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Synthesis

Strategies for red wolf recovery and management

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Abstract

Hinton et al. (2013) provided an important and timely review upon the 25th year of recovery efforts for the reintroduced red wolf *Canis rufus* population in north-eastern North Carolina. They concluded there were three main issues affecting red wolves requiring continued research: hybridization with coyotes *Canis latrans*, inbreeding, and demographic issues stemming from human-caused mortality. Herein, I add some suggestions to improve red wolf recovery efforts, focusing on management strategies: (1) perhaps most importantly, establishing a core canid conservation area where all *Canis* (i.e. coyotes and wolves) are protected throughout the three red wolf recovery zones, and better protection of all *Canis* outside that region. Due to lax state hunting laws, this will require greater protection of all *Canis* inhabiting the recovery area; (2) while I agree in principle to conserve a representative population of red wolves (which will be facilitated by suggestion #1), it is also important to recognize that hybridization between closely related species is a natural process which may promote preservation of red wolf genes by ensuring that their DNA is represented in wild *Canis* populations where pure red wolves may not actually live (i.e. outside the recovery area); (3) recognizing that red wolves would become more outbred if mated with closely related species or subspecies, such as the eastern wolf *Canis lycaon*. Suggestion #1 would likely help maintain a wolf-like animal within the core recovery area, and outside that area hybridization could be allowed to occur. Potential genetic restoration could occur if eastern wolves are introduced to the inbred red wolf gene pool. I conclude by offering eight strategies for conserving red wolves; many of these ideas can also be used to facilitate eastern wolf recovery in the Northeast United States.

Introduction

The red wolf *Canis rufus* is a North American-evolved canid that formerly inhabited the eastern United States and is a closely related, or possibly the same species as the recently described eastern wolf *C. lycaon* (Chambers et al. 2012, Rutledge et al. 2010, 2012a, Wilson et al. 2000, 2009). It has been reintroduced into north-eastern North Carolina where a wild population of ~100 wolves reside (Beeland 2013, Hinton et al. 2013). Hinton et al. (2013) concluded that hybridization with coyotes *C. latrans*, inbreeding, and human-caused mortality continue to hamper red wolf recovery. They offered avenues for future research centred on a better understanding of these three main issues affecting red wolves. However, due to the focus on research priorities, I believe that three issues associated with red wolf recovery were neglected and need to be addressed from a management perspective:

(1) better protection of all *Canis* species (i.e. coyotes and wolves) will strengthen recovery efforts and potentially reduce hybridization in the core recovery area;

(2) hybridization is a natural process that may ensure the survival of red wolf genes outside the recovery area; and

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(3) mating with closely related species or subspecies may help reduce inbreeding depression, thus consideration should be given to introducing eastern wolves into the wild and/or captive population.

Herein, I offer eight "strategies" for trying to accomplish the above mentioned management needs.

Better protection of all *Canis* species will strengthen wolf recovery efforts

Hinton et al. (2013) noted that human killing of protected red wolves is hampering recovery efforts through: (1) direct mortality and reduction of the red wolf population; (2) potentially increasing inbreeding by lowering the number of red wolves in the recovery area; and (3) increasing the occurrence of coyote hybridization with red wolves in the recovery zones, via more frequent territorial openings of former red wolf territories that are colonized by coyotes who then pair bond with remaining red wolves. Rutledge et al. (2010) noted that reducing levels of exploitation by expanding no-harvest zones and/or instituting bag limits and strict harvest regulations of all *Canis* species were relatively simple and inexpensive long-term ways to promote the persistence of eastern wolves in Algonquin Provincial Park, Ontario (APP). Strict protections (i.e. no harvest) for all *Canis* (i.e. wolves and coyotes) in the recovery zones (1-3) as well as continued active efforts by red wolf biologists to maintain the red wolf through sterilizing coyotes and coyote x red wolf hybrids in the core recovery area will ensure that a robust wolf population remains and avoids hybridizing with coyotes (Hinton et al. 2013). Research in the APP area has shown that protection of all *Canis* has increased canid survival and reduced the amount of hybridization between coyotes and eastern wolves, effectively maintaining a more wolf-like animal there (Rutledge et al. 2010, 2012a, 2012b; Wilson et al. 2009). A recent court ruling may facilitate this in North Carolina, as a May 2014 judgement blocked coyote hunting in red wolf range because red wolves were suffering irreparable harm from direct gun-shot mortality from coyote hunters (Blue Ridge Now 2014, Boyle 2014). An exception was made within the recovery area that allows coyotes to be killed where they are causing documented problems on private land (Boyle 2014).

