The relevance of captive breeding as a successful component in water vole (Arvicola terrestris) translocation projects.

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Introduction

The legal protection of the water vole (Arvicola terrestris) under schedule 5 of the Wildlife and Countryside Act - section 9(4) - in 1998 led to a direct requirement to mitigate for the presence of this species on development sites. For projects which will result in the loss of habitat or burrows, 'reasonable effort' is required to relocate water voles into suitable unaffected areas prior to works commencing, and restore the habitat following development, create new habitat or enhance existing habitat (Dean. 2003).

Although clear in intent accurate quantification of how water vole populations actually respond to development induced mitigation projects has historically been difficult to define with assumptions of the success or failure of a technique being commonly based on little hard evidence. This situation has arisen due to a historic paucity in our understanding of the species itself, an inadequacy of follow-up monitoring and a suite of complications associated with the general conservation of this species in the wider countryside.

Although gaps still remain in our knowledge a welter of recent research now affords a fuller picture of this species requirements. There is little doubt that water voles are more complex than was initially perceived and it is therefore important to apply this advanced understanding to development mitigations to avoid the infliction of casual damage to this vulnerable species.

The authors of this paper although initially involved in a large scale captive breeding project for conservation reintroduction have to date assisted a significant number of translocation projects with a development led mandate. These projects have focused on captive breeding wild founders to establish substantial release populations of known age, sex ratio and health status. To date this technique has proven verifiably successful in the majority of sites where it has been applied and could prove to be a tangible component of successful translocation practice.

Captive breeding water voles

In 1994 A Red Data Book For British Mammals (Morris. 1993) was published and the first alarm bells signalling the plight of the water vole rang. Their clarion was swiftly corroborated by a series of national surveys funded by the Vincent Wildlife Trust (Strachan & Jeffries. 1993), which identified a serious constriction in the national range of the species. To date subsequent repeat surveys (Strachan, Strachan & Jeffries. 2000) suggest that the water vole may have incurred an overall national range decline in excess of 90% since the beginning of the 20th century.

This loss of range was principally due to the intensification of agriculture resulting in the widespread loss of wetlands and a significant diminution of riparian fringe habitat

due to either overgrazing or the extension of arable production. This situation was further complicated by the successful colonisation of introduced North American mink (Mustela vison) – a species that is capable of hunting water voles much more effectively than any native predator – and an associated range of incidental factors linked to population fragmentation (Strachan. 1998).

It is a fundamental error in any recovery process for an endangered species to leave the development of a captive breeding component until individual founders are in short supply. Genetic diversity will by this stage be extremely low and if husbandry protocols have to be developed from scratch any resultant human errors can be critical to the survival of the species (Durrell. 1992). For this reason captive breeding as a component of an overall conservation package is best refined when an initial threat is perceived as part of a process of general biological research.

The first large scale conservation breeding project was initiated by Derek Gow in 1994 at the New Forest Nature Quest with the express aim of developing a sustainable methodology for reproducing the species consistently and in sufficient numbers to render future reintroduction possible. Captive breeding had been recorded before in a study population maintained for Dr Barbara Blake at Queen Mary and Westfield College (Blake. 1982). Although her animals bred sporadically in a laboratory environment this project was prompted by a behavioural rather than conservation motivation and there was no imperative to refine a consistent breeding regime.

The first breeding attempts at Nature Quest were with animals captured from fish farms on the river Itchen. These were contained in large landscaped pens 30ft in diameter with pools, vegetation and burrowing banks. The retaining walls of these enclosures were constructed of 4ft high sheet tin and they were under-wired to a depth of 2.5ft with half-inch pet-mesh. Despite this last adaptation voles readily burrowed out and on one occasion a female which escaped in late summer and survived outside over-winter returned of her own volition to breed in the spring.

Although these pens were stocked with various combinations of animals we now know that they will only successfully contain a single breeding pair and their resultant offspring. Any other combination of breeding adults confined together inevitably resulted in severe fighting to the point of disability or death. This negative experience of mixing unrelated groups of adult individuals was replicated in a trial release project developed by the Wildfowl and Wetlands Trust at Slimbridge where severe aggression resulted in the swift collapse of a substantial confined population (C. Strachan. Personal communication). As an initial project objective was to maximise potential reproduction this enclosure design was eventually abandoned for all purposes excepting public display.

Slide 1 – Breeding pen with runs in straw bale.

