.</p> <p>Moderate dyspnoea.</p> <p>May involve physical handling and restraint e.g. to administer an injectable agent via intravenous (IV) or intraperitoneal (IP) route of entry; to apply cervical dislocation; to apply blunt trauma to the head.</p>

Impact category	Description of impact	Examples
SEVERE SUFFERING	Loss of consciousness is not immediate and there is severe suffering before death.	<p>Inhaled vapour causing severe irritancy and severe pain and/or distress.</p> <p>Convulsions occurring during unconsciousness when animal recovers consciousness prior to death (i.e. muscle spasms with periods of relaxation as in clonic convulsions).</p> <p>Severance of major arteries resulting in rapid blood loss, hypovolaemia and shock.</p> <p>Severe degree of sickness e.g. vomiting/retching, diarrhoea, lethargy/weakness etc.</p> <p>Severe dyspnoea</p> <p>May involve physical handling and restraint e.g. administration of an injectable agent to a non-sedated animal via a difficult-to-access route of entry (e.g. intracardiac, intrahepatic, intrarenal).</p>
EXTREME SUFFERING	Loss of consciousness is not immediate and there is extreme suffering before death.	<p>Inhaled vapour causing extreme irritancy and extreme pain and/or distress.</p> <p>Partial or full paralysis whilst conscious.</p> <p>Convulsions whilst conscious (i.e. prolonged muscle spasm without periods of relaxation as in tonic convulsions).</p> <p>Extreme degree of sickness e.g. vomiting/retching, diarrhoea, lethargy/weakness etc.</p> <p>Extreme dyspnoea.</p> <p>Severe internal haemorrhages causing swelling within confined spaces.</p> <p>May involve physical handling and restraint.</p>

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Online Resource 3:

Standard Operating Procedure UKRAT001: Spring trapping rats

Background

Norway rats (*Rattus norvegicus*) frequent urban and rural areas and may be found on commercial, municipal and domestic premises. They cause significant economic losses, eating 25-30 g of food per day each and contaminating far greater quantities with droppings, urine and hairs. They also transmit disease, cause chewing damage and create fire hazards by gnawing electrical wires. Spring trapping is one of several rat management methods with various degrees of efficacy, others including anti-coagulant poisons, live cage-traps, cholecalciferol, non-toxic lethal feeds, shooting, gassing, electrocution traps, glue traps, chemical repellents and proofing. Sonic and electro-magnetic deterrents are also available but there is little or no evidence that these methods are effective.

Spring traps are designed to kill rats by striking them on the head, neck or spinal column or by constriction of the thorax. A wide range of approved metal spring traps are available for killing rats, as well as snap traps (STs), also known as break-back traps, which do not currently require approval in the UK. This Standard Operating Procedure (SOP) is for lethal spring trapping of rats. This SOP is a guide only; it does not replace or override the legislation and should only be used subject to the applicable legal requirements.

Application

- The Prevention of Damage by Pests Act 1949 makes local authorities responsible for ensuring that their districts are kept free of rats (as far as is practicable). The Act also requires occupiers of non-agricultural land to notify the local authority if 'substantial numbers' of rats are living on or resorting to the land. Occupiers of agricultural land are not however required to notify the local authority regarding rats on their land. Under the Act, local authorities have the power to require

landowners and occupiers to control rat infestations on their land. Where necessary the local authority can conduct the control work and recover the cost from the landowner or occupier.

- Rats will thrive where there is cover, food and water and infestations occur in diverse circumstances as a result, including farms, food processing facilities, factories, hospitals, prisons, sewers, parks and gardens, and homes.
- Rats can legally be trapped at any time of year. They may breed year-round during mild conditions or if living indoors. Control should be undertaken promptly as soon as a problem is identified. Leaving a small infestation unmanaged may allow it to develop, increases the risk of damage and disease and makes subsequent control more difficult and expensive.
- Long-term reduction in rat numbers might be best achieved by trapping before breeding peaks, but trapping females with dependent pups raises welfare issues for the pups.
- Rat management campaigns may involve the use of more than one method as a combination of methods may prove most effective. Choice of method(s) will depend on the scale of the problem, the resources available (including competence/experience of the person conducting the management) and risks to non-target animals, people and hygiene.
- Rats tend to avoid areas that are regularly disturbed. Effective trapping relies on locating suitable runs and careful positioning of traps. Pre-baiting/baiting can be used to help overcome wariness.
- The term 'spring trap' generally applies to a trap that uses the power of a spring to strike and hold the target animal on a part of the body with sufficient force to kill it. Spring traps are designed to kill target animals by crushing vital organs. They aim to do this by either delivering a sharp blow to the head, neck or spinal column or by constriction of the thorax. Spring traps for rats include STs; these have a flat treadle or bait pan, which releases a metal loop/striking bar or plastic jaws to close down on the target, the aim being to crush the back of the skull or upper cervical vertebrae.
- Spring trapping can be useful as part of a larger rat management campaign, or where toxins are either not desirable or not permitted, where rats are not taking poisoned baits or to capture remaining rats following a poisoning exercise. Large numbers of traps are usually needed and their deployment, checking, re-siting and setting are time-consuming and labour-intensive, but digital trap monitoring systems are available to make the process more efficient.
- Spring trapping is often used on small-scale applications, such as by members of the public for killing rats in and around their homes. Unlike using poisons and fumigants, trapping has the advantage of retaining the carcasses (allowing simultaneous monitoring of rat numbers), preventing them from decomposing out of sight (and causing unpleasant smells) and reducing safety risks to humans and other animals.

- Spring traps approved in the UK for killing rats include certain BMI Magnum, DOC, Fenn, Kania, KORO, Solway, Springer, Tully and WCS Tube Traps. Metal spring traps tend to be used outdoors, in farm environments, and by pest controllers.
- A wide variety of unregulated STs constructed of wood/metal and or plastic are also available; these have blanket approval without requirement for testing. STs tend to be used indoors, by members of the public in domestic settings, on commercial premises, and by pest controllers.
- Regulated spring traps must be set in an appropriate tunnel to reduce the chance of attracting or killing non-target animals, but without impeding the action of the trap, e.g., in the case of rats, in a sewer, drainpipe, or similar structure. This is a requirement of the Spring Traps Approval (England) Order 2018 and its analogues for Wales, Scotland and Northern Ireland. STs must also be set in tunnels if used outdoors or elsewhere where non-target species may be at risk of capture or injury. They may be supplied, or placed, in secure boxes to prevent children or pets from being injured. Traps must be used according to manufacturer's instructions.
- There is no legal requirement to check rat spring traps in the UK. Both Defra and Natural England recommend that spring traps for rats are checked at least once a day but the Universities Federation for Animal Welfare (UFAW) guidelines recommend that they are checked at least twice daily.
- Following successful treatment of rats, it is vital that foods are stored securely and food spills cleared up, potential harbourage is cleared, vegetation kept short around rat runs and burrows and structures proofed against access by rats; otherwise re-infestation is likely to occur.
- Revisit the site regularly to monitor for new activity/damage.

Animal Welfare Considerations

Impact on target animals

- The Pests Act 1954 made it an offence, in England, Wales and Scotland, to use a spring trap for killing or taking animals, other than one approved by an Order of the Secretary of State. Some rat spring traps require this approval but rat STs are exempt under The Pests Act 1954, as implemented by The Small Ground Vermin Traps Order 1958.
- Animal welfare can be compromised up to the point when the animal becomes irreversibly unconscious. Traps which do require approval are approved if $\geq 80\%$ of twelve tests cause irreversible unconsciousness in the target animal within 5 minutes. Significantly shorter times to irreversible unconsciousness have been proposed by NoCheRo under a voluntary ST certification scheme being considered by the European Commission. However because STs do

not require approval, data on the time to irreversible unconsciousness are not in the public domain.

- The impact momentum and clamping force produced by rat STs, both of which influence the damage inflicted and thus the associated welfare impacts, have been shown to vary several-fold among different types of trap, indicating that welfare performance may be equally variable. STs with larger opening angles and double-peg springs may be more powerful and would be recommended over other types as they may be more likely to create tissue damage sufficient to cause rapid loss of consciousness; traps with a strong striking bar and a larger treadle are also recommended.
- An effective trap will fracture the cranium or upper cervical vertebrae, causing unconsciousness immediately or rapidly, followed by death. If a trap strikes a sub-optimal body location, and/or strikes with insufficient force, a trapped animal is likely to suffer injuries that result in a slower death.
- Any rat caught in a trap becomes a Protected Animal under the Animal Welfare Act 2006. The person deemed responsible for a Protected Animal is obliged to not cause it unnecessary suffering which could reasonably have been avoided or reduced. An offence is committed whether through an act, or a failure to act, and it is also an offence not to provide for an animal's needs, such as food, environment and protection from unnecessary pain, suffering, injury and disease. Because a trapped rat may not necessarily be killed quickly (for example if it is caught by a limb), traps need to be visited regularly.
- Trapped animals that are not killed immediately by the trap action are at risk of exposure, dehydration, starvation, shock, capture myopathy and predation. Animals that are not killed by the trap action can be severely injured by the trap or when trying to escape.
- Any trapped rats found alive should be humanely killed as soon as possible.

Impact on non-target animals

- If lactating females are trapped, their dependent pups will die of starvation or dehydration unless they are found and humanely killed.
- If performed correctly, spring trapping is relatively safe for non-target species, users and other people. Where there is risk of non-target capture, placing traps inside tunnels or boxes, can help to minimise these risks.
- Livestock and pets should be excluded from any area where traps are set.
- Live non-target animals, such as birds, cats or dogs, caught in traps must be examined for injuries and signs of illness or distress and treated as follows:

- Animals which are unharmed or have only received minimal injuries such as minor cuts or abrasions should be immediately released at the capture site (provided they can be released legally, e.g. are not on Schedule 9 of the Wildlife and Countryside Act 1981).
- Animals which have more severe, untreatable injuries or injuries that would compromise their survival in the wild, and animals suffering from thermal stress, hunger or dehydration, should either be humanely killed (unless protected) using a technique appropriate for the species or should receive appropriate attention. An animal suffering from thermal stress can initially be placed in a suitable quiet holding area which provides warmth or shade to allow recovery before release. Where necessary animals should be given food and water. Animals with treatable injuries that cannot be immediately released or those failing to recover from thermal stress should be presented to a veterinarian or a registered wildlife carer for treatment.
- If a domestic pet is caught, it should be taken to the nearest vet, animal shelter or council pound where it can be examined for injuries, scanned for a microchip and the owner contacted, or assessed for suitability for re-homing.
- If a spring-trapped rat is eaten by a predator, there is no secondary threat to the predator as is the case with poisoning.

Health and Safety Considerations

- Rats carry diseases that may be harmful to humans and other animals (including Leptospirosis [Weil's disease], Toxoplasmosis, Hantavirus and Salmonella). The Health and Safety at Work Act 1974 makes employers responsible for the health and safety of their employees, including managing the risk of rats transmitting disease. The Health and Safety Executive's Control of Substances Hazardous to Health (CoSHH) regulations require employers to make sure an assessment is conducted to identify risks to human health arising from rat-borne diseases.
- Good personal hygiene is encouraged when handling wild animals. Routinely wash hands and other skin surfaces if contaminated with faeces, blood and other body fluids and after handling traps. Cuts and grazes should be treated and covered with a waterproof dressing.
- Operators should be wary of the risks of injury when placing and setting traps. Wear waterproof gloves for protection from contamination. Wearing gloves may also prevent injuries from trap jaws but may hinder trap-setting.
- Operators should be protected by tetanus immunisation in case of infection of scratches/bites.

Equipment Required

Spring traps

- Rat spring traps. These should be well-maintained, not rusty and should operate smoothly and swiftly when triggered.
- Suitable tunnels or boxes for protecting non-target animals from potential injury (these are supplied with some traps). These are not required for STs in an enclosed space where there is no risk to non-target animals.

Other Equipment

- Personal protective equipment including waterproof gloves.
- Pliers for adjusting traps.
- Trowel (when setting traps outdoors).
- Pegs for tethering (when setting chained traps outdoors).
- Heavy metal or heavy wooden blunt implement for killing any rats found alive in traps.
- Waterproof bag for carrying rat carcasses.

Procedures

Surveying for rat activity

- Effective rat trapping relies on locating rat runs. Before setting traps carry out a survey to determine where rats are living, feeding and drinking and the routes they take between these places. All areas of activity must be identified to minimise the risk of reinvasion. All buildings and surrounding areas, including contiguous hedgerows and ditches should be surveyed.
- Key features to look for include holes/burrows (6-9cm diameter), runs (5-10cm wide through vegetation or along linear features – greasy marks may be left where rats contact hard surfaces), droppings (15-20mm long, straight and often flat at one end and pointed at the other, moist when fresh), damage (chewed/gnawed materials, e.g. food stuffs, edges of doorways and holes, wooden features, electrical wiring), footprints/tail marks in soft mud/dust/bulk grain, sightings of live/dead rats and a musky smell.
- The survey should also seek to establish any particular risks or likely problems, e.g., risks to non-target animals, hygiene failings and structural faults.

Setting and placing traps

- Wear gloves for operator protection and to help mask human odours.
- Traps are deployed (in boxes or tunnels where needed) and set straight away; traps are not baited though many STs come pre-treated with a lure. Existing food sources should be left undisturbed.
- De-grease and weather any new traps to get rid of any smell of oil, grease or humans.
- Careful placement of traps is crucial to maximise effectiveness. Traps should be placed in areas of obvious rodent activity, such as on runs or near active nests or droppings. Items, such as a board or a brick, may be used to direct rats towards traps.
- Make sure each trap is functioning correctly before setting it.
- Carefully pre-set the trap according to the manufacturer's instructions before placing in its final position. Adjust the trap mechanism if necessary using pliers.
- Set traps on rat runs inside an appropriate natural or artificial tunnel or box depending on trap type. A tunnel or box may not be necessary where an assessment indicates that there is no risk to non-target species because of the location of the trap, e.g. inside an enclosed loft cavity.
- Position STs at right angles to the rat's direction of travel as estimated from the survey, ideally alongside a wall or similar linear feature, with the trigger end almost touching the wall so the rat will pass over the trigger. Set the trap firmly in position with the treadle plate flush with the ground. Where possible, position traps amongst cover/behind boxes etc.
- Conceal the treadle plate with a light covering of soil/leaves if outside.
- The trap should be baited (using the same baits as used during pre-baiting, if traps were pre-baited).
- Where the trap is fitted with a chain, use this to secure the trap using a peg in the ground.
- Deploy plenty of traps (recommendations include ≥ 12 , 20 per poultry house and 2-3 dozen in a commercial establishment).
- Keep detailed records of the number of traps set and plans of where they are positioned. Keep these up to date for traceability.
- Traps should be checked at least once a day, between sunrise and sunset, to reset any that are sprung, remove dead rats and humanely kill any trapped rats that may still be alive.
- Continue trapping until rat activity in the area ceases. Consider moving traps every two weeks if rat activity continues.
- Once effective rat control has been achieved this can be replaced by a prevention strategy.

Humane killing of rats found alive in traps or dependent pups

- Any rats found alive in traps must be killed quickly and humanely using an appropriate method.
- The most suitable technique for humane killing in these circumstances is destruction of the brain with a strong and accurate CBH using a suitable implement.
- The operator should enter the trapping environment alone and trapped rats should be approached carefully to minimise panic, further stress and risk of additional injury to the trapped rat.
- Kill the trapped rat swiftly, while it is still attached to the trap. Strike the back of the rat's head accurately and strongly with a suitable heavy and blunt instrument.
- Death of the animal should always be confirmed by observing the following:
 - o Absence of rhythmic, respiratory movements;
 - o Absence of eye protection reflex (corneal reflex) or 'blink';
 - o A fixed, glazed expression in the eyes; and
 - o Loss of colour in mucous membranes (become mottled and pale without refill after pressure is applied).
- If the animal is not dead then repeat the killing method at once. Use a secondary method to ensure death (cervical dislocation, exsanguination, destruction of the brain) before disposing of the carcass.
- Personnel performing manually applied CBH must be properly trained and monitored for proficiency with this method of humane killing. No more than a few animals should be killed in this way at one time.
- If lactating females are trapped, efforts should be made to find any nests containing dependent pups and humanely kill them, to prevent them from dying of starvation or dehydration.

Disposal of rat carcasses

- Rats can carry infections that are dangerous to humans and other animals. Carcasses should be disposed of carefully and hygienically according to current legislation. For further advice, contact your Local Authority.

Further information

- Contact Natural England's Wildlife Management Advisors for more information and advice on site assessment and monitoring of rat numbers.

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An assessment of animal welfare impacts in wild Norway rat (*Rattus norvegicus*) management

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Online Resource 4:

Standard Operating Procedure UKRAT002: Cage trapping and killing of rats with a concussive blow to the head

Background

Norway rats (*Rattus norvegicus*) frequent urban and rural areas and may be found on commercial, municipal and domestic premises. They cause significant economic losses, eating 25-30 g of food per day each and contaminating far greater quantities with droppings, urine and hairs. They also transmit disease, cause chewing damage and create fire hazards by gnawing electrical wires. Cage trapping is one of several rat management methods with varying degrees of efficacy, including anti-coagulant poisons, spring traps, cholecalciferol, non-toxic lethal feeds, shooting, gassing, electrocution traps, glue traps, chemical repellents and proofing. Sonic and electro-magnetic deterrents are also available but there is little or no evidence that these methods are effective.

Rats may be cage trapped using cage traps (CTs) and then humanely killed. Relocation is not recommended on welfare grounds. This Standard Operating Procedure (SOP) is for cage trapping of rats followed by humane killing with a strong and accurate concussive blow to the head (CBH), using a suitable heavy implement. This SOP is a guide only; it does not replace or override the legislation and should only be used subject to the applicable legal requirements.

Application

- The Prevention of Damage by Pests Act 1949 makes local authorities responsible for ensuring that their districts are kept free of rats (as far as is practicable). The Act also requires occupiers of non-agricultural land to notify the local authority if 'substantial numbers' of rats are living on or resorting to the land. Occupiers of agricultural land are not however required to notify the local authority regarding rats on their land. Under the Act, local authorities have the power to require

landowners and occupiers to control rat infestations on their land. Where necessary the local authority can conduct the control work and recover the cost from the landowner or occupier.