Similarly, coyotes and red wolves could also be allowed to evolve outside the red wolf recovery area with reduced levels of exploitation through bag limits and strict harvest regulations (e.g. see Kane and Way 2014 for proposed management changes of carnivore hunting). This zone could encompass a predetermined area around the existing red wolf recovery area. Kyle et al. (2006) suggested that management policies should allow eastern canids (depending on the region: eastern wolves, red wolves, coyotes, northeastern coyotes) to continue to adapt to their changing environment as an efficient means towards establishing a *Canis* population that is able to effectively exploit the available habitat and prey-base. Within this context, issues arise from the difficulty of clearly distinguishing between these canids based on morphology and their tendency to hybridize, especially where sympatric (e.g. north-eastern North Carolina for red wolves and coyotes and south of Algonquin Park for eastern wolves and northeastern coyotes/coywolves [*Canis latrans* x *C. lycaon*; Way 2013]). This would require levels of protection not currently afforded to coyotes such as listing all *Canis* (i.e. including coyotes) in the red wolf recovery area under the Endangered Species Act (ESA) and Convention on the International Trade of Endangered Species (CITES) due to similarity of appearances.

Further, proper legislation giving wild red wolves more stringent protection, instead of being labeled as a non-essential experimental population, could also occur. This may be doubly important given the state of North Carolina's reluctance and benign neglect to reduce red wolf mortality (Beeland 2013) despite a recent spike in human-caused mortalities (USFWS 2013). As noted in Beeland (2013), the history of eastern wolves in APP reads as one huge natural experiment in the hybridization process whereby breeding barriers emerged between eastern wolves and other *Canis* species (i.e. coyotes and grey wolves, *Canis lupus*) when all *Canis* were protected. I offer ideas to help achieve this in the last major section of this paper called "strategies".

Hybridization is a natural process that may promote preservation of red wolf genes outside the recovery area

Hybridization is increasingly being recognized as common in nature, having been documented in amphibians, insects, fish, birds, and especially within closely related plant species (Way 2013). Hinton et al. (2013) noted that hybridization with coyotes is a major threat to the survival of the red wolf. While there is certainly reason to believe that continued hybridization will change both red wolves and coyotes, from an evolutionary perspective this necessarily is not a bad thing outside the core recovery area (Way et al. 2010). Rather, it may be enhancing the adaptive potential of both western coyotes and red (in North Carolina) and eastern wolves (in southern Ontario), allowing them to more effectively exploit available resources in rapidly changing environments (Kyle et al. 2006). Hybridization may allow red/eastern wolf genes to persist in regions (e.g. human-dominated areas) from which they would otherwise be extirpated (Kyle et al. 2008, Murray and Waits 2007, Way 2013).

Recent considerations of introgressive hybridization have suggested that the transfer of genetic material can be a source of genetic variation for adaptive characteristics, distinct from the parental species, thereby promoting reticulate evolution (Allendorf et al. 2001, Jiggins and Mallet 2000). Kyle et al. (2008: p. 700) noted that "coyote/wolf hybrids are likely harbouring wolf genes that would otherwise be lost due to genetic drift in a small isolated population . . . and hybridization is moving towards a *Canis* that is better adapted to anthropogenically modified landscapes." For example, this is evidenced by the fact that north-eastern coyotes/coywolves colonized north-eastern North America five times faster than western coyotes did coming from south of the Great Lakes through the Ohio area (Kays et al. 2010), while eastern wolf populations remained in more remote areas around APP and did not recolonize New England (Chambers et al. 2012, Rutledge et al. 2010, 2012a, 2012b). Thus, it appears that hybridization in this case positively benefitted two closely related species, whereby eastern wolf genes now persist in an area where the animal has been extirpated, and western coyote genes have spread to an area where they previously did not exist (Way et al. 2010). This has also occurred in the mid-Atlantic region where it appears that north-eastern coyotes and western coyotes have hybridized to produce an intermediate canid between the two, that retain eastern wolf genes but lower amounts than found in north-eastern coyotes (Bozarth et al. 2011). Coppinger et al. (2010) argued that hybridization should not be artificially prevented, as it may increase genetic variability and in some instances it creates phenotypic novelties (such as the north-eastern coyote/coywolf in north-eastern North America).

