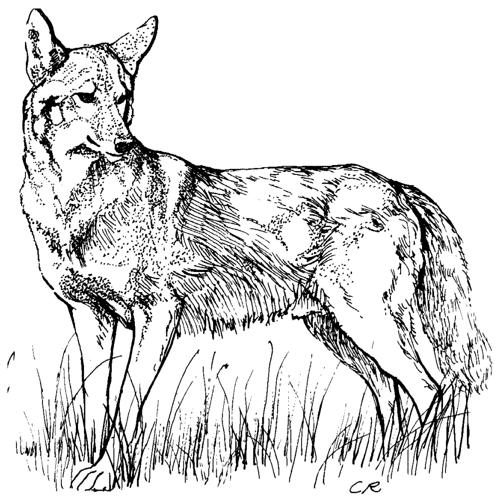
Red Wolf Recovery Program Adaptive Work Plan



Date Revised:
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Revised by:
Buddy Fazio, Team Leader
Chris Lucash, Wildlife Biologist
Art Beyer, Wildlife Biologist
Red Wolf Recovery
Alligator River National Wildlife Refuge
P.O. Box 1969
Manteo, NC 27954

PREFACE

This plan specifies the framework and general goals of an adaptive management plan by which the feasibility of controlling red wolf/coyote hybridization will be assessed while efforts to restore red wolves to northeastern North Carolina (NENC) continue. This plan specifies core components designed to meet annual goals; however, it retains the flexibility to adapt to new findings, either from the analysis of the data collected during the implementation of the plan or from the findings of modeling efforts of research partners (see below I, II and III), or both. From this framework, the data it is designed to collect, and the modeling efforts and sensitivity analysis currently underway, the Red Wolf Recovery Implementation Team (RWRIT) will be able to assess the program's progress and make recommendations regarding adaptations to the plan.

PURPOSE AND BACKGROUND

The purpose of this plan is to provide the implementation strategy and goals of adaptive management which are designed to assess, control and manage hybridization occurring between red wolves and coyotes while restoring the only extant population of red wolves in the United States. Red wolves had been declared extinct in the wild in 1980. The U.S. Fish and Wildlife Service began restoring red wolves to the wild in 1987. The history of the red wolf reintroduction program prior to the temporal scope of this plan is well documented (Phillips et al 2003, Gilbreath 1998, Phillips et al. 1995).

During the week of April 12, 1999, the Conservation Breeding Specialist Group (CBSG) of the IUCN's Species Survival Commission conducted a three and a half day facilitated workshop. The purpose of this workshop was to gather together experts who had studied wolves, coyotes, genetics, modeling, and canid population biology to discuss the biological and ecological issues facing red wolf recovery. Four subject areas were identified to be the focus of the workshop: (1) red wolf population monitoring, (2) red wolf hybridization with coyotes, (3) selection of additional release sites, and (4) the role of the captive breeding program.

After reviewing data on the reproduction of red wolves in the wild, the attendees of this workshop concluded that the proportion of hybrid litters from red wolf/coyote interbreeding was alarmingly high, and recommended the workshop focus solely on issues surrounding red-wolf/coyote hybridization, including: how much hybridization could occur in the population in NENC while still maintaining its genetic integrity, how to assess the degree of hybridization within the population, and how to limit hybridization to acceptable levels on a landscape scale. This work plan details an adaptive management approach (Holling 1978, Walters 1986) to these issues that is based on the recommendations from the CBSG workshop (Kelly et al. 1999).

ORGANIZATION OF THIS DOCUMENT

This plan is organized into three sections: (I) an overview of the adaptive management paradigm and a discussion of how the red wolf adaptive management plan (RWAMP) is consistent with this paradigm, (II) a description of the experimental approach of the adaptive plan, and (III) goals of the plan and measures by which adaptations to this plan should be based.

(I) Adaptive Resource Management and the Red Wolf Recovery Program

Adaptive resource management (ARM) is an approach derived from the need to blend research and management. To be effective resource stewards, wildlife managers should refrain from conducting research and management independently. Instead, sound scientific principles should be applied to solve problems. Adaptive management provides the paradigm by which this can be accomplished (Lancia et al. 1996).