- Rats will thrive where there is cover, food and water and infestations occur in diverse circumstances as a result, including farms, food processing facilities, factories, hospitals, prisons, sewers, parks and gardens, and homes.
- Rats can legally be trapped at any time of year. They may breed year-round during mild conditions or if living indoors. Control should be undertaken promptly as soon as a problem is identified. Leaving a small infestation unmanaged may allow it to develop, increases the risk of damage and disease and makes subsequent control more difficult and expensive.
- Long-term reduction in rat numbers might be best achieved by trapping before breeding peaks, but trapping females with dependent pups raises welfare issues for the pups.
- Rat management campaigns may involve the use of more than one method as a combination of methods may prove most effective. Choice of method(s) will depend on the scale of the problem, the resources available (including competence/experience of the person conducting the management) and risks to non-target animals, people and hygiene.
- Rats tend to avoid areas that are regularly disturbed. Effective trapping relies on locating suitable runs and careful positioning of traps. Traps are baited to encourage rats to enter them.
- Cage trapping can be useful as part of a larger rat management campaign, or where toxins are either not desirable or not permitted, where rats are not taking poisoned baits, or to capture remaining rats following a poisoning exercise. Cage trapping can be a useful alternative to poisoning where resistance is suspected or when a high-value crop needs protection. Large numbers of traps are usually needed and their deployment, checking, re-siting and setting are time-consuming and labour-intensive. CTs are bulky and may not be practical for small spaces.
- Cage trapping is also used on small-scale applications, such as by members of the public for killing rats around their homes. Unlike using poisons and fumigants, trapping has the advantage of retaining the rats (allowing simultaneous monitoring of rat numbers). When they are then killed, they do not decompose out of sight (causing unpleasant smells) and do not pose safety risks to humans and other animals.
- Cage trapping is conducted using cage traps (and sometimes box traps), some of which allow multiple captures. Cage traps are usually rectangular and constructed from wire mesh. They have a mesh or sheet metal trap door which is held open until the trap is triggered, either by a rat standing on a treadle or taking bait from a trigger inside the trap. When the trap is triggered, the door is closed (usually by a spring) and the rat is retained in the trap. Cage traps for rats measure approximately 35 x 15 x 15cm. Cage traps with a funnel entrance and one-way door are also available.

- Cage trapping can be targeted in many circumstances where rat activity arises, because it is relatively safe for non-target species, users and other people.
- Proper checking and humane killing of trapped rats are time-consuming and labour-intensive. In general, there is no legal requirement to check CTs in the UK but there is a legal obligation under The Animal Welfare Act 2006 (and its analogues in Scotland and Northern Ireland) not to cause unnecessary suffering to a captured wild animal. However, The Act does not specify how frequently live capture devices, such as cage traps, should be checked. Both Natural England and the Universities Federation for Animal Welfare (UFAW) guidelines recommend that CTs for catching rats are checked at least twice daily.
- Dealing with live trapped rats is challenging. Releasing rats is not recommended; letting them go near the point of capture is unlikely to solve the problem unless premises have been effectively rodent-proofed; release into an unfamiliar environment may have negative welfare and legal consequences; and rats are likely to be unwelcome there. The humane killing of rats is likely to be beyond the experience and ability of many people and repeated killing (as done by pest control operators) can cause operators emotional distress over time.
- Humane killing of live trapped rats is most efficiently and practically conducted using a CBH to destroy the brain. This method must be executed quickly and skilfully to ensure a rapid and humane death. Drowning is not an acceptable method.
- Following successful treatment of rats, it is vital that foods are stored securely and food spills cleared up, potential harbourage is cleared, vegetation kept short around rat runs and burrows and structures proofed against access by rats; otherwise re-infestation is likely to occur.
- Revisit the trapping site regularly to monitor for new activity/damage.

Animal Welfare Considerations

Impact on target animals

- Any rat caught in a trap becomes a Protected Animal under the Animal Welfare Act 2006. The person deemed responsible for a Protected Animal is obliged not to cause it unnecessary suffering which could reasonable have been avoided or reduced. An offence is committed, whether through an act, or a failure to act, and it is also an offence not to provide for an animal's needs, such as food, environment and protection from pain, suffering, injury and disease.
- A key welfare concern with cage trapping is the time a trapped animal spends in a trap before it is discovered. A trapped rat may be frightened and distressed, or may have been injured either by the trap mechanism, while trying to escape, or by a predator or conspecific attack. Trapped animals are also at risk of exposure, dehydration, starvation, shock, capture myopathy

and attack by predators. They could potentially also be injured by the trap door mechanism or when trying to escape. CTs need to be checked regularly.

- The other main concern related to cage trapping is what happens to the animal once it is found in the trap and how much it suffers as a result. It is not recommended that rats are released elsewhere because translocated animals may not adapt to or integrate into a new territory, and may suffer or die as a result. Killing cage trapped rats humanely is much less likely to cause suffering than release into an unfamiliar area, which could potentially constitute an offence under the Animal Welfare Act 2006.
- It is therefore recommended that, if a rat is captured alive, it is swiftly and humanely killed using a CBH as described in *Procedures* below. This method involves destruction of the brain by applying a strong and accurate blow to the back of the head with a suitable implement. Potential alternative methods might include shooting the animal in the trap, or administering a lethal overdose of appropriate gaseous or injectable anaesthetic. However, shooting a cage trapped rat with an air pistol is unlikely to be practical or safe for rat management purposes and the humaneness of this approach will depend on the skill of the operator and the behaviour of the trapped rat. Restrictions around the use of anaesthetics are likely to mean that these are also impractical for wider use in the pest control industry. Gaseous anaesthetics raise significant safety and environmental concerns and some are irritant to airways.
- Multiple captures in multiple-capture traps can result in stress and cannibalism.
- Cage trapping should be avoided in very cold weather conditions.
- Devices are available that send an alert to the trap operator when a trap is triggered, thus potentially reducing the amount of time an animal spends in a trap. Traps should still be checked regularly in case of device malfunction.

Impact on non-target animals

- If lactating females are trapped, their dependent pups will die of starvation or dehydration unless they are found and humanely killed.
- CTs should be safer for non-target animals than some other methods, but livestock and pets should be excluded from areas where traps are set.
- Live non-target animals caught in traps must be examined for injuries and signs of illness or distress and dealt with as follows:
 - o Animals which are unharmed or have only received minimal injuries such as minor cuts or abrasions should be immediately released at the site of capture (provided they can be released legally).

- o Animals which have more severe injuries or which are suffering from thermal stress, hunger or dehydration should either be humanely killed (unless protected) or should receive appropriate attention. An animal suffering from thermal stress can initially be placed in a suitable quiet holding area which provides warmth or shade to allow recovery before release. Where necessary animals should be given food and water. Animals with treatable injuries that cannot be immediately released or those failing to recover from thermal stress should be presented to a veterinarian or a registered wildlife carer for treatment.
- o Animals that have injuries which are untreatable or which would compromise their survival in the wild should be humanely killed using a technique appropriate for the species.
 - If a domestic pet is caught, it should be taken to the nearest vet, animal shelter or council pound where it can be examined for injuries, scanned for a microchip and the owner contacted, or assessed for suitability for re-homing.
 - Animals listed on schedule 9 of the Wildlife and Countryside Act, e.g. American mink, must not be released, and should either be humanely killed using a suitable method, or taken to an animal shelter.
 - If a live trapped rat is eaten by a predator, there is no secondary threat to the predator as is the case with poisoning.

Health and Safety Considerations

- Rats carry diseases that may be harmful to humans and other animals (including Leptospirosis [Weil's disease], Toxoplasmosis, Hantavirus and Salmonella). The Health and Safety at Work Act 1974 makes employers responsible for the health and safety of their employees, including managing the risk of rats transmitting disease. The Health and Safety Executive's Control of Substances Hazardous to Health (CoSHH) regulations require employers to make sure an assessment is conducted to identify risks to human health arising from rat-borne diseases.
- Good personal hygiene is encouraged when handling wild animals. Routinely wash hands and other skin surfaces if contaminated with faeces, blood and other body fluids and after handling traps. Cuts and grazes should be treated and covered with a waterproof dressing.
- Wear waterproof gloves for protection from contamination.
- Operators should be protected by tetanus immunisation in case of infection of scratches/bites.

Equipment Required

Cage traps

- Rat cage traps.

Other equipment

- Bait, e.g., chocolate nut spread.
- Personal protective equipment including waterproof gloves.
- Pliers for adjusting traps.
- Heavy metal or heavy wooden blunt implement for killing trapped rats.
- Hessian sack for restraining rat during killing with a blow to head.
- Waterproof bag for carrying rat carcasses.

Procedures

Surveying for rat activity

- Effective rat trapping relies on locating rat runs. Before setting traps carry out a survey to determine where rats are living, feeding and drinking and the routes they take between these places. All areas of activity must be identified to minimise the risk of reinvasion. All buildings and surrounding areas, including contiguous hedgerows and ditches should be surveyed.
- Key features to look for include holes/burrows (6-9cm diameter), runs (5-10cm wide through vegetation or along linear features – greasy marks may be left where rats contact hard surfaces), droppings (15-20mm long, straight and often flat at one end and pointed at the other, moist when fresh), damage (chewed/gnawed materials, e.g. food stuffs, edges of doorways and holes, wooden features, electrical wiring), footprints/tail marks in soft mud/dust/bulk grain, sightings of live/dead rats and a musky smell.
- The survey should also seek to establish any particular risks or likely problems, e.g., risks to non-target animals, hygiene failings and structural faults.

Setting and placing traps

- Wear gloves for operator protection and to help mask human odours.
- Weather any new traps to eliminate odours related to manufacture or humans.
- Traps are deployed, baited and set straight away; traps should be provisioned appropriately for the trap inspection frequency. Existing food sources should be left undisturbed.
- Careful placement of traps is crucial to maximise effectiveness and minimise welfare impacts. Traps should be placed in a sheltered position (with regard to animal welfare and public access), in areas of obvious rodent activity, such as on runs or near active nests or droppings.
- Make sure each trap is functioning correctly before setting it.
- Carefully pre-set the trap according to the manufacturer's instructions before placing in its final position. Adjust the trap mechanism, if necessary, using the pliers.

- Position traps on rat runs at right angles to the rat's direction of travel as estimated from the survey, ideally alongside a wall or similar linear feature, with the door end facing the wall, close to but not touching the wall so the rat will pass under the open cage door between the trap and the wall. Set the trap firmly in position and flush with the ground. Conceal the base of the trap with a light covering of soil/leaves if setting outside. Where possible position traps amongst cover/behind boxes etc. Make sure the setting rod and cage door do not foul on the wall, or on rubbish or debris thus interfering with the effective operation of the trap. Do not set traps where or when they will be exposed to extreme weather/temperatures, or close to water where there is a risk of flooding, to avoid rats drowning in traps.
- Deploy plenty of traps (recommendations include ≥ 12 , 20 per poultry house and 2-3 dozen in a commercial establishment).
- Keep detailed records of the number of traps set and plans of where they are positioned. Keep these up to date for traceability.
- Traps should be checked twice a day, shortly after dawn and at dusk, and trapped rats quickly and humanely killed. Trapped rats must be killed as soon as possible after capture.
- Continue trapping until rat activity in the area ceases. Consider moving traps every two weeks if rat activity continues.
- Once effective rat control has been achieved this can be replaced by a prevention strategy.

Humane killing of trapped rats or dependent pups

- Live trapped rats must be killed quickly and humanely using an appropriate method.
- The most suitable technique for humane killing in these circumstances is destruction of the brain with a strong and accurate CBH using a suitable implement.
- The operator should enter the trapping environment alone and trapped rats should be approached carefully to minimise panic, further stress and risk of injury of the trapped rat.
- Kill the trapped rat swiftly. Run the rat from the trap into a sack. Encourage the rat into a corner of the sack and restrain it there to prevent it from moving. Locate the rat's head and strike the back of its head accurately and strongly with a suitable heavy and blunt instrument.
- Death of the animal should always be confirmed by observing the following:
 - o Absence of rhythmic, respiratory movements;
 - o Absence of eye protection reflex (corneal reflex) or 'blink';
 - o A fixed, glazed expression in the eyes; and
 - o Loss of colour in mucous membranes (become mottled and pale without refill after pressure is applied).

- If the animal is not dead then repeat the killing method at once. Use a secondary method to ensure death (cervical dislocation, exsanguination, destruction of the brain) before disposing of the carcass.
- If more than one animal is trapped on the same trap, kill them one at a time, working as quickly as possible while maintaining accuracy.
- Personnel performing manually applied CBH must be properly trained and monitored for proficiency with this method of humane killing. No more than a few animals should be killed in this way at one time.
- If lactating females are trapped, efforts should be made to find any nests containing dependent pups and humanely kill them, to prevent them from dying of starvation or dehydration.

Disposal of rat carcasses

- Rats can carry infections that are dangerous to humans and other animals. Carcasses should be disposed of carefully and hygienically according to current legislation. For further advice, contact your Local Authority.

Further information

- Contact Natural England's Wildlife Management Advisors for more information and advice on site assessment and monitoring of rat numbers.

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An assessment of animal welfare impacts in wild Norway rat (*Rattus norvegicus*) management
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Online Resource 5:

Standard Operating Procedure UKRAT003: Glue trapping and killing of rats with a concussive blow to the head

Background

Norway rats (*Rattus norvegicus*) frequent urban and rural areas and may be found on commercial, municipal and domestic premises. They cause significant economic losses, eating 25-30 g of food per day each and contaminating far greater quantities with droppings, urine and hairs. They also transmit disease, cause chewing damage and create fire hazards by gnawing electrical wires. Glue traps (GTs) are one of several rat management methods with varying degrees of efficacy, including anti-coagulant poisons, spring traps, live cage-traps, cholecalciferol, non-toxic lethal feeds, shooting, gassing, electrocution traps, chemical repellents and proofing. Sonic and electro-magnetic deterrents are also available but there is little or no evidence that these methods are effective.

The use of GTs for trapping rats is a controversial method and should only be used as a last resort. Trapped rats should be humanely killed and not left to die on the board. This Standard Operating Procedure (SOP) is for glue trapping of rats followed by humane killing with a strong and accurate concussive blow to the head (CBH) using a suitable heavy implement. This SOP is a guide only; it does not replace or override the legislation and should only be used subject to the applicable legal requirements.

Application

- The Prevention of Damage by Pests Act 1949 makes local authorities responsible for ensuring that their districts are kept free of rats (as far as is practicable). The Act also requires occupiers of non-agricultural land to notify the local authority if 'substantial numbers' of rats are living on or resorting to the land. Occupiers of agricultural land are not however required to notify the local authority regarding rats on their land. Under the Act, local authorities have the power to require

landowners and occupiers to control rat infestations on their land. Where necessary the local authority can conduct the control work and recover the cost from the landowner or occupier.

- Rats will thrive where there is cover, food and water and infestations occur in diverse circumstances as a result, including farms, food processing facilities, factories, hospitals, prisons, sewers, parks and gardens, and homes.
- Rats can legally be trapped at any time of year. They may breed year-round during mild conditions or if living indoors. Control should be undertaken promptly as soon as a problem is identified. Leaving a small infestation unmanaged may allow it to develop, increases the risk of damage and disease and makes subsequent control more difficult and expensive.
- Long-term reduction in rat numbers might be best achieved by trapping before breeding peaks, but trapping females with dependent pups raises welfare issues for the pups.
- Rat management campaigns may involve the use of more than one method as a combination of methods may prove most effective. Choice of method(s) will depend on the scale of the problem, the resources available (including competence/experience of the person conducting the management) and risks to non-target animals, people and hygiene.
- Rats tend to avoid areas that are regularly disturbed. Effective trapping relies on locating suitable runs and careful positioning of traps. Rats may be less trap-shy of GTs than snap traps because they have a lower profile, but it has been reported that they can jump over them.
- GTs (or 'sticky boards') are pieces of wood, plastic or stiff cardboard covered in viscous glue consisting of mineral oils, resins and synthetic rubber. Rats become stuck to the glue by the feet and fur, and immobilised, when they run over the traps. GTs are not intended to be killing traps and should be treated as live-capture devices; unless traps are checked frequently, and trapped rats are swiftly killed, they are likely to die on the trap. GTs are for indoor use and need to be used in dry and dust-free environments (plastic or cardboard tunnels are available to cover and protect the glue from dirt and dust). If they are transported in a car they should be stored in a coolbox.
- Only GTs intended for use with rats must be used with rats; rats may be able to drag attached mouse GTs away making it difficult to find and kill rats humanely.
- Because of concerns about rat welfare and non-target capture, GTs should only be used as a last resort, e.g., for controlling rats where there is an immediate risk to public health within high-risk environments when all other control methods are not viable or are considered to have failed. Detailed records must be kept to show why other methods were considered inappropriate or to have failed.
- Cited advantages of GTs are that: (1) they are non-toxic and non-contaminating; (2) they hold the carcass in one place; (3) they have a 100% capture rate for animals that

encounter them; (4) no licence is required for their use; (5) they are inexpensive; (6) they can provide proof of presence of an ongoing infestation and may allow estimation of the extent (unlike baiting methods). GTs are favoured in certain environments, e.g. food processing, and (because of their low profile) where traps need to be deployed in small spaces.

- Proper checking and humane killing of trapped rats are time-consuming and labour-intensive. In general, there is no legal requirement to check live capture traps in the UK but there is a legal obligation under The Animal Welfare Act 2006 (and its analogues in Scotland and Northern Ireland) not to cause unnecessary suffering to a captured wild animal. However, The Act does not specify how frequently live-capture devices, such as GTs, should be checked. Natural England recommends that cage traps for rats should be inspected twice a day, while The Universities Federation for Animal Welfare (UFAW) guidelines recommend that GTs are checked at least twice daily and the Pest Management Alliance (PMA) Glueboard Code of Practice (CoP) states that GTs should be checked at a minimum of every 12 hours.

- Dealing with live-trapped rats is challenging. GTs should be used only by operators with adequate training and who are competent in the effective and humane use of this technique. Humane use of GTs is the legal responsibility of the pest controller and cannot be delegated to untrained people. Killing glue trapped rats is likely to be beyond the experience and ability of many people and repeated killing (as done by pest control operators) can cause emotional distress over time.

- Humane killing of glue trapped rats is most efficiently and practically conducted using a CBH to destroy the brain. This method must be executed quickly and skilfully to ensure a rapid and humane death. Drowning is not an acceptable method.

- Following successful treatment of rats, it is vital that foods are stored securely and food spills cleared up, potential harbourage is cleared, vegetation kept short around rat runs and burrows and structures proofed against access by rats; otherwise re-infestation is likely to occur.

- Revisit the site regularly to monitor for new activity/damage.

Animal Welfare Considerations

Impact on target animals

- Any rat caught in a trap becomes a Protected Animal under the Animal Welfare Act 2006. The person deemed responsible for a Protected Animal is obliged not to cause it unnecessary suffering which could reasonably have been avoided or reduced. An offence is committed whether through an act, or a failure to act, and it is also an offence not to provide for an animal's

needs, such as food, environment and protection from unnecessary pain, suffering, injury and disease.

- GTs are associated with significant welfare concerns and have been banned in the Republic of Ireland, New Zealand and India, and their use is prohibited or restricted in some Australian States. Some US companies and government departments have voluntarily banned the use of GTs.
- A key welfare concern with glue trapping is whether rats are simply left to die on glueboards and, if not, the length of time a rat remains trapped before it is discovered. Trapped animals are at risk of exposure, dehydration, starvation, exhaustion, shock, capture myopathy and predation or cannibalism.
- Rats trapped on GTs are also at risk of suffering pain and distress through being trapped, the physical effects of the glue on functioning (e.g. suffocation), and trauma resulting from panic and escape attempts (e.g. hair being pulled out, skin torn and limbs broken), or from predator or conspecific attack. Some animals are reported to have chewed through their own limbs in an effort to escape. After a few hours, they may be covered in their own faeces and urine. GTs need to be checked regularly.
- Another major concern related to glue trapping is whether trapped rats are swiftly and humanely killed. The killing method recommended by the Pest Management Alliance is a strong and accurate blow to the head with a suitable implement. Drowning is not an appropriate method. Killing rats is likely to be beyond the experience and ability of many people and repeated killing (as done by pest operators) can cause emotional distress over time.
- Rats must not be trapped using GTs intended for mice as these are smaller in size and there is a risk that trapped rats will escape, with a mouse GT attached, to die a slow and distressing death.

