U.S. Fish & Wildlife Service

Draft Revised Recovery Plan for the Red Wolf (*Canis rufus*)

Third Revision

June 2022

Thirteen year old female red wolf 1743; Alligator River NWR, March 2022
Photo credit: Jennifer Hadley

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Third Revision

(Original Approved July 12, 1982)

(First Revision Approved, September 18, 1984)

(Second Revision Approved, October 26, 1990)

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Red Wolf Recovery Team

for

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This plan is based largely on the Red Wolf Species Status Assessment (SSA) (Service 2018) and Recovery Planning for the Red Wolf, Workshop Report (Conservation Planning Specialist Group (CPSG) and Service 2021). This draft recovery plan was developed by the Red Wolf Recovery Team, a collaborative partnership among Federal and State agencies, Tribal representatives, County government, academia, zoos/conservation centers, non-profit organizations, non-governmental organizations, and landowners (see Appendix A). The Service gratefully acknowledges Phil Miller and Stephanie Winton (CPSG) and the members of the Red Wolf Recovery Team for their commitment and time to developing this recovery plan for the red wolf. We would also like to express our appreciation to our many partners for their active role in conservation of this species.

DISCLAIMER

The Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.)(Act), requires the development of recovery plans for listed species, unless such a plan would not promote the conservation of a particular species. Recovery plans delineate reasonable actions that are believed necessary to recovery and/or protect the species. Plans are prepared by the U.S. Fish and Wildlife Service, sometimes with the assistance of recovery teams, contractors, State agencies, and others. Plans are reviewed by the public before they are adopted by the U.S. Fish and Wildlife Service. The SSA on which this recovery plan is based was subject to peer review; therefore, this plan will not be subject to additional peer review. Objectives will only be attained and funds expended contingent upon appropriations, priorities, and other budgetary constraints. Recovery plans do not obligate parties to undertake specific tasks. Recovery plans do not necessarily represent the views nor the official positions or approval of any individuals or agencies involved in the plan formulation, other than the U.S. Fish and Wildlife Service. They represent the official position of the U.S. Fish and Wildlife Service only after they have been signed by the Regional Director or Director as approved. Approved recovery plans may be subject to modification as dictated by new findings, changes in species status, and the completion of recovery tasks. By approving this document, the Regional Director certifies that the information used in its development represents the best scientific and commercial data available at the time it was written. Copies of all documents reviewed in the development of the plan are available in the administrative record, located at the U.S. Fish and Wildlife Service's South Atlantic-Gulf and Mississippi Basin Regional Office, Atlanta, Georgia. Nothing in this plan should be construed as a commitment or requirement that any Federal agency obligate or pay funds in any one fiscal year in excess of appropriations made by Congress for that fiscal year in contravention of the Anti-Deficiency Act, 31 U.S.C. 1341, or any other law or regulation. Approved recovery plans are subject to modification as dictated by new information, changes in species status, and the completion of recovery actions. Please check for updates or revisions at the website below before using.

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This recovery plan can be downloaded free of charge from the USFWS website: http://www.fws.gov/endangered/species/recovery-plans.html

TABLE OF CONTENTS

INTRODUCTION

The U.S. Fish and Wildlife Service (Service) is now using a three-part process to develop our recovery plans (see https://www.fws.gov/endangered/esa-library/pdf/RPI.pdf). This approach is intended to reduce the time needed to develop and implement recovery plans, increase recovery plan relevancy over a longer timeframe, and add flexibility to recovery plan implementation so they we and our partners can adjust on the ground activities to new information or circumstances.

The three-part process of recovery planning includes:

1. The **Species Status Assessment** (SSA) or **Species Biological Report** (SBR) informs the recovery plan; it describes the biology and life history needs of the species, includes analysis of each species' historical and current conditions, and includes discussion of threats and conservation needs of each species. The SSA or SBR's format is structured around the conservation biology principles of resiliency, redundancy, and representation. These principles are used to assess the species' ability to maintain populations over time (viability) (Shaffer and Stein 2000, pp. 307-310; Smith et al. 2018, entire; Wolf et al. 2015, entire). The SSA for the red wolf was completed in 2018 (Service 2018).
2. The **Recovery Plan** contains a streamlined overview of the recovery strategy for the species (indicating how its recovered state (viability) will achieve redundancy, resiliency, and representation), as well as the elements required under section 4(f)(1)(B) of the Act:
    (i) Objective, measurable criteria which, when met, would result in a determination, in accordance with the provisions of this section, that the species be removed from the list;
    (ii) A description of such site-specific management actions as may be necessary to achieve the plan's goal for the conservation and survival of the species; and
    (iii) Estimates of the time required and the cost to carry out those measures needed to achieve the plan's goal and to achieve intermediate steps toward that goal.
3. In cooperation with our partners, we will prepare a **Recovery Implementation Strategy** (RIS), which serves as an operational plan for stepping down the site-specific recovery actions into more detailed activities. The RIS is a short-term, flexible operational document focused on how, when, and by whom the site-specific recovery actions from the recovery plan will be implemented. This approach allows us to incorporate new information and adapt to changing circumstances with greater flexibility and efficiency as that information becomes available and to improve coordination with the states and other partners to achieve recovery. We note, however, activities in the RIS must be consistent with and contribute to implementing actions in the recovery plan, and cannot revise or add actions without a recovery plan revision. The RIS will focus on the period of time and scope of activities that work best for our partners to achieve recovery goals.

Using this approach, new information on species biology, recovery implementation, or detailed activities that support the recovery plan actions may be incorporated by updating the SSA/SBR

or RIS without concurrent revision of the entire plan, unless changes to statutorily required elements are necessary.

