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**Field Report**

# Translocating red wolves using a modified soft-release technique

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## Abstract

Intensive management of the reintroduced red wolf *Canis rufus* population in northeastern North Carolina (USA) is required, in part, to limit introgression of coyote *Canis latrans* genes through red wolf-coyote mating. To reduce these matings, and to enhance the red wolf population, the Red Wolf Recovery Program released wolf pairs or solitary wolves into vacant areas or areas previously occupied by a coyote or wolf-coyote hybrid. Five male-female wolf pairs and four solitary wolves were held in a central captive facility (for 17-64 days), then subsequently in a portable, electrified corral (for 11-24 days), before being released. Following release, three of five pairs established a territory in the vicinity of the acclimation/release site and defended it from other canids; however, only one of four solitary wolves paired with a mate and defended the area from other canids. Three of five unsuccessful release events ended with the wolves being killed while homing to their original capture site.

## Introduction

The red wolf once occurred throughout the mid-Atlantic and southeastern United States (Nowak 2002). The species was extirpated from most of its former range by the early part of the 20th Century, primarily by predator control activities and changes in land use (Nowak 1972). The red wolf was listed as endangered in the United States in 1967 (USFWS 1967) and was one of the first species to attract recovery attention. In the mid 1970s, the U.S. Fish and Wildlife Service began capturing the few remaining wild wolves to initiate a captive breeding program. The ultimate goal of the program was to restore the red wolf into portions of its former range (USFWS 1990). That goal was realized in 1987 when four male-female adult pairs of captive-born red wolves were successfully released on Alligator River National Wildlife Refuge (NWR), North Carolina (Parker 1987a; Parker and Phillips 1991).

Although the red wolf remains listed as Critically Endangered (IUCN 2003), the restoration efforts show signs of success. In 2005, approximately 100 red wolves in 20 packs inhab-

ited more than 6,000km$^2$ of public and private lands in northeastern North Carolina. Intensive management of the red wolf population is required, however, to reduce wolves breeding with the coyote, which recently expanded its range into North Carolina (DeBow et al. 1998). Since the initial 1987 red wolf release, the free-ranging population has been augmented by releasing captive-born wolves (Phillips 1994), wild-born wolves from island propagation sites (Parker 1987b) and, more recently, by fostering captive-born pups into wild-born litters (Waddell et al. 2002). The Red Wolf Recovery Program also attempted to reduce wolf-coyote matings and enhance and expand the red wolf population by releasing wild-born wolves into areas vacant of wolves, into areas containing potential mates (i.e. solitary wolves), or to replace coyote or wolf-coyote hybrids (Kelly et al. 1999).

The Red Wolf Recovery Program has made use of hard- and soft-release methods to restore wolves. Soft-release methods typically include the construction of a semi-permanent enclosure (e.g. chain-linked fence) to acclimate the animal(s) to the surroundings prior to release, and generally increase the likelihood of a successful release when compared to hard-release methods (Fritts 1993, but see Phillips et al. 2003). However, construction of a fixed fence enclosure can be costly, time consuming, destructive of native vegetation, and impracticable in some remote locations or rugged terrain.

Herein we present details of nine, modified soft-release events of translocated red wolves using a portable, electrified acclimation corral.

## Methods

*Study area*

The work was conducted in a five-county area (Beaufort, Dare, Hyde, Tyrrell, and Washington) in northeastern North Carolina designated as the red wolf experimental population area (Figure 1) (USFWS 1995). This area is largely rural, with few improved roads, and bounded by the Albemarle Sound to the north, Roanoke and Pamlico Sounds to the east, and the Pamlico River to the south. The natural communities of the area are characterized as non-riverine swamp forest, high and low pocosin, and pond pine *Pinus serotina* woodland communities (Shafale and Weakley 1990). Agricultural cropland, primarily soybean, corn, cotton, and wheat (USDA 2004), and timberland forests of loblolly-shortleaf pine and oak-gum-cypress (Brown 2004) predominate the area. Approximately 27% of the land is owned and managed by the federal and state governments as four national wildlife refuges and 12 state game lands.