Adaptive management is characterized by a 4 step process (Walters 1986): (1) reach a consensus among stakeholders, (2) analyze existing data and model preliminary predictions regarding various management schemes, (3) assess how sensitive predictions are to changes in various assumptions and variables, and (4) implement management in an experimental context. Adaptation of a plan is effected via feedback from experimental results generated in step. Because the red wolf recovery program (RWRP) was seen to be in a crisis stage by the participants of the CBSG workshop, the RWRP did not adhere to the sequential implementation of this process. Instead, based on the results of the CBSG workshop, several of the four steps outlined above were engaged simultaneously. Nonetheless, the Service's mission of working with others and basing decisions on sound science is consistent with the adaptive management paradigm and provided somewhat of a head-start on the four steps mentioned above. The current state of each step is detailed below.

Reach a Consensus among Stakeholders (1)

In the ideal ARM paradigm, all stakeholders concede something to implement a plan. In the context of the red wolf recovery program, red wolves were reintroduced under the experimental non-essential (ENE) designation available in section 10(j) of the Endangered Species Act. This designation allowed for a weakening of the provisions of the act that prohibit the take of an endangered species. So in a broad sense, advocates of wolf introduction and restoration conceded a higher level of protection of wolves to accomplish restoration; and, by having greater flexibility to take wolves, opponents to wolf restoration were more amenable to having wolves on their land. The rule-making process associated with an ENE designation provides the forum for reaching consensus. This process typically involves public meetings and written comment periods that result in the revision of a proposed rule to reflect consensus. The red wolf program followed such a process to derive its current management rule; however, the advent of a serious threat to recovery from hybridization precipitated the need to change the current red wolf rule. Prior to initiating the rule-changing process, the RWRP pro-actively conducted open houses in the local communities to inform stakeholders of the need to change the rule and described conceptually the adaptive plan being proposed. Although the RWRP is assessing the data to determine if further rule changes are indeed necessary, the open houses have functioned to inform and begin the process of generating consensus. Additionally, RWRP personnel continue to present and discuss strategies of the RWAMP opportunistically with landowners and other members of the local public, particularly when management activities are conducted on non-federal land.

Analyze Existing Data and Generate Models (2)

Prior to the CBSG workshop, no analysis had examined hybridization between the reintroduced population of red wolves and the eastern coyote and little empirical data existed on this topic. Participants of the CBSG workshop crafted a simple, theoretical, deterministic model of coyote genetic introgression into the NENC red wolf population. This model apparently indicated the current red wolf population could sustain very little hybridization if it was to maintain its genetic identity. Since this model, the workshop recommendations and therefore much of this adaptive management plan were based largely on theoretical information, the Service, via partners at universities, initiated research projects to address the dearth of data and to construct more applicable models to guide management decisions and actions.

The projects deemed requisites to controlling hybridization were a genetic test to distinguish pure red wolves from hybrids, and a more substantial model of coyote introgression. As more information has been gathered, additional models of social interactions between sympatric red wolves and coyotes, and red wolf survival analysis were to be undertaken.

Assess How Sensitive Predictions Are To Changes In Assumptions and Variables (3)

At the CBSG workshop, the need to assess the sensitivity of the models that would guide the current plan and future adaptations was evident. Field efforts would collect data on key variables or to test key assumptions, but collecting this data would not detract from affecting change in the population towards achieving recovery goals. The models would then be refined with empirical data from red wolves, coyotes and/or hybrids in NENC as these data became available and the models would serve to influence future management recommendations.

As an example of the sensitivity assessment of the introgression model, a recent modeling run was conducted where 75% of hybrids and mixed pairs were sterilized. This scenario had a large impact on the integrity of the red wolf genome with 30-year projections predicting greater than 90% retention. Simulation of removal of hybrids was not nearly as effective. The introgression model to date would support the hypothesis that sterile hybrids are functioning as effective place holders, thereby reducing the rate of emigration of hybrids and potential introgression into the red wolf population.

Likewise, a red wolf/coyote/hybrid spatial use model is currently being developed, based on empirical results derived from the field component of the red wolf recovery program in NENC. Results from these analyses may identify variables or assumptions that significantly affect the management options best tailored for reducing wolf-hybrid encounters and maximizing available space for wolf colonization. Ideally, the introgression and spatial models will eventually be integrated to assess the overall impact of hybridization on a landscape scale and help determine how effective the adaptive management plan is.

Implement Management in an Experimental Context (4)

See III below (Implementation of the Plan and Measures by which Adaptations should be based) for information on how the red wolf program is implementing this component of the adaptive management paradigm.

