Captive breeding as a recovery component of water vole (Arvicola terrestris) conservation projects.

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"…..ex sergeant parker who stayed on at Isington mill as an odd job man during the last years of the Field Marshall……..was said to have been attacked by a horde of infuriated water-rats when clearing weed out of the mill race – and died as a result of his injuries. 'Most unfortunate' was supposed to have been Monty's callous comment."
(Horne. 1995)

The endemic subspecies of the Northern water vole (*Arvicola terrestris amphibius*) was once such a familiar aspect of riparian Britain that Kenneth Grahame based his character of Ratty in his classic novel "Wind in the Willows" on this species. Although widely referred to in modern times as water-rats they were once accorded a variety of other titles such as Crabers, Water dogs, British beavers and Campagnols (Ryder.1962). In parts of Aberdeenshire the black form commonly was called an "Earthhound" and was believed to inhabit graveyards!

The water vole is the largest of the three vole species native to mainland Britain and mature adults can weigh up to 350grams. Unlike its counter-part European subspecies (Arvicola terrestris sherman) British water voles normally inhabit riparian fringe habitat and are seldom found in substantial landlocked populations. Water voles are virtually entirely vegetarian – although exceptional instances of the consumption of fish carrion and cannibalism have been observed – and have been recorded feeding on 227 plant species (Strachan.R. 1999) the most favoured of which are reeds, grasses, rushes and sedges. In winter this seasonal emphasis changes to accommodate roots, rhizomes and tubers, which they hoard as a food reserve in underground burrows. These burrow systems have underwater entrance and exit holes and nesting chambers lined with shredded dry vegetation. In winter some tunnels will be stopped up with soil or harvested vegetation while in summer emergent burrow entrances are commonly surrounded by evenly mown 'vole lawns' within easy reach of their perimeter. In seasonally occurring reed beds where burrowing is not possible football sized nests constructed from intricately woven vegetation can be constructed above the normal water level. These structures have been readily created in rush clumps by captive bred animals within a short period of their release. Water voles can mate on the land or in water and will normally produce an average of around 20 offspring per annum in captivity. Field signs of water vole presence such as stems of plant material cut at a distinctive 45-degree angle, latrines, feeding platforms, tracks, runs and burrows are easy to observe where they are common.

Stephanie Ryder writing in 1962 stated that " *wherever there is good water contained in firm banks ……..…you may be sure to find signs of water vole habitation*" and until comparatively recently this was still widely perceived to be the case. In 1990 a series of national surveys funded by the Vincent Wildlife Trust (Strachan & Jeffries. 1993), identified a serious constriction in the national range of the water vole and subsequent repeat surveys (Strachan, Strachan & Jeffries. 2000) now suggest that this species may have disappeared from over 90% of its former range.

This steep decline is linked directly to the intensification of agricultural practice over the course of the last century. Extensive wetland drainage, increasing densities of livestock overgrazing riparian vegetation and arable cultivation to the edge of watercourses have been coupled with substantial river, stream or ditch canalisation programmes and unsympathetic annual dredging regimes. The impact of these processes has been further compounded by bank side reinforcement programmes employing concrete or metal pilling, the successful colonisation of introduced North American mink (*Mustela vison*) – a predator against which they have no developed defence - and an associated range of further incidental factors such as accidental poisoning or sporadic human persecution.

As a result of the above water voles are now legally protected under Schedule 5 of the Wildlife and Countryside Act but this legal protection although preventing their reckless destruction can do little to halt their continued decline. The national distribution of this species is now highly fragmented and in many counties they are already extinct. Current predictions are that this situation will worsen leading to further countywide extinctions by 2010. Where extensive populations of water voles still occur species recovery incentives are generally focused on improving and extending tracts of suitable habitat coupled with the co-ordinated destruction of mink. Where significant vole populations are no longer extant a more active process of restoration to support, restore and rejoin relict populations will be essential if this species is to recover.

It is against this back-ground that water vole restoration utilising either translocated animals or captive bred offspring has become an identified component of the national Biological Action Plan (BAP) for this species (HMSO.1995). Water vole translocations (the direct movement of wild caught animals from one site to another) – which have commonly been practised as a component of human development projects - are problematic (Gow, Holder and Jeffrey 2004) due to the low number of animals frequently involved, their high territorial fidelity (Dean. 2003) and their short reproductive lifespan. The sourcing of sufficient offspring from healthy donor populations (harvesting) might be a mechanism for providing future release stocks but this - as yet un-quantified - process can only be employed if the security of donor populations can be guaranteed. Water voles are known to be predated by a range of 'native' predators such as red foxes (*Vulpes vulpes*), otters (*Lutra lutra*) stoats (*Mustela erminea*), pike (*Esox lucius*), grey herons (*Ardea cinerea*), brown rats (*rattus norvegicus*) and domestic cats (Strachan. 1997). In a population study on the river Itchen – where no mink were present - the average seasonal mortality of a robust water vole population was estimated to exceed 70% (Jordan. 1996).

The first large scale water vole breeding project began in 1994 at the New Forest Nature Quest with the express aim of developing a sustainable methodology for reproducing this species consistently. Although breeding attempts had been successful in a study population at Queen Mary and Westfield College (Blake. 1982) no effort had been made to reproduce this short-lived species in sufficient numbers to render reintroductions possible. Even though this was not a conservation priority action at that time 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 any process of general biological research.

The first breeding attempts at Nature Quest were with animals captured from fish farms on the river Itchen in Hampshire. These were contained in large landscaped pens, which were 30ft in diameter with pools, selected food vegetation and adequate 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 weld-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 accord 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 in the spring inevitably results in severe fighting to the point of extreme 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 (Strachan.C. Personal communication). As an initial project objective was to maximise potential reproduction this enclosure design was eventually abandoned for all purposes excepting public display.