A further series of smaller breeding pens were trialled before the final prototype that is currently employed emerged. These are wooden framed cages (6ft long by 4ft high by 4ft broad) with solid wooded floors. They are meshed throughout with half-inch pet-mesh and have half opening front lids and doors to allow easy access. The floor substrate consists of forest bark with a bale of straw at the back covered by a waterproof roofing sheet to create an artificial banking. The voles will readily burrow

into this feature creating runs, nests and chambers. Swimming water is provided via a shallow garden seed tray at the front of the pen, which is changed daily in the summer time. As summer breeding pens these facilities work extremely well and groups of sibling litters have successfully over-wintered in these enclosures.

Breeding regime

The breeding regime consists of pairs of voles bred the previous year being introduced simultaneously to each other from February to March. Mates are selected to ensure relatively even weights and most females will produce a litter by mid May. Reproduction generally averages another three subsequent litters annually (Holder. K and Jeffrey. C. Unpublished) although up to seven litters have been recorded from an individual pair. The average number of juveniles produced from a breeding pen is around twenty. Providing a stable food supply is maintained water voles in these large family groups are very tolerant of each other although occasionally odd individuals have to be removed. These animals typically start to emerge for long periods during the day, sit in a hunched position with scruffy fur and may have obvious bite marks or move in a lethargic fashion. When isolated from the main group they will generally recover quickly from any superficial wounds and can on occasion survive significant injuries.

When the breeding pens are checked for juveniles any early litter offspring are removed. Although both the straw bankings and floor substrates are replaced at this time careful disturbance of nests of tiny, naked juveniles rarely results in casualties as their parents will readily remove them by carrying them in their mouths to a new nest site. This high natural fidelity to their offspring is unusual in small mammals but has been historically recorded in the wild (Paxman. 1994) and might be a behavioural adaptation to short term rises in water level. Stephanie Ryder who studied water voles in the 1960's (Ryder. 1962) recorded males assisting females in this process.

Adult captive females at the end of a single breeding season are commonly so physically exhausted from reproductive exertion that despite additional feeding their body condition rapidly fades and they either die or lose the use of their hind limbs. Occasionally adult males in captivity will survive to mate again after a second winter but their breeding performance is generally poor. Having worked with approximately 2000 animals to date for various reintroduction and translocation projects we have never had a known age individual survive for over 2.5 years although a 3 year old has been recorded (Ryder. 1962). A study in 1971 suggested that few wild water voles ever attained the age of 2 (Stoddart. 1971) and the average wild lifespan is therefore likely to be at least 50% less than the maximum captive figure (G. Law. Personal communication). Wild population survival may therefore be largely dependant on a series of swiftly reproducing generations.

At the end of the breeding season any remaining adults are over-wintered in standard laboratory rodent cages with larger groups of sub-adult juveniles being wintered outside. Breeding between individuals in these sibling groups is extremely unusual even if they are left together until well into a potential breeding season.

Captive diet consists of commercial rabbit food, apples, carrots, greens and other vegetables. Chewing fruitwood is provided to curtail tooth growth although in older animals malformations may occur which require regular treatment.

Disease

A full health assessment protocol has been developed for screening release populations (Sattisfield et all. 2002). This combined process involves regular weighing and physical assessment, faecal screening, post mortems of dead animals and blood sampling. As an additional caveat approximately 2.5% of substantial released populations are post mortemed to check for abnormalities or disease. Although to date no significant conditions have been identified it is important that this process is applied in order to

- Expand our knowledge of water vole disease
- Ensure that released populations are healthy in the first instance
- Avoid the transmission of any obvious deleterious pathogens to linking wild populations.

Infestations of what are probably endemic mites are relatively common in over-wintered animals. When extreme these can result in an individual losing the fur around its eyes – forming noticeable pink spectacles – and genitals. Generally these occur at high densities in old or otherwise stressed individuals and can be easily treated by using domestic veterinary products.

Slide 2 – Old female with mite infestation around her eyes.

Some animals exhibit respiratory conditions which to date appear to be individually specific and non-contagious. Simple stress situations such as handling for short periods can occasionally produce an onset of prolonged wheezing. In our long-term captive population these conditions are generally confined to individuals in excess of 2 years old.

In the longer term inbreeding could potentially prove to be a much more significant problem for isolated populations. The reproductive rate of this species is extremely rapid and it is clear from review of various populations drawn from different sources that small isolated founder groups seldom breed as well as stocks drawn from large vigorous populations when subjected to the same regime of captive care. As a population becomes more inbred the incidence of white tail tips and feet together with head or chest spots becomes more common. Historically populations of completely cream animals have been recorded. Coupled with this phenomenon is the rising incidence of health problems including abnormalities, the most extreme example being a male that lived a full lifespan with a twisted foreleg and 16 additional toes.