This revised recovery plan is based on the Red Wolf SSA (Service 2018, entire), which describes the life history and biology of the species, the current status of the species, and the threats that impact the species and the Recovery Planning for the Red Wolf, Workshop Report (CPSG and Service 2021) developed by the Red Wolf Recovery Team. These supplemental documents are available free to the public online in the Service's publication archive. The SSA can be found at https://ecos.fws.gov/ServCat/DownloadFile/161384. The Workshop Report can be found at https://ecos.fws.gov/ServCat/DownloadFile/221153. A RIS is being developed by the Red Wolf Recovery Team. The SSA and RIS will be updated as necessary.

Background

The red wolf was first listed in 1967 as "threatened with extinction" under the Endangered Species Preservation Act of 1966 and is currently listed as an "endangered species" under the Act. It is a distinct canid species (National Academies of Sciences, Engineering, and Medicine 2019, p. 61) native to North America. Historically, it ranged from southeastern United States, westward to the Edwards Plateau in Texas, north to the lower Midwest (i.e., southeastern Missouri and southern Illinois) and east into southern Pennsylvania and extreme southeastern New York (Wildlife Management Institute (WMI) 2016, pp. 19, 22-23; Figure 1).

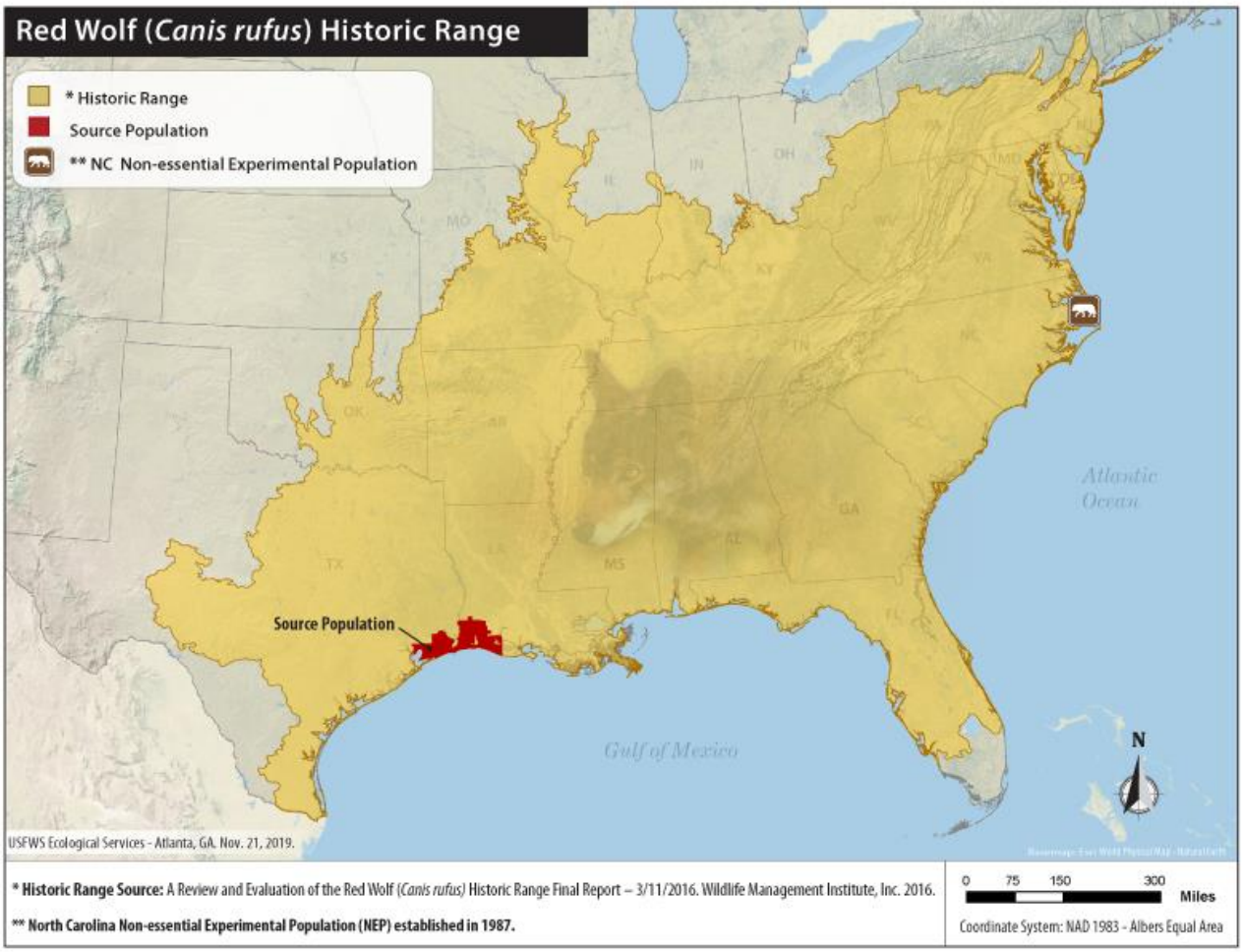

Figure 1. Historic range defined by WMI (2016, p. 23) and source population in Texas and Louisiana.

Though once common throughout its range, red wolf populations were decimated by the early 20th Century as a result of intensive predator control programs and habitat degradation and alteration (Service 1990, pp. 8-9). By 1972, the range of the red wolf was limited to a small coastal area in southeast Texas and southwest Louisiana (Riley and McBride 1972, p. 1; Figure 1).

The remnant population in Texas and Louisiana was found in fallow fields, bayous, marshes, and coastal prairie. However, the Service recognizes that this may not have been preferred red wolf habitat. Other habitats have been suggested, but given the wide historical distribution, red wolves probably utilized a large suite of habitats (Service 2018, p. 21). Any habitat in the southeastern United States of sufficient size, and which provides adequate food, water, and cover, could potentially be suitable for the red wolf. The diet of red wolves varies depending on available prey, but usually consists mainly of white-tailed deer, but can also include smaller mammals such as raccoons, rabbits, rodents, and nutria (Service 2018, p. 23).