Impact on non-target animals

- If lactating females are trapped, their dependent pups will die of starvation or dehydration unless they are found and humanely killed.
- GTs are not target specific so must be positioned to avoid risk to non-target animals.
- If a non-target animal becomes trapped and is still alive, and it can be seen immediately that it has injuries that would be untreatable or which would compromise its survival in the wild, it should be humanely killed (while still attached to the trap) using a technique suitable for the species. Otherwise, live-trapped non-target individuals should be freed from the GT by massaging affected areas with a suitable (and warmed) food grade oil or similar emollient.

- Animals freed successfully from GTs must be kept in a warm, dark and quiet holding area, ideally until a vet is available, when the animal should receive treatment for being “oiled,” as oil affects an animal’s ability to regulate its body temperature. If a vet is not available, the animal should be examined for injuries and signs of illness or distress, assessed for suitability for release. If the animal appears uninjured and has suffered only minimal oiling – and appears well enough - it may be released (provided it can be released legally) at the site of capture. Otherwise, it should be humanely killed using a technique appropriate for the species.
- If a domestic pet is caught, it should be taken to the nearest vet, animal shelter or council pound where it can be examined for injuries, scanned for a microchip and the owner contacted, or assessed for suitability for re-homing.
- Animals listed on schedule 9 of the Wildlife and Countryside Act must not be released, and should either be humanely killed using a suitable method, or taken to an animal shelter.
- If a rat trapped on a GT is eaten by a predator, the predator’s mouth could potentially become stuck together but otherwise there is no secondary threat to the predator (unlike with poisoning).

Health and Safety Considerations

- Rats carry diseases that may be harmful to humans and other animals (including Leptospirosis [Weil's disease], Toxoplasmosis, Hantavirus and Salmonella). The Health and Safety at Work Act 1974 makes employers responsible for the health and safety of their employees, including managing the risk of rats transmitting disease. The Health and Safety Executive’s Control of Substances Hazardous to Health (CoSHH) regulations require employers to make sure an assessment is conducted to identify risks to human health arising from rat-borne diseases.
- Good personal hygiene is encouraged when handling wild animals. Routinely wash hands and other skin surfaces if contaminated with faeces, blood and other body fluids and after handling traps. Cuts and grazes should be treated and covered with a waterproof dressing.
- Wear waterproof gloves for protection from contamination.
- Operators should be protected by tetanus immunisation in case of infection of scratches/bites.

Equipment Required

Glue traps

- Rat GTs (of a colour that blends well with the site background).

Other equipment

- Personal protective equipment including waterproof gloves.
- Food grade oil or other suitable emollient for releasing non-target captures.
- Heavy metal or heavy wooden blunt implement for killing trapped rats.
- Waterproof bag for carrying used GTs and rat carcasses.

Procedures

Surveying for rat activity

- Effective rat trapping relies on locating rat runs. Before setting traps carry out a survey to determine where rats are living, feeding and drinking and the routes they take between these places. All areas of activity must be identified to minimise the risk of reinvasion. All buildings and surrounding areas, including contiguous hedgerows and ditches should be surveyed.
- Key features to look for include holes/burrows (6-9cm diameter), runs (5-10cm wide through vegetation or along linear features – greasy marks may be left where rats contact hard surfaces), droppings (15-20mm long, straight and often flat at one end and pointed at the other, moist when fresh), damage (chewed/gnawed materials, e.g. food stuffs, edges of doorways and holes, wooden features, electrical wiring), footprints/tail marks in soft mud/dust/bulk grain, sightings of live/dead rats and a musky smell.
- The survey should also seek to establish any particular risks or likely problems, e.g., risks to non-target animals, hygiene failings and structural faults.

Setting and placing GTs

- Wear gloves for operator protection and to help mask human odours.
- GTs are deployed indoors. Existing food sources should be left undisturbed.
- Careful placement of GTs is crucial to maximise effectiveness. GTs should be placed in areas of obvious rodent activity, such as on runs or near active nests or droppings.
- GTs are for indoor use and should be positioned so as to avoid risk to non-target species.
- Care should be taken to ensure there is no oil or dust on either the GTs, or the floor, as these may prevent rats' feet from becoming stuck to the glue.
- Position GTs on rat runs and other rat movement areas as estimated from the survey, ideally alongside a wall or similar linear feature. Set the GT firmly in position and flush with the ground. Do not set GTs where or when they will be exposed to extreme weather/temperatures, or close to water where there is a risk of flooding, to avoid rats drowning on GTs.

- Keep detailed records of the number of GTs set and plans of where they are positioned. Keep these up to date for traceability.
- GTs should be checked within 12 hours, with inspection times arranged to minimise the time rodents are likely to be on GTs. Trapped rats must be killed humanely and as soon as possible after capture.
- Continue using GTs until rat activity in the area ceases. Consider moving GTs every two weeks if activity continues.
- Once effective rat control has been achieved this can be replaced by a prevention strategy.

Humane killing of trapped rats or dependent pups

- Glue trapped rats must be killed quickly and humanely using an appropriate method.
- The most suitable technique for humane killing in these circumstances is destruction of the brain with a strong and accurate CBH using a suitable implement.
- The operator should enter the trapping environment alone and trapped rats should be approached carefully to minimise panic, further stress and risk of injury to the trapped rat.
- Kill the trapped rat swiftly, while it is still attached to the trap. Strike the back of the rat's head accurately and strongly with a suitable heavy and blunt instrument.
- Death of the animal should always be confirmed by observing the following:
 - o Absence of rhythmic, respiratory movements;
 - o Absence of eye protection reflex (corneal reflex) or 'blink';
 - o A fixed, glazed expression in the eyes; and
 - o Loss of colour in mucous membranes (become mottled and pale without refill after pressure is applied).
- If the animal is not dead then repeat the killing method at once. Use a secondary method to ensure death (cervical dislocation, exsanguination, destruction of the brain) before disposing of the carcass.
- If more than one animal is trapped on the same trap, kill them one at a time, working as quickly as possible while maintaining accuracy.
- Personnel performing manually applied CBH must be properly trained and monitored for proficiency with this method of humane killing. No more than a few animals should be killed in this way at one time.
- If lactating females are trapped, efforts should be made to find any nests containing dependent pups and humanely kill them to prevent them from dying of starvation or dehydration.

Disposal of rat carcasses

- Rats can carry infections that are dangerous to humans and other animals. Carcasses should be disposed of carefully and hygienically, while still attached to traps, and according to current legislation, to avoid the trap becoming a non-target risk for animals that might try to remove the dead rat from the trap. For further advice, contact your Local Authority.

Disposal of used GTs

- At the end of treatment collect and account for all GTs that were deployed.
- Cover sticky surfaces to avoid accidental trapping of non-target animal or subsequent misuse.
- Dispose of GTs carefully in accordance with advice from your Local Authority.

Further information

- Contact Natural England's Wildlife Management Advisors for more information and advice on site assessment and monitoring of rat numbers.

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An assessment of animal welfare impacts in wild Norway rat (*Rattus norvegicus*) management
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Online Resource 6:

Standard Operating Procedure UKRAT004: Anticoagulant rodenticide for rats

Background

Norway rats (*Rattus norvegicus*) frequent urban and rural areas and may be found on commercial, municipal and domestic premises. They cause significant economic losses, eating 25-30 g of food per day each and contaminating far greater quantities with droppings, urine and hairs. They also transmit disease, cause chewing damage and create fire hazards by gnawing electrical wires. Poisoning with an anticoagulant rodenticide (AR) is one of several rat management methods with varying degrees of efficacy, including spring traps, glue traps, live cage-traps, cholecalciferol, non-toxic lethal feeds, shooting, gassing, electrocution traps, chemical repellents and proofing. Sonic and electro-magnetic deterrents are also available but there is little or no evidence that these methods are effective.

ARs are poisons that act by disrupting the target rodent's blood clotting mechanisms, ultimately causing death by internal haemorrhaging and external bleeding. This Standard Operating Procedure (SOP) is for poisoning rats using an AR. This SOP is a guide only; it does not replace or override the legislation and should only be used subject to the applicable legal requirements.

Application

- The Prevention of Damage by Pests Act 1949 makes local authorities responsible for ensuring that their districts are kept free of rats (as far as is practicable). The Act also requires occupiers of non-agricultural land to notify the local authority if 'substantial numbers' of rats are living on or resorting to the land. Occupiers of agricultural land are not however required to notify the local authority regarding rats on their land. Under the Act, local authorities have the power to require

landowners and occupiers to control rat infestations on their land. Where necessary the local authority can conduct the control work and recover the cost from the landowner or occupier.

- Rats will thrive where there is cover, food and water and infestations occur in diverse circumstances as a result, including farms, food processing facilities, factories, hospitals, prisons, sewers, parks and gardens, and homes.
- Rats can legally be poisoned at any time of year. They may breed year-round during mild conditions or if living indoors. Control should be undertaken promptly as soon as a problem is identified. Leaving a small infestation unmanaged may allow it to develop, increases the risk of damage and disease, and makes subsequent control more difficult and expensive.
- Long-term reduction in rat numbers might be best achieved by poisoning before breeding peaks, but killing females with dependent pups raises welfare issues for the pups.
- Rat management campaigns may involve the use of more than one method as a combination of methods may prove most effective. Choice of method(s) will depend on the scale of the problem, the resources available (including competence/experience of the person conducting the management) and risks to non-target animals, people and hygiene. It is important not to rely entirely on using rodenticides for rat control, and programmes that also incorporate physical and/or biological control will be more effective in the long-term.
- The majority of rodenticides available for use against rats are ARs. ARs interfere with the metabolism of vitamin K, which is involved with the production of blood clotting factors. If these are absent or below critical concentrations, the blood fails to clot and internal haemorrhaging and external bleeding occur.
- ARs are successful because they are 'chronic' poisons, meaning that symptoms of poisoning appear slowly (and so rats are more likely to consume a lethal dose) and because active ingredients are easily formulated into palatable bait. Rat infestations are typically reduced in 2-4 weeks. A further advantage of the relatively slow mode of action, with death occurring on average after 5-7 days (minimum 2-3), is that this allows use of an antidote in cases of accidental poisoning of non-target species including humans.
- Rat populations in many parts of the UK have become genetically resistant to several of the original (First Generation ARs (FGARs)). Where genetic resistance to FGARs exists it is not best practice to use them. Second Generation ARs (SGARs), which have more potent anti-clotting actions, are now widely used but resistance to some of these has also arisen among rat populations. SGARs are considered to provide an efficient and practical solution to rat infestations, bringing considerable benefits in food hygiene, public health and animal husbandry. However, compared to FGARs, SGARs are relatively persistent in the environment and they present a greater risk of both primary and secondary non-target poisoning. SGARs

should be used only when other methods of achieving rat control have been carefully considered and cannot provide an effective solution to the rat problem at the site.

- Although SGARs are hazardous to non-target animals, no alternative rodenticides are currently available that are safer and equally effective. Use of FGARs is preferable to SGARs in those areas where FGAR resistance is known not to exist among rats. However, FGARs may take longer to control rat infestations and more bait may need to be applied, because of their lower potency. Since 2016, all SGARs can be used 'in and around buildings'; some can also be used in other outdoor scenarios (in open areas or at waste dumps). Only bromadiolone and difenacoum (and the non-anticoagulant rodenticide cholecalciferol) may be used in permanent baiting programmes but resistance to bromadiolone and difenacoum in some areas should be taken into account.
- The UK SGAR Stewardship Regime, developed by the Campaign for Responsible Rodenticide Use (CRRU), is intended to assure the UK Health and Safety Executive that ARs can continue to be used and their risks can be reduced to an acceptable level. All professional pest controllers using SGARs must apply the CRRU UK Code of Best Practice (2015), which underpins the Regime. Long-term rodenticide baiting should no longer be routine practice and is permitted only in certain circumstances.
- Baits are available in various formulations. Formulation choice will depend on site characteristics, previous treatment history, the conditions of authorisation given on product labels, non-target species or other hazards, the outcomes of the COSHH, environmental assessment and cost. Generally, rodents may find particulate baits more palatable than wax blocks but blocks may be more suitable in adverse environmental conditions, e.g. in sewers. Treated grain may be less likely than wax blocks to be kicked out of burrows.
- Operators must be properly trained and competent in the use of the rodenticides concerned. They must be aware of the potential hazards that the rodenticides may pose. Product label instructions and directions for use should be read, understood and followed.
- Rats are wary of unfamiliar objects appearing in their territories, so - where permitted for the product, where practical, and where this can be done safely for non-target animals – professional pest controllers may protect and secure bait points using existing materials rather than bait boxes. This may bring rats into contact with baits more effectively and reduce the length of time for which rodenticides need to be used and non-targets are potentially exposed to it.
- Outside buildings, bait must be adequately protected from children and as far as possible from non-target animals. Packs/sachets or blocks can be carried away by rats and should be properly secured at the placement site. It is more difficult for rats to carry or hoard large

quantities of loose grain or pellet bait, so loose bait poses a lesser risk to non-target animals if dropped or made accessible by rats.

- Baits must be appropriately secured. Unless you can place bait under suitable cover, or (when baiting indoors) restrict access by other species, you will need to use a secure bait box – either homemade or a commercially available tamper-resistant model.
- Indoors, and where non-targets can be effectively excluded, rather than placing bait directly on the floor, plastic trays or other means should be used to contain bait and facilitate clearing up.
- Rats killed using rodenticides may die in inaccessible areas and, unless the bodies can be retrieved, they may cause problems with odours, in which case another method, e.g. traps, could be more suitable.
- Following successful treatment of rats, it is vital that foods are stored securely and food spills cleared up, potential harbourage is cleared, vegetation kept short around rat runs and burrows and structures proofed against access by rats; otherwise re-infestation is likely to occur.
- Revisit the site regularly to monitor for new activity/damage.

Animal Welfare Considerations

Impact on target animals

- ARs disrupt a poisoned animal's blood clotting response. The response is delayed, so for the first few days the rat appears well and eats normally. The nature, degree and duration of suffering depend on the site and severity of any haemorrhaging, which are in turn influenced by the nature of the compound, the dose received and individual predisposition. Time to death is typically 4-8 days and while there is variation, symptomatic periods range from hours to - more often - 1-3 days, and up to 4-5 days. Evidence suggests rats remain conscious throughout.
- Rats will die after a few days as a result of internal haemorrhage (into the gut, tissues, body cavities, joints, and inside the skull) or bleeding from external wounds or from orifices. Bleeding into joint spaces and inside the skull is known to be very painful in humans and there is a concern that anticoagulants may cause such pain in rodents. Bleeding into intra- and inter-muscular spaces is also likely to cause significant pain.
- Evidence from humans (whose clotting times may be sub-optimal for weeks or even months) suggests that sub-lethally poisoned rats could be ill or disabled for considerable periods, potentially compromising their welfare.

Impact on non-target animals

- If lactating females are poisoned, their dependent pups will die of starvation or dehydration unless they are found and humanely killed.
- Rodenticide use presents the risk of primary non-target poisoning through access to poison baits or secondary non-target poisoning of predatory or scavenging species (e.g., cats, dogs and badgers) through access to poisoned rodent carcasses or to the poisoned carcasses of non-target bait feeders, such as wood mice or voles. If you suspect a pet, or another non-target animal, has been poisoned call the vet straight away and if possible provide the toxin's name, strength and the amount the animal has been exposed to, as well as the animal's weight if that is known.
- Predators generally need to consume several poisoned rodents before becoming ill but because ARs can bio-accumulate in the livers of predators or scavengers, dangerous levels can be reached and secondary poisoning can occur although this may be rare. Accumulated ARs have been found in the stomachs and livers of many wild carnivore species and fatal secondary AR poisoning has been implicated in the deaths of members of several wild bird and mammal species as well as domestic cats and dogs. Symptoms of secondary AR poisoning observed in non-target animals are similar to some of those observed in rats although the timescales involved can vary.
- Successful treatment may be possible in cases of companion animal consumption depending on the timeframe.
- The CRRU UK Code of Best Practice is designed to facilitate the effective use of rodenticides while minimising exposure to wildlife. This should be followed whenever rodenticides are used.

Health and Safety Considerations

- The GB Biocidal Products Regulation (2021) concerns the placing on the market and use of biocidal products. It is important that users of pesticides take all reasonable precautions to protect the health of humans, animals and plants, to safeguard the environment and, in particular, to avoid the contamination of water. Product label instructions must be followed.
- Operators must be properly trained and aware of the risks associated with rodenticide use.
- Users must satisfy the requirements of the Health and Safety Executive's Control of Substances Hazardous to Health Regulations (COSHH) for each rodenticide used, including the availability of adequate storage and suitable protective clothing. As with all pesticide use it will be necessary for such users to have made a risk assessment of the compounds that they intend to use. Planning must include the action to be taken in the event of accidental poisoning.

Records should be kept of rodenticide use and its placement at the site. The requirements for protective clothing and safe working practices must be understood before treatments are carried out.

- If poisoned bait contacts the skin, immediately wash the area with soap and water. Wash hands, arms and face before eating, drinking or smoking and wash clothes after use. If poisoning occurs go directly to hospital; Vitamin K₁ is available as an antidote.
- Rodenticides must be stored in a safe and secure location, with a 'Hazard Warning' sign prominently displayed and containers properly labelled.
- Carcasses of poisoned animals and unused bait are classified as 'controlled waste' and so must be disposed of either by transfer to a licensed waste disposal facility or by burning or burial on site.
- Rats carry diseases that may be harmful to humans and other animals (including leptospirosis [Weil's disease], toxoplasmosis, salmonellosis and Hantaan fever). The Health and Safety at Work Act 1974 makes employers responsible for the health and safety of their employees, including managing the risk of rats transmitting disease. The COSHH regulations require employers to make sure an assessment is conducted to identify risks to human health arising from rat-borne diseases. Operators should be protected by tetanus immunisation.
- Good personal hygiene is encouraged when handling poisons and rat carcasses. Routinely wash hands and other skin surfaces if contaminated with faeces, blood and other body fluids and after handling poison. Cuts and grazes should be treated and covered with a waterproof dressing and waterproof gloves should be worn, together with any additional protective equipment specified on the product label.

Equipment Required

Poison

- AR baits.
- Bait trays, boxes or containers as required.

Other equipment

- Personal protective equipment including waterproof gloves.
- Heavy metal or heavy wooden blunt implement for killing any poisoned rats that are discovered alive.
- Suitable waterproof bags for carrying poisoned carcasses and any collected uneaten bait.

Procedures

Surveying for rat activity

- Effective rat poisoning relies on locating rat runs and nesting areas. Before deploying poison, carry out a survey to determine where rats are living, feeding and drinking and the routes they take between these places. All areas of activity must be identified to minimise the risk of reinvasion. All buildings and surrounding areas, including contiguous hedgerows and ditches should be surveyed.
- Key features to look for include holes/burrows (6-9cm diameter), runs (5-10cm wide through vegetation or along linear features – greasy marks may be left where rats contact hard surfaces), droppings (15-20mm long, straight and often flat at one end and pointed at the other, moist when fresh), damage (chewed/gnawed materials, e.g. food stuffs, edges of doorways and holes, wooden features, electrical wiring), footprints/tail marks in soft mud/dust/bulk grain, sightings of live/dead rats and a musky smell.
- The survey should also seek to establish any particular risks or likely problems, e.g., risks to non-target animals, hygiene failings and structural faults.