Reintroduction

The first monitored reintroduction of water voles was trialled at the Barn Elms Wetlands Centre in 2001. Although a few older animals were utilised for this project the bulk of the released population of 147 were captive bred juveniles in their year of birth. These animals were all fitted with individual microchips and were selected to ensure an average release weight of around 108 grams. Dispersing juveniles in Scotland have been recorded at 50 grams (Lambin. X. Personal communication) and under a suite of good habitat conditions water voles can gain weight extremely rapidly thus attaining breeding condition in a single season. Animals released at Barn Elms in

July and recaptured in late summer had more than doubled their body weight and one female released at 90 grams produced a litter in a trap when captured in October (R. Strachan. Personal communication).

Juvenile water voles were released on both a hard (straight into areas of tall vegetation with no subsequent support) and soft (from release pens dug into the ground with food support for a time) release basis. Preliminary results from this and subsequent projects suggest strongly that the latter option is more effective. (R Strachan. Personal communication). If maintained together juveniles can be released in sibling groups of up to four animals. Various different styles of release pens have been trialled successfully from large tin enclosures to more compact folding aluminium pens developed for Severn Trent Water. These operate on the principal that the water voles dig to freedom through an open earth floor whilst providing initial protection from likely predators. Release cages must be provided with abundant bedding material and chopped apples for both food and moisture. They should be dug well into the ground immediately adjacent to the waters edge and screened from the sun with dense vegetation. Water voles will commonly continue to utilise well-sited release pens as latrine and feeding areas for some time following release.

The timing of release for juveniles should coincide with late spring/early summer vegetative food and cover abundance. Failure to achieve this threshold in their year of birth is best remedied by holding them again over winter and releasing as prime breeding adults in spring. Both techniques have been trialled and both age groups have worked well as release candidates. Care should be taken that water level stability is guaranteed in potential release sites as severe fluctuations either way can be a critical factor in the success or failure of a colony (C. Strachan. Personal communication) Water voles are a very robust species but in common with most riparian mammals they have an extremely dense fur coat. If subjected to movement or handling stress during periods of extreme heat they can die rapidly and chopped apple – a quarter per animal – must always be included for consumption to provide moisture during transport.

Translocation

Some commonly employed water vole mitigation techniques, which are part of standard practice are based on assumptions, which may be incorrect.

A recent study by Cresswell Associates (Dean. 2003) highlighted for example that the standard displacement methodologies of vegetation strimming and scraping do not always result in water voles revoking their original territories. Radio collared animals within a scraped and strimmed development footprint chose to remain in their own burrow systems whilst moving further afield to forage in adjacent remaining cover. They returned to their burrows via underwater entrances and during this process left few field signs of their presence. Another recent study of microchipped individuals which were translocated out of a development foot-print to an unaffected area of adjacent habitat emphasised this territorial fidelity with a single female crossing a ‘football pitch’ sized building site to return to her original place of capture on three separate occasions (A. Best. Personal communication).

Although both these studies involved small numbers of individuals they challenge common perception and highlight a real requirement for active research to address the effectiveness of commonly applied techniques.

The national water vole guidelines stress that population translocation should be the least preferable alternative for development led mitigation (R. Strachan. Personal communication). Developers are instead encouraged to focus on the creation of fresh receptor habitat adjacent to existing populations, which can then be encouraged to migrate by using techniques such as dewatering or seasonal habitat removal. In projects where this strategy is not applicable and translocation is the only alternative it is extremely important that the following factors are considered.

Water voles seldom exceed the age of two and a half in captivity. This maximum lifespan is unlikely to be attained by most wild individuals. The capture and successful re-establishment of un-aged wild individuals – even if their territorial fidelity is ignored – is therefore problematic. Due to natural winter mortality spring captures before the breeding season are likely to yield low numbers of mainly young breeding adults while autumn captures can result in a mixed bag of small juveniles, old adults past their active reproductive life, and early litter juveniles coming into their prime. Such populations can be skewed in percentage depending on external seasonal factors – i.e. droughts when juvenile survival can be extremely low – and can although numerically robust be productively redundant. It is possible by over-wintering in captivity to separate by weight and condition most old adults from mature juveniles, as these animals even when captured in good condition will naturally start to loose weight rapidly while juvenile weight gains increase. Other age indicators such as fur mite infestations, respiratory conditions and overgrown teeth or claws assist this process.

