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To: North Carolina Wildlife Resources Commission & United States Fish and Wildlife Service

Comments on Proposed Regulations for coyote hunting and red wolf listing and Resolutions concerning red wolf recovery

Summary

In this letter we address the North Carolina Wildlife Resources Commission's proposed rule changes to institute coyote (*Canis latrans*) hunting rules and list the red wolf (*Canis rufus*) on the North Carolina Protected Species List. These actions are important steps to promote red wolf recovery but, unfortunately, the recent resolutions adopted by the Commission undermine these intentions and emphasize misconceptions about the red wolf to the public. Despite the notion asserted in the resolutions, a significant body of scientific evidence indicates that the red wolf is distinct from other species of canids. Furthermore, the red wolf in North Carolina has been minimally impacted by genetic introgression from coyotes, and hybrids compose a minimal portion of the red wolf recovery area. Rejecting red wolf conservation due to the challenges posed by hybridization ignores evidence from other wolf populations and runs counter to the actions of wildlife agencies across North America, including the Commission's, in protecting other species impacted by genetic introgression. People within North Carolina and the entire nation support the recovery of these native predators, and it is important for the WRC to rescind the resolutions, recognize the success of the program, and become an active participant in red wolf recovery.

Main body

We, the undersigned, submit the following comments in response to the North Carolina Wildlife Resources Commission's (hereafter Commission) joint resolutions regarding the recovery of the red wolf (*Canis rufus*) and the proposed regulations for coyote management in eastern North Carolina. We applaud the Commission's decision to add the red wolf as a threatened species to the state's Protected Animal List and modify coyote (*Canis latrans*) hunting regulations in the five-county red wolf recovery area. The red wolf is one of the world's most endangered mammals and has been the focus of an intensive recovery effort by the US Fish and Wildlife Service (hereafter USFWS) and its various partners to restore the species to a portion of its historic range in eastern North Carolina. These efforts have not only created a self-sustaining population of red wolves, but have inspired large mammal recovery and reintroduction programs around the world.

As has been indicated by the recent review issued by the Wildlife Management Institute (hereafter WMI), the reintroduction of the red wolf has been an incredible achievement. This same report highlights challenges facing the future of red wolf recovery in North Carolina. The Commission's proposals to institute coyote hunting regulations and place the red wolf on the North Carolina Protected Animal List are important steps to alleviate these concerns and foster red wolf recovery. As was highlighted by the WMI report, illegal killing of red wolves threatens the long-term persistence of the population. Over the past decade red wolf mortality caused by

gunshot has increased (USFWS 2007, Bartel and Rabon 2013, Gese et al. 2015). Studies of wolf populations around the world have revealed how anthropogenic mortality can disrupt natural social dynamics and impact patterns of space use, mating patterns, pack dynamics, dispersal, and predation (see Brainerd et al. 2008, Wallach et al. 2009, Rutledge et al. 2010b, 2012a, Borg et al. 2014, Wielgus and Peebles 2014). For this red wolf population, such breeder loss can suppress population growth through loss in recruitment (Sparkman et al. 2011). Breeder loss due to anthropogenic mortality, especially gunshot, is linked to hybridization with coyotes (Bohling and Waits 2015). Incidental mortality of red wolves increases the likelihood of hybrid litters being produced and facilitates coyote presence, which reduces the efficacy of the USFWS' management program and threatens population viability.

Implementing coyote hunting regulations in the five-county area are a tremendous step towards developing a solution to enhance the viability of the red wolf population and reduce threats posed by hybridization. Lessons can be drawn from observations of the closely related eastern wolf (*Canis lycaon* or *Canis lupus lycaon*) population in Algonquin Park. Following bans on the hunting of wolves in areas surrounding the park, natural social dynamics were restored and genetic introgression was diminished (Rutledge et al. 2010b, 2012a). Establishing restrictions and protocols for the harvest of coyotes in the five-county recovery area is an innovative approach to satisfy landowners while providing safeguards to limit red wolf mortality. Furthermore, many landowners and private trappers already work with the USFWS to minimize the impact of hunting and trapping activities on the red wolf (Beeland 2013, WMI 2014).