Environmental assessment

- An environmental assessment to consider the possible threats to wildlife and domestic animals should be undertaken and documented whenever rodenticides are used, particularly in outdoor locations. This must include any specific risks identified and the measures that are being taken to minimise adverse effects on non-target species. This should be regularly reviewed during the course of the programme and documented.

Deployment of poison

- Wear gloves for operator protection and to help mask human odours.
- Bait boxes or trays that are to be used may be deployed without bait a few days in advance of beginning AR treatment in order to facilitate habituation by rats; alternatively, AR baited boxes or trays may be deployed straight away. Existing food sources should be removed wherever possible.
- Before embarking on a baiting programme, read the product label carefully to ensure that the correct, legal and safe procedure for that specific product is followed and to check the quantities of bait to be laid, the number and frequency of bait points.
- Careful placement of poison baits is crucial to maximise effectiveness. Baits should be placed

in areas of obvious rodent activity, such as on runs, near active nests or droppings, or – where permitted on the product label - inside burrows. Inside buildings, attention should also be paid to ledges, beams, partitions, bases of walls, conduits, false floors and ceilings. Outdoors, bait stations may be placed in hedgerows, ditches or other habitat features if the label allows. Outdoors or where non-target access is a risk, baits should be well protected. Badgers, foxes and dogs are capable of overturning bait boxes and this risk should be reduced by securing bait boxes in position.

- Sufficient bait points should be established at appropriate locations that will cover all areas of rodent activity (following bait label instructions) but accounting for potential restrictions including hazards to non-target species, risk of contaminating sensitive areas (e.g. food preparation areas), adverse conditions and where baits will be regularly disturbed or eliminated.
- Baits must be placed so that they are not accessible to children, domestic pets, livestock or wildlife larger than the target. Inspect baits regularly; any spilled or exposed baits should be removed and disposed of safely.
- Risks to non-target animals should be managed, e.g., by using tamper-resistant bait boxes, choosing bait station positions carefully, limiting the duration of poisoned baiting periods, checking for and removing poisoned rodents and regularly checking bait station for signs of the presence of non-target organisms. If non-target species appear to be taking baits, then bait points should be moved or better protected. Poisoned bait should not be deployed at bait points where non-target uptake persists.
- Where possible, contamination by dust or moisture should be avoided.
- Always keep a record of the type of rodenticide used, the quantity of bait laid and where this has been placed. A simple site plan indicating the location of bait points will help to keep track of the treatment.
- Bait points should be checked regularly and topped up as necessary. If bait is allowed to run out, become unpalatable, or there are insufficient bait points, then control is likely to be unsuccessful. Keep a record of bait inspection/replenishment visits too.
- At the end of treatment, remove any remaining bait and update records to indicate that the infestation is controlled and that as far as is reasonably practical all steps have been taken to ensure that the site is free of rodenticide bait.
- Once effective rat control has been achieved this can be replaced by a prevention strategy.

Humane killing of poisoned rats

- Any rats that are found alive but poisoned should be killed quickly and humanely using an appropriate method.

- The most suitable technique for humane killing in these circumstances is destruction of the brain with a strong and accurate CBH using a suitable implement.
- The operator should approach poisoned rats alone and carefully to minimise panic and further stress to the poisoned rat.
- Kill the rat swiftly, by striking the back of the rat's head accurately and strongly with a suitable heavy and blunt instrument.
- Death of the animal should always be confirmed by observing the following:
 - o Absence of rhythmic, respiratory movements;
 - o Absence of eye protection reflex (corneal reflex) or 'blink';
 - o A fixed, glazed expression in the eyes; and
 - o Loss of colour in mucous membranes (become mottled and pale without refill after pressure is applied).
- If the animal is not dead then repeat the killing method at once. Use a secondary method to ensure death (cervical dislocation, exsanguination, destruction of the brain) before disposing of the carcass.
- Personnel performing manually applied CBH must be properly trained and monitored for proficiency with this method of humane killing. No more than a few animals should be killed in this way at one time.
- If lactating females are poisoned, efforts should be made to find any nests containing dependent pups and humanely kill them, to prevent them from dying of starvation or dehydration.

Collection and disposal of rat carcasses

- Rats can carry infections that are dangerous to humans and other animals while poisoned animal carcasses present the risk of secondary poisoning to non-target animals. Wherever rodenticides are used, it is a requirement that rodent carcasses are regularly collected and disposed of. Other animal carcasses should also be dealt with in this way. Carcasses must be disposed of safely. For further advice contact your Local Authority.

Further information

- Contact Natural England's Wildlife Management Advisors for more information and advice on site assessment and monitoring of rat numbers.

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An assessment of animal welfare impacts in wild Norway rat (*Rattus norvegicus*) management
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Online Resource 7:

Standard Operating Procedure UKRAT005: Cholecalciferol rodenticide for rats

Background

Norway rats (*Rattus norvegicus*) frequent urban and rural areas and may be found on commercial, municipal and domestic premises. They cause significant economic losses, eating 25-30 g of food per day each and contaminating far greater quantities with droppings, urine and hairs. They also transmit disease, cause chewing damage and create fire hazards by gnawing electrical wires. Calciferol is a non-anticoagulant rodenticide used in the form ergocalciferol (Vitamin D₂) and more recently in the form of cholecalciferol (Vitamin D₃) to kill rats and mice; only cholecalciferol (CCF) is approved in Europe. Other rat management methods with various degrees of efficacy include anticoagulant poisons, non-toxic lethal cellulose baits, spring-traps, live cage-traps, shooting, gassing, electrocution traps, glue traps, chemical repellents and proofing. Sonic and electro-magnetic deterrents are also available but there is little or no evidence that these methods are effective.

CCF acts to stimulate the absorption of calcium from the intestines and to mobilise calcium from bones causing an increase in circulating calcium levels (hypercalcaemia) and calcification of soft tissues, particularly in the major arteries and kidneys. This Standard Operating Procedure (SOP) is for poisoning rats with CCF. This SOP is a guide only; it does not replace or override the legislation and should only be used subject to the applicable legal requirements.

Application

- The Prevention of Damage by Pests Act 1949 makes local authorities responsible for ensuring that their districts are kept free of rats (as far as is practicable). The Act also requires occupiers of non-agricultural land to notify the local authority if 'substantial numbers' of rats are living on or resorting to the land. Occupiers of agricultural land are not however required to notify the local

authority regarding rats on their land. Under the Act, local authorities have the power to require landowners and occupiers to control rat infestations on their land. Where necessary the local authority can conduct the control work and recover the cost from the landowner or occupier.

- Rats will thrive where there is cover, food and water and infestations occur in diverse circumstances as a result, including farms, food processing facilities, factories, hospitals, prisons, sewers, parks and gardens, and homes.
- Rats can legally be poisoned at any time of year. They may breed year-round during mild conditions or if living indoors. Control should be undertaken promptly as soon as a problem is identified. Leaving a small infestation unmanaged may allow it to develop, increases the risk of damage and disease and makes subsequent control more difficult and expensive.
- Long-term reduction in rat numbers might be best achieved by poisoning before breeding peaks, but killing females with dependent pups raises welfare issues for the pups.
- Rat management campaigns may involve the use of more than one method as a combination of methods may prove most effective. Choice of method(s) will depend on the scale of the problem, the resources available (including competence/experience of the person conducting the management) and risks to non-target animals, people and hygiene. Another factor may be whether the rat population is resistant to anticoagulant rodenticides.
- CCF, or Vitamin D3, is the naturally occurring form of Vitamin D, essential for the healthy development and function of mammals. Vitamin D is necessary for the formation of normal bone, but in high concentrations promotes excessive intestinal absorption of calcium and reabsorption of bone materials, which can lead to hypercalcaemia, osteomalacia and metastatic calcification of the blood vessels. The rodenticidal properties of CCF result from the effect of Vitamin D3 overdose, and calcification of blood vessels, particularly around the heart, heart failure and kidney failure have all been mooted as causes of death.
- CCF is a pro-hormone and fulfils the EU exclusion criteria on the basis of having endocrine disrupting properties as defined in Regulation (EU) No 2017/2100). However, the active ingredient is currently approved for use in the EU (and consequently the UK) because it is considered a valuable tool for controlling rats in areas where the prevalence of anticoagulant resistance is high.
- CCF is an acute poison, producing symptoms more quickly than anticoagulants. In order for CCF treatment to be effective, rats need to consume a lethal dose during their first or second feeds (2-3 days), after which they are likely to develop bait aversion. Bait aversion and wariness among rats may prevent CCF from being fully effective.

- CCF is reported to cause death in Norway rats within 1-13 days of consuming a lethal dose. CCF rodenticides are considered to provide a valuable alternative tool for managing rat populations, including those resistant to anti-coagulant rodenticides.
- However, palatability problems and degradation can compromise effectiveness, so it is less suited for outdoor use, especially if damp.
- Operators must be properly trained and competent in the use of the products concerned. Product label instructions and directions for use should be read, understood and followed.
- Outdoors, bait must be adequately protected from children and as far as possible from non-target animals.
- Rats are wary of unfamiliar objects appearing in their territories, so - where practical, and where this can be done safely for non-target animals - professional pest controllers may protect and secure bait points using existing materials rather than bait boxes. This may bring rats into contact with baits more effectively and reduce the length of time for which non-targets are potentially exposed to it.
- Baits must be appropriately secured. Unless you can place bait under suitable cover, or (when baiting indoors) restrict access by other species, you will need to use a secure bait box – either homemade or a commercially available tamper-resistant model.
- Indoors, rather than placing bait directly on the floor, plastic trays or other means should be used to contain bait and facilitate clearing up.
- Following successful treatment of rats, it is vital that foods are stored securely and food spills cleared up, potential harbourage is cleared, vegetation kept short around rat runs and burrows and structures proofed against access by rats; otherwise re-infestation is likely to occur.
- Revisit the site regularly to monitor for new activity/damage.

Animal Welfare Considerations

Impact on target animals

- CCF poisoning interferes with calcium homeostasis and while reports vary, they indicate that rats poisoned with CCF die within 1-13 days of ingesting a lethal dose.
- Fatal CCF cases in humans revealed calcification of heart and lung tissue, arteries and renal tubules. Human victims report severe frequent headaches, nausea, and pain and severe discomfort elsewhere in the body.
- CCF poisoned rodents display signs of pain and dysfunction including a reluctance to move, lethargy, weakness, anorexia, weight loss, hunched posture, rough coat and dehydration

followed at larger doses by tremors and coma. Calcification of blood vessels and internal organs have been recorded in rodents. The extended symptomatic period is associated with anorexia, bringing secondary disabling effects. Prolonged pain interferes with abilities to forage, exacerbating weight loss and dehydration, and hinders escape from predators.

- Sub-lethally poisoned animals may recover fully but this can take weeks and long-term effects may include renal damage.

Impact on non-target animals

- If lactating females are poisoned, their dependent pups will die of starvation or dehydration unless they are found and humanely killed.
- CCF is toxic to non-target animals and primary non-target poisoning is a risk. The resulting hypercalcaemia and associated physical impacts are difficult to reverse and antidotes are not readily available. Poisoned dogs have shown gastrointestinal haemorrhage, myocardial necrosis, calcification of vascular walls and, in the most severe cases, the kidneys and stomach. If you suspect a pet, or another non-target animal, has been poisoned call the vet straight away and if possible provide the toxin's name, strength and the amount the animal has been exposed to, as well as the animal's weight if that is known.
- This SOP does not involve pre-baiting but, if pre-baiting is used, care must be taken that this does not encourage non-target animals to eat the poison bait, although these risks may be managed using commonly-applied risk mitigation measures.
- There is some evidence that secondary poisoning may be possible if predators eat rodents killed with calciferol but this is not thought to be a major issue.

Health and Safety Considerations

- The GB Biocidal Products Regulation (2021) concerns the placing on the market and use of biocidal products. It is important that users of pesticides take all reasonable precautions to protect the health of humans, animals and plants, to safeguard the environment and, in particular, to avoid the contamination of water. Product label instructions must be followed.
- Operators must be properly trained and aware of the risks associated with rodenticide use.
- Users must satisfy the requirements of the Health and Safety Executive's Control of Substances Hazardous to Health Regulations (COSHH) for each rodenticide used, including the availability of adequate storage and suitable protective clothing. As with all pesticide use it will be necessary for users to have made a risk assessment of the compounds that they intend to use. Planning must include the action to be taken in the event of accidental poisoning. Records

should be kept of product use and its placement at the site. The requirements for protective clothing and safe working practices must be understood before treatments are carried out.

- If poisoned bait contacts the skin, immediately wash the area with soap and water. Wash hands, arms and face before eating, drinking or smoking and wash clothes after use. If poisoning occurs go directly to hospital.
- Rodenticides must be safely stored and containers labelled. They must be stored in a safe and secure location, with a 'Hazard Warning' sign prominently displayed and containers properly labelled.
- Poisoned rat carcasses and unused bait are classified as 'controlled waste' and so must be disposed of either by transfer to a licensed waste disposal facility or by burning or burial on site.
- Rats carry diseases that may be harmful to humans and other animals (including Leptospirosis [Weil's disease], Toxoplasmosis, Hantavirus and Salmonella). The Health and Safety at Work Act 1974 makes employers responsible for the health and safety of their employees, including managing the risk of rats transmitting disease. The COSHH regulations require employers to make sure an assessment is conducted to identify risks to human health arising from rat-borne diseases. Operators should be protected by tetanus immunisation.
- Good personal hygiene is encouraged when handling baits and rat carcasses. Routinely wash hands and other skin surfaces if contaminated with faeces, blood and other body fluids and after handling baits. Cuts and grazes should be treated and covered with a waterproof dressing and waterproof gloves should be worn, together with any additional protective equipment specified on the product label.

Equipment Required

Baits

- CCF baits.
- Bait trays, boxes or containers as required.

Other Equipment

- Personal protective equipment including waterproof gloves.
- Heavy metal or heavy wooden blunt implement for killing any poisoned rats that are discovered alive.
- Suitable waterproof bags for carrying poisoned carcasses and any collected uneaten bait.

Procedures

Surveying for rat activity

- Effective rat baiting relies on locating rat runs and nesting areas. Before deploying baits, carry out a survey to determine where rats are living, feeding and drinking and the routes they take between these places. All areas of activity must be identified to minimise the risk of reinvasion. All buildings and surrounding areas, including contiguous hedgerows and ditches should be surveyed.
- Key features to look for include holes/burrows (6-9cm diameter), runs (5-10cm wide through vegetation or along linear features – greasy marks may be left where rats contact hard surfaces), droppings (15-20mm long, straight and often flat at one end and pointed at the other, moist when fresh), damage (chewed/gnawed materials, e.g. food stuffs, edges of doorways and holes, wooden features, electrical wiring), footprints/tail marks in soft mud/dust/bulk grain, sightings of live/dead rats and a musky smell.
- The survey should also seek to establish any particular risks or likely problems, e.g., risks to non-target animals, hygiene failings and structural faults.

Environmental assessment

- An environmental assessment to consider the possible threats to wildlife and domestic animals should be undertaken and documented whenever rodenticides are used, particularly in outdoor locations. This must include any specific risks identified and the measures that are being taken to minimise adverse effects on non-target species. This should be regularly reviewed during the course of the programme and documented.

Deployment of baits

- Wear gloves for operator protection and to help mask human odours.
- Bait boxes or trays that are to be used may be deployed without bait a few days in advance of beginning AR treatment in order to facilitate habituation by rats; alternatively, CCF baited boxes or trays may be deployed straight away. Existing food sources should be removed wherever possible.
- Before embarking on a baiting programme, read the product label carefully to ensure that the correct, legal and safe procedure for that specific product is followed and to check the quantities of bait to be laid, the number and frequency of bait points.
- Careful placement of baits is crucial to maximise effectiveness. Baits should be placed in areas of obvious rodent activity, such as on runs, near active nests or droppings. Inside buildings, attention should also be paid to ledges, beams, partitions, bases of walls, conduits,

false floors and ceilings. Outdoors, bait stations may be placed in hedgerows, ditches or other habitat features if the label allows. Outdoors or where non-target access is a risk, baits should be well protected. Badgers, foxes and dogs are capable of overturning bait boxes and this risk should be reduced by securing bait boxes in position.

- Sufficient bait points should be established at appropriate locations that will cover all areas of rodent activity (following bait label instructions) but accounting for potential restrictions including hazards to non-target species, risk of contaminating sensitive areas (e.g. food preparation areas), adverse conditions and where baits will be regularly disturbed or eliminated.
- Baits must be placed so that they are not accessible to children, domestic pets, livestock or wildlife larger than the target.
- CCF baits can be left down for about 5-7 days, but should be checked daily; any spilled or exposed baits should be removed and disposed of safely. As soon as takes cease at individual points, all bait remaining in them should be removed.
- Where possible, contamination of baits by dust or moisture should be avoided.
- Risks to non-target animals should be managed, e.g., by using tamper-resistant bait boxes, choosing bait station positions carefully, limiting the duration of poisoned baiting periods, checking for and removing poisoned rodents and regularly checking bait station for signs of the presence of non-target organisms. If non-target species appear to be taking baits, then bait points should be moved or better protected. Poisoned bait should not be deployed at bait points where non-target uptake persists.
- Always keep a record of the product used, the quantity of bait laid and where this has been placed. A simple site plan indicating the location of bait points will help to keep track of the treatment.
- Bait points should be checked regularly and topped up as necessary. Replace any baits that become damp or wet and replenish depleted baits. If bait is allowed to run out, become unpalatable, or there are insufficient bait points, then control is likely to be unsuccessful. Keep a record of bait inspection/replenishment visits too.
- At the end of treatment, remove any remaining bait and update records to indicate that the infestation is controlled and that as far as is reasonably practical all steps have been taken to ensure that the site is free of rodenticide bait.
- Once effective rat control has been achieved this can be replaced by a prevention strategy.

Humane killing of poisoned rats

- Any rats that are found alive but poisoned should be killed quickly and humanely using an appropriate method.

- The most suitable technique for humane killing in these circumstances is destruction of the brain with a strong and accurate CBH using a suitable implement.
- The operator should approach poisoned rats alone and carefully to minimise panic, further stress and risk of additional injury to the trapped rat.
- Kill the rat swiftly, by striking the back of the rat's head accurately and strongly with a suitable heavy and blunt instrument.
- Death of the animal should always be confirmed by observing the following:
 - o Absence of rhythmic, respiratory movements;
 - o Absence of eye protection reflex (corneal reflex) or 'blink';
 - o A fixed, glazed expression in the eyes; and
 - o Loss of colour in mucous membranes (become mottled and pale without refill after pressure is applied).
- If the animal is not dead then repeat the killing method at once. Use a secondary method to ensure death (cervical dislocation, exsanguination, destruction of the brain) before disposing of the carcass.
- Personnel performing manually applied CBH must be properly trained and monitored for proficiency with this method of humane killing. No more than a few animals should be killed in this way at one time.
- If lactating females are poisoned, efforts should be made to find any nests containing dependent pups and humanely kill them, to prevent them from dying of starvation or dehydration.

