5-YEAR REVIEW
Red Wolf (*Canis rufus*)

GENERAL INFORMATION

Background:

1. Is there an existing status review for the species? (e.g., listing document, 5 Year Review, 12-month petition finding, reclassification rule).

   ☒Yes

   ☐No

   If yes, list the applicable documents:

   - Red Wolf 5-Year Status Review 2007
   - Red Wolf Species Status Assessment (SSA) 2018

2. When was this current 5-Year Review initiated (provide date and FR citation)?

   October 31, 2016 (81 FR 75425)

3. Has all new information acquired since the last status review been evaluated?

   ☒Yes

   ☐No

4. Is there substantive new information since the last status review, such as:

   - New conservation agreements in place
   - Significant change in numbers, population, and/or habitat
   - Change in threats
   - New survey data
   - New research findings
   - New taxonomic information

   ☒Yes

☐No

If yes, continue to 5. If no, continue to Conclusion.

5. Updated Information and Current Species Status

Methodology to Update Information and Complete Review

In accordance with section 4(c)(2) of the Endangered Species Act (Act), the purpose of a 5-year review is to assess each threatened and endangered species to determine whether its status has changed since the time of its listing, or its last status review and whether it should be classified differently or removed from the list of threatened and endangered species.

The U.S. Fish and Wildlife Service (Service) reports the results of a comprehensive biological status review as part of a Species Status Assessment (SSA) to inform this 5-year review and, if needed, recovery planning. The SSA provides a thorough account of the species' overall viability and, therefore, extinction risk; the current and future viability of the red wolf is described in terms of resiliency, redundancy, and representation. The SSA represents the Service's evaluation of the best available scientific information. The SSA underwent independent peer and partner review before being used as the scientific basis to support a decision making process regarding the recommendation presented in this 5-year review.

Below, we provide updated analyses of all available information, including information that has become available since the 2007 5-year review, which resulted from the SSA.

Biology and Habitat

New Interpretations of Red Wolf Historical Range

A recent review of available information regarding historical records of red wolves in the U.S. by Wildlife Management Institute (WMI), concluded that earlier range delineations had been too restrictive and that the historical range of the red wolf encompassed southeastern U.S. westward to the Edwards Plateau in Texas, north to the lower Midwest (i.e., southeastern Missouri, southern Illinois) and east into Southern Pennsylvania and extreme southeastern New York (WMI 2016, pp.19, 22-23). See the SSA (USFWS 2018, pp. 12, 15) for additional information, including a map of the historical range as described by WMI.

Red Wolf Origin and Taxonomy

The red wolf (*C. rufus*) has generally been accepted as the valid designation for wolves in the southeastern United States; however, there is a lack of consensus among the scientific community regarding the taxonomy and genetic ancestry of the red wolf. For more than 30 years, various studies have reached conflicting conclusions as to the origin, and therefore, the correct taxonomic status of the red wolf. Since the 2007 5-year review, additional morphological and genetic studies have become available, all of which continue to reach conflicting conclusions.

Several studies provide support for Audubon and Bachman's original designation of red wolf as a subspecies of the gray wolf (*C. l. rufus*) (Lawrence and Bossert 1967, pp. 228-230; Phillips and Henry 1992, p. 597; and Wayne 1995, p. 11). Others have supported designation of the red wolf as a separate species (*C. rufus*) (Atkins and Dillon 1971 in Paradiso and Nowak 1972, p. 4; Paradiso and Nowak 1971, pp. 7, 8; Paradiso and Nowak 1972, entire; Gipson *et al*. 1974 in Nowak 1979, p. 26; Freeman 1976 in Nowak 1979, p. 26; Elder and Hayden 1977 in Nowak 2002, p. 98; Nowak 1979, pp. 12, 29-30, 34; Nowak 1992, p. 594; Nowak 1995, pp. 388, 389, 394; Nowak 2002, pp. 99, 118; Kurten and Anderson 1980 in Nowak 2002, p. 98; Hall 1981 in Nowak 2002, p. 98; Phillips and Henry 1992, p. 597; Bertorelle and Excoffier 1998 in Hedrick *et al*. 2002, p. 1906; Hedrick *et al*. 2002, p. 1912; Chambers *et al*. 2012, pp. 29, 32, 34; Hinton and Chamberlain 2014, pp. 857-859; Hohlenlohe *et al*. 2017, p. 2).

