Majority positive attitudes cannot protect red wolves (*Canis rufus*) from a minority willing to kill illegally

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ARTICLE INFO

ABSTRACT

In January 2021, there were 7 known individual red wolves (*Canis rufus*) remaining in the only wild population, located in Northeastern North Carolina (NENC). Anthropogenic mortality is the largest threat to survival of this population. Leading theory predicts that by understanding the attitudes and behavioral inclinations of the general public toward red wolves, better decisions can be made about how and where to concentrate outreach and interventions. Another view is that a very small minority of individuals must refrain from killing endangered species before restoration can succeed, so research and interventions need to focus on those few. We conducted interviews and surveys in nine counties in and around the NENC reintroduction area to measure attitude and behavioral inclinations toward red wolves, acceptance of the red wolf recovery program, and trust in the lead agency. We used two sampling techniques and in both samples pluralities or majorities liked red wolves, supported their restoration, disliked policy that would limit red wolf protections, trusted the agency, and would not kill a wolf illegally. While these data seem favorable for red wolf recovery, our results show a small group of people are driving the species to extinction through poaching. Self-identified male hunters in the probability group reported the greatest inclination to poach, with 11% saying they would kill any wolf they encountered on their own. We recommend engaging peer processes that discourage illegal behaviors and focusing energetic anti-poaching interventions on hostile actors to restore red wolves in this human dominated landscape.

1. Introduction

Restoring endangered species and protecting them in the long-term is a complex and difficult task worldwide, especially when they are controversial large predators. Critically endangered red wolves, *Canis rufus* were extinct in the wild and had been absent for over 100 years from eastern North Carolina when they were reintroduced from captive-born individuals in 1987 (Barclay, 2002; USFWS, 2020a). Once abundant throughout the eastern US from the Atlantic Coast west to Texas and from the Gulf of Mexico north to the Ohio River Valley and central New York, red wolves were eradicated, in part through government sponsored eradication programs, as Europeans migrated and settled throughout the US east of the Mississippi (Gilbreath & Henry, 1998). Wolf bounties were awarded in North Carolina in the late 1700's and red wolves were eradicated from the state by the late 1800's (Barclay, 2002; Mech and American Museum of Natural History, 1970; Webster et al., 1985). In 1967, they were designated as endangered and became one of the first species listed under the U.S. Endangered Species Act (ESA)

(Hinton et al., 2013). They were reintroduced into northeastern North Carolina (NENC) in 1987 beginning with four pairs of wolves into Alligator River National Wildlife Refuge (ARNWR), but their populations grew slowly and then diminished again recently, mainly being threatened by high rates of poaching (Hinton et al., 2016b) to a low of only 7 known wolves in December 2020 (USFWS, 2020b). Poaching was the major cause of mortality (51–64%), whether or not one includes estimates of cryptic poaching (3–30%), followed by vehicle collisions (15–21%) and legal killing (6%) (Agan et al., 2021). Critical to their survival will be revealing the psycho-social, political, attitudinal, and behavioral mechanisms leading to poaching (illegal killing), part of which this research will investigate.

Scholars and agencies assume that positive attitudes in the broad public will promote conservation of endangered species while negative attitudes may hinder (Jørgensen, 2013; Zajac et al., 2012; Clark, 2009). Attitude surveys have been a primary tool for assessing perceptions of natural resources including wolves (Manfredo, 2008). The Theory of Planned Behavior (TPB) predicts an individual's intentions to perform a

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behavior, which is a function of their attitude, subjective norms and perceived behavioral control (PBC) (Ajzen, 1985). This theory has been used extensively to understand motivations and behaviors toward large carnivores including wolves in Europe (Johansson et al., 2016), leopards in India (Jhamvar-Shingote and Schuett, 2013), jaguars in Brazil (Marchini and Macdonald, 2012), and tolerance of gray wolves in the United States (Browne-Nuñez et al., 2015). At the societal level, negative attitudes can increase resistance to public policy regarding wolf recovery (Bruskotter and Fulton, 2012; Dressel et al., 2015; Houston et al., 2010). On an individual level, negative attitudes can lead to poaching (Browne-Nuñez et al., 2015). In their most recent 5-year review, the USFWS stated, "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" (Weller, 2018) echoing commentaries on large carnivores globally (Treves and Karanth, 2003). Previous studies have concluded that the social and political aspects of red wolf recovery, in particular for residents and hunters within the five county red wolf recovery area, have been overlooked (Serenari et al., 2018; Vaughan et al., 2011).