Collection and disposal of rat carcasses

- Rats can carry infections that are dangerous to humans and other animals while poisoned animal carcasses present the risk of secondary poisoning to non-target animals. Wherever rodenticides are used, it is a requirement that rodent carcasses are regularly collected and disposed of. Because Rats poisoned with calciferol may die 4-10 days after consuming a lethal dose, searching for bodies may need to continue beyond the end of the treatment. Other animal carcasses should also be dealt with in this way. Carcasses must be disposed of safely. For further advice contact your Local Authority.

Further information

- Contact Natural England's Wildlife Management Advisors for more information and advice on site assessment and monitoring of rat numbers.

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An assessment of animal welfare impacts in wild Norway rat (*Rattus norvegicus*) management
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Online Resource 8:

Standard Operating Procedure UKRAT006: Non-toxic lethal cellulose bait for rats

Background

Norway rats (*Rattus norvegicus*) frequent urban and rural areas and may be found on commercial, municipal and domestic premises. They cause significant economic losses, eating 25-30 g of food per day each and contaminating far greater quantities with droppings, urine and hairs. They also transmit disease, cause chewing damage and create fire hazards by gnawing electrical wires. Non-toxic lethal cellulose (CELL) bait containing powdered corn cob (PCC) is not currently authorised for use in the UK or EU and this Standard Operating Procedure (SOP) has been created only for the purposes of assessing the welfare impacts of this method.

Methods that are available for managing rats, with varying degrees of efficacy, include anti-coagulant poisons, cholecalciferol, spring-traps, live cage-traps, shooting, gassing, electrocution traps, glue traps, chemical repellents and proofing. Sonic and electro-magnetic deterrents are also available but there is little or no evidence that these methods are effective.

CELL baits are used as a non-toxic food source that kills rats by disrupting their digestive system, resulting in lethal dehydration. They are marketed as a “natural and environmentally-friendly” alternative to anti-coagulant rodenticides. While PCC was included in Annex 1 of the EU Biocidal Products Regulation (2013), and is therefore an approved active ingredient, no PCC products are currently authorised for use in the UK or EU, although such products are used in North and South America. This SOP is for killing rats with non-toxic lethal CELL bait containing PCC. This SOP is for reference only and should not be used for the deployment of bait.

Application

- The Prevention of Damage by Pests Act 1949 makes local authorities responsible for ensuring that their districts are kept free of rats (as far as is practicable). The Act also requires occupiers of non-agricultural land to notify the local authority if 'substantial numbers' of rats are living on or resorting to the land. Occupiers of agricultural land are not however required to notify the local authority regarding rats on their land. Under the Act, local authorities have the power to require landowners and occupiers to control rat infestations on their land. Where necessary the local authority can conduct the control work and recover the cost from the landowner or occupier.
- Rats will thrive where there is cover, food and water and infestations occur in diverse circumstances as a result, including farms, food processing facilities, factories, hospitals, prisons, sewers, parks and gardens, and homes.
- Rats can legally be baited with CELL baits at any time of year (provided such a product is authorised for use in the UK). Control should be undertaken promptly as soon as a problem is identified. Leaving a small infestation unmanaged may allow it to develop, increases the risk of damage and disease and makes subsequent control more difficult and expensive.
- Long-term reduction in rat numbers might be best achieved by baiting before breeding peaks, but killing females with dependent pups raises welfare issues for the pups.
- Rat management campaigns may involve the use of more than one method as a combination of methods may prove most effective. Choice of method(s) will depend on the scale of the problem, the resources available (including competence/experience of the person conducting the management) and risks to non-target animals, people and hygiene.
- CELL baits disrupt the digestive system of rats and are thought to cause dehydration, reduced blood volume and reduced blood pressure, culminating in circulatory shock and reportedly death within a few days. The manufacturer of Eradirat (no longer available as the manufacturer went out of business) claimed that "after ingestion, dehydration commences, causing blood thickening and circulatory collapse, rats become lethargic and retreat to their burrow where they lapse into a coma and die. Rats dehydrate and are mummified, usually in their burrows."
- CELL baits are not currently available in the UK.
- They can be used indoors and outdoors and are safe to use in food processing, food packing and food storage areas. They are marketed as better alternatives to anti-coagulant rodenticides for several reasons: 1) they are poison-free; 2) there is no issue of genetic resistance towards CELL baits (as there is with anti-coagulants); 3) there is no risk of secondary effects on predators that eat rats killed with CELL baits; and 4) uneaten bait will degrade naturally. It is also claimed that there are no risks of primary effects on non-target animals but there is

potential for non-target small herbivorous or omnivorous animals to eat the baits and die or suffer ill-effects as a result.

- The products are based on PCC (e.g., 40-100%), in some cases mixed with wheat flour and molasses and they are presented as a rodenticide. They are sold as ready to-use pellets, sometimes with attractants or flavours added. Unlike conventional baits, CELL baits need to form a significant part of a rat's diet to be effective, but their efficacy and mode of action are not well known. There are reports of problems with palatability and that rats tend to eat other food if this is available, but there is some evidence that palatability can be improved by the addition of attractants.
- Operators must be properly trained and competent in the use of the products concerned. Product label instructions and directions for use should be read, understood and followed.
- While CELL baits are promoted as safe to non-target animals, risks cannot be ruled out. Therefore, it is good practice, outside buildings, for bait to be adequately protected from children and as far as possible from non-target animals.
- Rats are wary of unfamiliar objects appearing in their territories, so where practical, and where this can be done safely for non-target animals, it might be better to protect and secure bait points using existing materials rather than bait boxes. This may bring rats into contact with baits more effectively and reduce the length of time for which baits need to be used and non-targets are potentially exposed to it.
- Baits must be appropriately secured. Unless you can place bait under suitable cover, or (when baiting indoors) restrict access by other species, you will need to use a secure bait box – either homemade or a commercially available tamper-resistant model.
- Indoors, rather than placing bait directly on the floor, plastic trays or other means should be used to contain bait and facilitate clearing up.
- Following successful treatment of rats, it is vital that foods are stored securely and food spills cleared up, potential harbourage is cleared, vegetation kept short around rat runs and burrows and structures proofed against access by rats; otherwise re-infestation is likely to occur.
- Revisit the site regularly to monitor for new activity/damage.

Animal Welfare Considerations

Impact on target animals

- CELL-based products interfere with rats' water absorption, causing dehydration. Reports vary but suggest that death occurs within a few days of bait ingestion. Dehydration is thought to occur rapidly and is associated with reduced blood volume (hypovolaemia) and reduced blood

pressure, culminating in circulatory shock, multi-organ failure and death. The presence of a large volume of insoluble CELL fibre in the gut probably inhibits water reabsorption from the gut back into the bloodstream and also draws water from the blood into the gastrointestinal tract. This leads progressively to dehydration and hypovolaemia. The water-swollen CELL bait in the gut lumen creates pressure on the walls of the gut, inhibiting thirst and water intake, further exacerbating dehydration and hypovolaemia. Severe bowel impaction is reported. Electrolyte imbalance may occur. Animals are reported to become huddled and lethargic in the last few hours before death, suggesting pain, discomfort or sickness. However, a 2010 study in which CELL bait was the only available food (no-choice) found that two CELL bait products were ineffective for rats, with only one of twelve animals dying within 10 days when the experiment was stopped (although the other rats were weak), despite rat faeces consisting entirely of CELL after six days.

- In contrast, in a no-choice laboratory test of two CELL baits with house mice (*M. musculus*), 44 of 46 mice were dead by day 21 of the trial but this was largely due to cannibalism, potentially indicating that the main effect of the bait was starvation (CELL baits are low in nutrients) or dehydration. The author commented that while cannibalism was not observed in trials with brown rats, such an effect may have occurred if the rat study had been continued for longer. In any case it is not known whether such behavior would occur in a free-living population, because, in a choice study, when other food was available, rats consumed insufficient CELL bait for it to have an effect. One study with black rats showed that CELL bait palatability may be improved by adding attractants.

Impact on non-target animals

- If lactating females are killed, their dependent pups will die of starvation or dehydration unless they are found and humanely killed.
- CELL baits are marketed as being of no risk to children, pets, livestock or birds. Larger animals are unlikely to be affected because they won't consume sufficient CELL bait, but there is a possibility that small herbivorous or omnivorous animals may become ill or die if they consume the bait. The effect of non-target CELL baiting may be reversible, up to a certain point.
- Predators that eat rodents killed using CELL bait will not suffer secondary effects.

Health and Safety Considerations

- The GB Biocidal Products Regulation (2021) concerns the placing on the market and use of biocidal products. It is important that users of pesticides take all reasonable precautions to

protect the health of humans, animals and plants, to safeguard the environment and, in particular, to avoid the contamination of water. Product label instructions must be followed.

- Operators must be properly trained and aware of the risks associated with rodenticide use.
- Users must satisfy the requirements of the Health and Safety Executive's Control of Substances Hazardous to Health Regulations (COSHH) for each rodenticide used, including the availability of adequate storage and suitable protective clothing. As with all pesticide use it will be necessary for users to have made a risk assessment of the compounds that they intend to use. Records should be kept of product use and its placement at the site. The requirements for protective clothing and safe working practices must be understood before treatments are carried out.
- Products must be safely stored and containers labelled.
- Rat carcasses must be disposed of appropriately.
- Rats carry diseases that may be harmful to humans and other animals (including Leptospirosis [Weil's disease], Toxoplasmosis, Hantavirus and Salmonella). The Health and Safety at Work Act 1974 makes employers responsible for the health and safety of their employees, including managing the risk of rats transmitting disease. The COSHH regulations require employers to make sure an assessment is conducted to identify risks to human health arising from rat-borne diseases. Operators should be protected by tetanus immunisation.
- Good personal hygiene is encouraged when handling baits and rat carcasses. Routinely wash hands and other skin surfaces if contaminated with faeces, blood and other body fluids and after handling baits. Cuts and grazes should be treated and covered with a waterproof dressing and waterproof gloves should be worn, together with any additional protective equipment specified on the product label.

Equipment Required

Baits

- CELL baits.
- Small plastic freezer bags, bait trays, boxes or containers as required.

Other Equipment

- Personal protective equipment as required.
- Waterproof gloves.
- Heavy metal or heavy wooden blunt implement for killing any baited rats that are discovered alive.
- Suitable waterproof bags for carrying rat carcasses and any collected uneaten bait.

Procedures

Surveying for rat activity

- Effective rat baiting relies on locating rat runs and nesting areas. Before deploying baits, carry out a survey to determine where rats are living, feeding and drinking and the routes they take between these places. All areas of activity must be identified to minimise the risk of reinvasion. All buildings and surrounding areas, including contiguous hedgerows and ditches should be surveyed.
- Key features to look for include holes/burrows (6-9cm diameter), runs (5-10cm wide through vegetation or along linear features – greasy marks may be left where rats contact hard surfaces), droppings (15-20mm long, flat at one end and pointed at the other, moist when fresh), damage (chewed/gnawed materials, e.g. food stuffs, edges of doorways and holes, wooden features, electrical wiring), footprints/tail marks in soft mud/dust/bulk grain, sightings of live/dead rats and a musky smell.
- The survey should also seek to establish any particular risks or likely problems, e.g., risks to non-target animals, hygiene failings and structural faults.

Environmental assessment

- An environmental assessment to consider the possible threats to wildlife and domestic animals should be undertaken and documented whenever rodenticides are used, particularly in outdoor locations. This must include any specific risks identified and the measures that are being taken to minimise adverse effects on non-target species. This should be regularly reviewed during the course of the programme and documented. A record of the assessment should be retained.

Deployment of baits

- Wear gloves for operator protection and to help mask human odours.
- Bait boxes or trays that are to be used may be deployed without bait a few days in advance of beginning AR treatment in order to facilitate habituation by rats; alternatively, CELL baited boxes or trays may be deployed straight away. Existing food sources should be removed wherever possible.
- Before embarking on a baiting programme, read the product label carefully to ensure that the correct, legal and safe procedure for that specific product is followed and to check the quantities of bait to be laid, the number and frequency of bait points.
- CELL baits should be bagged up in 50g or 100g plastic freezer bags or placed in small bowls for deployment.

- Careful placement of baits is crucial to maximise effectiveness. Baits should be placed in areas of obvious rodent activity, such as on runs, near active nests or droppings. Inside buildings, attention should also be paid to ledges, beams, partitions, bases of walls, conduits, false floors and ceilings. Outdoors, bait stations may be placed in hedgerows, ditches or other habitat features if the label allows. Outdoors or where non-target access is a risk, baits should be well protected. Badgers, foxes and dogs are capable of overturning bait boxes and this risk should be reduced by securing bait boxes in position.
- Sufficient bait points should be established at appropriate locations that will cover all areas of rodent activity (following bait label instructions) but accounting for potential restrictions including hazards to non-target species, risk of contaminating sensitive areas (e.g. food preparation areas), adverse conditions and where baits will be regularly disturbed or eliminated.
- Baits must be placed so that they are not accessible to children, domestic pets, livestock or wildlife larger than the target. Inspect baits regularly; any spilled or exposed baits should be removed and disposed of safely.
- Where possible, contamination by dust or moisture should be avoided.
- Always keep a record of the product used, the quantity of bait laid and where this has been placed. A simple site plan indicating the location of bait points will help to keep track of the treatment.
- Bait points should be checked regularly and topped up as necessary. Replace any baits that become damp or wet and replenish depleted baits. If bait is allowed to run out, become unpalatable, or there are insufficient bait points, then control is likely to be unsuccessful. Keep a record of bait inspection/replenishment visits too.
- Although CELL baits should not be harmful to the environment, any remaining bait should be removed at the end of treatment and records updated to indicate that the infestation is controlled and that as far as is reasonably practical all steps have been taken to ensure that the site is free of rodenticide bait.
- Once effective rat control has been achieved this can be replaced by a prevention strategy.

Humane killing of baited rats

- Any rats that are found alive but suffering the effects of CELL baiting should be killed quickly and humanely using an appropriate method.
- The most suitable technique for humane killing in these circumstances is destruction of the brain with a strong and accurate CBH using a suitable implement.
- The operator should approach affected rats alone and carefully to minimise panic and further stress to the rat.

- Kill the rat swiftly, by striking the back of the rat's head accurately and strongly with a suitable heavy and blunt instrument.
- Death of the animal should always be confirmed by observing the following:
 - o Absence of rhythmic, respiratory movements;
 - o Absence of eye protection reflex (corneal reflex) or 'blink';
 - o A fixed, glazed expression in the eyes; and
 - o Loss of colour in mucous membranes (become mottled and pale without refill after pressure is applied).
- If the animal is not dead then repeat the killing method at once. Use a secondary method to ensure death (cervical dislocation, exsanguination, destruction of the brain) before disposing of the carcass.
- Personnel performing manually applied CBH must be properly trained and monitored for proficiency with this method of humane killing. No more than a few animals should be killed in this way at one time.
- If lactating females are baited, efforts should be made to find any nests containing dependent pups and humanely kill them, to prevent them from dying of starvation or dehydration.

Collection and disposal of rat carcasses

- Rats can carry infections that are dangerous to humans and other animals. Wherever rodenticides are used, it is a requirement that rodent carcasses are regularly collected and disposed of. Other animal carcasses should also be dealt with in this way. Carcasses must be disposed of safely. For further advice contact your Local Authority.

Further information

- Contact Natural England's Wildlife Management Advisors for more information and advice on site assessment and monitoring of rat numbers.

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An assessment of animal welfare impacts in wild Norway rat (*Rattus norvegicus*) management

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Online Resource 9: Frequency of stakeholder confidence scores for impact and duration assessments for six rat management methods. Blank cells are not relevant to assessment for a particular method; glue trap deployment was not deemed to impact upon rats until they are trapped, so deployment cell is blank for glue traps. Confidence scores are: 0=no animal data available, possible negative affective experiences inferred from human reports; 1=low confidence, more specific/detailed animal data required; 2=moderate confidence, more specific/detailed animal data would clarify; 3=high confidence. Median confidence scores are highlighted yellow.

	PART A DEPLOYMENT					PART A LIVE CAPTURE					PART B KILLING														
	Overall impact			Duration		Overall impact			Duration		Level of suffering			Duration											
	Confidence score	n			Confidence score	n		Confidence score	n		Confidence score	n		Confidence score	n										
	0	1	2	3	n	0	1	2	3	n	0	1	2	3	n	0	1	2	3	n					
Snap traps	0	0	0	15	15	0	0	2	13	15						0	12	1	0	13	0	1	8	3	12
Cage traps followed by concussive blow to head	0	0	0	15	15	0	0	2	13	15	0	0	12	2	14	0	0	0	15	15	0	0	0	15	15
Glue traps followed by concussive blow to head											0	0	1	14	15	0	0	0	15	15	0	0	0	15	15
Anticoagulants (scenario 1*)	0	0	2	12	14	0	0	4	10	14						0	0	9	5	14	0	0	2	12	14
Anticoagulants (scenario 2*)	0	1	2	12	15	0	0	0	15	15						0	0	9	5	14	0	0	2	12	14
Cholecalciferol (scenario 1*)	0	0	2	12	14	0	0	4	10	14						0	0	0	14	14	0	0	3	11	14
Cholecalciferol (scenario 2*)	0	1	2	12	15	0	0	0	15	15						0	0	0	14	14	0	0	3	11	14
Cellulose (scenario 1*)	0	0	2	12	14	0	0	4	10	14						0	0	6	9	15	0	0	1	14	15
Cellulose (scenario 2*)	0	1	2	12	15	0	0	0	15	15						0	0	6	9	15	0	0	1	14	15

*In deployment scenario 1, for the three baiting methods, boxes/tunnels or trays are deployed (without bait) a few days in advance of beginning baiting treatment. In deployment scenario 2, anticoagulant/cholecalciferol/cellulose baited boxes/tunnels or trays are deployed straight away. Existing food sources are removed wherever possible in both scenarios.

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Online Resource 10: Welfare assessment for snap trapping. Median confidence score is given.

CONTROL METHOD: SNAP TRAPPING UKRAT001

Assumptions

Best practice is followed in accordance with the Standard Operating Procedure UKRAT001.

It is assumed for this assessment that rats are captured using snap traps (break-back traps) that meet the AIHTS standards for regulated traps (at least 80% of 12 tests cause irreversible unconsciousness within 5 minutes).

Traps are deployed (in boxes or tunnels where needed) and set straight away; traps are not baited though many break-back traps come pre-treated with a lure. Existing food sources are left undisturbed.

Traps are checked once every day, between sunrise and sunset.

Part A: Assessment of overall welfare impact prior to killing method

Domain 1 Water or food restriction, malnutrition				
No impact	Mild impact	Moderate impact	Severe impact	Extreme impact
<i>Evidence</i>				
No impact				
Domain 2 Environmental challenge				
No impact	Mild impact	Moderate impact	Severe impact	Extreme impact
<i>Evidence</i>				
No impact				
Domain 3 Injury, disease, functional impairment				
No impact	Mild impact	Moderate impact	Severe impact	Extreme impact
<i>Evidence</i>				
No impact				
Domain 4 Behavioural or interactive restriction				
No impact	Mild impact	Moderate impact	Severe impact	Extreme impact
<i>Evidence</i>				
Rats are often described as neophobic but their foraging behaviour is the outcome of conflicting motivations between curiosity (neophilia) and caution (neophobia), known as ‘the omnivore’s paradox’ (Berdoy & Drickamer, 2007). Exposure of rats to an unfamiliar environment interferes with object recognition, and opposing drives to avoid and explore novel objects (Ennaceur et al, 2009) are likely to have a mild impact under this domain when boxes/tunnels are first deployed.				