*Study animals*

Fourteen wild-born red wolves (6 males:8 females) were used in the study. Seven (2:5) of the animals were born and reared in the wild within the experimental population area (i.e. residents), and five wolves were born and reared at island propagation sites: (2:2) Bulls Island in Cape Romain NWR, South Carolina and (1:0) St. Vincent NWR, Florida (Henry et al. 1995). Two sibling wolves (1:1) were wild-born in the Great Smoky Mountains National Park (GSMNP), Tennessee (Parker 1990), but were transferred to the captive facility at Alligator River NWR (hereafter referred to as Sandy Ridge) when they were seven months of age. The mean age at time of release was 26.3 $\pm$ 2.8 SE months (range 17 to 35) for males and 29.1 $\pm$ 6.1 SE months (range 20 to 71) for females. The study wolves were not known to have prior reproductive experience, unless otherwise noted. Wolves were fitted with a radio (VHF) telemetry collar (Model 315, 400, or 500, Telonics, Inc., Mesa, AZ 85204-6699), and a transponder chip (Model EID-ID100, Eidap, Inc., Sherwood Park, Alberta, Canada T8H 2M8) was inserted subcutaneously between the shoulders prior to being moved from Sandy Ridge.

*Acclimation corral*

A portable, electrified corral was used as an acclimation pen (Figure 2). The corral fencing was constructed of lightweight plastic and nylon mesh, approximately 2.3m high; the area (and shape) of the corral varied depending on the location, but was generally 200m$^2$. The lower 1.2m of fencing was nylon mesh approximately 5cm by 10cm, with an interwoven 16-gauge wire for connection to an electrical current (Model ElectroStop, Premier 1 Supplies, Washington, IA 52353).

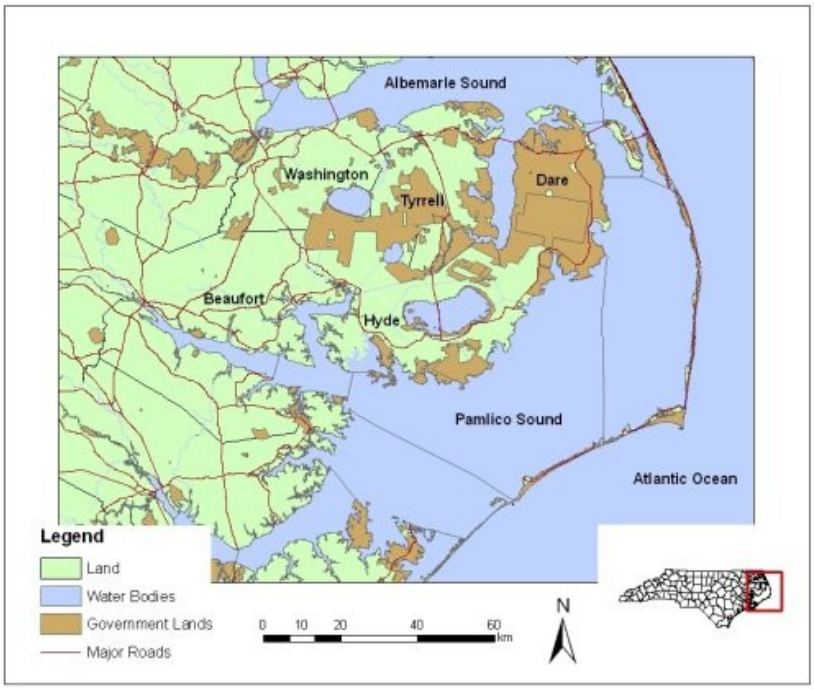


Figure 1. Map of the red wolf experimental population area in North Carolina showing lands owned by federal and state governments.