To prevent extinction of the species, the Service established a formal recovery program in 1973 and began trapping individuals in the Texas-Louisiana area to establish a red wolf captive breeding program, with the intention of returning the species to areas within its historic range (Service 1990, pp. 9-10). The captive population started with 14 founder red wolves. In 1984, the captive program received the Association of Zoos and Aquariums' approval for a Red Wolf Species Survival Plan (SSP) program (which provides oversight for maintaining a healthy and genetically diverse captive stock). By this time, there were approximately 63 individuals in the captive population (Service 2018, p. 13).

In 1986, a nonessential experimental population (NEP) was established in eastern North Carolina for red wolves. The term "nonessential" is a legal designation of experimental populations under section 10(j) of the Act. Under section 10(j), the Service may designate a population of a listed species as experimental if it will be released into suitable natural habitat outside the species' current range. An experimental population may be considered "essential" or "nonessential." The population of red wolves in eastern North Carolina was designated as an NEP because it was fully protected in captivity. The NEP area is 6,000 square kilometers (2,317 square miles) of federal, state, and private lands in Beaufort, Dare, Hyde, Tyrrell, and Washington counties on the Albemarle Peninsula (Figure 1). In 1987, reintroduction efforts were initiated at Alligator River National Wildlife Refuge (NWR) to establish an eastern North Carolina red wolf population (ENC RWP) in the NEP area. Between 1987 and 1994, over 60 adult red wolves were released from the captive population into the ENC RWP; by the mid-1990s, red wolves in the wild were maintaining territories, forming packs, and successfully breeding (Hinton et al. 2013, p. 725).

A strategy to propagate wild red wolf offspring was initiated in 1987 with the establishment of an island propagation site on Bulls Island, Cape Romain NWR in South Carolina. Island propagation sites allow red wolves to breed in a somewhat controlled, but natural, environment to give them wild experience. Two additional propagation sites were established, one in 1989 on Horn Island, Mississippi, and another in 1990 on St. Vincent NWR, Florida (Service 1990, pp 17-18). The only remaining island propagation site, St. Vincent NWR, continues to contribute to the ENC RWP through translocation of wild red wolves.

In 1991, a second experimental population was introduced in the Great Smoky Mountains National Park (GSMNP), Tennessee. However, this effort was terminated in 1998 due to extremely low pup survival and the inability of the red wolves to establish home ranges within GSMNP. Establishing a reintroduced population of red wolves depends on the released animals producing offspring that survive to replace natural mortality and increase the population. Without surviving wild offspring, there was no expectation that the population would contribute to recovery (63 FR 54152).

Past Recovery Planning

The Service previously published three recovery plans for the red wolf. In July 1982, a Red Wolf Recovery Plan was approved by the Director of the Service. Revisions and updates to this plan were approved on September 18, 1984. The original recovery team was disbanded, and a new team was appointed by the Service's Southeast Regional Director in 1986. The latest (and most

current) plan was approved on October 26, 1990. There has been a significant passage of time since the last plan was developed; much has changed and new information on the red wolf has become available in the last three decades. We are updating the recovery plan to properly guide recovery actions considering the current status of the species and new information. In 2021, the Service convened a new Recovery Team composed of 51 stakeholders (e.g., researchers, private citizens, wildlife biologists, natural resource managers, zoo biologists, etc.) (For a complete list of Recovery Team members see Appendix A) tasked with helping develop a revised recovery plan for the red wolf.

Additional recovery teams were convened for various purposes over the years. In 1999, a Red Wolf Recovery Implementation Team was convened to review Service progress as they implemented an adaptive management plan and to provide recommendations regarding adaptations to the plan (Service 2005, p. 2; Stoskopf et al. 2005, p. 1147). In 2015, the Service convened a recovery team to undertake an evaluation of the Red Wolf Recovery Program to determine the actions needed to achieve recovery of the red wolf and assess the extent to which those actions could be implemented on the landscape (Group Solutions 2016, p. 5).

Current Species Status

Today, there are approximately 230 red wolves in the captive population. The ENC RWP – currently the only known population in the wild – grew to a peak of 100-120 red wolves in 2012. However, the population has since rapidly declined, mainly due to anthropogenic mortality (e.g., gunshot and vehicle strikes) (USFWS 2022). Details on the Service's understanding of the life history needs and species condition can be found in the SSA (Service 2018).

Due to the declining population size and mortality of one or both red wolves in established breeding pairs, there were no known red wolf pups born in the wild in 2019, 2020, or 2021. In January of 2022, there was an estimated total of 15-17 red wolves, with 8 known (collared) red wolves, in the ENC RWP. The Service is currently implementing actions, such as adaptive management (e.g., coyote sterilization), translocation of red wolves from an island propagation site on St. Vincent NWR, and releases of red wolves from the captive population into the ENC RWP, to create new red wolf breeding pairs. Additionally, the Service is pursuing pup fostering to increase the population in the wild. As a result of management actions taken in 2020 and 2021, a litter of red wolf pups was born in the wild in 2022.

Our assessment of the species' viability, defined as the ability of the species to persist and maintain populations in the wild over time, is based on the concepts of resiliency, redundancy, and representation (Service 2018, pp. 10-12). The SSA framework uses the principles of resiliency, redundancy, and representation (i.e., "the three Rs"; Wolf et al. 2015, entire; Service 2016, entire) to assess a species' viability at specific points in time. A species with a high degree of resiliency, representation, and redundancy is better able to adapt to novel changes and to tolerate environmental stochasticity and catastrophes. In general, species viability will increase with increases in resiliency, redundancy, and representation (Smith et al. 2018, p. 306).

