U.S. Fish & Wildlife Service

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

Third Revision

September 2023

Members of the Milltail pack; Alligator River NWR, April 2023
Photo credit: Eric Kelvington

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

Third Revision

(Original Approved July 12, 1982)

(First Revision Approved, September 18, 1984)

(Second Revision Approved, October 26, 1990)

Prepared by:
Red Wolf Recovery Team

for

U.S. Fish and Wildlife Service
Southeast Region
Atlanta, Georgia
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ACKNOWLEDGMENTS

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) and Recovery Planning for the Red Wolf - Part 2: Revisions and Updates, Workshop Report (CPSG and Service 2023), developed by the Red Wolf Recovery Team, and the Population Viability Analysis (PVA) of the Red Wolf (*Canis rufus*) (Miller et al. 2023). This revised recovery plan was developed by the Red Wolf Recovery Team, a collaborative partnership among Federal and State agencies, Tribal Nation 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 recover and/or conserve 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 subject to public review and comment, as required by the Act, 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 Southeast 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.

Approved: MICHAEL OETKER Digitally signed by MICHAEL OETKER Date: 2023.09.29 14:48:35 -04'00'

Acting Regional Director, U.S. Fish and Wildlife Service, Southeast Region

Date: _____

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This recovery plan can be downloaded free of charge from the Service website: https://ecos.fws.gov/ecp/species/37

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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 for the Red Wolf includes:

1. The **Species Status Assessment** (SSA) 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'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 do not replace the statutory requirement to describe site-specific management actions to the maximum extent practicable; rather, 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 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, Recovery Planning for the Red Wolf, Workshop Report (CPSG and Service 2021) and Recovery Planning for the Red Wolf - Part 2: Revisions and Updates, Workshop Report (CPSG and Service 2023), developed by the Red Wolf Recovery Team, and the Population Viability Analysis (PVA) of the Red Wolf (*Canis rufus*) (Miller et al. 2023). These supplemental documents are available free to the public online in the Service's publication archive:

- SSA: https://ecos.fws.gov/ServCat/DownloadFile/161384
- 2021 Workshop Report: https://ecos.fws.gov/ServCat/DownloadFile/221153
- 2023 Workshop Report: https://ecos.fws.gov/ServCat/Reference/Profile/158737
- PVA: https://ecos.fws.gov/ServCat/DownloadFile/237369

The PVA was created to assist with the formulation of science-based recovery criteria and site-specific actions for achieving long-term demographic and genetic recovery of the Red Wolf in the wild (Miller et al. 2023, p. i). The software package used to build this PVA model, Vortex, is an individual-based model used to evaluate the impact of threats to the future growth and stability of small populations of endangered species and the potential for future improvements to species status through implementing alternative management actions (Miller et al. 2023, p. i). The PVA updates and expands the previous analysis done by Faust et al. (2016) by explicitly incorporating coyotes into the population simulation and exploring opportunities to establish new populations beyond the existing population in Eastern North Carolina (Miller et al. 2023, p. 31). As models, PVAs have inherent uncertainty. In the development of this PVA for Red Wolf, a number of assumptions were made when developing scenarios and are detailed in the report. It is important to recognize that PVA methodologies are not intended to give absolute and accurate "answers" for what the future will bring for a given species or population. However, PVA results can be used to make comparisons of the relative performance of a simulated population under alternative management activities or different assumptions of environmental conditions and can highlight the factors most important for recovering a species. In this comparative framework, results from PVA efforts can provide a critical base of evidence when deriving meaningful and justifiable endangered species recovery criteria (Miller et al. 2023, p. 31; Doak et al. 205, pp. 195-196; Himes Boor 2014, pp. 39-40).

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).