It is important to note that regardless of the potential benefits that hybridization with coyotes may provide, red wolves as we know them (as a species morphologically and behaviourally distinct from both coyotes and grey wolves) will almost certainly disappear if gene swamping by coyotes is allowed, especially given that coyote-like animals would quickly outnumber wolf-like animals in the system if efforts to prevent hybridization were ceased (Kays et al. 2010, Way 2013). Rather, the broader area would likely be occupied by eastern coyote-like animals that, across their population, but not in any one animal, may contain much or most of the present red wolf genome (Kays et al. 2010, Way et al. 2010, Way 2013). A potential problem with hybridization is the swamping of red wolf genes to the point where complexes of genes interacting together that produce a unique phenotype no longer occur, and "red wolf" genes become isolated in a sea of coyote genes. However, the northeast U.S. has an intermediately sized canid (the northeastern coyote/coywolf) that has recently been described as being statistically different from both eastern wolves and coyotes, even though it is generally thought of as more coyote-like (Way 2013). Hybridization, as described above, would likely occur outside the recovery zone, while better protection of all *Canis* will strengthen efforts in the core recovery area (i.e. zones 1-3) to maintain a wolf-like animal through reduced hybridization, similar to that observed in and around APP (Rutledge et al. 2010) and is described in strategy #1. It is likely that ongoing human efforts (such as

sterilizing coyotes) will still have to occur to assist with red wolf recovery, as there is a much smaller wolf population in the red wolf recovery area than around APP where eastern wolves are buffered from coyotes due to their larger population (Hinton et al. 2013, Rutledge et al. 2010, 2012a).

Reducing inbreeding depression

Hinton et al. (2013) also noted that inbreeding depression is hampering recovery efforts to the point where red wolves travel through other wolf territories and pair with coyotes, possibly to outbreed. As stated above, a representative population of red wolves in recovery zones 1-3 (see Hinton 2013: 726) could be maintained by sterilizing coyotes and red wolf x coyote hybrids, and by protecting all *Canis* in that area (strategy #1). However, it is important to recognize that mating with a closely related species or subspecies may facilitate genetic rescue, as this has been successfully accomplished with Florida panthers *Puma concolor coryi* when they were bred with a closely related subspecies of mountain lion from Texas (Johnson et al. 2010, Pimm et al. 2006).

Thus, consideration should also be given to fostering eastern wolves into the red wolf population (Beeland 2013). Given that they are the same or a closely related species that historically ranged up the eastern seaboard (Chambers et al. 2012; Kyle et al. 2008; Rutledge et al. 2010, 2012a; Wilson et al. 2000), eastern wolves could potentially help outbreed the population. Genetic rescue can be managed in the core recovery zone to infuse new genes into the population but limit the extent of coyote and/or eastern wolf influence, similar to the way in which Texas puma genes were limited in Florida (Rutledge et al. 2012a, 2012b, Stoskopf et al. 2005). This could be accomplished by either transplanted eastern wolf adults from the APP region, similar to the way in which female Texas pumas were introduced into Texas (Johnson et al. 2010, Pimm et al. 2006), and/or through fostering of eastern wolf pups to wild (or possibly captive) red wolf females (Beeland 2013). It is likely that fostering eastern wolf pups and/or introducing eastern wolves to the captive breeding pool will be less controversial than restoring wild adults to the region.

Strategies: Suggestions to help achieve red wolf (and other carnivore) recovery

Recovery of a predator such as the red wolf may be hamstrung by state wildlife agencies that are typically hostile to carnivore conservation (Beeland 2013, Bruskotter et al. 2011, 2014a). Therefore, innovative strategies may be required to achieve red wolf (and other carnivore) recovery. In this section, eight management suggestions are offered to address this problem including: (1) providing additional revenue streams into wildlife agencies; (2) reforming wildlife agencies; (3) including social sciences and ethics/public policy in wildlife management decisions and guidelines; (4) formally recognizing and using the courts to acknowledge wildlife (specifically predators) as a public trust resource and not a special interest resource (e.g. for hunters); (5) maintaining federal protections through some sort of legislation similar to marine mammal, raptor, and wild horse acts; (6) revising the ESA to explicitly allow protection of similarity of appearance clause for animals like *Canis* (wolves and coyotes); (7) increasing tolerance for carnivores; and (8) rewarding land owners by incentivizing canid conservation.