The concepts of resiliency, redundancy, and representation are:

Resiliency is the ability of a species to withstand environmental stochasticity (e.g., normal, year-to-year variations in environmental conditions such as temperature, rainfall), periodic disturbances within the normal range of variation (e.g., fire, floods, storms), and demographic stochasticity (e.g., normal variation in demographic rates such as mortality and fecundity). Measured by the size and growth rate of each population, genetic health, connectivity, and habitat quantity, quality, configuration, and heterogeneity. Resiliency is important because it gauges the probability that the populations comprising a species are able to withstand or bounce back from environmental or demographic stochastic events.

Redundancy describes the ability of a species to withstand catastrophic events. Measured by the numbers and distribution of populations relative to the scale of potential catastrophic events. Redundancy is important because it gauges the probability that the species has a margin of safety to withstand or can bounce back from catastrophic events.

Representation describes the ability of a species to adapt to both near-term and long-term changes in the species' physical and biological environments (i.e., adaptive capacity). We can best gauge representation by examining the breadth of genetic, phenotypic, and ecological diversity found within a species and its ability to disperse and colonize new areas. Representation is important because it gauges the probability that a species is capable of adapting to environmental changes.

For the red wolf to maintain viability, its populations, or some portion of its populations, must be resilient. Resilient red wolf populations occupy habitats of sufficient size to sustain growing, reproducing populations of adequate size to withstand introgression pressure and produce viable offspring that reach maturity and expand the population through the formation of new packs. Therefore, the general needs of the red wolf for viability are (Service 2018, pp. 28-29):

- Adequate Numbers – to establish and maintain pack structures, defend territories, produce viable offspring, and find suitable mates (i.e., sufficient unrelated, conspecific individuals to prevent selection of heterospecific mates);
- Adequate Habitat – to support multiple packs and provide sufficient resources for packs to complete all components of its life history and avoid anthropogenic mortality at a rate which will facilitate population maintenance;
- Genetic Diversity – sufficient captive and wild stock to support genetic diversity goals and sufficient capacity within the captive population to maintain or improve genetic diversity (based on the 12 founder lines) while supporting releases; and
- Multiple Resilient Populations within the Historic Range – multiple populations are likely needed to protect against catastrophic loss.

The only red wolf population in the wild (ENC RWP) has been largely declining since 2012 and is at risk of extirpation due to low resiliency associated with declining growth rate (higher mortality than reproduction), risks due to demographic stochasticity characteristic of small population size, and low redundancy and representation associated with a single wild population. Additionally, the captive population has been limited in its ability to grow (though recent investments to increase space is relieving some of this pressure) and recently has largely been used to maintain the already limited genetic diversity from the 12 founding individuals that have living descendants in the captive stock today. Therefore, the red wolf is currently not resilient

and cannot become resilient without intervention (Service 2018, pp. 29-30, 70). There is only one known red wolf population in the wild and the distribution of that single population is not sufficient to withstand a single large catastrophic event; therefore, the species currently has no redundancy in the wild. Without establishing new wild populations, the species is unlikely to have redundancy in the future. The captive population represents the genetic fail-safe for the entire population and much of the future recovery potential for the species. Twelve of the original fourteen genetic lines are still represented in the captive population; therefore, some genetic diversity has been maintained. Into the future, expansion of the captive population should maintain genetic diversity while providing future releases as necessary to support wild populations (Service 2018, pp. 31, 71). There is currently limited representation in the wild. Until natural populations of sufficient size are established and recruiting, maintaining representation in the wild will be difficult.

Current Species Threats

We assess "threats" to a species during our determination of whether a species is a threatened or endangered species due to any of the five factors in the Act:

A) the present or threatened destruction, modification, or curtailment of its habitat or range;
B) overutilization for commercial, recreational, scientific, or educational purposes;
C) disease or predation;
D) the inadequacy of existing regulatory mechanisms; and
E) other natural or manmade factors affecting its survival

Below are factors affecting the species. Factors in bold were identified in the SSA and by the Recovery Team as the primary threats to the species (Service 2018, pp. 31-54; CPSG and Service 2021, pp. 8-15).

- Future habitat loss from development (wild population)
- Future habitat loss from sea level rise and increased flooding (wild population)
- Disease and parasites (captive and wild population)
- Intraspecific strife (territorial competition between red wolves) (captive and wild population)
- **Anthropogenic-related mortality** (e.g., gunshot, vehicle strikes, management mortality, poisoning, and suspected illegal activity) (wild population)
- **Coyote hybridization/introgression** (wild population)
- **Small population size and associated inbreeding depression** that decrease species resiliency and exacerbate impacts of other threats (captive and wild population)
- **Negative public perception** of canids that may undermine recovery efforts and could exacerbate some threats above (wild population)

RECOVERY VISION AND STRATEGY

A recovery vision is a description of the state of the species in terms of resiliency, redundancy, and representation when recovery has been achieved and protections under the Act are no longer needed. The recovery strategy is the recommended path for achieving the recovery vision, and ultimately, delisting criteria.

Recovery Vision

In the future, wild and free red wolves will coexist with humans in multiple viable populations across the historic range, where ongoing threats are effectively ameliorated through conservation activities, the public's trust and engagement, and aligned policies among all stakeholders. The recovery of the red wolf will provide a strong sense of community ownership, cultural importance, and pride, in line with the values of the communities in which they occur.

Recovery Strategy

The recovery strategy for the red wolf focuses on improving resiliency and redundancy and maintaining representation to meet the species' needs for viability. Specifically, the strategy seeks to expand distribution of the species in the wild, increase population abundance, maintain gene diversity long-term, and implement collaborative conservation to address species threats as well as societal values related to red wolf recovery. This approach recognizes that recovery requires that the species' needs for viability (multiple resilient populations, genetic diversity, and adequate numbers and habitat) be met and certain biological targets (i.e., criteria) achieved, but that those targets would be difficult to achieve and likely cannot be met without social acceptance of and support for the strategies and red wolf recovery.