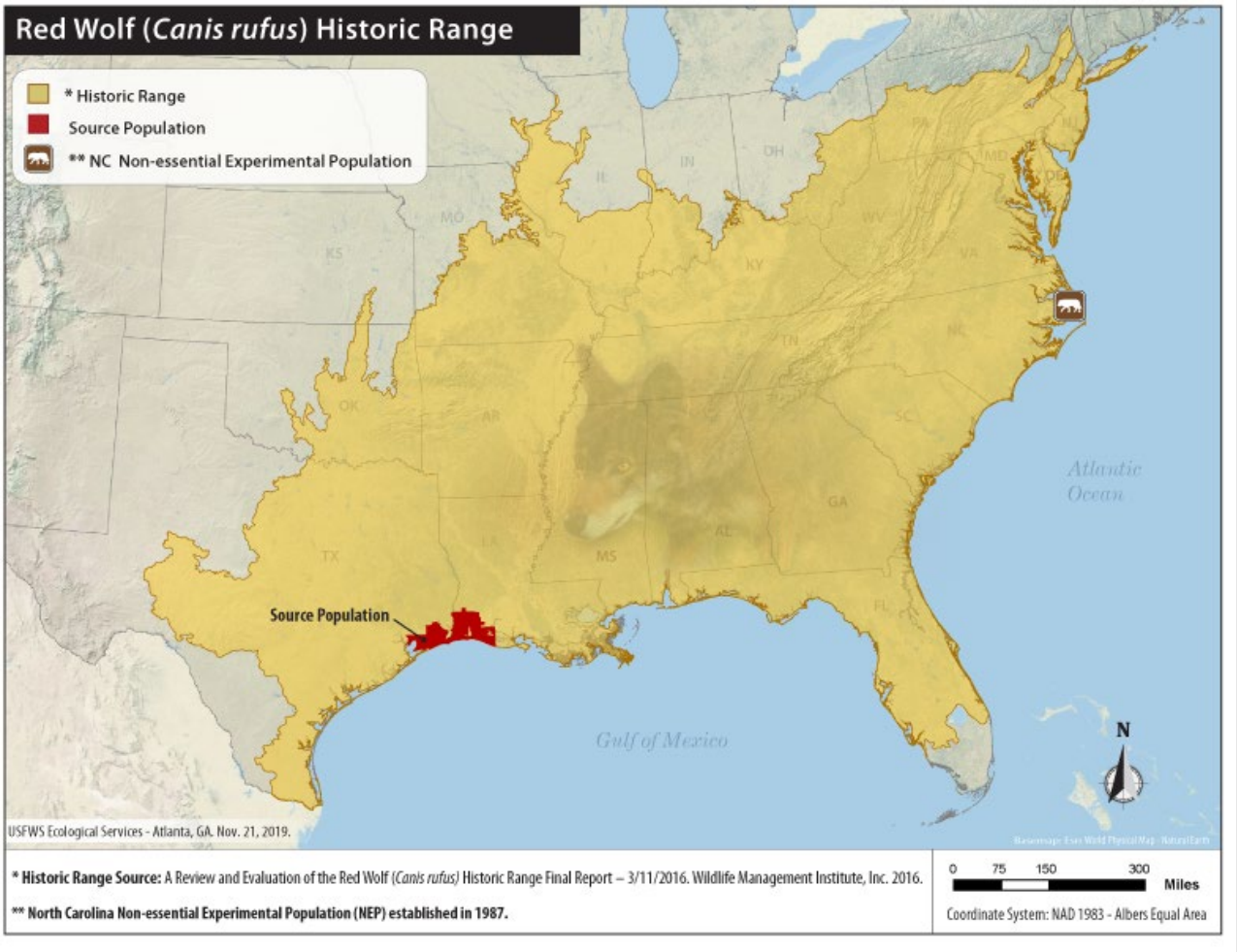

Figure 1. Historic range defined by WMI (2016, p. 23) and source population in Texas and Louisiana.

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, although it 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 along the coastal region of the Texas-Louisiana border 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 program received the Association of Zoos and Aquariums' (AZA) 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 SSP 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; it is not a term meant to indicate a lack of value. 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 the species was fully protected under the care of the SSP program. The NEP area is approximately 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 this area. Between 1987 and 1994, over 60 Red Wolves were released from the SSP 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). Between 1995 and 2014, 34 Red Wolves were released, and 39 Red Wolf pups were fostered into the ENC RWP (Service 2022b). These management actions led to population growth and a peak population of 100-120 Red Wolves in 2012 (Service 2018).

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). Because the proximity of Bulls Island to the mainland allowed Red Wolves to swim from the island to the mainland and the amount of visitation to Horn Island, these sites did not provide a controlled or natural, wild environment and are no longer used for island propagation. 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. Of 30 wild Red Wolf pups from seven litters, only 2 that were removed from the wild at 6 months of age are known to have survived. 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). Of the 37 Red Wolves released in the GSMNP, 26 were recaptured from or died outside the park boundaries; it was suspected that low availability of prey in the steep heavily forested slopes was the likely cause of Red Wolves to move beyond the borders of the GSMNP. Because this was the typical response to Red Wolves released in GSMNP, it suggested it was less preferred habitat when compared to lower-elevation areas (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 53 individuals representing various agencies and organizations (e.g., Tribal Nation representatives, Federal and State agencies, County government, academia, zoos/conservation centers, non-profit organizations, non-governmental organizations, and landowners) tasked with developing a revised recovery plan for the Red Wolf (For a complete list of Recovery Team members see Appendix A).

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 entire 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

In 2022, the Red Wolf SSP was renamed and moved under AZA's Saving Animals From Extinction (SAFE) program. Today, there are approximately 270 Red Wolves in the SAFE

population. Although the ENC RWP grew to a peak of 100-120 in 2012, the population then rapidly declined until 2021, mainly due to anthropogenic mortality (e.g., gunshot and vehicle strikes) (Service 2022). Hybridization with coyotes, which is exacerbated by human-caused mortality (particularly breeding pairs), limitations of the ability to manage hybridization, limited releases, pup fostering and translocations from St. Vincent NWR, and low Red Wolf numbers also played a key role in this decline.

Gunshot mortality stemmed from coyote presence on private land and associated unintentional killing of Red Wolves as people increased efforts to eradicate coyotes, as well as intentional illegal gunshot mortality. Additionally, there was backlash towards Red Wolves and the Service's efforts after a court enjoined coyote hunting at night and without a permit within the ENC RWP (*Red Wolf Coalition, et al.* v. *North Carolina Wildlife Resources Commission*), which some private landowners felt infringed on their private property rights and led to loss of access to conduct management on key pieces of private property. The Service suspended management activities (e.g., pup fostering, releases, translocations, and coyote sterilization) while independent reviews of the Red Wolf Recovery Program were ongoing by the Wildlife Management Institute and others. Between 2015 and 2018, there were no Red Wolf releases, translocations, or pup fostering. The Service began trapping, sterilizing, and releasing coyotes as a tool to manage hybridization between Red Wolves and coyotes in 1999. In 2014, the Service sought renewal of a permit issued by the North Carolina Wildlife Resources Commission (NCWRC) to continue coyote sterilization in the ENC RWP. The Service was only permitted to trap coyotes provided that all trapped coyotes were euthanized; sterilization and release were not authorized. From 2015 to 2018, a permit for coyote sterilization was issued to the Service, though coyote sterilizations were not implemented.

In 2019, the Service resumed management actions with the translocation of a male red wolf from St. Vincent NWR to the ENC RWP and coyote sterilizations under a permit from NCWRC. Between 2020 and 2023, 24 Red Wolves were released (includes releases from the SAFE population and translocation of wild Red Wolves from St. Vincent NWR) and 5 Red Wolf pups were fostered into the ENC RWP (Service 2023). 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. The Service is currently implementing actions, such as adaptive management (e.g., coyote sterilization/euthanasia), translocation of Red Wolves from an island propagation site on St. Vincent NWR, and releases of Red Wolves from the SAFE population into the ENC RWP, to create new Red Wolf breeding pairs within the ENC RWP. Additionally, the Service is pursuing pup fostering to increase the population in the wild where the necessary prerequisites are present. As a result of management actions taken in 2020 and 2021, a litter of Red Wolf pups was born in the wild in 2022. In 2023, this same breeding pair gave birth to another litter of Red Wolf pups. Also in 2023, two additional litters were born in the wild in acclimation pens within the ENC RWP to a family group from the SAFE population and a wild female paired with a male from the SAFE population. In July of 2023, there was an estimated total of 23-25 Red Wolves, with 13 known (collared) Red Wolves, in the ENC RWP.