An additional electrified 16-gauge wire at ground level prevented animals from digging out of the corral. A solar-charged, battery-operated 12-volt fence charger (Model Parmak Solar Magnum Charger, Country Supply, Louisiana, MO 63353) provided electricity to the interwoven and digging wires. The upper portion of fencing was approximately 10cm by 15.25cm non-electrified, plastic mesh (Model Barrier Fencing, Forestry Supplies Inc., Jackson, MS 39284). The plastic and nylon fencing were fastened together and to polyvinylchloride (PVC) posts using cable ties, then secured to the ground with nylon ropes and stakes.

Figure 2. A solitary, male red wolf (M1166) in the portable, electrified acclimation corral.

Cost for the corral mesh was approximately US$250, and the solar-powered battery and fence charger approximately US$480. The PVC pipe and other miscellaneous supplies (e.g. rope, stakes, hammers) to construct the corral cost approximately US$300. The time

required to construct the corral varied depending on the number of people assisting, but generally took less than eight hours. Dismantling the acclimation corral typically took less than two hours. After the initial set-up, the plastic and nylon fencing can be rolled and stored together to minimize the time required to construct the corral for future releases.

*Release sites*

Release sites were selected based on known historical use by wild canids (i.e. red wolves, coyotes, or wolf-coyote hybrids), habitat, and land ownership. Eight of the nine release events occurred on federally owned property in Alligator River NWR (Dare County), Mattamuskeet NWR (Hyde County), or Pocosin Lakes NWR (Hyde, Tyrrell, and Washington Counties). The remaining release event occurred within the red wolf experimental population area on private property (Hyde County) with the permission of the landowner. The release corrals were constructed in mature and regenerating mixed pine hardwood, high shrub pocosin, or bottomland hardwood habitats, except for the release on private property which was in a fallow farm field.

*Acclimation and release*

All release events were part of the management strategy outlined in a Population and Habitat Viability Assessment (Kelly et al. 1999). The purpose of the releases was twofold: 1) to decrease or prevent wolf-coyote matings; and, 2) to enhance and expand the red wolf population.

Acclimation and release events took place during the pair bonding (1 October – 31 January; $n$ = 3), breeding (1 February – 31 March; $n$ = 3), or whelping (1 April – 31 May; $n$ = 3) period. Five release events occurred as a male-female pair and four releases involved solitary animals (1:3). All wolves were held in 225m$^2$ fixed chain-link pens at Sandy Ridge prior to release to acclimatize them to the climate (i.e. non-residents), an enclosure, and, in five cases, another wolf. Time spent at Sandy Ridge ranged from 17 to 64 days (mean = 38.4 $\pm$ 5.5 SE days).

Wolves were moved into the release corral in portable kennels and placed in a metal den box. Road-killed white-tailed deer *Odocoileus virginianus* and/or commercially packaged horse meat (Bravo Packing, Inc., Carney's Point, NJ 08069 and Dallas Crown, Inc., Kaufman, TX 75142), was provided once or twice a week depending on weather and prior feeding amount, and to minimize human disturbance. Uneaten food from the previous feeding was removed from the site to limit attracting scavengers. Two metal water tubs were placed inside the corral; water was available *ad libitum*. An inspection of the corral and, if possible, a visual observation of each wolf was made during the feeding visit. Any repairs to the corral fencing or digging wire were completed as quickly as possible; time spent at the corral was less than 20 minutes per visit.

Wolves were held in the release corral from 11 to 24 days (mean = 16.0 $\pm$ 1.5 SE days). In general, the holding time was minimized to reduce the likelihood of immigration or recolonization by coyotes or wolf-coyote hybrids into the release area. No wolf escaped the corral prior to release.

On the day of release, the electrified fence wires were disconnected, a section of the mesh was raised and tied up, and the digging wire removed at that section. A road-killed deer carcass was placed several meters outside the fence to entice the animals to leave the corral, and to encourage the released wolves to return to the area and establish a territory (Figure 3).