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 weld-mesh and have half opening front lids and doors to allow easy access. Their floor substrate consists of forest bark and 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. As breeding pens these facilities work extremely well and groups of sibling litters have been over-wintered successfully in these enclosures.

The annual 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 and Jeffrey. Unpublished). 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 due to aggression. These pens are checked for juveniles every three months and any early litter offspring are removed for release. 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 new nests. This high natural fidelity to their offspring is unusual in small mammals but has been historically recorded in the wild (Paxman. 1994) and could be a behavioural adaptation to short term rises in water level. This rescue response has been recorded in other riparian rodent species such as the European beaver (*Castor fiber*) and male water voles have been recorded assisting females with this process (Ryder 1962).

Adult females at the end of a single breeding season are commonly so physically exhausted from reproduction 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. At the end of the breeding season any remaining adults are culled and sub-adults are wintered outside in sibling groups of around 7 individuals. Even if left together until well into a potential breeding season reproduction amongst sibling groups is extremely unusual.

Their captive diet consists of commercial rabbit food, apples, carrots, cabbage, sweet corn, melons and pears. Chewing fruitwood is provided to curtail tooth growth. In older animals malformations of the front incisors may continuously reoccur despite regular treatment.

A health assessment protocol for screening release populations (Sattisfield et all. 2002) has been developed as part of a combined process of physical assessment, faecal screening, post mortem and blood sampling. As an additional caveat approximately 2.5% of substantial released populations are euthanased to check for abnormalities or disease. *Toxoplasma* (Gelling. Personal communication) and *Yersinia Tuberculosis* has been recorded in this species and infestations of what are probably endemic mites are relatively common in over-wintered animals. These can result in an individual losing the fur around its eyes – forming noticeable pink spectacles – and genitals but can be easily treated by using domestic veterinary products. 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 but 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 (Jeffery and Holder. Unpublished). Recent studies of upland populations in Scotland have demonstrated an ability to genetic exchange over considerable distances and additionally suggest that there may be natural behavioural tendencies to avoid inbreeding (Lambin et al. 2003). As a population becomes more inbred the incidence of white body markings becomes common and historically populations of completely cream animals have been recorded. (Strachan.R. Personal communication). Any large-scale recovery project for this species must encompass the coordinated release of a series of genetically distinct vole populations, which have the future potential to interlink

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. Animals released at Barn Elms in July and recaptured in late summer had more than doubled their body weight and one female released weighing 90 grams produced a litter in a trap when captured in October (Strachan.R. Personal communication). Under a suite of good habitat conditions water voles can obtain a weight gain of 1.2grams per day attaining breeding condition in a single season.

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. (Strachan.R. 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 but they all operate on the principal that the voles dig to freedom through an open earth floor whilst providing temporary cover from predators. Release cages must be supplied with abundant bedding 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 are a physically robust species but in common with most riparian mammals they have an extremely dense fur coat and if subjected to stress during periods of extreme heat they can die rapidly. Chopped apple – a quarter per animal – must always be included for consumption to provide moisture during transport and release. 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. 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 (Strachan.C. Personal communication). Failure to achieve this threshold in their year of birth is best remedied by holding over winter and releasing as breeding adults in spring. Releases of both juveniles (in their year of birth) and breeding adults (late litter offspring over-wintered and released in the spring) have been trialled and worked well. The release of small populations of individuals exceeding these age groups produces poor breeding results (Gow and Holder. In preparation).

At the time of writing the authors have participated in the production of over 2000 animals for 17 translocation/reintroduction/supplementation projects in England. To date 1 release has failed due to a variety of external factors, 6 have successfully established vigorous populations some of which are expanding rapidly, 1 is indeterminate and 7 are too recent to adequately 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 (Eyre. Personal communication) has been highly successful. The best of these projects in large wetland complexes – Pagham harbour and Barn Elms - have within a few years seen released populations of captive bred animals expand rapidly to colonise the entire available reintroduction zone.

In conclusion it must be clearly stressed that this captive breeding and release process is currently an effort in the refinement of technique. The two keys to successful water vole restoration are the availability of large-scale mosaics of sustainable wetland habitat and the effective long-term control of North American mink (Strachan.R 1998). Both these criteria are obviously reliant on significant cooperative partnerships and until recently is was difficult to envisage how these could be effectively secured. The development of the Chichester Costal Plain sustainable farming partnership provides a tantalisingly, intelligent example of how this can actually be achieved (Strachan.R and Holmes Ling 2003). This remarkable venture has seen a consortium of organisations combine to create through agri-environment schemes a 8400ha project site within which the availability of water vole habitat has trebled in a very few years. This has been accomplished by the restriction of livestock in riparian corridors by fencing, the creation of field margin junction ponds and the restoration of existing farm ponds. This project has employed a simple but highly effective "mink raft" system designed by the Game Conservancy Trust (Reynolds. 2003) to target, eliminate and the re-monitor for the presence of this alien predator. Water voles from our captive breeding project released into this site in May 2002 have now combined with few relict populations to colonise most of the available habitat within the project area.

The fact that the once common and widespread water vole has suffered in excess of a 90% range decline in the British Isles is a damning inditement of our historic land use. It is however a robust species capable of incredible regeneration where its circumstances are ideal and there are grounds for considerable optimism that even at this late stage its declining fortunes can still be reversed by coordinated action. .

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Acknowledgements

I would like to acknowledge the support of the principal personnel involved in this process – Sarah Bridger, Kathy Holder, Jane Howard and Carly Jeffrey – whose abilities led directly to what has been achieved to date. Mike Jordan assisted our early efforts with animal capture and husbandry information. Both Rob Strachan and Chris Strachan assisted with boundless enthusiasm and practical critique.

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