Our assessment of 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 from coyotes 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 (resiliency, redundancy, and representation) 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 (i.e. coyote) mates) (Resiliency);
- 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 (Resiliency);
- Genetic Diversity – sufficient SAFE and wild stock to support genetic diversity goals and sufficient capacity within the SAFE population to maintain or improve genetic diversity (based on the 12 founder lines) while supporting releases (Representation); and

- Multiple Resilient Populations within the Historic Range – multiple populations are likely needed to protect against catastrophic loss (Redundancy).

The only wild Red Wolf population (ENC RWP) experienced significant decline between 2012 and 2020. Since 2020, management actions have stemmed the decline and the population has experienced a slight increase. However, the population is at risk of extirpation due to low resiliency associated with high mortality rates, risks due to demographic stochasticity characteristic of small population size, and low redundancy and representation associated with a single wild population. Additionally, due to space limitations, the SAFE population has been limited in its ability to grow and has largely been used to maintain the already limited genetic diversity in the SAFE population; however, recent investments to increase space is relieving some of this pressure, resulting in growth of the SAFE population. Therefore, the Red Wolf is currently not resilient and cannot become resilient without intervention (Service 2018, pp. 29-30, 70). The distribution of the single wild 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 SAFE 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 SAFE population (two of the founders were initially bred, but do not have surviving descendants) (Faust et al. 2016, p.13); 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. Details on the Service's understanding of the life history needs and species condition can be found in the SSA (Service 2018).

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 past, current, and future factors that have, are, or could affect the Red Wolf (both the SAFE and wild populations). Threats are not mutually exclusive as one can trigger another or exacerbate the impacts of another. Factors in bold were identified in the SSA and by the Recovery Team as current primary threats to the species (Service 2018, pp. 31-54; CPSG and Service 2021, pp. 8-15).

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

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 the species.

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 involved with Red Wolf recovery. 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 community 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 for redundancy and, therefore, Red Wolf viability (the species' ability to persist in the wild). To improve redundancy and resiliency, populations should occur in areas of adequate habitat, ideally in suitable areas representing different habitat types, which support a viable population and provide sufficient resources for packs to complete life history and facilitate population maintenance or growth (Service 2018, p. 28).

We have not yet identified locations for establishing new Red Wolf populations. 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). These studies use various criteria (e.g., distance from towns or roads, habitat type, prey density, human population, minimum area, etc.) to evaluate or rank specific sites for suitability; however, these sites have not been assessed to determine whether they could support a viable Red Wolf population. A recently completed population viability analysis (PVA; Miller et al. 2023) provides insights into population characteristics needed for a viable population.

It is important that State wildlife agencies be vested partners, working alongside the Service in the establishment of Red Wolf populations; therefore, State wildlife agencies will be engaged early in the site selection process. The Service and State wildlife agencies should use information from the PVA, information in available studies, along with information within this recovery plan, to identify ecologically and socially suitable locations for reintroductions that could support a Red Wolf population that would meaningfully contribute to recovery of the species across its historic range.

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. Furthermore, given land ownership in the Southeast, establishing Red Wolf populations must be a collaborative effort with Tribal Nations, state, county, and municipal government agencies, other Federal agencies, landowners, and the local community in order for populations to be successful (see *Implement collaborative conservation* section below).

Red Wolves are thought to have utilized a large suite of habitats historically (Service 2018, p. 21) and varied their diet based on available prey within those habitats. Being a habitat generalist should optimize land suitable for Red Wolves; however, the habitat degradation and alteration that led to the decimation of the species left a highly fragmented and altered landscape. Habitat restoration will likely be needed in all potential areas to expand suitable habitat that will provide sufficient resources to support a viable population. Ideally, populations should be established in different habitat types to increase diversity, redundancy, and viability. Future habitat loss from sea level rise and increased flooding is one of the factors that could affect the viability of the Red Wolf. The ENC RWP area is expected to be impacted by sea level rise and climate change (Service 2018, pp. 66-67, 69). As such, the effects of sea level rise must be taken into consideration as the population is managed in the future. Climate change will likely affect all

portions of the historic range of the Red Wolf, differentially. As sites are identified, current and future climate change stressors will be incorporated and considered in individual population strategies.

Increase population abundance and maintain gene diversity long-term

A robust SAFE population is needed to not only support the establishment of multiple wild populations (redundancy), but also maintain the species' genetic diversity (representation) (. Establishing and growing wild populations will require a combination of releases of Red Wolves from the SAFE population, fostering of SAFE-born Red Wolf puppies into wild litters, and/or translocation of wild Red Wolves, and adaptive management (e.g., placeholder concept (removal/sterilization of coyotes)) (Miller et al. 2023, pp. 19-22, 27-31, 38) until those populations can persist without these significant human interventions. These are proven management techniques, as demonstrated by the successful growth of the ENC RWP to its peak in 2012 and an evaluation of the placeholder concept that found coyote sterilization and the placeholder concept to be effective in managing coyote introgression (Gese and Terletzky 2015, p. 18; Gese et al. 2015, p. 200). Based on modeling efforts, increasing the SAFE population to at least 400 Red Wolves and increasing the number of paired females that produce litters by 15% will support the number of individuals removed for release into the wild over an extended time (see Appendix B for release scenarios) while also retaining a relatively high level of gene diversity (Miller et al. 2023, pp. 11, 24-25, 30, 38).