(II) Goals of the Adaptive Plan and a Description of the Experimental Approach

The goals of the RWAMP are to (1) reduce interbreeding between red wolves and coyotes to a level that does not threaten the long term genetic integrity of the red wolf in the wild while simultaneously (2) building and maintaining the wild red wolf population from the east to west of the NENC recovery area (see Figures 1&2). Achievement of the first of these goals is approached by eliminating the breeding potential of coyotes within the study area through removing some coyotes immediately upon capture and by sterilizing, radio-collaring and releasing others. This adaptive approach allows for the second of the plan's goals, namely increasing the wolf population.

Man's inability to control coyotes is noteworthy (Lantz, 1905; Balser, 1974). Recall that wolves were rather easily exterminated from the U.S. during the predator control efforts of the early 20th century, while at the same time the range of the coyote increased. Decades of effort have been spent trying to remove coyotes to protect domestic lambs from predation. However, efforts to remove the offending individuals are often problematic and produce inconsistent results (Conner et al., 1998; Sacks et al., 1999b). Because coyotes are territorial and typically kill lambs to provision their pups (Till and Knowlton, 1983; Sacks et al., 1999a), researchers began testing whether surgically-sterilized but hormonally-intact coyotes could function to protect lambs by defending their space against coyotes needing to provision pups (Bromley and Gese, 2001a; Bromley and Gese, 2001b). It is this concept of holding space that is being applied to manage hybridization by providing managers time, information, and a higher degree of control over the recovery landscape, while simultaneously providing reproductive advantage to the red wolf.

Eliminating "zones of ignorance" is the primary component of the management process to ensure that all intact (breeding) pairs are wolves. These "zones of ignorance" are areas where no known canid is present, or where a nomadic (Crabtree 1988) or transient (Windberg and Knowlton 1988) red wolf is present but its status is unknown. Sterilization of coyotes and hybrids not only achieves one of the goals of the RWAMP by limiting coyote genomic introgression, but it also provides a biological means by which zones of ignorance can be systematically assessed and eliminated., a critical intermediate step in the transition to a landscape occupied predominantly by red wolf breeding groups. Ultimately, sterilization is a method that allows territorial space to be held until that animal can be replaced naturally or by management actions.

The underlying tenet of this approach is that space, and therefore territories, is limited on the recovery peninsula. Given a small, introduced wolf population, that space is initially best occupied by breeding pairs of wolves, non-breeding mixed (wolf/coyote) pairs, and non-breeding coyote pairs. In this way, introgression of non-wolf genes will be controlled and territories will be unavailable for colonization by intact coyote or mixed pairs. As the wolf population grows, having space available to dispersing wolves becomes increasingly important and this space is provided through natural interspecific behavior and/or management actions.

(III) Implementation of the Plan and Measures by which Adaptations should be based

The RWAMP is framed around the following biological seasons:

Months	Biological Season	Associated Field Work
October - January	Pre-breeding/Pair Bonding	Trap wolf groups to ID and radio collar
February-March	Breeding	Address partial zones of ignorance
April-May	Whelping	Den work: transponder and ID pups
June-September	Pup-rearing	Survey zones of ignorance

Goals, by season, and general methods of the RWAMP are presented below. These goals will be implemented in a priority order from Zone 1 through Zone 3, according to the three zones identified during CBSG workshop and later modified (Figures 1 and 2). Implementation of this plan is reviewed twice annually, usually in spring and late summer. An outline of goals and tasks follow:

1. October - January (Pre-breeding/Pair Bonding):
    a. Confirm and monitor the identification and disposition of individuals within known wolf groups.
        i. Capture and assess ID of wolves (pack members) not previously captured and/or identified. ID is determined by genetic analysis of blood samples, morphological measurements and pedigree data.
        ii. Confirm the presence, via recapture or survey, of previously identified and radio-collared wolves that have disappeared. Surveys methods can include identification of tracks, scat, or images from remote cameras as well as visual observations of

wolves themselves. The presence of a breeder may be confirmed from genetic assessment of pups at time of their capture.

iii. Capture and radio collar pups identified and implanted with transponders at the den the previous whelping season, as needed.

b. Provide space for dispersing or inserted wolves.

i. Remove sterile space-holders.

ii. Identify associates of previously suspected lone wolves, and remove non-wolf canids (see 2.b.i-iii.)

c. Conduct insertions of wolves into areas previously occupied by coyotes or hybrids.