**Figure 3.mov. [click on link to display**] Video of the release of a solitary, male red wolf (M1166) from the portable, acclimation corral. N.B. The video is in Quicktime Movie format. (Quicktime is available free for download for Macintosh or Windows-based computers at http://www.apple.com/quicktime/).

Ground and/or aerial radio telemetry was used to determine when the animal(s) exited the corral. If the wolves did not leave the corral after several days, biologists would return and open a larger section of fencing. The corral was dismantled and removed when the animal(s) departed the pen. The wolves' movements were monitored weekly by ground and/or aerial radio telemetry.

## Results

The first paired wolf release event consisted of

a male (M1053) from St. Vincent NWR and a female (F952) born in the GSMNP (Table 1). The purpose of the release event was to fill an area vacant of wolves, coyotes, or wolf-coyote hybrids. Upon release, the pair established a territory in the immediate area of the release corral and defended it against other canids for more than two years before the male was displaced by a wild-born male wolf (M1149). M1149 and F952 mated and produced a litter of six pups in April 2003, and possibly a litter in 2005.

The second release event included a male (M1108) from Cape Romain NWR and a resident female (F808). The female was a proven breeder, having whelped litters in 1999 and 2000. The purpose of the release event was to pair the resident female with another mate following the death of M894 in November 2000. Upon release, the pair established a territory in the area and defended it against other canids until the female was found dead on 17 July 2001. The cause of her death is unknown. M1108 paired with a wild-born female (F1037) who dispersed to the area in April 2001; the two produced litters in 2002 and 2004. Telemetry contact with M1108 was lost in November 2004.

A male (M951) born in the GSMNP and a female (F1109) from Cape Romain NWR formed the third paired release event. The male was killed when hit by a vehicle three weeks after his release, approximately 18km from the release site. The female's radio collar failed on 18 December 2001. It is likely the female died because her radio signal has not been recorded since, nor has she been recaptured despite repeated trapping attempts. Coyotes or wolf-coyote hybrids had been removed from the release area prior to the release of the wolves.

The fourth male-female paired release included a resident male (M1112) and a female (F1165) from Cape Romain NWR. The purpose of this release event was to pair the male with a mate. Upon their release, the male remained in the release area, but the female moved 8-10km northeast of the release area establishing a new territory. The male was found dead in October 2004; the cause of death is unknown. The female remained unpaired through the next breeding season.

The final paired release event included resident wolves M1136 and F1170. The purpose of this release event was to pair the female wolf with a mate after removing a coyote or wolf-coyote hybrid from the area. After release in the female's territory, the pair established and defended the territory until M1136 was displaced by a captive-born, wild-fostered male (M1171) that immigrated to the area as an adult in November 2003. M1171 paired and mated with F1170 and the two produced a litter in April 2004 and again in 2005. M1136 paired with a wild-born female (F1148); it is thought that they had a litter in 2005, but lost their pups when the pair was displaced from their territory by another wolf pair.

The first solitary release involved a female (F1073). The purpose of this release event was to insert a potential mate into an area where a coyote or wolf-coyote hybrid was removed and an un-collared, solitary male wolf was thought to reside. The female was known to have dispersed from her natal range to the area from which she was captured (i.e. Beaufort County). The female returned to Beaufort County within a couple of weeks of release, approximately 13-16km from the release site. It is possible she had a mate in the area from which she was captured, and was suspected of producing a litter in 2003 based on her restricted movements during the whelping season. She was killed by gunshot in February 2004.

Female F1070, a sibling of F1073, was the subject of the second solitary release event and a second attempt to release a potential mate for the un-collared male thought to reside within the release area. Upon release, the female appeared to be homing to her natal territory (approximately 43km from the release site) where she was first captured. She was killed when struck by a vehicle approximately 33km from the release site nine days after release.