Many studies have focused on the origin of the red wolf rather than addressing taxonomic questions (Chambers *et al*. 2012, p. 3). This is particularly true for genetic studies. With these various hypotheses concerning the origin of the red wolf, some authors also provide taxonomic recommendations. One hypothesis suggests that red wolves evolved as a distinct lineage from a common ancestor with coyotes (*C. latrans*) and should be recognized as a full species (Nowak 2002, pp. 106, 117, 119; Nowak and Federoff 1998, pp. 722-723; Bertorelle and Excoffier 1998 in Hedrick 2002, p. 1906; Chambers *et al*. 2012, p. 34; Hohenlohe *et al*. 2017, pp. 1, 2).

Advances in molecular genetic capabilities has led to even greater controversy regarding interpretations of wolf taxonomy (Chambers *et al*. 2012, pp. 4-5). With the onset of applied genetic techniques in the 1990s came new hypotheses suggesting the red wolf evolved via hybridization between gray wolves and coyotes (Wayne and Jenks 1991, pp. 566-567; Roy *et al*. 1994, p. 565; Roy *et al*. 1996, pp. 1420-1421; Wayne 1995, p. 9; Wayne and Gittleman 1995, pp. 4, 7; Wayne *et al*. 1998, pp. 726, 728; Reich *et al*. 1999, pp. 139, 143; vonHoldt *et al*. 2011, pp. 8, 9; vonHoldt *et al*. 2016, p. 7; Hohenlohe *et al*. 2017, pp. 1, 2; vonHoldt *et al*. 2017, p. 1). However, there is disagreement over the timeframe in which hybridization took place; estimates range from as far back as the Pleistocene (10,000 years ago) to as recent as 300 years ago with European settlement (Wayne 1995, pp. 10-11; Roy *et al*. 1994, p. 565; Wayne and Gittleman 1995, pp. 7-8; Roy *et al*. 1996, p. 1421; Reicht *et al*. 1999, p. 143; vonHoldt *et al*. 2011, p. 8; Sefc and Kobmuller 2016, pp. 1-2; vonHoldt *et al*. 2016, pp. 7-8; Hohenlohe *et al*. 2017, p. 2; vonHoldt *et al*. 2017, p. 2). Recommendations on the taxonomic status of red wolf are given by some authors and vary with ancient hybridization origin and recent hybridization origin, with some concluding the red wolf is a distinct species (Nowak 1992, p. 594; Sefc and Kobmuller 2016, pp. 1-2 (part of eastern wolf, *C. lycaon*); Hohenlohe *et al*. 2017, pp. 1, 2) and others concluding it is merely a hybrid and not distinct from gray wolves and coyotes (Wayne and Jenks 1991, p. 566; Roy *et al*. 1994, pp. 565-566; Wayne 1995, p. 9-11; Wayne and Gittleman 1995, pp. 4-7; Roy *et al*. 1996, p. 1420; Wayne *et al*. 1998, p. 726; vonHoldt *et al*. 2016, p. 8; vonHoldt *et al*. 2017, p. 1).

Genetics studies have also resulted in suggestions that the red wolf and Algonquin wolf are a distinct North American evolved wolf species, the eastern wolf (*C. lycaon*), that evolved from a common ancestor with coyotes (Wilson *et al*. 2000, pp. 2158, 2164; Kyle *et al*. 2006, p. 12; Wilson *et al*. 2012, p. 2328). However, due to a bottleneck associated with captive breeding, the red wolf's contemporary genetic signature has diverged (Rutledge *et al*. 2015, p. 2).