Expand distribution of the species

With only one nonessential experimental population of red wolves in the wild, additional populations are necessary to red wolf viability and, therefore, the species' ability to persist in the wild. Populations should occur in areas of adequate habitat, ideally in suitable areas representing different habitat types, which support multiple packs and provide sufficient resources for packs to complete life history and facilitate population maintenance or growth (Service 2018, p. 28). Given the patchwork of landowners in the Southeast and that Federal land ownership accounts for less than 10 percent of land ownership in the region (Vincent and Hanson 2020, pp. 7-8), suitable areas will likely include not only Federal land, but also State, municipal, and private land.

At this time, we do not have sufficient information to specifically identify additional locations for establishing new red wolf populations. An ongoing population viability analysis (PVA) will provide crucial insights into the biological, demographic, and genetic characteristics of red wolf populations that may combine to meaningfully contribute to recovery of the species across its historic range. PVAs translate information on population structure and demographics into estimates of extinction likelihood over a specified timeframe under modeled conditions. As

models, they have inherent uncertainty but they are nevertheless useful in exploring potential population responses under a range of conditions and management scenarios. Within the context of red wolf recovery, the PVA is expected to provide insight into the range of potential population sizes and annual growth rates that, over time, could be expected to be needed to attain demographic and genetic viability. This information will help identify sites that could potentially support a red wolf population of the desired size and demographic and ecological characteristics. Various aspects of red wolf reintroductions have been evaluated in published and unpublished literature, including identifying factors for release success (van Manen et al. 2000), evaluating specific sites for suitability (Shaffer 2007; Jacobs 2009), and evaluating the red wolf historical range for potential reintroduction sites (Dellinger et al. 2017; O'Neal 2018; Toivonen et al. 2022; Drobes 2022). This available information, along with information within this recovery plan and insights provided by the PVA, will be used in analyses of potential reintroduction sites.

Increase population abundance and maintain gene diversity long-term

To establish multiple viable populations, a robust captive population is needed to not only support wild populations, but also maintain the species' genetic diversity. This will likely require a combination of releases of red wolves from the captive population, fostering of captive-born red wolf puppies into wild litters, and/or translocation of wild red wolves and adaptive management until those populations can persist without significant human intervention. Additionally, sufficient genetic variation of wild red wolves is needed to have adaptive capacity into the future. Long-term viability or adaptive potential depends on the store of genetic variability. It is desirable to retain as much genetic variability as possible, as it is uncertain when loss of genetic variability might manifest in compromised reproductive function or physical and physiological abnormality (Soulé et al. 1986). Although we are starting from a reduced genetic pool compared to the historical genetic make-up, we recognize the need to conserve as much of the extant genetic diversity as possible to reduce chances of inbreeding depression, and corresponding reductions in fitness, and to improve the species future adaptive potential, such as responding to changes in their environment or novel diseases (Service 2018, p. 33).

Genetically, demographically, and behaviorally appropriate captive red wolves are needed for reintroductions into the wild. The captive population must increase to a sufficient size, maximize reproduction, reduce mortality, and sustain a healthy population for it to remain demographically strong, maintain genetic diversity in the long term, and support continued releases into the wild in the future (Service 2018, p. 62; CPSG and Service 2021, p. 18).

For wild populations to ultimately be successful, though, they must persist freely. That is, they are self-sustaining and not reliant on annual or frequent management interventions, such as releases, translocations, or placeholder management to counter human-caused mortality or coyote introgression. Ideally, there will be natural dispersal between populations. However, at this time we do not have sufficient information on additional population locations to rely on natural dispersal. Occasional interventions may be needed to maintain genetic diversity or demographic stability, based on best available scientific information.

For red wolf populations to be viable, adequate numbers are needed so that populations can establish and maintain pack structures, defend territories against coyotes, find suitable mates (i.e., sufficient unrelated conspecific individuals to prevent selection of heterospecific mates), and produce viable offspring. Having intact packs and wolf breeding pairs holding core territories should limit the potential for coyote introgression and maintain a sufficient level of red wolf ancestry to retain red wolf behavior and red wolf phenotype. With appropriate population/pack structure, red wolves are expected to establish and maintain their role as the apex predator with natural biological processes (e.g., survival, reproduction, dispersal, and natural mortality) that support population growth and stability.

Establishing wild populations and ensuring long-term viability requires threats to the red wolf be adequately addressed. The SSA identified threats to the species, which includes both the wild (ENC RWP) and captive populations. While it is anticipated that most of the threats the species faces now are threats that additional populations would potentially face, an assessment of site-specific threats must be conducted for any new populations. Any threats that impact important population vital rates (e.g., mortality, breeding) the species' social/behavioral needs to maintain those rates, or habitat must be minimized to a threshold that will allow for population growth and stability, future viability, and maintenance of genetic diversity.

Implement collaborative conservation to address species threats as well as societal values related to red wolf recovery

For any species, effective recovery requires participation by multiple parties, including State and Federal agencies, local communities where populations are established - particularly private landowners, local governments, nongovernmental organizations (NGOs), and academia. While the Service is primarily responsible for administering the Act, other Federal and State agencies also play important roles. For example, some Federal agencies manage large land holdings that could serve as centers for red wolf reintroductions. State agencies are responsible for managing other wild canids (e.g., coyotes) and wild ungulates (e.g., white-tailed deer) and these agencies share statutory trust responsibilities for listed species and recovery. Recovery success would ultimately confer management of the species to these agencies. Given differences in agency missions, statutory authorities, expertise, cultures, and constituency expectations, success of red wolf recovery depends in large part on there being a shared understanding among all stakeholders regarding cooperation needed by all for successful recovery.