Table 1. Results of nine paired and solitary releases involving 14 red wolves using the portable, electrified acclimation corral.

| Animal ID | ♂ Age at Release (mths) | ♀ Age at Release (mths) | Days at Sandy Ridge | Days in corral | Release Purpose | Release Date | Release Period | Pair Bond[b] | Territory[c] | Litter[d] |
|---|---|---|---|---|---|---|---|---|---|---|
| M1053 x F952 | 29 | 29 | 64 | 12 | Insert wolf pair into area vacant of wild canids. | 4/10/00 | Pair bonding | Yes | Yes | Yes |
| M1108 x F808[a] | 22 | 71 | 32 | 11 | Pair female wolf with a new male following the death of her mate. | 16/3/01 | Breeding | Yes | Yes | Yes |
| M951 x F1109 | 35 | 22 | 40 | 12 | Replace coyotes or wolf-coyote hybrids. | 4/4/01 | Whelping | No | No | No |
| M1112[a] x F1165 | 32 | 20 | 22 | 15 | Pair male wolf with a potential mate. | 21/1/03 | Pair bonding | No | Yes | No |
| M1136[a] x F1170[a] | 23 | 22 | 27 | 21 | Replace coyote or wolf-coyote hybrid; pair female wolf with a potential mate. | 26/3/03 | Breeding | Yes | Yes | Yes |
| F1073[a] | -- | 23 | 45 | 19 | Replace coyote or wolf-coyote hybrid; potential wolf mate residing in area. | 17/4/02 | Whelping | No | No | No |
| F1070[a] | -- | 24 | 63 | 16 | Replace coyote or wolf-coyote hybrid; potential wolf mate residing in area. | 10/5/02 | Whelping | No | No | No |
| M1166 | 17 | -- | 17 | 24 | Replace coyote or wolf-coyote hybrid; potential wolf mate residing in area. | 1/11/02 | Pair bonding | Yes | Yes | Yes |
| F1140[a] | -- | 22 | 36 | 14 | Pair female wolf with M1112 following dispersal of F1165. | 28/2/03 | Breeding | No | No | No |

[a] Resident of experimental population area.
[b] At least one wolf from the release successfully formed a pair bond with another wolf.
[c] At least one wolf from the release successfully defended a territory around the release site.
[d] At least one wolf from the release successfully bred and raised a pup in the wild.

The third solitary wolf release involved a yearling male (M1166) from Cape Romain NWR. The purpose of this release event was to insert a potential mate into an area where a coyote or wolf-coyote hybrid was removed and a radio-collared female wolf (F904) was residing. Radio telemetry monitoring indicated the release corral was frequently visited by the female wolf prior to the release of the male. The male wolf paired with the female after his release, and established and defended the territory against other canids. The pair produced litters in 2004 and 2005.

The last solitary wolf released was a female (F1140) captured by a local trapper after the wolf naturally dispersed from her natal range. The purpose of this release event was to pair the female with M1112 following the dispersal of F1165. Female F1140 appeared to be homing to the area where she was first trapped (approximately 23km from the release site) when she was struck by a vehicle and killed (approximately 13km from the release site) nine days after her release.

## Discussion

The use of a portable, electrified corral appears to be an effective method for soft releasing male-female paired red wolves, as three of five of the paired releases were successful. Grey wolves translocated and soft released as groups (including family groups) showed greater release site fidelity and pack establishment than did individually released wolves (Fritts et al. 1997; Bradley et al. 2005). Paired red wolf releases generally occurred during the pair bonding and breeding periods, and time spent in captive holding and in the release corrals was similar. These factors may have contributed to the success of these release events.

Releases using a solitary wolf had mixed results. In the case of the release of the solitary male, a female red wolf was known to reside near the release site and she visited the corral numerous times. Her visits to the pen likely contributed to the two wolves forming a social bond after the male's release, establishing a territory around the release site, and defending it from other canids. Boyd et al. (2000) reported that an adult male grey wolf visited an adult female grey wolf and her pups while they were being held in a similar pen. Upon releasing the penned wolves, the male was reported to have "successfully joined the pack." The timing of the releases (i.e. November and December) during the pair bonding period probably contributed to the released wolves successfully pairing with the wild wolves in both release events. Although wolves may form social bonds at any time of the year, releasing wolves during the late fall or early winter period may contribute to the long courtship period needed to form the social ties for mating (Mech 1970).