Providing additional revenue streams into wildlife agencies

Development of other revenue streams could serve to reduce agencies' reliance on hunting licence sales, thereby lessening the incentive to minimize real and perceived effects of carnivores on game species (Bruskotter et al. 2014b). Sources of revenue could include excise taxes on non-hunting, wildlife-related goods (e.g. bird feeders, binoculars, spotting scopes, specialty camera lenses), state sales tax on wildlife-related goods, a mandatory "licence" for the use of state lands, and redistribution of some of the sizeable economic contributions that wildlife watching (including tourism) already bring (U.S. Department of the Interior et al. 2013) which could be directed toward wildlife management activities. It is well known that state wildlife agencies have an undue influence from consumptive users (see sources in Bruskotter et al. 2014b), despite wildlife being a public trust resource that everyone pays for (U.S. Dept. of Interior et al. 2013), even if wildlife department revenues are composed of mostly hunting/fishing dollars. Thus, large carnivores, and especially wolves, challenge traditional wildlife management in the U.S. because state wildlife agencies lack an incentive for conserving carnivores. The reliance of states upon hunters as the primary source of revenue generation creates a reason to reduce large carnivore populations, at least to the extent that they are perceived as not conflicting with valued game species (see Bruskotter et al. 2014b). Until funding mechanisms can be expanded to generate revenue to state wildlife agencies from more diverse sources, state agencies will have no reason to preserve carnivore populations. Yet, such actions are likely to be viewed skeptically by the largely non-hunting and urban public, which, in turn, could act to erode trust in state fish and wildlife agencies, and the wildlife profession (Bruskotter et al. 2014b, Way and Bruskotter 2012).

Reforming wildlife agencies

Bruskotter et al. (2014b) noted that public harvest of wildlife is a useful tool for helping agencies to meet wildlife population objectives and that the opportunity to engage in these activities is valued by the hunting community. However, implementing hunting and trapping of carnivores could also come at a cost; in particular, wildlife management agencies risk alienating non-traditional stakeholders (e.g. non-consumptive users of wildlife, urban residents) who tend to view hunting and trapping more skeptically, especially of carnivores (Treves et al. 2009, Way and Bruskotter 2012). Therefore, reforming wildlife agencies to include a representative mix of wildlife stakeholders beyond just hunters and trappers may help restore credibility to wildlife agencies and give state agencies more acceptance of carnivore management plans. This is important given the fact that society generally supports carnivore conservation more than is reflected in state management plans that have been dictated by "traditional" consumptive users of wildlife (Way and Bruskotter 2012). Expanding public involvement and outreach could also help agencies reach a broader, more diverse group of citizens interested in wildlife. While such actions will not necessarily reduce the incentive for agencies to minimize the perceived negative impacts of carnivores, they could increase agency trust among non-hunters, and ultimately, foster greater support of management activities (Bruskotter et al. 2014b).

Including ethics and public policy in wildlife management decisions

How we ought to live with people, animals and the natural world is the central concern of ethics (Lynn 2006, 2010). Unlike medical and human subject research, there is no cadre of agency ethicists that help identify and sort out the ethical issues that arise in wildlife management (Minter and Collins 2005, Vucetich and Nelson 2010). Yet the moral norms that guide traditional wildlife conservation — animals as commodities for human ends, the unquestioned legitimation of lethal management, and the insensibility to individual animals and their well-being (i.e. managing for the population) — are nonetheless pervasive (Lynn 1998, Lynn 2007, Lynn 2010). This is, however, beginning to change. Leopold's land ethic was one of the first efforts on this account, and it bears mentioning that it was the management of wolves and other predators that prompted his thinking in these regards (Leopold 1968). There is increasing attention to managing wildlife according to ethical criteria by combining scientific with ethical knowledge in academic publications, comments on agency decisions, legislative testimony, and legal action (e.g. Hadidian et al. 2006, Lavigne 2006). Since science and ethics complement each other and should produce better environmental policies and wildlife management, ethical positions help keep facts and values transparent and accountable, and thereby improve the possibility of developing well-justified policies on managing predators like red wolves. Way et al. (2010) noted that to secure the valuable ecological and evolutionary contributions of eastern coyotes/coywolves, conservation management will need ethical guidance in its policies and practices. Specifically it will need to limit the lethal management of these canids for instrumental purposes like sport hunting to help preserve the ecologi-

cal function provided by eastern coyotes/coywolves in the Northeast (Way 2013).