Sufficient genetic variation of wild Red Wolves is needed to have adaptive capacity into the future (representation). 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 SAFE-born Red Wolves are needed for reintroductions into the wild. The SAFE population must increase to a sufficient size, maximize reproduction, reduce mortality, and sustain a healthy population behaviorally suitable for reintroduction into the wild 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 (resiliency), 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 have not identified additional population locations though ability for natural dispersal between populations may be a consideration in identifying those future sites. Given the

existing condition of the landscape within the Southeast (e.g., fragmented, mixed ownership), however, it may be unlikely that additional population locations that would allow for natural dispersal between them will be possible. 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 Red Wolf breeding pairs holding core territories should limit the potential for coyote introgression and maintain a sufficient level of Red Wolf ancestry. 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. Research and monitoring of populations will provide information on introgression and genetic viability, behavior, and population growth; based on those findings, strategies and recommendations can be adapted as needed.

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 population (ENC RWP) and the SAFE population. 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 should be conducted for any new population. 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. Strategies to minimize threats to Red Wolves in new populations will depend on site-specific conditions and will be informed by the Service and State wildlife agencies, as well as other managing agencies, and other contributors engaged at that particular site (see *Implement collaborative conservation* section below). With coyotes occupying a much larger range than they did historically, we expect that hybridization with coyotes will be a threat to every Red Wolf population and adaptive management will be needed to limit coyote hybridization and introgression and reduce the coyote population. This entails trapping coyotes, then either removing or sterilizing coyotes, and radio-collaring and releasing the sterilized coyotes at the site of capture.

Based on population modeling of the ENC RWP, reducing mortality by 50%, specifically vehicle strikes and gunshot mortality, and increasing coyote sterilization rate to 10% of the intact coyote population and removal of 5% of coyotes are actions that will be most effective in facilitating an increase in the Red Wolf population and minimizing coyote hybridization and introgression (Miller et al. 2023, pp. 19-22, 26-27, 38).

To reduce mortality to the levels indicated in Miller et al. (2023, pp. 18-21, 31, 38) that will facilitate population growth, current activities to reduce vehicle strikes and gunshot mortality in the ENC RWP must continue. To reduce vehicle mortality within the ENC RWP, orange reflective material is affixed to the bright orange radio collars (GPS and VHF) on Red Wolves to

increase visibility to drivers along roadways at night. Portable electronic message boards are deployed along roads in locations throughout the ENC RWP area when and where Red Wolves are crossing roads regularly or remaining in close proximity to roads. The orange collars with orange reflective material also provide additional identification for the public to potentially decrease gunshot mortality due to misidentification. Additional efforts to reduce gunshot mortality include continued public outreach, including 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. Additionally, effective law enforcement is essential to wildlife conservation. Agents within the Service's Office of Law Enforcement (OLE) are tasked with, among other things, investigating wildlife crimes. On National Wildlife Refuges, Federal Wildlife Officers (FWO) are the law enforcement professionals tasked with protecting natural resources and public safety across the NWR System. OLE agents and FWOs collaborate with State wildlife law enforcement, when appropriate, to enforce federal wildlife laws and investigate Red Wolf mortalities, including potential gunshot mortalities and other illegal killings. Information collected during investigations are used to help the Department of Justice prepare potential cases for prosecution. OLE agents and wildlife officers are also important partners in distributing information and outreach materials to increase the public's understanding of wildlife conservation and promote compliance with wildlife protection laws.

Additional strategies to reduce vehicle strikes and gunshot mortality within the ENC RWP may be identified in the future by the Service and State agencies, as well we other managing agencies, and other contributors (see *Implement collaborative conservation* section below). It will be important to maintain flexibility in implementing strategies to reduce vehicle strikes and gunshot mortality. Strategies need to change as conditions on the ground change, new science becomes available, or new technology is developed, in order to be effective.

A major component to management of the ENC RWP is minimizing interbreeding between red wolves and coyotes and limiting coyote gene introgression into the wild Red Wolf population while simultaneously building a restored Red Wolf population. The Service currently conducts coyote removal and sterilization on NWR lands and private lands, under a valid permit obtained from NCWRC and with landowner permission, within the ENC RWP. Currently, areas in close proximity to wild Red Wolves are targeted for coyote removal and sterilization. Sterilization does not affect the bond of a coyote pair which mate for life, nor does it impact the size of their territory or the vigor with which they defend it, meaning they will continue to limit the intrusion of "new" coyotes into their territory, thus limiting the overall population. Additionally, sterile coyotes are not capable of breeding with other canids, effectively limiting the growth of the coyote population and limiting hybridization events with wild red wolves. Ultimately, these "placeholder" canids are replaced by Red Wolves either naturally (e.g. displacement) or via management actions (e.g., removal followed by pairing wild or translocated Red Wolves into the territory). This management technique has been effective in managing the adverse effects of hybridization on the wild Red Wolf genome. However, to reach the level of coyote removal and sterilization needed, as identified by Miller et al. (2023, p. 38), to minimize coyote hybridization/introgression and facilitate population growth, these efforts must increase. This

may be achieved continuing with the current strategy, targeting areas in close proximity to wild Red Wolves and expanding efforts as the Red Wolf population expands, or efforts may be conducted across the 5-county area simultaneously. With either strategy, this will require collaboration with the State, other Federal agencies, and the public.

Implement collaborative conservation to address species threats as well as societal values related to Red Wolf recovery

We can achieve better conservation through partnerships. Recovery of threatened and endangered species cannot be done by a single agency or organization; the Service must work with others to be successful. This concept is so important that "working with others" is the foundation of the Service's mission. For any species, effective recovery requires participation by multiple parties, including Tribal Nations, State and Federal agencies, landowners and other community members, nongovernmental organizations (NGOs), zoological institutions and wildlife centers, and scientific researchers. In the instance of a reintroduction being implemented under section 10(j), an experimental population, the Service is to consult with State wildlife agencies, local governmental entities, affected Federal agencies and affected private landowners in developing and implementing experimental population rules (50 CFR 17.81(d). A collaborative partnership will not only result in benefits to the Red Wolf, but all parties will mutually benefit from working together.