Due to the importance of private lands to red wolf conservation, social acceptance, input, and cooperation towards creation of viable recovery strategies is vital. To achieve social acceptance, stakeholders, and especially private landowners, will be sought out to participate and contribute to the management of wild red wolf populations. Any reintroduction effort will be coordinated with these stakeholders and must also consider and be planned with the needs of the community in mind.

For a species surrounded by a legacy of conflict, increasing stakeholder engagement will require establishing trust and building a true partnership that projects honesty, transparency, and open

communication, not only for the benefit of red wolves but for all stakeholders (federal, state, NGOs, academia, and private landowners) that are part of the community at-large.

RECOVERY CRITERIA

Recovery criteria provide objective, measurable targets for achieving the recovery vision. The recovery criteria represent the most current scientific information available for the species and is our assessment of conditions that would likely support a determination that listing under the Act is no longer required for red wolves. The criteria described below provide one path to recovery, but other configurations, with variations in the number and distribution of robust populations, could also support a delisting determination if the species is not likely to become in danger of extinction in the foreseeable future throughout all or a significant portion of its range.

Revisions to the Federal Lists of Endangered and Threatened Wildlife and Plants, including delisting, must reflect determinations made in accordance with sections 4(a)(1) and 4(b) of the Act. Section 4(a)(1) requires that the Secretary determine whether a species is an endangered species or threatened species because of threats to the species, based on an analysis of the five listing factors in section 4(a)(1). Section 4(b) require that the determination be made "solely on the basis of the best scientific and commercial data available." Thus, while recovery plans provide important guidance to the Service, States, and other partners on methods of minimizing threats to listed species and measurable criteria against which to measure progress towards recovery, they are guidance and not regulatory documents. A decision to revise the status of, or remove a species from the Lists, however, is ultimately based on an analysis of the best scientific and commercial data then available, regardless of whether that information differs from the recovery plan. When changing the status of a species, we first propose the action in the Federal Register to seek public comment, followed by a final decision announced in the Federal Register.

The delisting criteria reflect the best available information on the red wolf. These criteria address the five factors described in section 4(a)(1) of the Act and incorporate resiliency, redundancy, and representation.

Delisting Criteria. We may initiate an assessment of whether recovery of red wolf has occurred and delisting is warranted when the following criteria have been met.

Criterion 1: Three viable wild populations occur within the red wolf historic range and are distributed to maximize species redundancy.

Red wolf populations would be considered for delisting if they meet the following conditions:

- occur in suitable areas representing different habitat types within the historic range (see Service 2018, p. 15; Figure 1 for historic range);
- occur in habitats of sufficient quantity and quality to support natural demographic processes (e.g., survival, reproduction, dispersal, and mortality) that lead to stable or increasing populations;

Criteria Justification
Three populations is a target identified by the Recovery Team (CPSG and Service 2021, p. 6) that will provide the redundancy needed to protect the species from catastrophic loss (Multiple Resilient Populations) by reducing the likelihood that all populations are affected simultaneously and the likelihood of populations possessing similar vulnerabilities to catastrophic events. We recognize that there may be opportunity to achieve recovery with fewer or more populations depending on the configuration of sites, their features, and demographic rates (Service 2018, p. 29).

Wild red wolf populations will occur in sufficient quantity and quality of suitable areas of varying habitat that will support multiple packs and provide sufficient resources for packs to complete life history and minimize the rate of anthropogenic mortality to a rate that will facilitate population growth and maintenance (Adequate Habitat). Meeting this criterion means achieving adequate numbers and habitat needed for resiliency and representation and, therefore, viability.

At this time we do not have sufficient information on population locations to identify metrics such as target population size (number), target mortality and fecundity rates, or the quantity or quality of habitat/areas needed. Several PVAs have been developed for the red wolf (Simonis et al. 2015, Faust et al. 2016, Simonis et al. 2017); however, these PVAs modeled only the viability of the captive population and ENC RWP, not what is needed for viability (i.e. recovery) of the species as a whole. Results from the ongoing PVA may be used to determine the number of populations that could achieve recovery and set targets for each population based on site-specific information associated with the locations of future populations. These targets will be incorporated into the RIS and management plans developed for each population, which will be updated over time as deemed necessary.

-and-

Criterion 2: Threats to the red wolf are effectively mitigated such that the wild populations exhibit sufficient numbers, structure, and behaviors to maintain ecologically functional and phenotypic population characteristics and remain viable into the foreseeable future.

Threats are either eliminated or minimized to levels that do not negatively impact population function (i.e., mortality and fecundity rates result in stable or increasing growth rate and support pack behavior).

Red wolf populations would be considered for delisting if they meet the following conditions:

- maintain sufficient red wolf ancestry to retain red wolf behavior and red wolf phenotype;
- have less than a 5% risk of extinction over 100 years; and
- does not require extensive human interventions.

Criteria Justification
Abatement of threats to the red wolf will allow populations to grow, become stable, and contribute to the recovery of the species into the foreseeable future and to meet Criterion 1, listed

above. When threats to the red wolf are effectively mitigated, a population will be comprised of a sufficient number of red wolves to support pack structure and behavior (Adequate Numbers) (Service 2018, P. 28). Maintaining sufficient red wolf ancestry to retain red wolf behavior and phenotype will conserve the role of the red wolf as the apex predator, capable of defending territories against coyotes, finding suitable mates, and producing viable offspring, across a diverse landscape (i.e. maintaining ecologically functional and phenotypic population characteristics) (CPSG and USFWS 2021, pp. 5, 6), and is evidence of effective mitigation of coyote hybridization and introgression. Additionally, a stable population is indicative that anthropogenic-related mortality, along with public perception, has been adequately addressed. Recruitment levels will be sufficient to offset any anthropogenic mortalities that occur (e.g., vehicle strikes) and sufficient to maintain genetic diversity for adapting to environmental conditions in the future.