We also recommend that the Commission extend these rules to private trappers and controlled fox hunting preserves in which landowners purchase legally trapped coyotes for stocking fenced hunting preserves. As of 2007 there were 142 listed facilities in North Carolina according to the Commission's data. Five of those were located in the five-county red wolf recovery area. We strongly suggest the Commission improve monitoring of these facilities and include them in the proposed rule changes.

These rule changes to coyote hunting and red wolf listing were proposed to enhance collaboration and reach compromise between the Commission, USFWS, and various stakeholders. Unfortunately, the recent resolutions adopted by the Commission and submitted to the USFWS undermine the intentions to protect red wolves and emphasize misconceptions about the red wolf to the public. Several of the statements in the Commission's resolutions do not reflect our current understanding of red wolf biology, management, and taxonomy. We seek to address these statements and clarify misconceptions regarding this species.

The red wolf has been at the center of scientific debate regarding the taxonomy of the species. In its resolutions the Commission referenced this debate with the following statements:

“Whereas, purity of the red wolf genome is questionable and has been debated since initiation of restoration efforts”

“Whereas, increases in coyote populations combined with coyote/red wolf hybridization and introgression has eliminated a taxonomically unique red wolf”.

These statements over-generalize our knowledge of the red wolf and reinforce several misconceptions. The red wolf was originally described by Audubon and Bachman in 1851. Since then, numerous taxonomists have documented the distinctiveness of red wolves relative to other North American canids based on morphological characteristics (Goldman 1937, McCarley 1962, Paradiso 1968, Paradiso and Nowak 1972, Gipson et al. 1974, Elder and Hayden 1977, Nowak 2002). However, by the middle of the 20th century biologists had noted that the red wolf was being impacted by hybridization with coyotes in the remaining portion of its range (McCarley 1962, Gipson et al. 1974, Goertz et al. 1975, Elder and Hayden 1977, Freeman and Shaw 1979). A major motivation for initiating a captive breeding program was to protect the species from extinction via genetic swamping. The 14 individuals selected for the program were identified as red wolves based on morphological and behavioral characteristics along with breeding experiments (USFWS 1989, Phillips et al. 2003).

Since then, advances in molecular techniques have facilitated investigations of the ancestry of these 14 founders and the species as a whole. Several earlier studies proposed that these founders possess evidence of introgression from coyotes (Wayne and Jenks 1991, vonHoldt et al. 2011) and questioned the validity of the species, suggesting it may be a product of recent hybridization between gray wolves and coyotes (Roy et al. 1994, 1996, Wayne et al. 1998, Reich et al. 1999). Others have suggested that the red wolf is a distinct North American-derived canid sharing a close evolutionary history with coyotes and possibly sister to eastern wolves in southeastern Canada (Wilson et al. 2000, Hedrick et al. 2002, Kyle et al. 2006, Rutledge et al. 2012b).

Uncertainty over the status of the red wolf has contributed to the belief among some of the public, and even the scientific community, that the current red wolf population is composed of hybrids and does not form a distinct genetic or morphological entity. This perception, reflected in the resolutions adopted by the Commission, is incorrect for several reasons. First is the notion that the founders of the captive red wolf program were heavily impacted by genetic introgression and cannot be distinguished from other canid species, which would thus invalidate red wolf conservation efforts. This is incorrect: the founders were selected based on their morphological characteristics which distinguished them from sympatric canids (USFWS 1989, Phillips et al. 2003). Additionally, genetic evidence has revealed that the founder red wolves possess a unique mitochondrial haplotype that has not been observed in other canid populations (Adams et al. 2003). Studies incorporating nuclear DNA have shown that the founders and their descendants can be distinguished from other canids using population genetic techniques (Miller et al. 2003, vonHoldt et al. 2011, Bohling et al. 2013).