Conserving this nation's fish, wildlife, plants, and habitat are enhanced when successful partnerships with Tribal Nations are established. There is a broad range of collaborative management opportunities available to the Service and Tribal Nations, including holding informative discussions to seek Tribal input, entering into formal agreements with Tribal Nations, and sharing conservation management of resources. Additionally, the Service will consult and collaborate with Tribal Nations when developing conservation plans. Along with using the best available scientific and commercial data, we will solicit and consider Traditional Ecological Knowledge (TEK), which enhances conservation planning. TEK is the evolving knowledge acquired by indigenous and local peoples over hundreds or thousands of years. It includes relationships between plants, animals, natural phenomena, landscapes, and timing of events that are used for lifeways, including but not limited to hunting, fishing, trapping, agriculture, and forestry. Furthermore, the cultural importance of Red Wolves to Native American Tribes is an aspect of Red Wolf recovery that has been missing. The Red Wolf was and is an animal of cultural importance to Native American Tribes. For example, the Red Wolf is one of the most important cultural icons of the Cherokee Nation and the Cherokee People. Foundational to origin stories and clan system, the Red Wolf is considered an equal who lived in symbiotic relationship with Cherokee People. They relied on the Red Wolf for "locating" and "building" villages and assisted Cherokee with hunting activities. They played integral roles in Cherokee cultural practices and the "curing" of the sick. It was/is the Red Wolf with whom the Cherokee People share terrestrial and cerebral existence as equals. They are as much Cherokee as are the Cherokee People, and in times past when the Cherokee were more "enlightened", the Cherokee People were as much Red Wolf as They (Gwin and Toombs 2022, pers. comm).

Incorporating Indigenous TEK into Red Wolf conservation will fill that gap and enhance conservation by ensuring recovery planning takes a more holistic approach.

While the Service is the primary agency responsible for administering the Act, State and other Federal agencies also play important roles. Partnerships with States are critical to efforts to conserve listed species. For example, State wildlife agencies have authority for and are responsible for conserving and managing all wildlife, including other wild canids (e.g., coyotes) and wild ungulates (e.g., white-tailed deer). They also share statutory trust responsibilities for listed species conservation and recovery; Section 6 of the Act encourages States to develop and maintain conservation programs for threatened and endangered species. Furthermore, recovery success would ultimately confer management of the Red Wolf to these agencies. Therefore, State agencies are partners in Red Wolf recovery. Engaging State wildlife agencies early in the process of identifying potential reintroduction sites, addressing questions and concerns, including State management authority over wildlife, will facilitate building trust and will be key to establishing a strong partnership and forging a successful path to reintroducing this species back onto the landscape and establishing a viable population. Federal agencies are required under Section 7 of the Act to proactively use their legal authorities to conserve endangered or threatened species. Additionally, some Federal agencies manage large land holdings that could serve as centers for Red Wolf reintroductions.

Private land will be critical to establishing viable Red Wolf populations given the historical range of the Red Wolf. Large and small landowners and other community members are the backbone of conservation and have the most direct bearing on Red Wolf recovery as they are the ones that live with Red Wolves. Due to the importance of landowners and local community support to Red Wolf conservation, gaining trust is critical to successful recovery. This will require developing improved approaches for public engagement, shared strategies to address threats, and engagement in management of wild Red Wolf populations. When planning and implementing reintroduction efforts, the Service and State wildlife agency will coordinate and collaborate with landowners and other members of the community. Reintroductions must also consider and incorporate the needs of the community, including landowner use and activities on their property. Those needs should be prioritized as we work together to recover the species. Developing a process that allows those that are affected by decisions to be engaged will facilitate incorporation of social and cultural values of the community into recovery.

NGOs play critical and diverse roles in conservation, contributing resources and expertise to the protection of natural resources at local, national, and international levels. Contributions and actions include advocacy and influencing policy by engaging in public campaigns and engaging with policy makers, research and data collection, raising awareness with public outreach and education, mobilizing action, protecting and restoring habitats, managing habitats or populations, and providing or pooling resources and expertise to conservation efforts (Mathewson et al. 2019, pp. 305-312). For Red Wolf, specifically, NGOs have played a critical role in advocating for the protections and recovery of the species, raising public awareness of the importance of Red Wolf conservation, garnering support for conservation efforts, addressing the challenges facing Red Wolves, research, and developing and contributing directly to on-the-ground efforts, such as

habitat restoration. Through the combination of science, community engagement, and advocacy, NGOs can enhance the effectiveness of wildlife conservation.

The Red Wolf SAFE program is comprised of 50 zoological institutions and wildlife centers. The Service entrusted the care, breeding, and safeguarding of the Red Wolf to AZA institutions in the early 1970's. This program was critical in preventing extinction of the Red Wolf and is the foundation of recovery, providing genetically, demographically, and behaviorally appropriate animals to release into the wild. In addition, maintaining a healthy viable population, the SAFE program is also committed to growing education and awareness efforts – zoological institutions and wildlife centers are often the first source of information and are a trusted messenger of endangered species and conservation-related issues, and aiding research vital to recovery and management of Red Wolves.

Scientific researchers provide the science needed to inform decision-making and management. Red Wolves, both the wild and SAFE populations, have been the subject of numerous research projects, including diseases to better understand and improve the health of Red Wolves, assisted reproductive technologies, genetics, morphology, and hybridization with coyotes. Research will continue to play an important role in recovery, particularly the incorporation of social science, as we expand our knowledge and address challenges Red Wolf recovery has and will face.

Collaboration among these varied parties is key to successful recovery. Each has a role to play and unique perspectives that will make recovery of the Red Wolf possible. Recognizing and honoring the unique contributions of these parties to Red Wolf recovery, this document will refer to these parties as contributors.

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 contributors regarding cooperation needed by all for successful recovery. We will establish Red Wolf teams (RWT) at each reintroduction site to facilitate a shared understanding of successful recovery. We anticipate RWTs would consist of at least Service and State representatives and, with other contributors, would develop strategies to address threats and recover the Red Wolf at their site. RWTs could also regularly review recovery progress and make recommendations as needed, address conflicts, engage with hunting, trapping, and wildlife conservation groups to promote transparency, collaboration, and partnerships, and collaboratively develop with States strategies and recommendations for long-term population viability and post de-listing monitoring assistance (CPSG and Service 2021, pp. 22-23).