In 2016, an expert workshop was convened to investigate and address key questions related to uncertainty surrounding hybridization and the potential increase in introgression with coyotes and challenges to survival of red wolves. The main contribution of the workshop was the evaluation of competing evolutionary origin hypotheses for the red wolf, specifically whether the red wolf is a listable entity under the ESA (Pacifi and Mills 2016, p. 13). Although the attending experts did not reach consensus on a hypothesis, they did agree that there was a logical and valid path to make a determination that the red wolf is a listable entity under the ESA either as a species (*C. rufus*), a subspecies or distinct population segment (DPS) of eastern wolf (*C. lycaon*), or a subspecies or DPS of gray wolf (*C. lupus*) (Pacifi and Mills 2016, p. 16). However, even with this conclusion, the Service must ensure the red wolf meets the definition of species under the ESA. The term “species” under the ESA includes any subspecies of fish or wildlife or plants, and any DPS of any species of vertebrate fish or wildlife which interbreeds when mature.

The debate over the taxonomic status of the red wolf has continued for more than 30 years. Genetic studies present conflicting interpretations and offer various theories on the origin of the red wolf and recommendations on the correct taxonomic status. There are three main theories on the origin of the red wolf: (1) the red wolf originated from ancient hybridization between gray wolves and coyotes, (2) the red wolf originated from recent (post European colonization) hybridization between gray wolves and coyotes, and (3) the red wolf evolved from a common ancestor with the coyote, but is of a lineage divergent from coyotes. Additionally, one of the mammal taxonomy authorities (Wilson and Reeder, Mammal Species of the World Third Edition 2005) does not recognize the red wolf as a distinct species, but does recognize it as a subspecies of gray wolf. Given the fact that the scientific community is not in agreement on the question of red wolf taxonomy, in 2017, the USFWS conducted a review of all the evidence related to red wolf taxonomy. The most recent scientific publications continue to provide conflicting interpretations and support for different theories of origin, specifically theories 2 and 3 above; therefore, USFWS continues to recognize the red wolf as the species *Canis rufus*.

In 2018, Congress directed the Service, via the Department of the Interior, Environment, and Related Agencies Appropriations Act, 2018, to initiate a study, through a qualified independent entity, to determine whether or not animals currently classified as red wolves are a taxonomically valid species. The study is to include publication of a scientific literature review, including genetic research, no later than one year after the date of enactment of the Act and, if the literature is inconclusive, shall include any additional necessary research and publication no later than three years after the date of enactment of the Act. The study will be initiated within 90 days of enactment of the Act.

Red Wolf Genetics and Management

New information regarding conservation of the red wolf gene pool can be found in the SSA. A new population viability model (PVA) was completed in 2016 (Faust *et al*. 2016, entire). The PVA models viability of the captive stock, as well as the wild nonessential experimental population (NEP) in eastern North Carolina, to better comprehend the conditions under which the two populations can persist in the future and how viability would be impacted by movement between the populations. For information on genetic diversity needs for red wolf viability, current gene diversity, and projected gene diversity under current conditions for up to 43 years, see the SSA (USFWS 2018, pp. 28-30). For future projected probability of reaching the genetic target set by the Red Wolf Recovery Plan (USFWS 1989) (80 – 85% genetic diversity over 150 years) under various management scenarios, see the SSA (USFWS 2018, pp. 55-66).

Additionally, the "placeholder program" has been evaluated and found to be an effective way to manage coyote introgression (Gese and Terletzky 2015, p. 18). Details of this evaluation and the impact on hybridization with coyotes and coyote gene introgression can be found in the SSA (USFWS 2018, pp. 33-38).