There is evidence of introgression from other canid species, especially coyotes, in the genome of the founders (Wayne and Jenks 1991, Hailer and Leonard 2008, vonHoldt et al. 2011). These findings require careful interpretation. The field of evolutionary biology is increasingly recognizing the commonness of hybridization in nature and its role as an adaptive force. Both theoretical and empirical observations of hybrid systems have demonstrated that gene flow can occur between different species yet various mechanisms can maintain their distinctiveness (Gilman and Behm 2011, Abbott et al. 2013, Shurtliff 2013, Larson et al. 2014, Poelstra et al. 2014, Robbins et al. 2014). Genetic material can be exchanged between distinct groups that challenge our ability to interpret evolutionary relationships (Nittinger et al. 2007, Peters et al. 2007, Denton et al. 2014).

Thus, limited introgression of coyote genetic material is not evidence that the founders do not reflect the morphological, ecological and, evolutionary legacy of the historic red wolf genome. The fact remains that red wolves display distinct morphology, behaviors, vocalizations, genetic markers, and biochemical signatures compared to other North American canids (McCarley 1962, 1978, Paradiso and Nowak 1972, Ferrell et al. 1980, Phillips and Henry 1992, Nowak 2002, Adams et al. 2003, Hailer and Leonard 2008, Bohling et al. 2013, Hinton and Chamberlain 2014). Limited introgression should not preclude conservation of this species. Across North America, wildlife such as Great Lakes wolves (*Canis lupus*)(Leonard and Wayne 2008, Wheeldon and White 2009), caribou (*Rangifer tarandus*)(McDevitt et al. 2009), mule deer (*Odocoileus hemionus*)(Latch et al. 2011), wild turkeys (*Meleagris gallopavo*)(Latch et al. 2006), and polar bears (*Ursus maritimus*)(Cronin et al. 2014, Cahill et al. In press) display genetic legacies of introgression yet are recognized as units worthy for conservation by wildlife agencies. The Commission has promoted black duck (*Anas rubripes*) conservation even though this species has been impacted by hybridization across its entire range to the point where it is genetically indistinguishable from mallards (*Anas platyrhynchos*) (Ankney et al. 1986, Avise et al. 1990, Mank et al. 2004). Rejecting the conservation of the red wolf based on evidence of introgression runs contrary to practices by the Commission and other wildlife agencies.

The second major misconception extends this impression of uncertain ancestry to the modern population. As inferred by the Commission resolutions, there is a perception that hybridization has rendered the red wolf recovery area a landscape devoid of ‘true’ red wolves that have been genetically swamped by coyotes. This is incorrect. The USFWS engages in an aggressive monitoring program that combines trapping, den surveys, morphometrics, and genetic testing to characterize the population (Stoskopf et al. 2005). Since the adoption of the management program in 2000, there have been more than four times (126 vs. 30) as many red wolf litters than hybrid litters in the recovery area (Bohling and Waits 2015). Although coyotes have become more abundant over time, since 2003 hybrids represent only 15% of the individuals captured by USFWS biologists (Gese et al. 2015). Non-invasive genetic surveys based on fecal material reveal that red wolves are clearly identifiable based on genetic markers and hybrids compose only a minor (<5%) component of the canid population (Adams et al. 2007, Bohling 2011, Bohling and Waits 2011). In fact, when the Commission funded research aimed to investigate the dietary habits of red wolves, coyotes, and hybrids (see McVey et al. 2013), the decision was ultimately made to exclude hybrids from the study because the sample size was too low.

In 1993 a female red wolf bred with a coyote and produced two F1 hybrid males that subsequently back-crossed with the red wolf population (Stoskopf et al. 2005, Adams 2006). Based on pedigree records, this is the only occurrence of introgression into the reintroduced red wolf population. The overall red wolf population is composed of less than 4% coyote ancestry (Gese et al. 2015). These backcrossed individuals are genetically (Bohling et al. 2013) and morphologically (Hinton and Chamberlain 2014) indistinguishable from ‘pure’ red wolves and these admixed individuals do not demonstrate hybrid vigor (Brzeski et al. 2014). Thus, the Commission’s assertion that the red wolf population is increasingly introgressed and no longer forms a distinct genetic unit is incorrect.

Coyotes are now a permanent fixture in the state of North Carolina, which has led to the perception that the red wolf population will not be viable in the long-term due to hybridization.