This collaborative conservation approach is vital to addressing societal and cultural values and achieving social acceptance. For a species surrounded by a legacy of conflict, increasing contributor 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 contributors 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.

- Populations occur in suitable habitats of sufficient quantity and quality to support natural demographic processes (e.g., survival, reproduction, dispersal, and mortality) that lead to viable populations, as described in Criterion 2.

Criteria Justification
Establishing at least three viable populations (see Criterion 2), distributed across the historic range (see Service 2018, p. 15; Figure 1 for historic range), provides the redundancy needed to protect the species from catastrophic loss (Multiple Resilient Populations) by reducing the likelihood that all populations are affected simultaneously (CPSG and Service 2021, p. 6). However, 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).

Populations will be established in habitats of sufficient quantity and quality to support a self-sustaining, viable population of Red Wolves 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) (Service 2018, p. 28). Ideally, Red Wolf populations should be established in different habitats. For example, because the ENC RWP is located in a coastal plain ecoregion, it would be ideal to have another population within an interior ecoregion (e.g., 8.3 and/or 8.4 ecoregion) to address potential impacts from climate change, such as sea level rise. Additionally, populations in varying representative environments increases the diversity of the populations. Populations should be widely distributed to reduce the likelihood of populations possessing similar vulnerabilities and single or multiple catastrophic events causing extinction of the species by impacting discrete populations simultaneously. The greater the redundancy the Red Wolf has, the more viable it will be.

We expect one of the three needed populations to be the ENC RWP. Future habitat loss from sea level rise and increased flooding is expected to impact the ENC RWP (Service 2018, pp. 66-67, 69) and could affect the population's ability to reach viability (see *Criterion 2*). The effects of sea level rise and increased flooding, as well as changes in patterns of rainfall, duration, and intensity of summer heatwaves and winter weather that could occur as climate change progresses, will be taken into consideration as the population is managed in the future. Since additional locations have not yet been identified, we do not know how climate change will affect future population sites. It is likely that climate change will affect different portions of the range differently. As sites are identified, current and future climate changes stressors will be considered and incorporated into individual population strategies.

Meeting this criterion means achieving adequate numbers and habitat needed for redundancy and resiliency.

We have not yet identified potential locations for additional Red Wolf populations. Available published and unpublished literature evaluate specific sites for suitability or evaluate the historical range for potential sites, but they do not assess whether the sites could potentially support a viable population of Red Wolves. Using population characteristics needed for a viable population, described in the recently completed PVA (Miller et al. 2023), we can identify locations that could potentially provide for those characteristics and support a viable population of Red Wolves; for example, within the historic range of the species, an area that can support around 280-300 Red Wolves. Other factors evaluated in available literature, such as distance from towns or roads, habitat type, prey density, human population, minimum area, etc. may also be used in combination with information from the PVA to determine sites that will provide the Red Wolf the best chance at success. However, the establishment of a Red Wolf population must be a collaborative effort between the Service and State wildlife agencies, as well as other contributors. Information in Miller et al. (2023), combined with the various suitability studies available, will be used as the basis to begin discussions with these entities to identify additional locations. It is not possible for us to identify additional sites without extensive public engagement first. It would be premature, and could negatively impact the process, to include

specific sites in the recovery plan without the collaborative efforts needed to ensure a successful reintroduction.

-and-

Criterion 2: Each Red Wolf population meets the following criteria for viability:

- One of the three populations consists of at least 180 individuals, the other 2 populations consists of a minimum of 280 individuals each, based on an estimate of the number of individuals 1 year and older;
- At least 80% of current and future founder gene diversity has been maintained;
- Once the population meets minimum abundance, the population is stable or growing for a period of 10 years without extensive human interventions (mean population growth rate for those 10 years is ≥1.0); and
- Each population has a 95% probability of persistence for 100 years.

Criteria Justification
For populations to be viable, they must be resilient and maintain representation. We anticipate one of the three populations to be the ENC RWP. Based on modeling of this population (i.e., a 6,000 square kilometers (2,317 square miles) area with an estimated carrying capacity of 200 Red Wolves and management as described in Miller et al. (2023, pp. 19-25)), a resilient population with adequate representation maintained would consist of at least 180 Red Wolves with at least 80% of current and future founder gene diversity maintained and the probability of extinction over 100 years is 5 or less percent (Miller et al. 2023, p. 27; CPSG and Service 2021, p. 5; CPSG and Service 2023, p. 4). Modeled scenarios indicate that 80% of current gene diversity can be maintained in this area for 90 years (from January 1, 2022, the start of the PVA analysis; Miller et al. 2023, p. 25). We include in this criterion future gene diversity to account for potential introduction of new founders in the future either through a new population discovery or new technology. The introduction of new founders will increase the ability to maintain at least 80% gene diversity. We acknowledge that gene diversity could be maintained for 100 years with management, such as pup fostering, implemented for longer than modeled conditions (50 years).

To maximize genetic retention, two populations should consist of at least 280 Red Wolves. This is based on an area with a carrying capacity of 300 Red Wolves. Modeled scenarios for this size area indicate 80% gene diversity can be maintained for 100 years from the start of the PVA modeling (January 1, 2022) (Miller et al. 2023, p. 28). Additionally, a resilient population is one that when minimum abundance is met, it continues to grow or remain stable, without extensive human interventions, for a period of 10 years (two Red Wolf generations); that is, the mean population growth rate for those 10 years is equal to or greater than 1.0 (in calculating population growth, a rate of growth, λ, equal to 1 means the population is stable, greater than 1 means the population is increasing).

This criterion is indicative of effectively mitigated threats to the Red Wolf and a population large enough to support pack structure and behavior, such as defending territories against coyotes, finding suitable mates, and producing viable offspring (Adequate Numbers) (Service 2018, P. 28). Furthermore, our objective is to have wild Red Wolf populations achieve the abundance and genetic integrity needed to be resilient 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. A stable or growing population, in absence of extensive interventions, 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 and sufficient to maintain genetic diversity for adapting to environmental conditions in the future.