Current conditions in the NEP area appear to be inadequate to establish a viable self-sustaining red wolf population (Murray *et al*. 2015, pp. 338, 341). As discussed in the previous 5-year review (USFWS 2007, p. 15), although there is enough space available in the NEP area, Stoskopf (2007), Murray (2007), and Knowlton (2007) suggest the NEP population may have reached its functional carrying capacity with little room for significant additional numbers of wolves on the NEP area. They note that suitability of remaining habitat may be poor. This was later confirmed by Gese *et al*. (2015, p. 200) and Murray *et al*. (2015, p. 343). In fact, these marginal habitats, not preferred by the red wolf, are occupied primarily by coyotes (Murray *et al*. 2015, p. 343). In addition to carrying capacity, Hinton *et al*. (2017a, p. 422) showed that a more complex relationship existed and that anthropogenic mortality because a factor. Hinton *et al*. (2017a, p. 426) noted that in order to reduce the negative effects of anthropogenic mortality and ensure long-term persistence of red wolves, the Service will need to continue with the Red Wolf Adaptive Management Work Plan.

Red Wolf Adaptive Management Work Plan (RWAMWP)

The northeast North Carolina reintroduction area was chosen due to the reduced potential for interaction with coyotes, which were thought to be absent. However, by the early 1990's coyotes were known to be present and had interbred with wolves leading to the need for a Red Wolf Adaptive Management Plan (RWAMWP). The RWAMWP is designed to reduce or eliminate this threat (Gese *et al*. 2015, p. 193; USFWS 2009–2013). The RWAMWP assumes sterilized coyotes/hybrids will hold a territory until wolves can colonize it when it becomes available. Territories become available through selective removal of coyotes with wolves eventually excluding coyotes/hybrids naturally through competitive exclusion and strife. Although the placeholder theory has been successfully used to control coyote introgression at the heavily managed NEP of red wolves, its long term effectiveness at the landscape level is unsustainable and has been questioned (WMI 2014, p. 87). Murray *et al*. 2015 (p. 342), explained that, even if permanent threat abatement (i.e., banning coyote hunting) is fully successful, it is unclear whether improved wolf survival and recruitment will provide sufficient demographic advantage to override perpetual colonization of the recovery area by coyotes/hybrids. Coyotes now occupy virtually the entire eastern coast of North America (Stoskopf *et al*. 2005; Murray & Waits 2007), meaning that the threat of hybridization with recovering red wolves is strong and pervasive (Murray *et al*. 2015, p. 343). Unlike most wolf populations (e.g., gray and Mexican wolves), occupied red wolf territories in North Carolina are not contiguous and vacant landscape persists in the interstitial spaces (USFWS 2007; Gese *et al*. 2015). This speaks to marginal wolf habitat in the NEP area and the constant opportunity for colonization by coyotes/hybrids; these animals may have lesser territorial requirements and more plastic habitat needs than wolves. Not surprisingly, habitat loss is a pervasive impediment to species recovery in contemporary North American landscapes (Kerr & Deguise 2004; Schwartz 2008). Accordingly, it may simply not be possible to achieve competitive exclusion of coyotes/hybrids by red wolves in North Carolina (see Murray & Waits 2007) (Murray *et al*. 2015, p. 343).

Hinton *et al*. 2017a (p. 424) showed that with more detailed individual data it became clear that wolf mortality rates were much higher than Murray's analysis showed (42% from 2000 to 2013; with an increasing trend through time vs 25% consistently as reported by Murray (Hinton *et al*. 2017a, p. 424). The population was not stable/increasing, but declining, in large part due to anthropogenic mortality which facilitated hybridization with coyotes and made it more difficult for the wolves to recover from losses,

Hinton *et al*. (2017b, p. 12) noted “The competitive exclusion theory implies that coexistence depends on the degree to which shared resources are limiting and partitioned by sympatric competitors (Gause 1934; Hardin 1960). Red wolves and coyotes display similar habitat selection (Hinton *et al*. 2015a, 2016b) and our results show they rely on similar prey, albeit in different proportions. Consequently, significant overlap in resource use indicates that competition between red wolves and coyotes is likely intense and may not promote coexistence.” Red wolves and coyotes maintain exclusive territories in which displacement of canids is unidirectional, with red wolves displacing coyotes but not vice versa (Gese and Terletzky 2015). However, when mating opportunities are lacking, similar use of resources allows red wolves and coyotes to successfully form and maintain congeneric breeding pairs. Developing conservation strategies to strengthen reproductive isolation between red wolves and coyotes will result in fewer congeneric pairings and reduce hybridization but those strategies are unlikely to facilitate coexistence. Fredrickson and Hedrick (2006) and Hinton *et al*. (2013) suggested the extent to which reproductive barriers and positive assortative mating existed between red wolves and coyotes were the most important factors determining success of red wolf recovery.”