Acknowledge predators as a public trust resource

Recent federal court decisions under the public trust doctrine require U.S. governments to act as trustees to manage wildlife sustainably for current and future generations including non-lethal uses (Bruskotter et al. 2011). Another avenue to curb exploitation of carnivore populations would be to use the courts to force state governments to adopt policies designed to secure the conservation of these species under the public trust doctrine. Acknowledging states' hostility toward grey wolves, Bruskotter et al. (2011) claimed that building the case law necessary for broader judicial application of the wildlife trust will require interested citizens and the groups who represent them to force its application in the courts. Without judicial application of an enforceable obligation, the fate of wolves, and many other imperiled (and controversial) species, remains uncertain. Similar to Bruskotter et al.'s (2011) concerns for grey wolves, conservation of red wolves is possible if states are forced to recognize a legal obligation to conserve species as a public trust resource. The authors further noted that the state-trustee's obligation is heightened where, as is the case with the grey wolf, the species at issue has recently been removed from the list of endangered species. Indeed, the imposition of ESA protections for wolves was an indication that states failed in their past duties. Thus, endangered species require renewed diligence and attention on the part of the state to ensure compliance with federal protections. The state's duty requires it to refrain from taking actions that substantially impair the species and, in all other cases where less than substantial impairment is at issue, to balance the public's interest in preservation of the species against the interests advanced by the impairment (Bruskotter et al. 2011). It could be argued that allowing the killing of coyotes in the red wolf recovery area impairs the survival of red wolves and violates the public trust doctrine. A recent court ruling agreed with this statement when, in May 2014, it cancelled coyote hunting in red wolf range because red wolves were being killed by coyote hunters (Blue Ridge Now 2014, Boyle 2014).

Maintaining federal protections through legislation

Bruskotter et al. (2014b) noted that most of the conservation successes associated with large carnivore recovery came about because of federal, ESA protections, as opposed to state-led efforts. Absent changes in state policy, federal legislation or agency rule-making could be used to help ensure that the broader public interest in wildlife is represented especially regarding carnivore management. For example, because wolf populations in the west occur primarily on federal public lands managed by the U.S. Forest Service, Bureau of Land Management and National Park Service, these agencies could adopt rules designed to limit hunting and trapping of large carnivores by limiting the length or timing of hunts, methods of take, or by zoning areas to restrict harvest (Bruskotter et al. 2014b, Way and Bruskotter 2012). In North Carolina, this could include National Wildlife Refuge Land (Beeland 2013). Further, federal legislation akin to those acts protecting bald *Haliaeetus leucocephalus* and golden eagles *Aquila chrysaetos*, marine mammals and wild horses might also be used in a similar capacity. Interestingly, a citizen-initiated state carnivore conservation act is in the early stage of determining legislative feasibility whereby a more egalitarian attempt at carnivore management is set forth (Kane and Way 2014). However, given the extent to which wolf reintroduction and recovery has been couched as an issue of "states' rights", opposition to federal intervention is likely to be acute in certain regions of the country (Bruskotter 2014b) unless attempts are also made to increase tolerance for large carnivores (see Treves and Bruskotter 2014).

Revising ESA to explicitly allow protection of similarity of appearance clause

While seemingly intuitive, an obvious way to help conserve red (and eastern) wolves is to modify the ESA to include the protection of animals that appear similar to the protected animal; for instance, protecting coyotes in red and eastern wolf range. This strategy would need to be complemented with other issues discussed here, such as recognizing that this similarity of appearance clause would be to help conserve a public trust resource and that finding ways to increase the tolerance of all carnivores will help achieve management objectives. A recent court ruling justified this position when a judge blocked coyote hunting in red wolf range because the two species are easily confused (Blue Ridge Now 2014, Boyle 2014).