Domain 5 Anxiety, fear, pain, distress, thirst, hunger				
No impact	Mild impact	Moderate impact	Severe impact	Extreme impact
<i>Evidence</i> Rats may experience mild anxiety because of opposing drives to explore novel objects (Ennaceur et al, 2009).				

Overall impact
Mild impact
Confidence score = 3

Duration of impact				
Immediate to seconds	Minutes	Hours	Days	Weeks
Confidence score = 3				
<i>Evidence</i> Observations indicate that rats take a few days to become sufficiently habituated to the presence of the boxes/tunnels, to enter these and potentially become trapped.				

Score Part A
5

CONTROL METHOD: SNAP TRAPPING UKRAT001
Part B: Assessment of killing method

Level of suffering				
No impact	Mild impact	Moderate impact	Severe impact	Extreme impact
Confidence score = 1				

Time to insensibility				
Immediate to seconds	Minutes	Hours	Days	Weeks
Confidence score = 2				

Score Part B
A-F

Summary of evidence

Duration

In this assessment, snap traps are likely to cause irreversible unconsciousness within 300 seconds (5 minutes) in most cases, as they are assumed to meet the International Agreement on Humane Trapping Standards (IAHTS). However, the best available rat traps are known to cause irreversible unconsciousness in <30 seconds if the striking bar strikes the rat on the back of the cranium or the back of the neck with sufficient force (upper cervical vertebrae) (German Environment Agency, 2020).

Suffering

There are no impacts under Domains 1 and 2. A wide range of physical impacts may occur under Domain 3. For example, an effective trap will kill by striking the correct anatomical location with sufficient impact momentum to fracture the cranium or upper cervical vertebrae, causing unconsciousness immediately or rapidly, followed by death (Mason & Littin 2003; Parrott et al., 2009; Morriss & Warburton 2014). If the trap strikes the neck, the clamping force may kill by occluding blood vessels supplying the brain or, if partially occluded carotids/jugulars are accompanied by a collapsed trachea, through hypercapnia (Nutman et al, 1998). If the trap strikes the body, thoracic compression may kill by causing asphyxiation resulting in hypoxia and hypercapnia (Parrott et al., 2009; Beausoleil & Mellor, 2015). In general, the impact momentum of a trap damages the nervous system, blood vessels and organs. Where this damage is not immediately lethal, haemorrhaging and swelling results in pain through the accumulation of pressure or restricted venous return, where inflammatory mediators cannot be eliminated from the injured area. Trapped animals may also experience cardiogenic shock (due to heart failure) and haemorrhagic shock (Gregory 2004). An animal dying from blood loss is likely to become unconscious before death and both time to unconsciousness and time to death will depend on the rate of blood loss and, where a body strike occurs, on whether there is any fatal compression of the heart and lungs, neurological damage, or other physical injury impairing core functions such as respiration. If the spinal cord is damaged this may be extremely painful or the rat could be paralysed and feel no direct pain. While a trapped rat remains conscious it will be prevented from performing normal behaviours, e.g., escape behaviour, and will experience impacts under Domain 4 as a result. Trapped animals that are not killed instantly are likely to experience at least pain and fear and potentially other unpleasant experiences leading to severe distress (Parrott et al 2009) under Domain 5. Impacts may change over time. Overall, the AIHTS threshold, of irreversible unconsciousness within 5 minutes, is not sufficient to rule out the possibility of the killing action causing impacts from 'no suffering' through to 'extreme suffering'.

Summary

CONTROL METHOD	SNAP TRAPPING	UKRAT001
OVERALL HUMANENESS SCORE		5-AF
Comments		
This assessment assumes that the SOP is followed but if traps do not meet the AIHTS standard, or they are poorly positioned or set, then impacts could be increased through animals taking longer than 5 minutes to reach irreversible unconsciousness or to die.		
Rats can be trapped year-round and may breed at any time depending on conditions. Trapping during breeding, as assessed here, could have welfare impacts for dependent pups. If lactating females are killed, efforts should be made to find any nests containing dependent pups and humanely kill them to prevent them from dying of starvation or dehydration.		

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An assessment of animal welfare impacts in wild Norway rat (*Rattus norvegicus*) management

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Online Resource 11: Welfare assessment for cage trapping followed by a concussive blow to the head. Median confidence score is given.

CONTROL METHOD: CAGE TRAPPING AND CONCUSSIVE BLOW TO THE HEAD

UKRAT002

Assumptions

Best practice is followed in accordance with the Standard Operating Procedure UKRAT002.

Rats are captured using standard single-capture, rat wire-mesh cage traps.

Traps are deployed, baited and set straight away. Existing food sources are left undisturbed.

Traps are checked twice a day, shortly after dawn and at dusk.

Note that if animals are handled the impact will be more severe.

Release of live-trapped rats is not recommended on welfare grounds.

Part A1: Assessment of welfare impact excluding killing method: trap deployment

Domain 1 Water or food restriction, malnutrition				
No impact	Mild impact	Moderate impact	Severe impact	Extreme impact
<i>Evidence</i>				
No impact				
Domain 2 Environmental challenge				
No impact	Mild impact	Moderate impact	Severe impact	Extreme impact
<i>Evidence</i>				
No impact				
Domain 3 Injury, disease, functional impairment				
No impact	Mild impact	Moderate impact	Severe impact	Extreme impact
<i>Evidence</i>				
No impact				
Domain 4 Behavioural or interactive restriction				
No impact	Mild impact	Moderate impact	Severe impact	Extreme impact
<i>Evidence</i>				
Rats are often described as neophobic but their foraging behaviour is the outcome of conflicting motivations between curiosity (neophilia) and caution (neophobia), known as ‘the omnivore’s paradox’ (Berdoy & Drickamer, 2007). Exposure of rats to an unfamiliar environment interferes with object recognition, and opposing drives to avoid and explore novel objects (Ennaceur et al, 2009) are likely to have a mild impact under this domain when cage traps are first deployed.				

Domain 5 Anxiety, fear, pain, distress, thirst, hunger				
No impact	Mild impact	Moderate impact	Severe impact	Extreme impact
<i>Evidence</i>				
Rats may experience mild anxiety because of opposing drives to explore novel objects (Ennaceur et al, 2009).				

Overall impact
Mild impact
Confidence score = 3

Duration of impact				
Immediate to seconds	Minutes	Hours	Days	Weeks
			Confidence score = 3	
<i>Evidence</i>				
Observations indicate that rats take a few days to become sufficiently habituated to the presence of the cage traps, to enter these and potentially become trapped.				

Score Part A1
5

Part A2: Assessment of welfare impact excluding killing method: capture

Domain 1 Water or food restriction, malnutrition				
No impact	Mild impact	Moderate impact	Severe impact	Extreme impact
<i>Evidence</i>				
Some bait is provided in traps and rats will be subject to a mild impact in this domain, with short-term water (and possibly food) restrictions that are within normal tolerance levels for the species. Rats may lose bodyweight through dehydration (Pearson et al, 2003) but trapping is avoided in adverse conditions to prevent dehydration (Waudby et al, 2019) and traps are checked every 12 hours to prevent animals dying of starvation or dehydration (Mason & Littin 2003).				

Domain 2 Environmental challenge				
No impact	Mild impact	Moderate impact	Severe impact	Extreme impact
<i>Evidence</i>				
Trapping is avoided in adverse conditions to prevent hypothermia which may cause loss of bodyweight (Pearson et al, 2003) or death (Waudby et al, 2019), although conditions can change over a 12-hour trap inspection period and so sufficient shade and protection from unexpected adverse weather is provided. A captured rat may be exposed to short-term damp, cold or hot conditions, depending on trap location, but these should be within their physiological adaptive capacity and represent a mild impact.				

Domain 3 Injury, disease, functional impairment				
No impact	Mild impact	Moderate impact	Severe impact	Extreme impact
<i>Evidence</i>				
Cage trapped rats may sustain minor mouth injuries when chewing on the trap in an effort to escape. Cage trapped small mammals experience increased stress levels, although covering the trap to reduce visibility for the trapped rat should reduce this effect (Bosson et al, 2012). There is mixed information on whether stress hormone levels in small				

mammals increase with length of time trapped (Bosson et al, 2012; Fletcher and Boonstra, 2006).

Domain 4 Behavioural or interactive restriction				
No impact	Mild impact	Moderate impact	Severe impact	Extreme impact
<i>Evidence</i>				
Normal behaviour and movement are restricted by the cage, causing a moderate to severe impact in this domain. Rats may become agitated because they are prevented from conducting behaviour that they are highly motivated to perform, e.g., hiding/escaping from predators (cats or dogs) or from cannibalism by other trapped rats, foraging, moving and lactating females may be agitated by being prevented from caring for pups. In some cases, predators (raptors or terrestrial predators) may approach or even attack a trap containing a rat, but the rat will be unable to perform normal escape behaviour.				
Domain 5 Anxiety, fear, pain, distress, thirst, hunger				
No impact	Mild impact	Moderate impact	Severe impact	Extreme impact
<i>Evidence</i>				
Rats are likely to experience fear and distress while trapped (Mason & Littin 2003), equating to a moderate to severe impact.				

Overall impact
Moderate-severe
Confidence score = 2

Duration of impact				
Immediate to seconds	Minutes	Hours	Days	Weeks
Confidence score = 3				
<i>Evidence</i>				
Rats may be trapped for up to 12 hours before being found and killed if best practice guidance is followed.				

Score Part A2
5-6

CONTROL METHOD: CONCUSSIVE BLOW TO THE HEAD

UKRAT002

Part B: Assessment of killing method

Level of suffering				
No impact	Mild impact	Moderate impact	Severe impact	Extreme impact
Confidence score = 2				

Time to insensibility				
Immediate to seconds	Minutes	Hours	Days	Weeks
Confidence score = 3				

Score Part B
D

Summary of evidence

Duration

The time for an operator to approach a rodent in a cage trap, transfer it into a sack, apply a concussive blow to the head (CBH), and for the rat to reach irreversible unconsciousness, is likely to be a few minutes at most.

Suffering

There is no impact under Domain 1, but there may be some impact under Domain 2 as the rat is briefly held within a sack before being killed. Provided CBH is administered effectively, the rat should be rendered unconscious instantly (AVMA, 2020) and there would be no functional impact under D3. (The rat will need to be well positioned in a corner of the sack and held firmly to achieve an optimal strike when the blow is delivered.) The trapped rat will experience impacts under Domain 4 as it is unable to escape the operator when they approach and then transfer the rat to a sack and position it for killing. Trapped rats are likely to experience fear and distress during this time (Mason & Littin 2003; Prout & King, 2006), producing mental impacts (D5). Overall, the impact of the killing process is likely to be 'moderate suffering'.

Summary

CONTROL METHOD	CAGE TRAPPING AND CONCUSSIVE BLOW TO THE HEAD	UKRAT002
OVERALL HUMANENESS SCORE	5-6D	
Comments		
<p>This assessment assumes that the SOP is followed but if cage traps are checked less often than specified, or trapped rats not killed quickly after discovery, then impacts could be increased. Prolonged periods of being trapped will lead to dehydration, starvation, exhaustion and exposure. If cage traps were inspected much more frequently the level of distress would be reduced.</p> <p>The killing and handling process is likely to take a few minutes. The skill and confidence of the operator will have a significant effect on welfare. If not performed correctly there will be varying degrees of consciousness with associated pain (Close et al 1996). Operators performing manually applied CBH must be properly trained and monitored for proficiency with this method of euthanasia. Repeatedly performing CBH can result in operator fatigue, loss of efficacy and welfare concerns (AVMA 2020).</p> <p>Death should be confirmed and if necessary a second blow quickly deployed.</p> <p>Rats can be trapped year-round and may breed at any time depending on conditions. Trapping during breeding, as assessed here, could have welfare impacts for dependent pups. If lactating females are killed, efforts should be made to find any nests containing dependent pups and humanely kill them to prevent them from dying of starvation or dehydration.</p>		

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An assessment of animal welfare impacts in wild Norway rat (*Rattus norvegicus*) management

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Online Resource 12: Welfare assessment for glue trapping followed by a concussive blow to the head. Median confidence score is given.

CONTROL METHOD: GLUE TRAPPING AND CONCUSSIVE BLOW TO THE HEAD

UKRAT003

Assumptions

Best practice is followed in accordance with the Standard Operating Procedure UKRAT003.

Rats are captured using glue traps that are designed and sold for use with for rats.

Glue traps are used indoors only. They are deployed and existing food sources are left undisturbed.

Traps are checked every 12 hours.

Part A: Assessment of welfare impact excluding killing method: capture

Domain 1 Water or food restriction, malnutrition				
No impact	Mild impact	Moderate impact	Severe impact	Extreme impact
<i>Evidence</i>				
No bait can be provided in glue traps and because rats have a relatively high metabolic rate they will generally experience a moderate impact in this domain. Water and food restrictions may impact their physiological state or body condition but such effects would remain within the capacity of the body to recover if a good quality diet was restored. Animals left for a very long time may die of starvation or dehydration (Mason & Littin 2003).				
Domain 2 Environmental challenge				
No impact	Mild impact	Moderate impact	Severe impact	Extreme impact
<i>Evidence</i>				
Glue traps are used indoors where rats would not normally experience environmental conditions beyond their physiological adaptive capacity. However, once trapped in glue, rats are likely to experience a moderate impact under Domain 2 because they may not be able to thermoregulate effectively as a result of being unable to move and because large areas of their skin may be covered with glue. Mice (<i>Mus musculus</i>) have been found covered in faeces and urine after 3-5 hours of being trapped on a glue traps (Frantz & Padula 1983).				
Domain 3 Injury, disease, functional impairment				
No impact	Mild impact	Moderate impact	Severe impact	Extreme impact
<i>Evidence</i>				
Glue traps cause moderate to extreme debility or incapacity. Rats become stuck to glue by their feet, body, head and fur (Frantz & Padula 1983; Mason & Littin 2003), often ending up lying on their side in the glue. As they attempt to escape the glue they become more firmly stuck. Impacts may include physical effects of the glue on functioning, e.g. trauma caused by panic and efforts to escape (glue trapped mice have been found with fur pulled out, skin torn, limbs broken (Frantz & Padula 1983)). Eyes may be damaged and mouths glued shut (Fenwick 2014). Some rodents bite through their own limbs to escape (Franz & Padula 1983). They may defecate and urinate excessively from panic and distress (MAF, 2008). Rats become exhausted from struggling (Mason & Littin, 2003) and may die of exhaustion or suffocation (Mason & Littin 2003).				

Domain 4 Behavioural or interactive restriction				
No impact	Mild impact	Moderate impact	Severe impact	Extreme impact
<i>Evidence</i>				
Rats are observed to run onto glue traps without noticing them so no effects of neophobia or neophilia are recorded here. Glue traps have an extreme impact on the behaviour and movement of trapped rats. Rats may become agitated because they are prevented from conducting behaviour that they are highly motivated to perform, e.g., hiding/escaping from predators (cats or dogs) or from cannibalism by other trapped rats, foraging, moving and lactating females may be agitated by being prevented from caring for pups. Self-mutilation may occur when rats are trapped for long periods (Mason & Littin 2003). Lactating females may be agitated by being prevented from caring for young.				
Domain 5 Anxiety, fear, pain, distress, thirst, hunger				
No impact	Mild impact	Moderate impact	Severe impact	Extreme impact
<i>Evidence</i>				
Rats will experience extreme inescapable anxiety, fear and pain, and breathlessness if suffocation occurs on glue traps (Mason & Littin 2003; Beausoleil & Mellor, 2015). Trapped rodents will experience fear and perhaps pain if subjected to aggression or predation by other animals. They are also likely to experience hunger and thirst (Mason & Littin 2003).				

Overall impact
Extreme impact
Confidence score = 3

Duration of impact				
Immediate to seconds	Minutes	Hours	Days	Weeks
		Confidence score = 3		
<i>Evidence</i>				
Rats may survive for hours after being caught on glue traps (Tripathi et al 1994, in Fenwick 2014) and may be trapped for up to 12 hours before being found and killed, if best practice is followed.				

Score Part A
7

CONTROL METHOD: CONCUSSIVE BLOW TO THE HEAD **UKRAT003**
Part B: Assessment of killing method

Level of suffering				
No impact	Mild impact	Moderate impact	Severe impact	Extreme impact
		Confidence score = 3		

Time to insensibility				
Immediate to seconds	Minutes	Hours	Days	Weeks
		Confidence score = 3		

Score Part B
B-D

Summary of evidence

Duration

The time for an operator to approach a rodent on a glue trap, handle the glue trap as necessary, apply a concussive blow to the head (CBH), and for the rat to reach irreversible unconsciousness, is likely to be between seconds and a few minutes.

Suffering

There is no impact under Domains 1 and 2. CBH can destroy or render non-functional the brain regions responsible for cortical integration, in which case instantaneous unconsciousness will be caused with no impact under Domain 3 (AVMA 2020). However, in some cases, the position of the rat on the glue trap could interfere with achieving an optimal strike, resulting in some impact. There will be an impact under Domain 4 when the trapped rat is unable to avoid the approaching operator. Rats trapped alive are likely to experience fear and distress under Domain 5 when the operator approaches the trap and dispatches the rat (Mason & Littin 2003); glue trapped rodents may be squealing when approached (Mason & Littin 2003). No direct handling of the rat is involved but the animal is held in a fixed position on the glue trap, which may need to be manipulated before killing takes place. However, the impact of the whole killing process is likely to be 'mild suffering' to 'moderate suffering'. The Part B score here (B-d) is less than that for CBH applied after cage trapping (D) because CBH can be applied to a rat caught on a GT, while a rat in a CT will need to be moved to a sack before CBH can be applied.

Summary

CONTROL METHOD	GLUE TRAPPING AND CONCUSSIVE BLOW TO THE HEAD	UKRAT003
OVERALL HUMANENESS SCORE	7B-D	
Comments		
<p>This assessment assumes that the SOP is followed but if glue traps are checked less often than specified, or trapped rats not killed quickly after discovery, then impacts could be increased. Prolonged periods of being trapped will lead to dehydration, starvation, exhaustion and exposure. If glue traps were inspected much more frequently the level of pain/distress would be reduced.</p> <p>The killing process should last a few minutes at most. The skill and confidence of the operator will have a significant effect on welfare. If not performed correctly there will be varying degrees of consciousness with associated pain (Close et al 1996). Operators performing CBH must be properly trained and monitored for proficiency with this method of euthanasia. Repeatedly performing CBH can result in operator fatigue, loss of efficacy and welfare concerns (AVMA 2020). Death should be confirmed and if necessary a second blow quickly deployed.</p> <p>Rats can be trapped year-round and may breed at any time depending on conditions. Trapping during breeding, as assessed here, could have welfare impacts for dependent pups. If lactating females are killed, efforts should be made to find any nests containing dependent pups and humanely kill them to prevent them from dying of starvation or dehydration.</p>		

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An assessment of animal welfare impacts in wild Norway rat (*Rattus norvegicus*) management

Sandra E. Baker*, Michael Ayers, Ngaio J. Beausoleil, Steven R. Belmain, Manuel Berdoy, Alan P. Buckle, Christopher Cagienard, David Cowan, Jane Fearn-Daglish, Peter Goddard, Huw D.R. Golledge, Elizabeth Mullineaux, Trudy Sharp, Alick Simmons, Erik Schmolz

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Online Resource 13: Welfare assessment for anticoagulant baiting; Scenario 1. Median confidence score is given.