Translocations of significant numbers of known age breeding animals – at least 40 on a 50% sex ratio, into extremely good habitat – should be timed to coincide with an abundance of natural vegetative food and cover. Such releases must occur in either late spring or very early summer in order to allow individual animals time to settle, breed and establish territories before the onset of winter. Failure to achieve this threshold will result in poor seasonal breeding results and a much greater likelihood of population failure as a result. Water voles are known to be predated by a range of species such as red foxes (Vulpes vulpes), stoats (Mustela erminea), pike (Esox lucius) and grey herons (Ardea cinerea) (Strachan. 1997). The average seasonal mortality of wild water vole populations has been estimated to exceed 70% (Jordan. 1996) and releases of wild captured populations of a few individuals are on a genetic, numerical, age and sex ratio basis unlikely to form viable founder populations. If removed from a development footprint they are best combined with other unrelated animals to form larger more diverse release groups.

Slide 3 – Juvenile vole.

Female water voles exhibit a high fidelity to their dependent young in captivity. This factor has been recorded in the wild. If the abandonment of litters of juveniles underground is to be avoided as an aspect of a translocation project then capture should only commence before either the onset of breeding or at its seasonal end. In reality – depending on weather – this means trapping in late March/early April or

from mid September until the end of October using competent staff who can accurately assess lactation and sex. Trapping through the adjoining months of winter is complicated by the seasonal predilection of this species to develop winter food stores and thence become less physically active and more difficult to capture.

Animals should be released using a soft release methodology – slowly through a predator proof pen with bedding and food support – with subsequent population dispersal monitored by the assessment of microchipped animals. For significant projects consideration of longer term monitoring through founder gene lineage may be appropriate.

Water voles captured in a development footprint and translocated to immediately adjacent wetland may readily return to their initial territorial areas. If these original territories are scraped and strimmed this could result in an enhanced risk of predation (Dean. 2003). They are capable of undermining standard exclusion mitigation fences.

Water vole populations typically expand to exploit a wider availability of seasonal summer habitat and retract in winter to occupy features such as elevated or scrub-covered banks above normal flood levels. Deep summer pools are an equally significant feature as refugia in times of drought. The inclusion of these key, seasonal landscape features in receptor selection is significant. Receptor sites should possess a seasonal abundance of vegetative food and cover species with potential colonisation corridors to allow both future population expansion and genetic interchange. Care should be taken that North American mink are either absent or can be effectively controlled in the long term.

Conclusion

In response to the above criteria the authors have focused on a strategy of capturing wild founder individuals, which are then over-wintered in captivity to eliminate old or diseased animals. Breeding individuals in their reproductive prime are then captive bred to produce large release populations. These populations although not life skilled have no territorial fidelity, are of known age, sex composition, health status and are sufficient numerically to ensure a successful take despite significant predation. As a final consideration should a release fail for whatever reason a retained captive surplus can allow for a subsequent restocking or supplementation when the causes of initial failure have been assessed and remedied.

To date this process has been employed for 9 translocation/reintroduction/supplementation projects involving the breeding of over 2000 animals. At the time of writing 1 release has failed, 6 have successfully established vigorous populations some of which are expanding rapidly, 1 is indeterminate and 1 is still too early to assess. Animals provided historically from this captive breeding programme have established an additional 2 low-level populations (R.Strachan. Personal communication) which are still extant and a similar captive breed and release project run by Bristol Zoo on a site near the Royal Portbury docks (S. Eyre. Personal communication) has been highly successful.

The smallest release population that is known to have established as a result of this process derived from 50 (24.26) individuals released into excellent recreated habitat on the river Don (Best. 2003).

Summary
If water vole translocation/reintroduction projects are to succeed it is critical that suitable mink free receptor sites, which are sustainable in the long term, are either identified or designed. These must afford an abundance of suitable seasonal food and cover vegetation and should additionally incorporate features, which ensure that a released population cannot readily be compromised by either flooding or drought. For future success there must be reasonable chance of integration with other water vole colonies. Animals should not be translocated during their breeding season.

The age of a translocated population should be determined by over-winter separation of breeding adults from older non-breeding animals, which should be eliminated from release. If spring capture is attempted it is likely that the population will comprise low numbers of breeding adults with a strong territorial fidelity. Autumn populations will be larger with a greater diversity of age groups. Translocations involving significant populations of wild animals may be viable if mature juveniles are released in the spring following capture. This timing is essential to maximise the chances of their initial breeding generating offspring, which can themselves reproduce before the onset of winter. For smaller populations or groups, which cannot attain this release threshold, a captive breeding project component should be considered to ensure a sufficiently large release population of known breeding age, equal sex and clear health status.

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