Increasing tolerance for carnivores

Bruskotter et al. (2014a) noted that it is inaccurate to conclude that wolves cannot be recovered because some people dislike wolves, so concluding that wolves cannot be recovered because of human-caused mortality is to merely explain the potential threat to wolves. The actions required to recover wolves and remove them from the threatened or endangered list mainly involves reducing human-caused mortality of wolves. Treves and Bruskotter (2014) found that, although monetary incentives for predator tolerance appear to have been successful in several cases, there is evidence that predator-poaching is influenced more strongly by social factors, with peer group norms and government sanctioned predator-killing affecting people's intentions to poach predators. Treves and Bruskotter (2014) casted doubt on the notion that tolerance for predators is enhanced by allowing people to kill them. They therefore recommend caution in legalizing the killing of predators since it has not been demonstrated that killing carnivores (i.e. coyotes and wolves) improves human tolerance for them.

Rewarding land owners by incentivizing canid conservation

One novel concept may be to pay land owners who promote carnivore conservation. For example, payments (e.g. $5,000) could be made to landowners where pups are successfully raised on private property; lesser amounts could be given to "frequent presence" or just allowing wolves on private land. Making wolves an economic asset has potential, as Zabel and Holm-Muller (2008) described a performance-payment scheme that was developed and implemented in Sweden. The conservation performance payments were issued to communities for carnivore offspring and the amount was calculated to offset all the future damage that the animals are expected to cause. For example, Sami villages in Sweden received almost US$30,000 for successful reproduction of lynx *Lynx lynx* or wolverines *Gulo gulo* on their lands where they herd reindeer *Rangifer tarandus* (Zabel and Holm-Muller 2008). Given that most red wolves are radio-collared in the recovery area, this approach should be given serious merit as biologists would be able to document wolf presence and successful reproduction in specific areas.

Final comments regarding suggestions

It is important to note that many of the ideas regarding agency reform, funding reform, and public education are not new and have been recommended and/or tried in the U.S. with varying success for a decade or more. Each strategy will have serious costs and hurdles to overcome but that should not stop the conversation about canid conservation in the east. It is becoming clear that carnivore management by state agencies is a major dividing point between entrenched sides such as environmental NGOs, animal welfare groups, hunters, and ranchers. While I acknowledge that many of my suggestions are a top-down approach to state wildlife agencies, it is also apparent that state wildlife agencies in many ways act more like a private pro-hunting group, rather than an agency that is supposed to hold wildlife in the public's trust. It is critical, therefore, to gain internal support among agency biologists and commissions through working groups and technical groups. For example, an initial approach to gaining state agency support might be to use department funds to create a joint canid conservation and management working group within the venerable NE and SE Deer Technical and Furbearer Committees. In time, the working group might function independently, but initially if it was spawned by a group that included the deer committees, it might gain broader acknowledgement within the state governments. Hopefully, it would produce useful professional allies within those state agencies. While federal top-down mandates will only go so far for so long, current

state-led management of most carnivores may erode the public's trust in the agencies enshrined to manage them. It is my hope that this paper will ultimately bring forth discussion among biologists, ecologists, laypersons, NGOs and policy makers that results in some concrete and specific policy recommendations.

One useful approach may be in practising the approaches of conservation conflict transmission (Madden and McQuinn 2014) in reconciling diverging viewpoints and preferred management strategies. Conservation conflict transmission provides useful guidance for revealing and addressing social conflicts to improve the effectiveness of conservation efforts. Experience suggests that stakeholders will undervalue or even sabotage conservation solutions offered to solve immediate conservation issues if they do not also address deeper social and psychological needs, including those met through relationships (Madden and McQuinn 2014).

Conclusions

Hinton et al. (2013) provided a timely review of red wolves and suggested avenues for future research following 25 years of recovery efforts. I largely agree with the authors' assertions that hybridization with coyotes, inbreeding, and human-caused mortality continue to hamper red wolf recovery. This paper provides suggestions to develop effective management practices to augment red wolf recovery starting with a priority of establishing a core canid protected area (i.e. encompassing all three red wolf zones) where all *Canis* (i.e. coyotes and wolves) are fully protected with the focus on maintaining a wolf-like animal (i.e. the red wolf) inside the recovery area, and better protection of all canids outside of that region. Given the state of North Carolina's seemingly indifferent attitude toward red wolves (see Beeland 2013: 209–212) and a recent spike in human-caused red wolf mortality (USFWS 2013), additional protections for coyotes (as well as red wolves) may be necessary to successfully recover the red wolf where it exists in the wild. In the "Strategies" section of this paper I offer eight ideas to consider which might offer better buy-in to help protect red wolves (and carnivores in general).