Dynamics of the Restored Red Wolf Population

For updated information on NEP population dynamics, see the SSA (USFWS 2018, sections beginning on p. 29).

Five Factor Analysis

The recently completed SSA (USFWS 2018, pp. 31-54) contains an evaluation of the past, current and future factors affecting the needs of red wolf for viability (i.e., a five factor analysis). Below is a breakdown of new information in the SSA under each factor.

Present or threatened destruction, modification or curtailment of habitat or range.

- Development (USFWS 2018, p. 52)

Overutilization for commercial, recreational, scientific, or educational purposes.
Not known to have effects on red wolf populations (USFWS 2018, p. 31)

Disease or predation

- Disease and parasites (USFWS 2018, pp. 40-41)

Inadequacy of existing regulatory mechanisms
In the 2007 5-year review (USFWS 2007, pp. 26-28), we conclude that the nonessential experimental population status of the North Carolina population is effective in red wolf conservation and in allowing flexibility for red wolves and people. However, since the 2007 review, the rate of human caused mortality (e.g., gunshot, vehicle collision, poisoning, and suspected illegal activity) has increased, causing the population to decline to a critical level (USFWS 2018, pp. 31-32, 33-39, 52-53).

The rule under section 4(d) of the Act for the red wolf (50 CFR 17.84(c)) contains the necessary prohibitions and exceptions that allow for take of red wolves in certain situations. These exceptions include: 1) take with a valid permit for educational purposes, scientific purposes, the enhancement of propagation or survival of the species, zoological exhibition, and other conservation purposes consistent with the Act and in accordance with applicable State fish and wildlife conservation laws and regulations; 2) take on private lands provided that such taking is not intentional or willful, or is in defense of that person’s own life or the lives of others; 3) take on Federal, State, of local government lands provided that such taking is incidental to lawful activities, is unavoidable, unintentional, and not exhibiting a lack of reasonable care, or is in defense of that person’s own life or lives of others; 4) harassing provided that all such harassment is by methods that are not lethal or physically injurious to the red wolf; 5) take by private landowner on their property after efforts by project personnel to capture such animals have been abandoned and such actions are approved in writing; and 6) take by any employee or agent of the Service or State conservation agency if the action is necessary to: aid a sick, injured, or orphaned specimen, dispose of a dead specimen, or salvage a dead specimen which may be used for scientific study; take an animal that constitutes a demonstrable but non-immediate threat to human safety or that is responsible for depredations to lawfully present domestic animals or other personal property; and move an animal for genetic purposes.

Under the exceptions described above, take is required to be reported (except take with a valid permit and take by an employee or agent of the Service or State conservation agency). Reporting is not required but encouraged when take occurs outside the designated NEP area. Considering the increase in anthropogenic mortality, such as gunshot, suspected illegal activity, and poisoning (USFWS 2018 pp. 33-38, 40; Hinton *et al*. 2017a, pp. 424, 426) and a lack of corresponding reports of legal take to explain this increase, it appears that the NEP status is not effective at protecting the red wolf from illegal take.

Other natural or manmade factors

- Small population size and founder stock (USFWS 2018, pp. 32-33)
- Coyote introgression (USFWS 2018, pp. 33-38)
- Vehicle collision (USFWS 2018, p. 39)
- Gunshot mortality (USFWS 2018, p. 33-38)
- Poisoning and suspected illegal activity (USFWS 2018, p. 39)
- Fire (USFWS 2018, p. 41)
- Hurricanes and storms (USFWS 2018, p. 41)
- Sea-level rise and habitat inundation (USFWS 2018, pp. 41-50)
- Public perceptions (USFWS 2018, p. 51).
- Carcass use, dumping, and carnivore use of agricultural areas (USFWS 2018, p. 52).