Because some mortality is anthropogenic, reducing this threat will likely require continued efforts to reduce these mortality rates or population levels and reproduction will need to be sufficient to support these mortality rates. Some efforts that may be taken are: continued public education, targeted outreach to landowners near acclimation pens and where red wolves appear to be localizing movements, and broadly distributing identification cards that help hunters better distinguish red wolves from coyotes; releasing red wolves in winter when tourist traffic is lower; affixing bright orange radio collars (GPS and VHF) with orange reflective material on red wolves to provide additional identification for the public to potentially decrease gunshot mortality due to misidentification and increase visibility to drivers along roadways at night to reduce vehicle mortality; and deploying portable electronic message boards along roads in locations throughout the NEP area when and where we know red wolves are crossing roads regularly or remaining in close proximity to roads to reduce vehicle mortality.

We consider a viable population to be one that has less than a 5 percent risk of extinction over 100 years while maintaining adequate founder gene diversity (CPSG and Service 2021, p. 5). This risk of extinction benchmark falls within the community of practice of recent recovery plans assessed by Doak et al. (2015, p. 191). Adequate red wolf gene diversity addresses small population size and associated inbreeding depression (Genetic Viability) and achieves the genetic diversity needed for representation and, therefore, viability (Service 2018, p. 28).

Our objective is to have wild red wolf populations achieve abundance and genetic integrity to be viable and persist freely without extensive human assistance. That is, they are no longer reliant on annual or frequent management interventions to counter human-caused mortality or coyote introgression. We recognize that occasional interventions (releases or translocations) may be needed to maintain genetic diversity or demographic stability.

RECOVERY ACTIONS

Recovery Actions

This section provides site-specific actions that are necessary to achieve the recovery vision and meet the recovery criteria identified above. This recovery plan is a guidance document, not a

regulatory document; as such, implementation of recovery actions is voluntary and depends on the cooperation and commitment of numerous partners. Implementation of any recovery action will depend on its priority, availability of funds and resources, coordination with partners, and logistical constraints. These recovery actions will be accomplished by implementing shorter-term activities, which will be described in the RIS.

Recovery of the red wolf will be accomplished through the site-specific, to the extent practicable, management actions outlined below. While specific locations for new reintroduction sites have yet to be identified, the actions listed below apply to any identified and selected red wolf reintroduction site. Recovery will require collaboration among Federal and State agencies, private landowners, local communities, and other stakeholders. Recovery actions are assigned priorities to highlight the relative contribution they make toward species recovery (48 FR 43098):

- Priority 1- An action that must be taken to prevent extinction or to prevent the species from declining irreversibly.
- Priority 2 – An action that must be taken to prevent significant decline in species population/habitat quality or some other significant negative impact short of extinction.
- Priority 3 – All other actions necessary to provide for full recovery of the species.

The assignment of priorities does not imply that some recovery actions are of low importance, but instead suggests that lower priority items may be deferred until a later date while higher priority actions are implemented.

The recovery actions identified below (Table 1) are those that, based on the best available science, we believe are necessary to recover the red wolf. These actions will be used to develop a step-down recovery implementation strategy.

Estimated Time and Cost of Recovery Actions

Section 4(f)(1)(B) of the Act requires recovery plans to include estimates of the time required and the cost to carry out those measures needed to achieve the plan's goals. The estimated time and costs of recovery actions in this plan are highly uncertain. The time needed to implement recovery is a guide for meeting the recovery goals, objectives, and criteria discussed in this plan. The total cost of recovery is only an estimate and is based on many assumptions; it may change substantially as efforts to recover the species continue. We will continue to manage recovery of the red wolf adaptively, which could impact these time and cost estimates. While we have the statutory responsibility for developing and implementing this recovery plan, recovery of the red wolf will necessitate the involvement and contributions of Federal, Tribal, State, private, and local interests. Cost estimates, therefore, are not only Federal funds, but may include financial assistance as well as volunteer and in-kind support from other parties. The estimated costs are reported in Table 1. These estimates may be clarified in the RIS as activities are implemented and through collaborative work with Federal, State, NGO, and local stakeholders.

If all actions are fully funded and implemented, including full cooperation of all partners needed to achieve recovery, we expect the status of the red wolf to improve such that we can achieve delisting criteria around 2072, approximately 50 years. We estimate approximately 30 years for each population based on experience in the ENC RWP in which the population increased and was near carrying capacity after 25 years (1987-2012); additional time was added to account for further growth and different circumstances that could be present at new populations.

The estimated 50 years assumes more than one population at a time can be established and grown through releases and pup fostering supported by the captive population and any established wild population. We expect that as one population increases and becomes stable, support needed from the captive population will decrease, allowing the captive population to support another wild population. Additionally, we expect that as a wild population increases and reaches viability, it will be capable of providing support to another wild population in addition to the captive population. Projecting costs into the future, the total estimated cost associated with implementing recovery actions for red wolf would total $256,116,820 (Table 1).

Table 1. Recovery actions identified for red wolf, the associated Recovery Criteria that the action addresses, potential responsible parties, estimated cost, estimated time to completion, and priority number. Being identified as a responsible party indicates only that the partner may be equipped or have expertise to help complete the action.