Routine Activity Theory (RAT) has been used to address poaching problems in the US (Eliason, 2012; Treves et al., 2017). With actual control over a behavior, people are expected to carry out their intentions when the opportunity arises; opportunity consisting of motivation, a suitable target, and lack of guardianship (Ajzen, 2011; Eliason, 2012). Treves et al. (2017b) used the general framework of TPB and RAT and applied it to wolf-human interactions leading to the potential to poach. In NC, a fragmented landscape with private lands may promote opportunity for a subset of individuals, i.e., potential poachers who encounter red wolves where law enforcement is absent.

The Red Wolf Species Status Assessment (SSA), US Fish and Wildlife Service (USFWS), Rivenbark et al. (2018), Hinton et al. (2016b) and Agan et al. (2021) all report that gunshots were the most frequent cause of death for wild red wolves, most of which happen during the autumn and winter hunting season when hunters are more likely to have opportunistic encounters with red wolves than the average citizen (Hinton et al., 2015).

These two ideas seem to create opposing hypotheses about predicting success of ESA recovery efforts. The first hypothesis being that positive attitudes will promote recovery of endangered species and the second, that even when the majority hold positive attitudes, subsets of individuals can still undermine endangered species recovery through poaching. Indeed, it is possible that a small subset of individuals can undermine recovery of endangered species either politically or through illegal actions, and it appears as though high rates of poaching are committed by a few persons who dislike wolves (Bruskotter et al., 2014).

We had 3 goals related to respondents' stated views on red wolves, poaching, and protection. (1) We measured attitudes of landowners and hunters, and residents of the RWRA compared to non-residents from surrounding areas. Landowners and those in certain peer groups, e.g., hunters, have opportunity to poach or protect red wolves, and social norms might be particularly important if hunting is a social activity conducted in isolation from outgroup members. Given recent attention and concern about the causes and consequences of wolf-poaching, we aim to measure cognitive antecedents to poaching of red wolves. This might help in anti-poaching efforts or other policy design challenges for this critically endangered species. (2) The TPB expects a correlation between attitude to red wolves and intention to kill, and so our goal in this case is to quantify this correlation, and if possible, generate a specific, predictive model of the constellation of responses that characterize the individuals with a stated intention to poach red wolves. (3) To understand resistance or support for the red wolf recovery program and the ESA prohibition on take of red wolves, we will explore the relationships between attitude toward red wolves, support for their conservation, trust of the USFWS, and attitude toward current policy (we defined collectively as acceptance).

We report a survey that appears to support hypothesis 2 (subsets can

undermine), which requires a different intervention than broad-based public outreach. We show that a positive public attitude to the red wolf, to the agency, and to recovery efforts and disinclination to poach are in the majorities or pluralities of our two samples yet are counter-intuitively paired with a failing recovery effort demonstrated by the current size of the red wolf population and the steady rise in illegal killing.