Synthesis

Since 2007, the red wolf NEP has declined significantly. The primary factors affecting the future viability are anthropogenic mortality (wild populations), introgression (wild populations), and inbreeding depression (captive and wild populations. At present, in the North Carolina NEP, the birth rate is not sufficient to overcome the losses to mortality. This situation is further aggravated by introgression, which effectively reduces births of pure red wolves. There are now insufficient unrelated red wolves to replace lost breeders and therefore, the population cannot recover from their losses and overcome mortality resulting in a steadily declining population (USFWS 2018, p. 53). Without substantial intervention, complete loss of the NEP will likely occur within as few as eight years (Faust *et al.* 2016, p. 15). The NEP could avoid extirpation and be viable (<10% chance of extirpation in 125 years) as a population with intervention (Faust *et al.* 2016, p. 3) (See also USFWS 2018, p. Executive Summary).

It is important to emphasize that many factors affecting the species in North Carolina have been managed through various management strategies (see USFWS 2018, pp. 13-14, 34-35) within the recovery program (either in the NEP or the SSP). The interventions have been implemented to maintain purity of the genetic stock and ensure survival of wolves both in the SSP and in the NEP. However, some factors have proven particularly difficult to control. The Red Wolf Adaptive Management Plan (USFWS 2013, entire) appeared in 2015 to be effectively limiting genetic introgression (< 4% coyote ancestry from introgression since the reintroduction began) into the red wolf population, though hybridization is seen as an ongoing challenge (Gese *et al.*, 2015, p. 191, 200; USFWS 2018, pp 47-48).

With regard to the SSP, "While the SSP has been maintained at a relatively large population size of more than 150 animals for over 20 years, it needs to increase breeding and increase its population size/space to ensure long-term viability and its ability to serve as a strong source for animals to release to the wild" (Faust *et al*. 2016, p. 3; USFWS 2018, Executive Summary).

The SSP is intended to be the genetic fail-safe for the entire population and any future recovery potential for the species. Only twelve of the original 14 founders lines are represented and Faust *et al.* (2016) provide several scenarios through which the SSP could be expanded, genetic diversity (based on the remaining 12 founder lines) maintained, and future release efforts supported. While any future reintroductions would require a consideration of SSP capacity to support these efforts, it is clear that the SSP effort has maintained a genetically-diverse stock, given the remaining 12 founder lines, from which to grow the population and release the most diverse animals possible (USFWS 2018, p. 21).

Currently, only one wild population of the species exists and without substantial intervention, it is likely to go extirpated within decades. Without additional reintroduction sites the species is unlikely to have significant redundancy in the wild in the future. It could be argued that some level of redundancy is present in captivity because the species is held at multiple facilities throughout the U.S. however; this does not constitute a functioning, wild population (USFWS 2018, p. 30).

The current conditions in the NEP area are not favorable for red wolf self-sustainability and survival (Murray *et al*. 2015, pp. 341-343; Hinton *et al*., 2017a, p. 426). Murray *et al*. (2015, p. 343) noted that it is unclear if, even assuming that the entire NEP area (1.7 million acres) would be evenly available for red wolf recovery (i.e., good habitat across the area, local support), the likelihood of success for reaching self-sustainability is possible. As Murray *et al*. (2015, p. 341) discuss, "one important aim of the recovery program is to reach a stage where wolves saturate the landscape and naturally exclude coyotes/hybrids through competition and strife (Murray & Waits 2007). Numerical requirements for red wolf recovery are more modest than for most other endangered species (220 free-ranging individuals, see USFWS 1990; see also Neel *et al*. 2012), and considerable financial, personnel, and logistical investments are made each year in the Red Wolf Adaptive Management Plan (see USFWS 2009–2013; Gese *et al*., 2015). Despite these facts, basic conditions conducive to wolf population self-sufficiency simply have not been achieved." Hinton *et al*. (2017a, p. 426) reached a similar conclusion but from a different focus. They concluded that "[a]lthough the RWAMWP was successful in limiting coyote introgression (Gese and Terletzky 2015, Gese *et al*., 2015), it was not successful in providing conditions favorable for red wolf survival." The main reason for the presence of these unfavorable conditions is attributed to anthropogenic mortality and subsequent population decline and hybridization with coyotes (Hinton *et al*. 2017, 426).