We anticipate population metrics to fluctuate; however, monitoring populations for two generations (10 years) without annual or frequent pup fostering, releases, translocations, or coyote placeholder management will allow observation of population trends to ensure fluctuations are within expected levels and minimum abundance is likely to be maintained into the foreseeable future. We acknowledge, however, that occasional (e.g., every five years) minimal interventions such as pup fostering, release, or translocation may be needed to maintain genetic diversity or demographic stability.

The risk of extinction benchmark (95% probability of persistence for 100 years) falls within the community of practice of recent recovery plans assessed by Doak et al. (2015, p. 191) and the definition of "viable" developed by the recovery team (CPSG and Service 2021, p. 5). Gene diversity is based on the twelve founders represented in the captive and wild populations as well as any new founders (new individuals) discovered in the future. The gene diversity criterion addresses small population size and associated inbreeding depression (Genetic Viability), is evidence of effective mitigation of coyote hybridization and introgression, facilitates adaptability to changes in environmental conditions, and achieves the genetic diversity needed for representation and, therefore, viability (Service 2018, p. 28). The probability of extinction and genetic diversity criterion will be determined by site specific population simulation models using a scenario without extensive human interventions to ensure proper assessment of the population's status and ability to maintain population criteria into the foreseeable future.

Meeting this criterion means achieving adequate numbers and genetic viability needed for resiliency and representation.

-and-

Criterion 3: Adequate mechanisms or long-term commitments are in place that provide a high level of certainty that Criterion 2 for each population will be maintained into the foreseeable future without the protections of the Act.

Criteria Justification

Abatement of threats impacting the Red Wolf will allow populations to grow and become stable. However, threats must be eliminated or maintained at a level that will allow the population to persist and contribute to the recovery of the species into the foreseeable future. Because one of the greatest threats to Red Wolves is anthropogenic mortality, reducing this threat will likely require continued efforts to maintain acceptable mortality rates or population levels and reproduction will need to be sufficient to counter mortality rates. Furthermore, occasional interventions, may be needed to maintain genetic diversity or demographic stability. Maintaining appropriate threat levels, population levels, and reproduction may necessitate ongoing management commitments or regulatory mechanisms.

Recovery success will ultimately confer management of the species to State agencies, therefore, we will collaborate with State agencies, and other appropriate government entities, throughout implementation of the recovery plan to address threats to the species and prepare for the eventual transition of management authority once the Red Wolf is recovered. We will ensure State and other applicable agencies with responsibility for maintaining the recovered status of the Red Wolf have management plans or long-term commitments in place and agencies with regulatory control over factors affecting the Red Wolf have adequate regulations (e.g., laws, rules, regulations, and cooperative agreements) in place so that threats are either removed or ameliorated by those mechanisms such that populations are able to retain viability, as described in Criterion 2. Additionally, community engagement in recovery of the Red Wolf could result in long-term commitments, driven by the local community, which would also play an important role in the amelioration of threats and long-term viability of the species.

Meeting this criterion means providing the mechanisms and commitments needed for the Red Wolf to remain a viable species into the foreseeable future.

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 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, developed later as part of the RIS.

Recovery of the Red Wolf will be accomplished through the site-specific management actions identified, to the maximum extent practicable, below. The intent is for recovery actions to be broad enough to allow implementation flexibility and incorporation of new information over time, but also site-specific and detailed enough to clearly communicate what is necessary to achieve the species' recovery criteria. It is not practicable for us to identify site-specific

management actions for specific locations that cannot be determined until future conditions are known. While specific locations for new reintroduction sites have yet to be determined, many of the actions listed below apply to any identified and selected Red Wolf reintroduction site; those specifically developed for ENC RWP are identified. Recovery will require collaboration among all contributors. 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 stepped-down RIS. Implementation activities identified in the RIS will likely include activities currently being implemented, but will also include new activities as best available science indicates. Separating the non-statutorily required implementation activities in the RIS affords the Service flexibility in developing, updating, and adapting over time how recovery actions are achieved. For example, this flexibility is particularly important for Recovery Actions 14 and 15. Reducing mortality within the ENC RWP could be accomplished by implementing multiple strategies, including those currently being implemented. However, those strategies may change over time as conditions on the ground change, new science becomes available, or new technology or methods are developed. Accordingly, it is not practicable to provide further detailed site-specific management actions at this time.

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 among contributors.

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, in approximately 50 years (Miller et al. 2023, p. 39). We estimate it will take approximately 30 years for each population to reach minimum population targets and be a viable, self-sustaining population based on modeling of the ENC RWP (Miller et al. 2023, p. 25) and experience in the ENC RWP. After 25 years of increasing and reaching a peak population of 120 Red Wolves (1987-2012), space remained for additional Red Wolf territories, but the ENC RWP was beginning to show signs that within the next 5 years it would likely approach carrying capacity (without the increase in human-caused mortality that ultimately occurred). If the population had continued to grow to carrying capacity, the population would have reached a point where extensive human interventions would not be necessary and would be more limited to activities such as occasional pup fostering for genetic diversity and occasional translocations of Red Wolves within the ENC RWP, if part of a breeding pair was lost as a result of a human-caused mortality.