CONTROL METHOD: ANTI-COAGULANT POISONING UKRAT004

Assumptions

Best practice is followed in accordance with the Standard Operating Procedure UKRAT004.

Any bait boxes/tunnels or trays that are to be used are deployed (without bait) a few days in advance of beginning anti-coagulant baiting treatment. Existing food sources are removed wherever possible.

Part A: Assessment of welfare impact excluding killing method

Domain 1 Water or food restriction, malnutrition				
No impact	Mild impact	Moderate impact	Severe impact	Extreme impact
<i>Evidence</i>				
Obvious existing food sources have been removed where possible. Rats tend to follow foraging trails made by other members of their colony (Galef & Buckley, 1996). If these trails are interrupted and key food sources have been removed, then foraging success may be reduced. Together, reduced foraging success and bait shyness towards the anti-coagulant treated baits, when these are deployed, will have a mild impact under this domain.				
Domain 2 Environmental challenge				
No impact	Mild impact	Moderate impact	Severe impact	Extreme impact
<i>Evidence</i>				
No impact.				
Domain 3 Injury, disease, functional impairment				
No impact	Mild impact	Moderate impact	Severe impact	Extreme impact
<i>Evidence</i>				
No impact.				
Domain 4 Behavioural or interactive restriction				
No impact	Mild impact	Moderate impact	Severe impact	Extreme impact
<i>Evidence</i>				
There is a mild impact under this domain. Rats tend to follow foraging trails made by other members of their colony (Galef & Buckley, 1996). If these trails are interrupted and key food sources have been removed, then foraging behaviour will increase to compensate for disrupted foraging. Rats are often described as neophobic but their foraging behaviour is the outcome of conflicting motivations between curiosity (neophilia) and caution				

(neophobia), known as ‘the omnivore’s paradox’ (Berdoy & Drickamer, 2007). Exposure of rats to an unfamiliar environment interferes with object recognition, and opposing drives to avoid and explore novel objects (Ennaceur et al, 2009) may have a mild impact under this domain when boxes/tunnels are first deployed.

Domain 5 Anxiety, fear, pain, distress, thirst, hunger

No impact	Mild impact	Moderate impact	Severe impact	Extreme impact
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Evidence

Rats may experience mild anxiety because of hunger and because of opposing drives to explore novel objects (Ennaceur et al, 2009).

Overall impact

Mild impact

Confidence score = 3

Duration of impact

Immediate to seconds	Minutes	Hours	Days	Weeks
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Confidence score = 3

Evidence

Observations indicate that rats take a few days to become sufficiently habituated to the presence of the boxes/tunnels, to enter these and to eat anti-coagulant baits, when these are deployed.

Score Part A

5

CONTROL METHOD: ANTI-COAGULANT POISONING

UKRAT004

Part B: Assessment of killing method

Level of suffering

No impact	Mild impact	Moderate impact	Severe impact	Extreme impact
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Confidence score = 2

Time to insensibility

Immediate to seconds	Minutes	Hours	Days	Weeks
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Confidence score = 3

Score Part B

G-H

Summary of evidence

Duration

The timing of effects varies with bait uptake and individual. The time between first bait uptake and death typically ranges between 4-11 days. Signs are apparent for multiple days (Mason & Littin, 2003).

Suffering

The quantity of poison ingested and site of haemorrhage will affect type and severity of impacts under all domains. Bleeding in the gut will reduce appetite; rats are anorexic for several days before death and experience significant weight loss (Fisher et al 2010) under Domain 1. Poisoned rodents are seen above ground in exposed positions (Fisher et al 2010), which could lead to environmental impacts under Domain 2. Impacts under Domain 3 include haemorrhages into organs and body cavities including: muscles, joints (or articular cavities), the gastrointestinal tract, abdominal cavity, eye or reproductive organs. Depending on the body systems involved, these are likely to cause severe impairment and poisoned animals ultimately die of anaemia or hypovolaemic shock (Fisher et al 2010). Bleeding into the lungs may compromise respiratory function (Fisher et al 2010). If haemorrhaging occurs in the brain or central nervous system, ataxia or convulsions may occur. Some animals are paralysed (Littin et al 2000 in Fisher et al 2010). Poisoned animals exhibit poor overall condition (Mason & Littin, 2003) and a hunched posture. Behavioural impacts under Domain 4 include reduced grooming, struggling movements (Mason & Littin, 2003), reduced home range sizes (Walther et al, 2021) and reduced or altered activity (Cox & Smith, 1992; Fisher et al 2010). Poisoned rats spend time in exposed positions away from cover, lose their flight response and make no effort to protect themselves, rendering them more vulnerable to predation (Cox, 1991, cited in Fisher et al 2010). For the last couple of days before death, they tend to hide in cover and hardly move. Under Domain 5, haemorrhages in multiple enclosed spaces (especially gastro-intestinal tract, orbital, intra-cranial) are likely to cause severe pain (P.S.D., 1997). Bleeding into lungs may cause breathlessness (Broom, 1999; Beausoleil & Mellor, 2015). Other impacts include lethargy and weakness (Fisher et al 2010). Hypovolaemia will also lead to thirst and dizziness. Animals may experience anxiety and fear because they are unable to escape or defend themselves normally. Rats typically remain conscious throughout anti-coagulant poisoning until death (Mason & Littin, 2003) and thus will have the capacity for these sorts of unpleasant experiences from the start of signs to the time of death. The impact of the killing process caused by anti-coagulant poisoning is likely to be 'severe suffering' to 'extreme suffering'. The range of scores reflects variation in the location of haemorrhaging and the speed of blood loss and thus loss of consciousness.

Summary

CONTROL METHOD	ANTI-COAGULANT POISONING	UKRAT004
OVERALL HUMANENESS SCORE	5G-H	
Comments		
Rats can be poisoned year-round and may breed at any time depending on conditions. Poisoning during breeding, as assessed here, could have welfare impacts for dependent pups. If lactating females are killed, efforts should be made to find any nests containing dependent pups and humanely kill them to prevent them from dying of starvation or dehydration.		
Unused bait and poisoned rat carcasses should be collected and disposed of in accordance with local requirements to avoid primary and secondary poisoning of non-target animals.		

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An assessment of animal welfare impacts in wild Norway rat (*Rattus norvegicus*) management

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Online Resource 14: Welfare assessment for anticoagulant baiting; Scenario 2. Median confidence score is given.

CONTROL METHOD: ANTI-COAGULANTS UKRAT004

Assumptions

Best practice is followed in accordance with the Standard Operating Procedure UKRAT004.

Anti-coagulant baited boxes/tunnels or trays are deployed straight away. Existing food sources are removed wherever possible.

Part A: Assessment of welfare impact excluding killing method

Domain 1 Water or food restriction, malnutrition				
No impact	Mild impact	Moderate impact	Severe impact	Extreme impact
<i>Evidence</i> Obvious existing food sources have been removed where possible. Rats tend to follow foraging trails made by other members of their colony (Galef & Buckley, 1996). If these trails are interrupted and key food sources removed, then foraging success may be reduced. Together, reduced foraging success and bait shyness towards the anti-coagulant treated baits will have a mild impact under this domain.				
Domain 2 Environmental challenge				
No impact	Mild impact	Moderate impact	Severe impact	Extreme impact
<i>Evidence</i> No impact.				
Domain 3 Injury, disease, functional impairment				
No impact	Mild impact	Moderate impact	Severe impact	Extreme impact
<i>Evidence</i> No impact.				
Domain 4 Behavioural or interactive restriction				
No impact	Mild impact	Moderate impact	Severe impact	Extreme impact
<i>Evidence</i> There is a mild impact under this domain. Rats tend to follow foraging trails made by other members of their colony (Galef & Buckley, 1996). If these trails are interrupted and key food sources have been removed, then foraging behaviour will increase to compensate for disrupted foraging. Rats are often described as neophobic but their foraging behaviour is the outcome of conflicting motivations between curiosity (neophilia) and caution (neophobia), known as 'the omnivore's paradox' (Berdoy & Drickamer, 2007). Exposure of rats to an unfamiliar environment interferes with object recognition, and opposing drives to avoid and explore novel objects (Ennaceur et al, 2009) may have a mild impact under this domain when boxes/tunnels are first deployed.				
Domain 5 Anxiety, fear, pain, distress, thirst, hunger				
No impact	Mild impact	Moderate impact	Severe impact	Extreme impact
<i>Evidence</i> Rats may experience mild anxiety because of hunger and because of opposing drives to explore novel objects (Ennaceur et al, 2009).				

Overall impact
Mild impact
Confidence score = 3

Duration of impact				
Immediate to seconds	Minutes	Hours	Days	Weeks
			Confidence score = 3	
<i>Evidence</i>				
Observations indicate that rats take a few days to become sufficiently habituated to the presence of the boxes/tunnels, to enter these and to eat anti-coagulant baits.				

Score Part A
5

CONTROL METHOD: ANTI-COAGULANTS UKRAT004
Part B: Assessment of killing method

Level of suffering				
No impact	Mild impact	Moderate impact	Severe impact	Extreme impact
			Confidence score = 2	

Time to insensibility				
Immediate to seconds	Minutes	Hours	Days	Weeks
			Confidence score = 3	

Score Part B
G-H
<i>Summary of evidence</i>
<i>Duration</i>
The timing of effects varies with bait uptake and individual. The time between first bait uptake and death typically ranges between 4-11 days. Signs are apparent for multiple days (Mason & Littin, 2003).
<i>Suffering</i>
The quantity of poison ingested and site of haemorrhage will affect type and severity of impacts under all domains. Bleeding in the gut will reduce appetite; rats are anorexic for several days before death and experience significant weight loss (Fisher et al 2010) under Domain 1. Poisoned rodents are seen above ground in exposed positions (Fisher et al 2010), which could lead to impacts under Domain 2. Impacts under Domain 3 include haemorrhages into organs and body cavities including: muscles, joints (or articular cavities), the gastrointestinal tract, abdominal cavity, eye or reproductive organs. Depending on the body systems involved, these are likely to cause severe impairment and poisoned animals ultimately die of anaemia or hypovolaemic shock (Fisher et al 2010). Bleeding into the lungs may compromise respiratory function (Fisher et al 2010). If haemorrhaging occurs in the brain or central nervous system, ataxia or convulsions may occur. Some animals are paralysed (Fisher et al 2010). Poisoned animals exhibit poor overall condition (Mason & Littin, 2003) and a hunched posture, Behavioural impacts under Domain 4 include reduced grooming, struggling movements (Mason & Littin, 2003), reduced home range sizes (Walther et al, 2021) and reduced or altered activity (Cox & Smith, 1992; Fisher et al 2010). Poisoned rats spend time in exposed positions away from cover, lose their flight response and make no effort to protect themselves, rendering them more vulnerable to predation (Fisher et al 2010). For the last couple of days before death, they tend to hide in cover and hardly move. Under Domain 5, haemorrhages in multiple enclosed spaces (especially gastro-intestinal tract, orbital, intra-cranial) are likely to cause severe pain (P.S.D., 1997). Bleeding into lungs may cause breathlessness (Broom, 1999; Beausoleil & Mellor, 2015). Other impacts include lethargy and weakness (Fisher et al 2010). Hypovolaemia will

also lead to thirst and dizziness. Animals may experience anxiety and fear because they are unable to escape or defend themselves normally. Rats typically remain conscious throughout anti-coagulant poisoning until death (Mason & Littin, 2003) and thus will have the capacity for these sorts of unpleasant experiences from the start of signs to the time of death. The impact of the killing process caused by anti-coagulant poisoning is likely to be 'severe suffering' to 'extreme suffering'. The range of scores reflects variation in the location of haemorrhaging and the speed of blood loss and thus loss of consciousness.

Summary

CONTROL METHOD	ANTI-COAGULANTS	UKRAT004
OVERALL HUMANENESS SCORE		5G-H
<p>Comments</p> <p>Rats can be poisoned year-round and may breed at any time depending on conditions. Poisoning during breeding, as assessed here, could have welfare impacts for dependent pups. If lactating females are killed, efforts should be made to find any nests containing dependent pups and humanely kill them to prevent them from dying of starvation or dehydration.</p> <p>Unused bait and poisoned rat carcasses should be collected and disposed of in accordance with local requirements to avoid primary and secondary poisoning of non-target animals.</p>		

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Online Resource 15: Welfare assessment for cholecalciferol baiting; Scenario 1. Median confidence score is given.

CONTROL METHOD: CHOLECALCIFEROL UKRAT005

Assumptions

Best practice is followed in accordance with the Standard Operating Procedure UKRAT005.

Any bait boxes/tunnels or trays that are to be used are deployed (without bait) a few days in advance of beginning cholecalciferol baiting treatment. Existing food sources are removed wherever possible.

Part A: Assessment of welfare impact excluding killing method

Domain 1 Water or food restriction, malnutrition				
No impact	Mild impact	Moderate impact	Severe impact	Extreme impact
<i>Evidence</i>				
Obvious existing food sources have been removed where possible. Rats tend to follow foraging trails made by other members of their colony (Galef & Buckley, 1996). If these trails are interrupted and key food sources have been removed, then foraging success may be reduced. Together, reduced foraging success and bait shyness towards the cholecalciferol treated baits, when these are deployed, will have a mild impact under this domain.				
Domain 2 Environmental challenge				
No impact	Mild impact	Moderate impact	Severe impact	Extreme impact
<i>Evidence</i>				
No impact.				
Domain 3 Injury, disease, functional impairment				
No impact	Mild impact	Moderate impact	Severe impact	Extreme impact
<i>Evidence</i>				
No impact.				
Domain 4 Behavioural or interactive restriction				
No impact	Mild impact	Moderate impact	Severe impact	Extreme impact
<i>Evidence</i>				
There is a mild impact under this domain. Rats tend to follow foraging trails made by other members of their colony (Galef & Buckley, 1996). If these trails are interrupted and key food sources have been removed, then foraging behaviour will increase to compensate for disrupted foraging. Rats are often described as neophobic but their foraging behaviour is the outcome of conflicting motivations between curiosity (neophilia) and caution (neophobia), known as 'the omnivore's paradox' (Berdoy & Drickamer, 2007). Exposure of rats to an unfamiliar environment				

interferes with object recognition, and opposing drives to avoid and explore novel objects (Ennaceur et al, 2009) may have a mild impact under this domain when boxes/tunnels are first deployed.

Domain 5 Anxiety, fear, pain, distress, thirst, hunger

No impact	Mild impact	Moderate impact	Severe impact	Extreme impact
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Evidence
Rats may experience mild anxiety because of hunger and because of opposing drives to explore novel objects (Ennaceur et al, 2009).

Overall impact
Mild impact
Confidence score = 3

Duration of impact

Immediate to seconds	Minutes	Hours	Days	Weeks
			Confidence score = 3	

Evidence
Observations indicate that rats take a few days to become sufficiently habituated to the presence of the boxes/tunnels, to enter these and to eat cholecalciferol baits, when these are deployed.

Score Part A
5

CONTROL METHOD: CHOLECALCIFEROL UKRAT005

Part B: Assessment of killing method

Level of suffering

No impact	Mild impact	Moderate impact	Severe impact	Extreme impact
			Confidence score = 3	

Time to insensibility

Immediate to seconds	Minutes	Hours	Days	Weeks
			Confidence score = 3	

Score Part B
G-H

Summary of evidence

Duration

The time between cholecalciferol bait uptake and death varies between 1 and 13 days in Norway rats (2-4 days for Selontra® (EU, 2020), with acute signs appearing after 14-48 hours in rodents. Signs of poisoning are evident for several days (Mason & Littin, 2003).

Suffering

Under Domain 1, Cholecalciferol poisoning causes anorexia (with Selontra® rats stop feeding after 1-2 days (EU, 2020), leading to days without food or water and causing weight loss and likely starvation and/or dehydration (Mason & Littin, 2003). Behavioural changes could expose rats to environmental conditions outside the normal range experienced causing impacts under Domain 2. Under Domain 3, Cholecalciferol interferes with calcium homeostasis, causing mobilisation of calcium from the bone matrix and increased uptake in the gut, leading to hypercalcaemia and calcification within organs, including kidneys and heart, and blood vessels (Mason & Littin, 2003). Osteomalacia, due to bone resorption, may occur (RRAG 2018), predisposing animals to fractures. As a consequence of these effects, poisoned animals display vomiting, abnormal breathing, severe haemorrhages, tremors, coma, other central nervous system signs and necrotic tails. Elevated levels of circulating urea, due to kidney dysfunction, and secondary to renal failure, may lead to cerebral disturbance and ataxia. Rats will exhibit poor condition, piloerection and a hunched posture (Mason & Littin, 2003). The mode of death is most likely to be acute heart or renal failure (RRAG 2018; Mason & Littin, 2003). Anorexia, and potentially starvation-related weakness, result in secondary disabling effects under Domain 4. Animals may be reluctant to move and exhibit a lack of reaction to external stimuli. Prolonged pain interferes with ability to forage and hinders escape from predators (Mason & Littin, 2003). Under Domain 5, rodents are likely to experience sickness, lethargy, weakness, listlessness, thirst and pain (Mason & Littin, 2003). Pain and nausea are also likely when renal failure causes circulating urea levels in the blood to rise and because of build-up of urea crystals in organs and joints. Bone pain and muscle weakness may occur as a result of osteomalacia. Breathlessness may occur, as calcification of lung tissue has been seen in humans (Mason & Littin, 2003; Beausoleil & Mellor, 2015) and congestion and alveolar haemorrhaging have been observed in possum (*Trichosurus Vulpecula*) lungs (Jolly et al, 1993). Animals may experience anxiety and fear because they are unable to escape or defend themselves normally. Rats may experience confusion, depression and fatigue as direct effects of hypercalcaemia on the nervous system, as known in other species. There is no evidence that consciousness is reduced before the time of death (Fisher et al, 2010); thus rats are likely to remain capable of having these sorts of unpleasant experiences from the onset of poisoning until shortly before the time of death. The impact of the killing process caused by cholecalciferol poisoning is likely to be 'severe' to 'extreme'.

Summary

CONTROL METHOD	CHOLECALCIFEROL	UKRAT005
OVERALL HUMANENESS SCORE		5G-H
Comments		
Rats can be poisoned year-round and may breed at any time depending on conditions. Poisoning during breeding, as assessed here, could have welfare impacts for dependent pups. If lactating females are killed, efforts should be made to find any nests containing dependent pups and humanely kill them to prevent them from dying of starvation or dehydration.		
Unused bait and poisoned rat carcasses should be collected and disposed of in accordance with local requirements to avoid primary and secondary poisoning of non-target animals.		

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evidence from exposure to novelty and to an object recognition task in an open space and an enclosed space.

Behavioural Brain Research 197:417-434

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Online Resource OR16: Welfare assessment for cholecalciferol baiting; Scenario 2. Median confidence score is given.

CONTROL METHOD: CHOLECALCIFEROL POISONING UKRAT005

Assumptions

Best practice is followed in accordance with the Standard Operating Procedure UKRAT005.