Considering the full analysis described in the SSA (USFWS, 2018) the red wolf has virtually no **resiliency**, no **redundancy**, and very low **representation**. In addition, the experience for the last 32 years with the red wolf NEP in eastern North Carolina has demonstrated that the conditions for self-sustainability have not been met. Therefore, we recommend the red wolf remain an endangered species under the Act.

Conclusion:

☐Reclassify

☐ To a threatened species

☐ To an endangered species

☐ Delist (*Indicate reasons for delisting per 50 CFR 424.11):*

☐ Extinction

☐ Recovery

☐ Original data for classification in error

☒ No change is needed

RECOMMENDATIONS FOR FUTURE ACTIONS

In a 2016 Service Memorandum, Recommended Decisions in Response to Red Wolf Recovery Program Evaluation, the Service committed to completing a SSA for red wolf and using it to guide recovery actions, including updating the Red Wolf Recovery Plan. The Recovery Plan will facilitate the development of a vision of what recovery means for the species, what the impediments to recovery are, and possible ways to achieve it. The recovery plan will include: (1) clear, objective and measurable criteria for what recovery looks like for the species, so we know when to pursue delisting; (2) site specific management actions that describe, at a strategic and higher level, what needs to be done to accomplish the goal of recovery; and (3) the time and costs for implementing those actions.

The actual on-the-ground, prioritized activities for implementing the actions in the recovery plan will be described in a separate document, the Recovery Implementation Strategy (RIS). The RIS provides specific, prioritized activities to implement the recovery actions in the plan in the near term and affords us the ability to modify these activities in real time to reflect changes in the information available and progress towards recovery.

With only one non-essential experimental population in the wild, additional populations are necessary to red wolf viability and, therefore, its ability to persist in the wild. While the Service has not yet conducted an analysis of potential reintroduction sites, various aspects of red wolf reintroductions have been evaluated, including identifying factors for release success (van Manen *et al*. 2000), evaluating specific sites for suitability (Shaffer 2007; Jacobs 2009), and evaluating the historical range of the red wolf for potential reintroduction sites (Dellinger, *in prep*; Toivonen, pers. comm.).

The studies that are available have used slightly different criteria for evaluating suitability or release success of potential reintroduction sites. We intend to use this available information as a basis in which to begin our analysis for potential reintroduction sites. We know that reintroductions will need a large Federal land anchor and will include many stakeholders; for example, other federal agencies, state agencies, industry land holdings, conservation lands, and private land owners. Therefore, the recovery planning process, including identifying potential reintroduction sites, will include a diverse team of species experts and stakeholders. Our goal is to build a network of partnerships that will work together to establish recovery goals, an implementation plan, and execute on the ground work to reach the jointly-established recovery goals for the red wolf.

The red wolf remains a conservation-reliant species (i.e., cannot be recovered without intense human management). While it's genetic viability can be managed through the captive population, there is little chance of a naturally occurring wild population existing without active management. With the spread of coyotes across the entire red wolf historical range, there are no coyote-free habitats where a reintroduction program could be successful without active coyote management. Some of the value of the NEP has been as a wild population where management strategies could be tested for effectiveness. For example, the RWAMWP proved successful in limiting coyote introgression and maintaining red wolf territories, it was not successful in providing conditions favorable for its survival (Hinton *et al*., 2016). We anticipate the RWAMWP strategy will remain necessary for the eastern North Carolina NEP and any future NEPs.