2. February-March (Breeding):

a. Continue with objective 1.a. through March 15th for areas not completed during the pre-breeding season.

b. Determine genomic identity of new associates of previously suspected lone wolves to prevent hybrid mating (i.e., address partial zones of ignorance):

i. Capture, and assess genomic identity and decide disposition of every animal caught while trapping for suspected associates.

ii. Genomic identity is determined by genetic analysis of blood samples, morphological measurements and pedigree data.

iii. Use survey methods (see 1.a.ii.) to focus capture efforts and address zones of ignorance. Additional survey methods appropriate to this objective include siren surveys and public reports.

c. When 2.b. is completed focus can shift to addressing zones of ignorance.

d. Survey Zone 1 for presence of coyotes or hybrids (e.g., scat surveys for genetic ID).

3. April-May (Whelping):

a. Monitor all breeding-age canids (including sterilized ones) to ascertain whether they exhibit localized movements.

i. If non-wolf females or female associates of non-wolf males localize movement, efforts should be made to determine whether she has a litter, and, if so, it should be removed.

ii. If wolf females localize movements, try to locate the den beginning one week after the suspected whelping date. Blood samples should be taken from each pup for genetic analysis, and transponders inserted. Litters identified as non-wolf following genetic analysis should be removed.

b. Selectively cross-foster wolf pups or litters from wild or captive litters.

c. Continue with objective 2.c. if not yet complete.

4. June-September (Pup-rearing): Continue addressing zones of ignorance.

5. Year-round efforts; to the extent possible:

a. Relocate each radio-collared wolf via ground and aerial telemetry and use of satellite or GPS collars a minimum of 10 or more usable locations sampled per biological season.

b. Gather data relevant to assessing dispersal patterns of red wolves, coyotes, and coyote-red wolf hybrids.

c. Gather data essential to assess demographic parameters of the red wolf population necessary to assess viability of the red wolf population.

Seasonal variation in behavior dictates the timing for implementation of these goals. Focusing on known breeding groups of wolves during pre-breeding not only insures the ability to capture and begin tracking wolves that will serve as dispersers into the population, but also avoids exposing known wolf groups to activities (e.g., trapping and handling) during the breeding season that may compromise their ability to breed and produce a litter. In contrast, the focus on zones of ignorance during pre-breeding identifies vacant areas for dispersing wolves, while the focus during breeding and whelping seasons maximizes control of hybrid production. See Knowlton (1972) for a discussion of the temporal effectiveness of coyote control and why control during the breeding season is effective.

The approach outlined above will simultaneously reduce known introgression, reduce zones of ignorance, provide data to test key hypotheses and allow for the determination of the RWAMP's overall effectiveness. The following predictions can be used to test and evaluate the plan:

- P1: Red wolves are territorial to the exclusion of pairs or groups of coyotes.
- P2: The number of known red wolf breeding units increases over time.
- P3: The percent of coyote-free land occupied by red wolves increases over time.
- P4: Number of known "breeding" pairs or groups (sterilized pairs, and red wolf pairs) increases asymptotically with time.
- P5: The number of sterilized animals decreases over time.
- P6: The number of mixed pairs that change to wolf pairs is greater than the number of wolf pairs that change to mixed pairs.
- P7: The fraction of the known reproduction (red wolf and hybrid) that is hybrid decreases overtime.
- P8: The percent hybrid litters is on a trajectory to a value that is consistent with maintaining 90% of the founding genetic diversity for 100 years (1-2% of the red wolf reproduction is hybrid).

Statistically, testing some of these predictions may be problematic. Many are cast as time series data and a lack of independence of observations or pseudo-replication may be an issue, especially for analysis of variance and linear regression techniques. However, many can be cast as null models that should enhance their test-ability. Nonetheless, the most appropriate means by which these predictions are tested is evolving over time with guidance from the RWRIT. Table 1 below summarizes the current status regarding available data and future needs regarding these hypotheses.

Table 1. Red wolf adaptive management plan predictions and data needs.

Prediction	Data Currently being collected?	If No, Does Plan Address?
P1*	No	Yes, n>10 locations/animal/season
P2	Yes, baseline established	
P3*	No	Yes, n>10 locations/animal/season
P4	Yes, baseline established	
P5	Yes, baseline established	
P6	Yes	
P7	Yes	
P8	Yes	

* P1 and P3 are critical in validating the underlying tenet of this plan - that space is limiting and red wolves will exclude coyotes. Data with regard to these predictions is critical to assess the feasibility of managing hybridization, and thus whether red wolves can coexist with eastern coyotes. These predictions are not being tested because few coyotes are monitored in areas of wolf establishment.

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