Releasing a single wolf into an area with a potential mate does not ensure that the two animals will form a pair bond and establish and defend a territory. The three solitary female releases indicate that other factors play a role. In each of these release events the female appeared to be homing to the area where she was first captured. Bradley et al. (2005) reported that grey wolves, individually translocated and released, showed significant directionality in their movements toward their original capture site (see also Fritts et al. 1997). The ages of the female red wolves (i.e. 22 to 24 months) may have contributed to their post-release movements. Female red wolves are reported to disperse at approximately 23 months of age (Phillips et al. 2003), and similar ages have been reported for grey wolves (Fritts and Mech 1981; Gese and Mech 1991). Moreover, each of the solitary female releases occurred during the late breeding or whelping seasons (i.e. February, April, and May), and this may have been a factor contributing to the wolves leaving the release area. In grey wolves, female dispersal was reported to peak in April (Gese and Mech 1991). In addition, wide-ranging exploratory movements following release are not necessarily common in red wolves. Straight-line distances (range approximately 13 to 33km) travelled by the solitary females following release (and before their deaths) were within the limits of reported home range sizes for red wolves (Riley and McBride 1972; Shaw 1975; Phillips et al. 2003). These distances were also similar to distances reported from other red wolf release events (Phillips et al. 2003).

Based on the available literature and on the results of these nine release events, several factors may be important to success in future reintroductions and/or translocations of red

wolves. Releasing male-female pairs rather than solitary wolves, especially when the release area is not currently occupied by other wolves and at least one of the pair is familiar with the area, appears to be most successful. In addition, because yearling wolves are reported to have higher rates of dispersal (Fritts and Mech, 1981; Gese and Mech 1991; Phillips et al. 2003), adult wolves (i.e. >24 months of age) may be preferable for release. Adult grey wolves are reported to have a higher degree of success in settling a new territory and pairing with a mate after dispersing, than yearlings or pups (Gese and Mech 1991). Adult grey wolves also travelled less distance from their territories when dispersing. As a result, adult wolves may be more likely to establish a territory around the release site and exhibit less post-release exploratory movements than yearlings or pups (but see Bradley et al. 2005). Alternatively, releasing wolves that are exhibiting dispersal behaviour (of any age), rather than wolves that have remained in their natal territory or have dispersed to another area, may increase the likelihood of the animal establishing a territory around the release site. Fritts and Mech (1981) reported that dispersing grey wolves had a high degree of success in settling a territory and finding a mate in areas with abundant prey and an unsaturated wolf population. Wolves exhibiting dispersal behaviour were not used in this study, however, prey abundance and local wolf population density were factors considered important in the selection of release sites, and likely contributed to the success of releases. Lastly, releasing animals in the fall or early winter appears to increase the likelihood of animals forming social bonds.

The use of a portable, electrified corral as a practical management tool for translocation is relatively inexpensive, easy to construct, and useful in a variety of habitats. However, it does have one obvious disadvantage – it requires regular visitation and maintenance to reduce the probability of escape. Animals may prematurely escape if the electricity fails and the animals chew through the plastic and nylon mesh. For example, a pack of Mexican grey wolves *C. l. baileyi* consisting of an adult pair, a yearling male, and five pups, was reported to have escaped a non-electrified, portable corral by chewing a small hole near the bottom of the pen (V. Asher, unpublished data). A similar instance occurred in another release event when only the lower strands of the electric fencing were disconnected out of concern of causing injury to seven-week-old pups. In both cases, the pups were suspected of first chewing through the fence. Conversely, in a third release event involving the former wolf group, the wolves did not escape an electrified corral even though the electricity had inadvertently been disabled during a snowstorm. The release of a red wolf group with pups using the portable, electrified corral has not been attempted. Special attention should be given to the interaction of younger animals with the electrified fence.

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