As discussed by Henry and Lucash (2000, pp. 6-7), without private landowner support we will not be able to recover the red wolf. Due to the importance of private lands to red wolf conservation (over 90% private land ownership in the Southeast), socio-political factors are as important if not more important than ecological factors. Fundamental change is needed in the way stakeholders are engaged in management of wild-ranging red wolf populations. Additional factors impacting the current eastern North Carolina NEP such as sea level rise and anthropogenic mortality (e.g., vehicular strikes, poisoning, and gunshot) present additional challenges. Sea level rise will be additive year after year and impacts the long-term viability of this NEP. Both State agencies and the Service will need to engage with the public and develop strategies for managing coyote, and ensure that wild game populations are not adversely impacted by the presence of red wolves.

In conclusion, as we learn more about the management of red wolves, we need to continue to adapt our strategies and approaches. As described in the Red Wolf Recovery Team Report (2016), there is consensus that the current direction and management of the NEP project is unacceptable to the Service and stakeholders. Currently, the NEP is declining more rapidly than the worst case scenarios described in the most recent Population Viability Analysis (Faust *et al*. 2016). Based on the SSA review, it is obvious that there are significant threats to the NEP in eastern North Carolina and conditions for recovery of the species are not favorable and a self-sustainable population may not be possible. For example, the coyote population has continued to expand rapidly in eastern North Carolina and the risk of hybridization is at the highest levels. Hybridization is considered strong and pervasive even with the intensive management following the implementation of the RWAMWP. Gese *et al*., (2015, p. 200) concluded that ideally red wolves would fully occupy the entire NEP area and coyotes entering the area would be excluded by resident red wolves. However, the authors believe this is an unlikely scenario due to the fact that red wolf habitat in the NEP area is discontinuous and projected habitat changes will favor coyotes, therefore increasing the risk for hybridization. The risk of hybridization is exacerbated by the fact that there is a high degree of anthropogenic mortality (e.g., vehicular strikes, illegal gunshot, poisoning) in the NEP area. Human-caused mortality, in particular during red wolf breeding season, significantly increases the breeding pair disbandment, facilitating hybridization with coyotes. Based on these conditions, the Service is considering other management options to conserve the red wolf.

Despite the challenges and limitations facing the NEP project in eastern North Carolina, maintaining a small and more manageable wild population remains important to fostering the species in the wild. A smaller wild population will better allow for the support of the captive population component of the red wolf program, including but not limited to the SSP facilities. It will also help retain some of the influences of natural selection, serve as a small propagation population for future new reintroduction efforts and could provide a population for continued scientific research on wild behavior.

PEER REVIEW

A large part of the red wolf SSA involved seeking expert input on wolf biology, stressors, and current and future condition of the NEP and SSP. A draft SSA Report went through an extensive review process with peer and partner review, including North Carolina Wildlife Resources Commission. The final SSA Report, on which this 5-year review is based, has been revised in response to the comments and suggestions received from our peer reviewers and State agency reviewers. The intent of the SSA is to provide a living document that can be edited and reviewed regularly to keep it current with the best available science. Therefore, the SSA will continue to the updated and refined to best inform recovery planning efforts, management strategies and future 5-year status reviews.

U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW
Red Wolf (*Canis rufus*)

Current Classification: Endangered

Recommendation resulting from the 5-Year Review:

☐ Downlist to Threatened
☐ Uplist to Endangered
☐ Delist
☒ No change needed

Appropriate Listing/Reclassification Priority Number, if applicable:
5C

Review Conducted By:
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Regional Red Wolf Recovery Lead
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U.S. Fish and Wildlife Service

Approve MICHELLE EVERSEN Digitally signed by MICHELLE EVERSEN Date: 2018.04.23 18:21:58 -04'00' **Date** ____________

LITERATURE CITED

Additional literature reviewed for the red wolf can be found under the Literature Cited section of the SSA (pp. 73-83).

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