However, evidence suggests red wolf recovery is achievable. Initial modeling exercises predicted that the red wolf population would succumb to introgression under the assumption that they breed indiscriminately with coyotes (Kelly et al. 1999, Fredrickson and Hedrick 2006). Such predictions served as the impetus for the management program adopted by the USFWS (Stoskopf et al. 2005). Fredrickson and Hedrick (2006) revealed that assortative mating and red wolf aggression towards coyotes can limit gene flow and increase the viability of the red wolf population. USFWS biologists have observed red wolves displacing and killing coyotes (USFWS 2007). In fact, the abundance of hybrids observed in the five-county recovery area is less than predicted under their models (Bohling 2011, Gese et al. 2015). This suggests that the combined efforts of management and natural reproductive barriers can maintain the red wolf.

The Commission's proclamation that the red wolf is past the point of recovery due to the impacts of hybridization is contradicted by the best available science regarding the red wolf and other wolf populations. The eastern wolf population in Algonquin Park has maintained its genetic identity despite limited gene flow with coyotes and gray wolves (Grewal et al. 2004, Wilson et al. 2009, Rutledge et al. 2010a). Other wolf populations have been able to persist and expand despite occurrences of hybridization with domestic dogs (Verardi et al. 2006, Muñoz-Fuentes et al. 2010, Godinho et al. 2011). As we previously noted, curtailing wolf deaths, especially of breeders, due to human mortality will greatly increase the long-term viability of the population. Essentially the Commission is assessing the red wolf's fate before the outcome of the proposed coyote hunting regulations can be evaluated. In addition, the Commission perception that introgression poses an insurmountable conservation challenge runs contrary to its own actions. For example, the Commission is involved in recovering native brook trout (*Salvelinus fontinalis*) in the southern Appalachians that have been impacted by hybridization due to artificial stocking.

There are also misconceptions in the Commission's resolutions regarding the status of red wolves on private lands in the five-county recovery area. The Commission noted that original federal rules for the reintroduction program stated recovery efforts would be limited to federal lands (USFWS 1986). However, some perspective is needed. This was one of the first reintroduction programs involving a large carnivore and first attempts to create a wild population using captive-raised individuals. Given that the red wolf was declared extinct in the wild before the reintroduction program was initiated, federal biologists had little prior knowledge to base their expectations. In hindsight, expecting wolves to limit themselves to federal land was unrealistic. The USFWS later acknowledged this, including rule changes noting the importance of private lands to red wolf recovery (USFWS 1995).

There has been tremendous collaboration between the USFWS and local landowners to promote red wolf recovery (Phillips et al. 2003, Beeland 2013). The WMI report acknowledged the importance of these relationships in recovery efforts. Releases of red wolves on private lands involved cooperation between the USFWS and landowners, in contrast to the perception that wolves were constantly released against the wishes of landowners. Holding red wolf recovery to expectations made almost 30 years ago is unfair and ignores decades-long partnerships between the USFWS, landowners, and other stakeholders. It also runs contrary to wildlife management practices across the United States. Public-private partnerships are central to the efforts of wildlife agencies across the country, especially in the eastern US. The Commission is establishing a

dangerous precedent by declaring that private lands are off-limits for the release and recovery of wildlife species, especially if landowners feel they are negatively impacted by such actions.

To conclude, the rule changes proposed by the Commission are a positive step towards protecting the future of the red wolf in North Carolina. Increased collaboration between the Commission, USFWS, and other stakeholders is vital to these efforts and we are encouraged by these developments. However, we urge the Commission to rescind its resolutions. Statements that serve as the basis of the resolutions do not adhere to the best available science regarding red wolf biology and emphasis misconceptions about the recovery effort. This will only undermine efforts by both the Commission and USFWS. People within North Carolina and the entire nation support the recovery of this historically and ecologically important native mammal (WMI 2014). It is important for the Commission to recognize the success of the program and become an active participant in red wolf recovery. As a model for such participation, we suggest the Commission examine how the states of Florida and Arizona have become actively involved in the conservation and management of the Florida panther and Mexican wolf, respectively, in collaboration with the USFWS. Involvement by the Commission in promoting red wolf conservation and public acceptance of red wolves is long overdue in North Carolina.

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