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 SAFE 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 $327,930,911 (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	Action	Associated Criteria	Responsible Party	Estimated Time (years)	Total Cost (U.S. dollars)	Action Priority[1]
1	Develop with State wildlife agencies criteria for and identify all potential ecologically and socially suitable reintroductions sites that could support a viable population of Red Wolves within the species' historical range	1	Service, State wildlife agencies	1	$32,752	1
2	Further engage State wildlife agencies and other contributors in discussions and collaborative efforts to determine locations for additional Red Wolf populations	1, 3	Service, State wildlife agencies	3	$364,800	1
3	Increase capacity of the SAFE population to maintain a minimum of 400 Red Wolves to support establishment of wild populations of Red Wolves and maintain gene diversity	1, 2	SAFE	20	$9,540,000	1
4	Develop controlled propagation plan for the SAFE population to optimize reproduction and reduce mortality to reach a minimum of 400 Red Wolves, and sustain a healthy population	1, 2	SAFE, Service	1.5	$22,500	3
5	Organize and maintain Red Wolf teams (RWT) for each population to work towards recovery	1, 2, 3	Service, State wildlife agencies	50 per population	$5,419,554	1
6	Develop and implement mechanisms for formal participation of all contributors for each population to ensure engagement of all perspectives in Red Wolf recovery	1, 2, 3	RWT	50 per population	$11,521,200	1

Action Number	Action	Associated Criteria	Responsible Party	Estimated Time (years)	Total Cost (U.S. dollars)	Action Priority[1]
7	Develop and implement population-specific strategies and recommendations for each population with contributors, to include: • Reintroductions and techniques • Initial population targets • Habitat and prey needs and management • Research and adaptive management • Identification of site-specific threats • Strategies to address site-specific threats • Community engagement • 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, 3	Service, RWT	50 per population	$248,968,400 (for all three populations)	1
8	Sterilize or remove coyotes to minimize hybridization and facilitate establishment of Red Wolf populations	2, 3	Service, State wildlife agencies, other Federal agencies, Tribal Nations, and contributors	25	$5,844,780	1
9	Conduct outreach, engagement, and school programs on Red Wolf conservation within local communities associated with Red Wolf populations to improve hunter, trapper, landowner, and global public awareness of Red Wolves and garner support for Red Wolf conservation at local and regional levels	1, 2, 3	Service, SAFE, State wildlife agencies, other Federal agencies, Tribal Nations, NGOs	50 per population	$21,611,250	2
10	Develop, with State wildlife agencies and other appropriate government entities, a management plan for transition of management authority for each population to ensure the population retains viability	2, 3	Service, State wildlife agencies, Tribal Nations, other Federal agencies	2 per population	Included in Actions 5 and 7	

Action Number	Action	Associated Criteria	Responsible Party	Estimated Time (years)	Total Cost (U.S. dollars)	Action Priority[1]
11	Gather information needed to assess adequacy of existing management, long-term commitments, and regulatory mechanisms in mitigating or eliminating threats to Red Wolf in each population	3	Service, State wildlife agencies	10 per population	Included in Actions 6 and 7	3
12	Revise recovery plan to include site-specific recovery actions for new Red Wolf populations	2, 3	Service, State wildlife agencies,	2 per population	$174,400	3
13	Maintain or restore habitat within the ENC RWP area to provide sufficient resources to support a viable population	1, 2	RWT	50	$8,750,000	1
14	Implement and monitor strategies to reduce gunshot mortality in the ENC RWP to achieve the target 50% reduction of mortality, as detailed in Miller et al. 2023 PVA, to facilitate an increase in the Red Wolf population	2, 3	Service, State wildlife agencies, other contributors	50	Included in Actions 7, 8, 14, and 16	1
15	Implement and monitor strategies to reduce vehicle strikes in the ENC RWP to achieve the target 50% reduction of mortality, as detailed in Miller et al. 2023 PVA, to facilitate an increase in the Red Wolf population	2, 3	Service, State wildlife agencies, NC DOT, other contributors	50	$12,160,125	1
16	Increase law enforcement presence in ENC RWP area to assist in public outreach, deter illegal killing, investigate Red Wolf mortalities, enforce existing regulations, and coordinate with law enforcement from other agencies	2, 3	Service, State wildlife agencies	50	$3,521,150	2
	TOTAL COST				$327,930,911	

[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	Formerly Conservation Centers for Species Survival
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 National Zoo & Conservation Biology Institute
Karelus, Dana	Texas Parks and Wildlife
Keith, Jason	U.S. Fish and Wildlife Service
Kendall, Corinne	North Carolina Zoo
Lasher, Chris	American Red Wolf SAFE Program
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
Moore, Nicholas	Florida Fish and Wildlife Conservation Commission
Mossotti, Regina	Saint Louis Zoo; American Red Wolf SAFE Program
Nordsven, Ryan	U.S. Fish and Wildlife Service
Olfenbuttel, Colleen	North Carolina Wildlife Resources Commission

Name	Organization
Phillips, Mike	Turner Endangered Species Fund
Pollak, Kaleigh	Monacan Indian Nation
Rankin, Duke	U.S. Department of Agriculture Forest Service
Risch, Tom	Rutgers 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
Shipley, Andrea	North Carolina Wildlife Resources Commission
Songsasen, Nucharin	Smithsonian National Zoo & 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

APPENDIX B.

Release Scenarios Modeled in the PVA (Miller et al. 2023, p. 11)

Releases to ENC RWP only

Release-Low

Adults:	Four (two female, two male) each year for model years 1 through 5
Pups:	Six (three female, three male) each year for model years 1 through 20

Release-High

Adults:	Six (three female, three male) each year for model years 1 through 5
Pups:	Eight (four female, four male) each year for model years 1 through 20

Release-High50

Adults:	Six (three female, three male) each year for model years 1 through 5
Pups:	Eight (four female, four male) each year for model years 1 through 20, then eight every five years thereafter for model years 25 through 50

Establishing new populations

Large Release

ENCRWP

Adults:	Eight (four female, four male) each year for model years 1 through 5
Pups:	Eight (four female, four male) each year for model years 1 through 20

Wild-2

Adults:	Eight (four female, four male) each year for model years 6 through 10
Subadults:	Eight (four female, four male) each year for model years 6 through 10
Pups:	Eight (four female, four male) each year for model years 11 through 20, then eight every five years thereafter for model years 22 through 52

Wild-3

Adults:	Eight (four female, four male) each year for model years 11 through 15
Subadults:	Eight (four female, four male) each year for model years 11 through 15

Pups: Eight (four female, four male) each year for model years 16 through 25, then eight every five years thereafter for model years 29 through 59

Small Release

All populations: 50% of the Large Release values

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U.S. Fish & Wildlife Service

Female Red Wolf, 1743; Alligator River NWR, 2022
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