Action Number	Site- Specific Action	Associated Criteria	Responsible Party	Estimated Time (years)	Total Cost (U.S. dollars)	Action Priority [1]
1	Identify potential reintroduction sites of sufficient size with adequate habitat, prey, and conditions to support a functional population or subpopulation within the species' historical range using available reintroduction site studies and ongoing analyses	1	Service	3	$300,000	1
2	Increase the captive population to support establishing additional wild populations of red wolves and maintain gene diversity	1, 2	SSP	20	$9,540,000	1
3	Develop controlled propagation plan for the captive population to optimize reproduction, reduce mortality, and sustain a healthy population	1, 2	SSP, Service	1.5	$50,000	3
4	Organize and maintain interagency management teams (IMT) for each reintroduction site identified in Action 1 with appropriate Service, State wildlife agency, County government, local government, Tribal government, and/or other Federal agencies to jointly manage recovery of red wolves	1, 2	Service, State, and other Federal agencies, County government, local government, Tribal government	30 per population	$10,004,430	1
5	Increase formal participation of all stakeholders (e.g., individuals from the local community, particularly private landowners, other State, County, and Federal agency representatives, other Tribal representatives, NGOs) in management and recovery planning processes for each reintroduction site identified in Action 1 to ensure engagement of all perspectives in red wolf recovery	1, 2	IMT	30 per population	$26,417,330	1

Action Number	Site- Specific Action	Associated Criteria	Responsible Party	Estimated Time (years)	Total Cost (U.S. dollars)	Action Priority [1]
6	Develop and implement population-specific adaptive reintroductions for each reintroduction site identified in Action 1 with IMT and stakeholders. Management plans for each of these reintroductions should include, but are not limited to: • Reintroduction schedule and techniques • Initial population targets • Habitat and prey needs and management • Research and adaptive management • Identification of site-specific threats • Strategies to: o Maximize genetic health o Address anthropogenic threats (e.g., orange collars, mobile electronic road signs, etc.) o Target coyote hybridization/introgression o Minimize disease/parasitic outbreaks • Monitoring of: o Key population demographics o Genetic diversity and integrity o Long-term trends and movement o Specific causes of mortality o Threats	1, 2	Service, IMT	30 per population	$180,000,000	1
7	Conduct outreach and education on red wolf conservation within communities near or affected by reintroductions to improve hunter, trapper, landowner, and public awareness and tolerance of red wolves.	1, 2	Service, SSP, State wildlife agencies, other Federal agencies, Tribal governments, NGOs	30 per population	$29,805,060	2
	TOTAL COST				$256,116,820	

[1] Recovery actions are assigned numerical priorities to highlight the relative contribution they may make toward species recovery (48 FR 43098).
Priority 1 – An action that must be taken to prevent extinction or to prevent the species from declining irreversibly.
Priority 2 – An action that must be taken to prevent a significant decline in species population/habitat quality or some other significant negative impact short of extinction.
Priority 3 – All other actions necessary to provide for full recovery of the species.

APPENDIX A.

Red Wolf Recovery Team Members

Name	Organization
Adams, Jennifer	University of Idaho
Agan, Suzanne	Kennesaw State University
Benjamin, Pete	U.S. Fish and Wildlife Service
Beyer, Art	U.S. Fish and Wildlife Service
Brzeski, Kristin	Michigan Technology University
Butfiloski, Jay	South Carolina Department of Natural Resources
Casillas, Angelina	Weiler Woods for Wildlife Inc.
Cherry, Michael	Texas A&M University-Kingsville
Clegg, David	Tyrrell County, North Carolina
Davis, Kelly	Hyde County Landowner/ North Carolina Wildlife Resources Commission
Davis, Natalie	Point Defiance Zoo
DeWan, Amielle	Impact by Design Inc.
Faust, Lisa	Lincoln Park Zoo
Fies, Mike	Virginia Department of Wildlife Resources
Flock, Brian	Tennessee Wildlife Resources Agency
Gese, Eric	Utah State University
Gillikin, Mike	Florida Fish and Wildlife Conservation Commission
Gwin, Pat	Cherokee Nation
Gwynn, Becky	Virginia Department of Wildlife Resources
Harrison, Becky	U.S. Fish and Wildlife Service
Hinton, Joey	Wolf Conservation Center
Holderman, Dave	Texas Parks and Wildlife
Johnson, Amy	Smithsonian Conservation Biology Institute
Karelus, Dana	Texas Parks and Wildlife
Keith, Jason	U.S. Fish and Wildlife Service
Kendall, Corinne	North Carolina Zoo
Lasher, Chris	North Carolina Zoo
Long, Sarah	Independent Consultant
Lorenz, Nicole	Louisiana Department of Wildlife and Fisheries
Madison, Joe	U.S. Fish and Wildlife Service
Mitchell, Leigh	Upper Mattaponi Tribe
Mossotti, Regina	Endangered Wolf Center
Nordsven, Ryan	U.S. Fish and Wildlife Service

Name	Organization
Olfenbuttel, Colleen	North Carolina Wildlife Resources Commission
Phillips, Mike	Turner Endangered Species Fund
Pollak, Kaleigh	Monacan Indian Nation
Rankin, Duke	U.S. Department of Agriculture Forest Service
Risch, Tom	Arkansas State University
Ruder, Mark	University of Georgia
Rutledge, Liz	North Carolina Wildlife Federation
Sacks, Ben	University of California, Davis
Seegars, Wes	Hyde County Landowner/ North Carolina Wildlife Resources Commission
Andrea Shipley	North Carolina Wildlife Resources Commission
Songsasen, Nucharin	Smithsonian Conservation Biology Institute
Toivonen, Lauren	U.S. Fish and Wildlife Service
Valenta, Aaron	U.S. Fish and Wildlife Service
vonHoldt, Bridgett	Princeton University
Waddell, Will	Point Defiance Zoo (Retired)
Wayne, Robert	North Carolina Wildlife Resources Commission
Weller, Emily	U.S. Fish and Wildlife Service
Wheeler, Kim	Red Wolf Coalition

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U.S. Fish & Wildlife Service

Two year-old male red wolf 2282 after release on Alligator River NWR, February 2020
Photo Credit: Justin Grubb, Running Wild Media