2. Materials and methods

2.1. Study site

Our nine-county study site consists of the five counties within the red wolf recovery area (RWRA) on the Albemarle Peninsula in NENC (Beaufort, Dare, Hyde, Tyrrell, and Washington counties) and all four directly adjacent counties (Pitt, Craven, Pamlico, and Martin counties). Total human population for all nine counties according to the North Carolina 2017 estimated census was 421,712, equivalent to the lowest population density in the state (SEDAC, 2015). The population consists of 49.06% males and 50.93% females and has median age of 45.97 ("NC OSBM: LINC," retrieved 4/1/, 2019). The RWRA includes four USFWS managed National Wildlife Refuges: Alligator River, Mattamuskeet, Pocosin Lakes, and Swanquarter, a Department of Defense bombing range and state-owned lands (Fig. 1). Together, federal, state, and private lands in the RWRA cover approximately 6000 km^2.
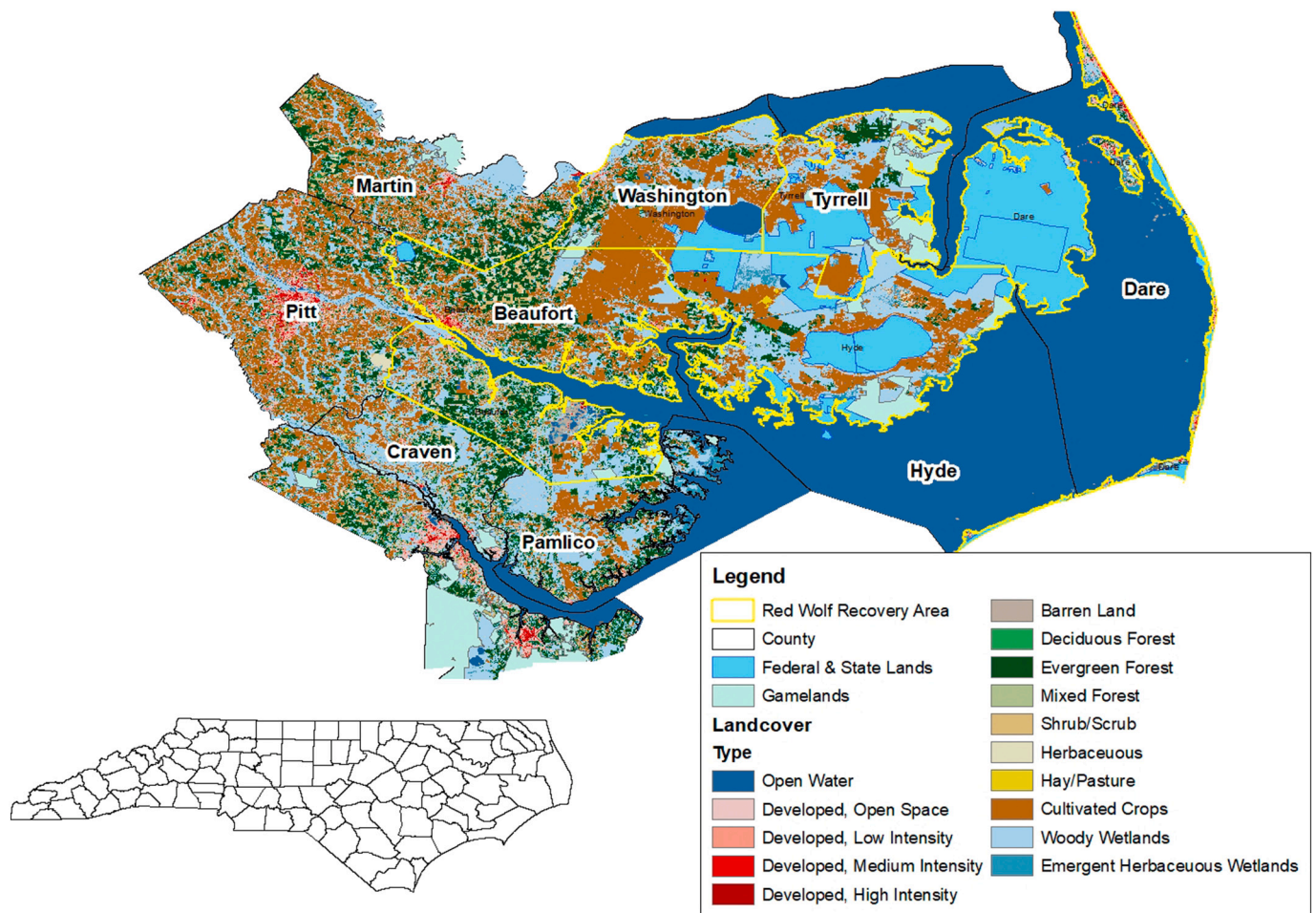
During spring and summer, agricultural crops comprise 30% of vegetation on the peninsula, and these areas are barren through fall and winter. The identification of agricultural areas is particularly important for our study as red wolves use these areas more than documented in other wolf studies (Hinton et al., 2016a; Mladenoff et al., 2009; Treves et al., 2009). This also increases the potential for interactions between wolves and humans (Hinton et al., 2016a) and increases opportunities for poaching.

Since our study asks sensitive questions about illegally killing red wolves, we used mixed methods research including in-depth interviews of selected key informants and anonymous surveys to limit risk to participants. In criminal justice research, self-administered internet surveys have reported double the amount of crime over those administered through an interview (Pepper et al., 2003), and so our anonymous survey should increase accuracy of reports about poaching behaviors, allowing us to identify would-be poachers of two types (those with access who would not knowingly kill a red wolf and those who would knowingly kill one).