It is important to emphasize that reducing levels of exploitation by expanding no-harvest zones and/or instituting bag limits and strict harvest regulations are relatively simple and inexpensive long-term ways to promote the persistence of wolves (see Rutledge et al. 2010) especially if social tolerance is gained (Treves and Bruskotter 2014). However, potential negative consequences of enhanced protection, such as the potential for increased livestock depredation and negative feelings among some segments of the public (i.e. hunters), should be considered for some stakeholders. The experience and findings of protecting all *Canis* around APP could be helpful in this context (Rutledge et al. 2010) as well as considering the eight "strategies" espoused in this paper.

Human-caused mortality is preventing red wolf recovery and is facilitating hybridization with coyotes in the recovery area (Hinton et al. 2013). Banning the hunting/trapping of all *Canis* in the recovery zone may be a critical step toward recovering *C. rufus* as occurred successfully for eastern wolves around APP (Rutledge et al. 2010). (Note: an exception could be made for areas within the recovery area where *Canis* are causing documented problems on private land.) I suggest that the federal government take ownership of this responsibility to protect red wolves as a unique and endangered species, especially since recent lawsuit determinations support this viewpoint (Boyle 2014). Additional federal legislation could also be drafted to better protect carnivores (see "strategies" section). There is strong evidence that better protection of all *Canis* will help maintain a wolf-like animal in the recovery area (Rutledge et al. 2010, 2012b), coupled with continued human-caused efforts like sterilizing coyotes in the region (Hinton et al. 2013). Outside of that area, hybridization can be allowed to naturally occur (Kyle et al. 2006). Consideration should also be given for reducing inbreeding by introducing eastern wolf genes into the red wolf gene pool.

Better protection (e.g. bag limits, shorter seasons) of all *Canis* may also aid in wolf recovery in the northeast U.S. as wild wolves are occasionally documented there (Kays and Feranec 2011), yet are usually killed in the process (Glowa et al. 2009). Wheeldon and Patterson (2012) stated that there may be ethical considerations for protecting wolves but providing virtually no safeguard for a closely related species, coyotes, especially if it is possibly preventing wolf recovery in the northeast (as well as in North Carolina). Possible federal protection or state carnivore conservation acts (see "Strategies" section) may help achieve this. Kays and Feranec (2011) noted that there is essentially no conservation plan for northeastern wolves, and thus no guidelines for promoting their recovery, yet wildlife managers should recognize that wolves are likely dispersing into the area. Similar to the red wolf/coyote situation, issues arise from the difficulty of clearly distinguishing eastern wolves from northeastern coyotes/coywolves based on morphology and their tendency to hybridize (Way et al. 2010). In fact, any wolves colonizing the northeast may already be assumed to just be large "coyotes" by state wildlife agencies because of their morphological and genetic similarities to north-eastern coyotes (Benson et al. 2012). With current management (i.e. year-long seasons) of coyotes in most East Coast states, wolves had no effective protection, not even in the red wolf recovery area (see USFWS 2013) until a very recent court ruling protected coyotes in red wolf range (Boyle 2014). While hybridization is a potential problem between coyotes and red/eastern wolves on the East Coast, natural selection may favour a more wolf-like canid if the two are allowed to breed and survive without intensive human killing, especially in designated recovery areas (Rutledge et al. 2010). The eight "strategies" offered in this paper offer guidance to help achieve successful red and eastern wolf recovery.

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Biographical sketch

Jonathan (Jon) Way is the author of two books: 1) *Suburban Howls*, an account of his experiences studying eastern coyotes in Massachusetts, and 2) *My Yellowstone Experience*, which details – in full colour – the spectacular wildlife, scenery, and hydrothermal features that can be found in the world's first national park. Jon is a Research Scientist at Clark University where he is continuing his goal of long-term ecological and behavioural research on coywolves. He runs an organization Eastern Coyote/Coywolf Research, works seasonally for Cape Cod National Seashore, is a part time post-doctoral researcher with the Yellowstone Ecological Research Center, frequently travels to the Yellowstone area, and is working on a third book project: *Coywolf*.