Cholecalciferol baited boxes/tunnels or trays are deployed straight away. Existing food sources are removed wherever possible.

Part A: Assessment of welfare impact excluding killing method

Domain 1 Water or food restriction, malnutrition				
No impact	Mild impact	Moderate impact	Severe impact	Extreme impact
<i>Evidence</i>				
Obvious existing food sources have been removed where possible. Rats tend to follow foraging trails made by other members of their colony (Galef & Buckley, 1996). If these trails are interrupted and key food sources removed, then foraging success may be reduced. Together, reduced foraging success and bait shyness towards the cholecalciferol treated baits will have a mild impact under this domain.				
Domain 2 Environmental challenge				
No impact	Mild impact	Moderate impact	Severe impact	Extreme impact
<i>Evidence</i>				
No impact.				
Domain 3 Injury, disease, functional impairment				
No impact	Mild impact	Moderate impact	Severe impact	Extreme impact
<i>Evidence</i>				
No impact.				
Domain 4 Behavioural or interactive restriction				
No impact	Mild impact	Moderate impact	Severe impact	Extreme impact
<i>Evidence</i>				
There is a mild impact under this domain. Rats tend to follow foraging trails made by other members of their colony (Galef & Buckley, 1996). If these trails are interrupted and key food sources have been removed, then foraging behaviour will increase to compensate for disrupted foraging. Rats are often described as neophobic but their foraging behaviour is the outcome of conflicting motivations between curiosity (neophilia) and caution (neophobia), known as 'the omnivore's paradox' (Berdoy & Drickamer, 2007). Exposure of rats to an unfamiliar environment interferes with object recognition, and opposing drives to avoid and explore novel objects (Ennaceur et al, 2009) may have a mild impact under this domain when boxes/tunnels are first deployed.				

Domain 5 Anxiety, fear, pain, distress, thirst, hunger				
No impact	Mild impact	Moderate impact	Severe impact	Extreme impact
<i>Evidence</i>				
Rats may experience mild anxiety because of hunger and because of opposing drives to explore novel objects (Ennaceur et al, 2009).				

Overall impact
Mild impact
Confidence score = 3

Duration of impact				
Immediate to seconds	Minutes	Hours	Days	Weeks
			Confidence score = 3	
Observations indicate that rats take a few days to become sufficiently habituated to the presence of the boxes/tunnels, to enter these and to eat cholecalciferol baits.				

Score Part A
5

CONTROL METHOD: CHOLECALCIFEROL POISONING

UKRAT005

Part B: Assessment of killing method

Level of suffering				
No impact	Mild impact	Moderate impact	Severe impact	Extreme impact
			Confidence score = 3	

Time to insensibility				
Immediate to seconds	Minutes	Hours	Days	Weeks
			Confidence score = 3	

Score Part B
G-H

Summary of evidence

Duration

The time between cholecalciferol bait uptake and death varies between 1 and 13 days in Norway rats (2-4 days for Selontra® (EU, 2020), with acute signs appearing after 14-48 hours in rodents. Signs of poisoning are evident for several days (Mason & Littin, 2003).

Suffering

Under Domain 1, Cholecalciferol poisoning causes anorexia (with Selontra® rats stop feeding after 1-2 days (EU, 2020), leading to days without food or water and causing weight loss and likely starvation and/or dehydration (Mason & Littin, 2003). Behavioural changes could expose rats to environmental conditions outside the normal range experienced causing impacts under Domain 2. Under Domain 3, Cholecalciferol interferes with calcium

homeostasis, causing mobilisation of calcium from the bone matrix and increased uptake in the gut, leading to hypercalcaemia and calcification within organs, including kidneys and heart, and blood vessels (Mason & Littin, 2003). Osteomalacia, due to bone resorption, may occur (RRAG 2018), predisposing animals to fractures. As a consequence of these effects, poisoned animals display vomiting, abnormal breathing, severe haemorrhages, tremors, coma, other central nervous system signs and necrotic tails. Elevated levels of circulating urea, due to kidney dysfunction, and secondary to renal failure, may lead to cerebral disturbance and ataxia. Rats will exhibit poor condition, piloerection and a hunched posture (Mason & Littin, 2003). The mode of death is most likely to be acute heart or renal failure (RRAG 2018; Mason & Littin, 2003). Anorexia, and potentially starvation-related weakness, result in secondary disabling effects under Domain 4. Animals may be reluctant to move and exhibit a lack of reaction to external stimuli. Prolonged pain interferes with ability to forage and hinders escape from predators (Mason & Littin, 2003). Under Domain 5, rodents are likely to experience sickness, lethargy, weakness, listlessness, thirst and pain (Mason & Littin, 2003). Pain and nausea are also likely when renal failure causes circulating urea levels in the blood to rise and because of build-up of urea crystals in organs and joints. Bone pain and muscle weakness may occur as a result of osteomalacia. Breathlessness may occur, as calcification of lung tissue has been seen in humans (Mason & Littin, 2003; Beausoleil & Mellor, 2015) and congestion and alveolar haemorrhaging have been observed in possum (*Trichosurus Vulpecula*) lungs (Jolly et al, 1993). Animals may experience anxiety and fear because they are unable to escape or defend themselves normally. Rats may experience confusion, depression and fatigue as direct effects of hypercalcaemia on the nervous system, as known in other species. There is no evidence that consciousness is reduced before the time of death (Fisher et al, 2010); thus rats are likely to remain capable of having these sorts of unpleasant experiences from the onset of poisoning until shortly before the time of death. The impact of the killing process caused by cholecalciferol poisoning is likely to be 'severe' to 'extreme'.

Summary

CONTROL METHOD	CHOLECALCIFEROL POISONING	UKRAT005
OVERALL HUMANENESS SCORE	5G-H	
<p>Comments</p> <p>Rats can be poisoned year-round and may breed at any time depending on conditions. Poisoning during breeding, as assessed here, could have welfare impacts for dependent pups. If lactating females are killed, efforts should be made to find any nests containing dependent pups and humanely kill them to prevent them from dying of starvation or dehydration.</p> <p>Unused bait and poisoned rat carcasses should be collected and disposed of in accordance with local requirements to avoid primary and secondary poisoning of non-target animals.</p>		

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An assessment of animal welfare impacts in wild Norway rat (*Rattus norvegicus*) management

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Online Resources 17: Welfare assessment for cellulose baiting; Scenario 1. Median confidence score is given.

CONTROL METHOD: CELLULOSE BAIT UKRAT006

Assumptions

Best practice is followed in accordance with the Standard Operating Procedure UKRAT006.

Any bait boxes/tunnels or trays that are to be used are deployed (without bait) a few days in advance of beginning cellulose baiting treatment. Existing food sources are removed wherever possible.

Cellulose baits with effective attractants are used to ensure consumption of lethal dose

Part A: Assessment of welfare impact excluding killing method

Domain 1 Water or food restriction, malnutrition				
No impact	Mild impact	Moderate impact	Severe impact	Extreme impact
<i>Evidence</i>				
Obvious existing food sources have been removed where possible. Rats tend to follow foraging trails made by other members of their colony (Galef & Buckley, 1996). If these trails are interrupted and key food sources have been removed, then foraging success may be reduced. Together, reduced foraging success and bait shyness towards the cellulose treated baits, when these are deployed, will have a mild impact under this domain.				
Domain 2 Environmental challenge				
No impact	Mild impact	Moderate impact	Severe impact	Extreme impact
<i>Evidence</i>				
No impact.				
Domain 3 Injury, disease, functional impairment				
No impact	Mild impact	Moderate impact	Severe impact	Extreme impact
<i>Evidence</i>				
No impact.				
Domain 4 Behavioural or interactive restriction				
No impact	Mild impact	Moderate impact	Severe impact	Extreme impact
<i>Evidence</i>				
There is a mild impact under this domain. Rats tend to follow foraging trails made by other members of their colony (Galef & Buckley, 1996). If these trails are interrupted and key food sources have been removed, then foraging behaviour will increase to compensate for disrupted foraging. Rats are often described as neophobic but				

their foraging behaviour is the outcome of conflicting motivations between curiosity (neophilia) and caution (neophobia), known as ‘the omnivore’s paradox’ (Berdoy & Drickamer, 2007). Exposure of rats to an unfamiliar environment interferes with object recognition, and opposing drives to avoid and explore novel objects (Ennaceur et al, 2009) may have a mild impact under this domain when boxes/tunnels are first deployed.

Domain 5 Anxiety, fear, pain, distress, thirst, hunger

No impact	Mild impact	Moderate impact	Severe impact	Extreme impact
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Evidence

Rats may experience mild anxiety because of hunger and because of opposing drives to explore novel objects (Ennaceur et al, 2009).

Overall impact

Mild impact

Confidence = 3

Duration of impact

Immediate to seconds	Minutes	Hours	Days	Weeks
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Confidence = 3

Evidence

Observations indicate that rats take a few days to become sufficiently habituated to the presence of the boxes/tunnels, to enter these and to eat cellulose baits, when these are deployed.

Score Part A

5

CONTROL METHOD: CELLULOSE BAIT UKRAT006

Part B: Assessment of killing method

Level of suffering

No impact	Mild impact	Moderate impact	Severe impact	Extreme impact
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Confidence score = 3

Time to insensibility

Immediate to seconds	Minutes	Hours	Days	Weeks
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Confidence score = 3

Score Part B

G-H

Summary of evidence

Duration

Data are sparse on the effects of cellulose baits on rats. According to a manufacturer’s website (no longer available, see Mason & Littin, 2003), the product takes 4-10 days “to work”, with up to 5 days between pellet acceptance and death. While eleven of twelve Norway rats survived a 10-day no-choice cellulose treatment

period, the other rat died on day 6 (Schmolz, 2010) . In a 14-day no-choice test on black rats (*Rattus rattus*), deaths occurred 5-9 days after ingestion of attractant enhanced cellulose bait (Zhelev et al, 2013). Signs are likely to be apparent for several days (Schmolz, 2010).

Suffering

Impacts under Domain 1 include progressive dehydration as water is drawn from the bloodstream into the gut lumen and is not reabsorbed into the body. Water intake also declines, probably because of gut impaction, indicating interference with the normal physiological feedback mechanism (RRAG 2018). Cellulose baits have little nutritive value and animals consuming lethal amounts will be starving. The faeces of such rats largely constitute cellulose. Animals likely die primarily of dehydration and starvation. Under Domain 2, rats may not seek shelter. Impacts under Domain 3 include hypovolemia (i.e. reduced blood volume) as a result of fluid movement from the blood into the intestinal cellulose bait. This results in reduced blood pressure, tissue ischaemia (oxygen deprivation), multi-organ failure and circulatory shock leading to death (RRAG 2018). Osmotic water transfer probably occurs into the gastrointestinal tract, leading to net movement of water from the bloodstream into the gut lumen. Water uptake is reduced, probably due to the swollen cellulose mass in the gut suppressing the thirst response (see Schmolz 2010; Zhelev et al 2013). The cellulose swells as it takes up fluid, resulting in gut distension and potentially obstruction. Severe caecal obstruction has been observed in black rats with dense faecal masses and enlarged, hard faecal balls in the bowel lumen (Zhelev et al 2013). Rats are huddled and lethargic (Mason & Littin 2003). Behavioural impacts under Domain 4 could potentially include cannibalism which has been observed in both captive rats and captive house mice (*Mus musculus*) (Schmolz 2010; Hsieh et al 2017). Cannibalism was potentially driven by starvation or thirst, but may not occur in free-ranging populations (Schmolz, 2010). Impacts under Domain 5 will include gastrointestinal pain and discomfort from distension of the gut, nausea or sickness, weakness due to hypovolaemia and likely hunger due to energy deprivation (Mason & Littin, 2003). Ischaemic pain and dizziness may also arise due to inadequate tissue perfusion as hypovolaemia becomes pronounced. It is not known whether affected rats are thirsty as, despite being dehydrated, drinking is reduced even when water is available probably due to interference with feedback mechanisms (RRAG, 2018). Animals may experience anxiety and fear because they are unable to escape or defend themselves normally. The impact of the killing process caused by cellulose baits is likely to be 'severe suffering' to 'extreme suffering'.

Summary

CONTROL METHOD		
OVERALL HUMANENESS SCORE	5G-H	
Comments		
Rats can be baited year-round and may breed at any time depending on conditions. Cellulose baiting during breeding, as assessed here, could have welfare impacts for dependent pups. If lactating females are killed, efforts should be made to find any nests containing dependent pups and humanely kill them to prevent them from dying of starvation or dehydration.		
Cellulose baits without attractants are unlikely to be effective due to demonstrated low palatability. Palatability has been increased using additives in captive no-choice trials but whether free-ranging animals would take such bait is not known.		
Unused bait and rat carcasses should be collected and disposed of in accordance with local requirements to avoid primary and (although unlikely) secondary poisoning of non-target animals.		

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Online Resource 18: Welfare assessment for cellulose baiting; Scenario 2. Median confidence score is given.

CONTROL METHOD: CELLULOSE BAITING UKRAT006

Assumptions

Best practice is followed in accordance with the Standard Operating Procedure UKRAT006.

Cellulose baited boxes or trays are deployed straight away. Existing food sources are removed wherever possible.

Cellulose baits with effective attractants are used to ensure consumption of lethal dose

Part A: Assessment of welfare impact excluding killing method

Domain 1 Water or food restriction, malnutrition				
No impact	Mild impact	Moderate impact	Severe impact	Extreme impact
<p><i>Evidence</i> Obvious existing food sources have been removed where possible. Rats tend to follow foraging trails made by other members of their colony (Galef & Buckley, 1996). If these trails are interrupted and key food sources removed, then foraging success may be reduced. Together, reduced foraging success and bait shyness towards the cellulose treated baits will have a mild impact under this domain.</p>				
Domain 2 Environmental challenge				
No impact	Mild impact	Moderate impact	Severe impact	Extreme impact
<p><i>Evidence</i> No impact.</p>				
Domain 3 Injury, disease, functional impairment				
No impact	Mild impact	Moderate impact	Severe impact	Extreme impact
<p><i>Evidence</i> No impact.</p>				
Domain 4 Behavioural or interactive restriction				
No impact	Mild impact	Moderate impact	Severe impact	Extreme impact
<p><i>Evidence</i> There is a mild impact under this domain. Rats tend to follow foraging trails made by other members of their colony (Galef & Buckley, 1996). If these trails are interrupted and key food sources have been removed, then foraging behaviour will increase to compensate for disrupted foraging. Rats are often described as neophobic but their foraging behaviour is the outcome of conflicting motivations between curiosity (neophilia) and caution (neophobia), known as 'the omnivore's paradox' (Berdoy & Drickamer, 2007). Exposure of rats to an unfamiliar</p>				

environment interferes with object recognition, and opposing drives to avoid and explore novel objects (Ennaceur et al, 2009) may have a mild impact under this domain when boxes/tunnels are first deployed.

Domain 5 Anxiety, fear, pain, distress, thirst, hunger

No impact	Mild impact	Moderate impact	Severe impact	Extreme impact
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Evidence

Rats may experience mild anxiety because of hunger and because of opposing drives to explore novel objects (Ennaceur et al, 2009).

Overall impact

Mild impact

Confidence score = 3

Duration of impact

Immediate to seconds	Minutes	Hours	Days	Weeks
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Confidence score = 3

Evidence

Observations indicate that rats take a few days to become sufficiently habituated to the presence of the boxes/tunnels, to enter these and to eat cellulose baits.

Score Part A

5

CONTROL METHOD: CELLULOSE BAITING UKRAT006

Part B: Assessment of killing method

Level of suffering

No impact	Mild impact	Moderate impact	Severe impact	Extreme impact
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Confidence score = 3

Time to insensibility

Immediate to seconds	Minutes	Hours	Days	Weeks
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Confidence score = 3

Score Part B

G-H

Summary of evidence

Duration

Data are sparse on the effects of cellulose baits on rats. According to a manufacturer’s website (no longer available, see Mason & Littin 2003), the product takes 4-10 days “to work”, with up to 5 days between pellet acceptance and death. While eleven of twelve Norway rats survived a 10-day no-choice cellulose treatment period, the other rat died on day 6 (Schmolz 2010) . In a 14-day no-choice test on black rats (*Rattus rattus*), deaths occurred 5-9 days after ingestion of attractant enhanced cellulose bait (Zhelev et al. 2013). Signs are likely to be apparent for several days (Schmolz 2010).

Suffering

Impacts under Domain 1 include progressive dehydration as water is drawn from the bloodstream into the gut lumen and is not reabsorbed into the body. Water intake also declines, probably because of gut impaction, indicating interference with the normal physiological feedback mechanism (RRAG 2018). Cellulose baits have little nutritive value and animals consuming lethal amounts will be starving. The faeces of such rats largely constitute cellulose. Animals likely die primarily of dehydration and starvation. Under Domain 2, rats may not seek shelter. Impacts under Domain 3 include hypovolemia (i.e. reduced blood volume) as a result of fluid movement from the blood into the intestinal cellulose bait. This results in reduced blood pressure, tissue ischaemia (oxygen deprivation), multi-organ failure and circulatory shock leading to death (RRAG 2018). Osmotic water transfer probably occurs into the gastrointestinal tract, leading to net movement of water from the bloodstream into the gut lumen. Water uptake is reduced, probably due to the swollen cellulose mass in the gut suppressing the thirst response (see Schmolz 2010; Zhelev et al 2013). The cellulose swells as it takes up fluid, resulting in gut distension and potentially obstruction. Severe caecal obstruction has been observed in black rats with dense faecal masses and enlarged, hard faecal balls in the bowel lumen (Zhelev et al 2013). Rats are huddled and lethargic (Mason & Littin 2003). Behavioural impacts under Domain 4 could potentially include cannibalism which has been observed in both captive rats and captive house mice (*Mus musculus*) (Schmolz 2010; Hsieh et al 2017). Cannibalism was potentially driven by starvation or thirst, but may not occur in free-ranging populations (Schmolz 2010). Impacts under Domain 5 will include gastrointestinal pain and discomfort from distension of the gut, nausea or sickness, weakness due to hypovolaemia and likely hunger due to energy deprivation (Mason & Littin 2003). Ischaemic pain and dizziness may also arise due to inadequate tissue perfusion as hypovolaemia becomes pronounced. It is not known whether affected rats are thirsty as, despite being dehydrated, drinking is reduced even when water is available probably due to interference with feedback mechanisms (RRAG 2018). Animals may experience anxiety and fear because they are unable to escape or defend themselves normally. The impact of the killing process caused by cellulose baits is likely to be 'severe suffering' to 'extreme suffering'.

Summary

CONTROL METHOD	CELLULOSE BAITING	UKRAT006
OVERALL HUMANENESS SCORE		5G-H
Comments		
Rats can be baited year-round and may breed at any time depending on conditions. Cellulose baiting during breeding, as assessed here, could have welfare impacts for dependent pups. If lactating females are killed, efforts should be made to find any nests containing dependent pups and humanely kill them to prevent them from dying of starvation or dehydration.		
Cellulose baits without attractants are unlikely to be effective due to demonstrated low palatability. Palatability has been increased using additives in captive no-choice trials but whether free-ranging animals would take such bait is not known.		
Unused bait and rat carcasses should be collected and disposed of in accordance with local requirements to avoid primary and (although unlikely) secondary poisoning of non-target animals.		

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