2.2. Interviews and survey instrument

Before developing our survey instrument, we conducted seven interviews with residents in the RWRA. We used several resources to contact residents as we wanted a diversity of experience and attitudes at this stage. Resources included online agriculture databases, hunting websites, USFWS personnel's recommendations, and online public tax assessors' databases. Those we interviewed owned more than 4 ha (10 acres) and had lived in the RWRA for the entire 30-year period of red wolf reintroduction. Initially, (Author name) (SA) interviewed two residents to simply listen to their stories to gain an understanding of how red wolves and their recovery is viewed by those living in the RWRA. Then we conducted semi-structured interviews with an additional five residents to inform our final survey instrument. Among our seven interviews, one self-identified as a red wolf poacher.

During each interview, SA solicited feedback about questions the respondents believed we should be asking, and SA modified the interviews iteratively. We audio-recorded interviews with permission from the interviewees, which a transcription service transcribed, and SA reviewed for accuracy. To enhance validity, we then triangulated our data collection by comparing the transcripts to field notes written during and immediately after the interviews. SA analyzed data from the

Fig. 1. Study site showing northeastern North Carolina, five-county Red wolf recovery area, four adjacent counties, federal and state-owned lands, and state game lands.

interviews with NVivo 12 software using thematic analysis and coding. She then sorted codes into categories and into overall themes as those categories appeared.

From these interviews combined with previously used survey instruments from similar attitude studies (Browne-Nuñez et al., 2015), we developed an 18-question online survey (Appendix 1). We designed it to measure respondents' attitudes and behavioral inclination toward red wolves, attitudes to the USFWS and red wolf recovery, and collect demographic (age and gender) and location (county and zip code) information about respondents.

2.3. Quantitative data collection

We surveyed adults ≥18 y old who lived in the study area as determined by our sampling methods below. We believed that in order to answer our questions, which involved comparing the attitudes and behavioral inclinations of different groups of people, we needed a diversity in our sampling methods that could bring in different demographics, group associations, and levels of salience. Therefore, we used two different methods of sampling: a pre-recruited panel (probability sample) and an anonymous survey link (convenience sample), distributed by email and internet respectively. We chose these methods because telephone surveys are no longer the best option due to low social acceptance along with other limitations (Yeager et al., 2011), and mail surveys were unaffordable.

Qualtrics Experience Management® (Qualtrics), a global data management company, offered a probability sample. They guaranteed 250

respondents residing in our nine-county study area and provided a cash incentive of $8 US for each respondent. We only received responses with no contact information for the panel participants. While the Qualtrics panel is designed to be statistically representative of the US population, our eventual randomly selected panel was not representative of the census population at our site due to the small size of our study area.

Second, for our convenience sample, we purchased 100,037 email addresses from National Data Group (NDG), for respondents age ≥ 18 and residing in the zip codes of our study area. From October 30–November 30, 2018, SA sent an email to those addresses with the link to the same instrument described above for the Qualtrics panel with an email reminder 1 week later.

We expected self-selection bias to be high in the convenience sample as we would expect salience to have a positive effect on response rate, biasing responses toward extremes and fewer 'don't know' responses (Dillman et al., 2014). We also expected salience of our survey to be lower for the probability sample, because it would include respondents with low knowledge, interest, or experience with red wolves. Therefore, we expected many neutral or 'don't know' responses from our probability sample. We expected our two pools to complement each other in terms of salience while perhaps diverging in terms of demographics. The probability sample may be more representative of the general populace whereas the convenience sample might predict how public meetings about red wolves and public comments on policy would appear.

We decided not to weight our data because post-stratification can adjust bias differences but never completely, typically removing less than half the bias (Tourangeau et al., 2013). If an original unadjusted

estimate produces a small bias, adjusting can sometimes significantly increase the amount of bias (Tourangeau et al., 2013). For example, in a 2019 study on respondent-driven sampling, unweighted data performed better, whereas bias in the weighted data was substantial with high type-1 error rates (Avery et al., 2019). Given the difference in distribution methodologies, we chose not to pool results across our two samples.

To evaluate potential differences between the two samples, we compared demographic information (gender, age, and location) for each to the census population of our study site using Chi-squared and one-sample *t*-tests. We collected overall age and gender data for our study site from the NC State Demographer LINC system, 2017 population estimates (NC OSBM: LINC, 2017). We also used hunting licenses registered with the state of North Carolina to compare with the percentage of hunters in each county from the survey (NC Wildlife Resources Commission, 2019).

2.4. Response

Through the two survey distribution methods, the response was $n = 1438$ probability and 445 convenience. Surveys that were started but were not completed in their entirety ($n = 1467$) were not used in this study to improve the quality of data (Hays et al., 2015). Of those 1467 incomplete surveys, all respondents were disqualified either because they identified as living outside our study site or were under the age of 18. In each of these situations, their survey automatically ended after that choice and no further data was collected. An additional 16 complete responses were disqualified as speeders (those who completed the survey quicker than was determined to be appropriate by Qualtrics for valid responses). The remaining 400 complete responses used for analysis consisted of 288 from the probability sample and 112 from the convenience sample.

We did not evaluate non-response bias and are unable to calculate the response rate for the probability sample since Qualtrics was unable to provide data regarding how many were initially contacted and respondents' identities were kept confidential. For the convenience sample, 445 surveys were started out of 82,128 emails that were considered deliverable, for a response rate of 0.5%. However, 75% of the surveys that were started were not completed because respondents did not live in our study area, and so our response rate may have been extremely low due to outdated email information. We had no way to track how the anonymous survey link was forwarded to others and so how many people were reached through this method is unknown.

2.5. Survey measurements

Survey respondents were asked to identify with groups relevant to wolf issues and they could choose all that applied to them, "To what extent would you include yourself with each of the following groups" (Bruskotter et al., 2018; Slagle et al., 2019): wildlife advocate, animal welfare advocate, hunter, conservation advocate, gun rights advocate, environmental advocate, farmer (crops), rancher (animals), and property rights advocate. Response choices were "strongly", "moderately", "slightly", and "not at all". We combined those who identified as "strongly" and "moderately" into identifiers and those who selected "slightly" or "not at all" as non-identifiers. We followed Bruskotter et al. (2018) by comparing how different identity groups responded to behavioral inclination questions.
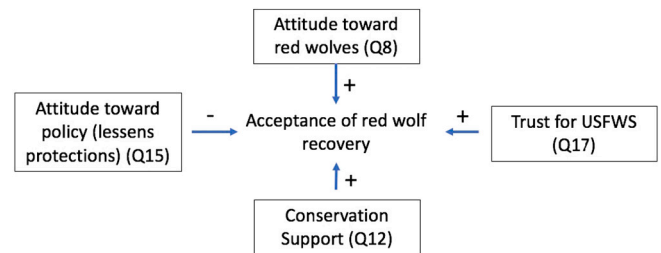
Attitude and behavioral inclinations were measured through five questions summarized in Table 1 with the full questionnaire in Appendix 1.

We combined four questions to create a multi-item scale variable encoding acceptance for the red wolf recovery program (Fig. 2). These four questions refer to measures of attitude, support, and trust, which we believe are all part of acceptance and have been used in other similar studies. (Balčiauskas and Kazlauskas, 2014). For this variable, we rescaled Q8 from 1 to 7 to 0–2, so that all four variables were equally

Table 1
Attitude and behavioral inclination measures.

Measurement	Question	Response choices
Attitude toward red wolves	Q8) How would you describe your general attitude toward red wolves?	"strongly like" (7), to "strongly dislike" (1) with "neutral" (4) and "I don't know"
Attitude toward conservation	Q12) Please state your level of support for conserving red wolves.	"support" (2), "neutral" (1), "oppose" (0), or "I don't know enough"
Attitude toward new policy proposal	Q15) The US Fish and Wildlife Service proposes that, "Wolves outside of the new (non-essential experimental population, NEP) management area would remain part of the NEP but take of these animals on non-federal lands would be allowed." What is your attitude to this proposal?	"like" (2), "neutral" (1), or "dislike" (0) and "I don't know enough to decide"
Trust for USFWS	Q17) Please state your attitude toward the US Fish and Wildlife Service	"trust" (2), "neutral" (1), or "mistrust" (0) and "I don't know enough"
Poaching Inclination	Q11) It's currently against the law for a private citizen to kill a red wolf except in defense of life (human, livestock, or pets). Are there any other situations you might try to kill a red wolf anyway?	(1) "any wolf I encounter on my own", 2) "the wolf did not run away from me when I was on foot", 3) "the wolf did not run away from my vehicle", 4) "the wolf was on my property", 5) "the wolf came too close to my home", 6) "the wolf approached my pet or farm animals", 7) "I would not kill a red wolf", 8) "I would support someone else killing a red wolf", and 9) "other"
Behavioral Inclination	Q14) What would you do if you saw a red wolf on your property?	1) "I would try to protect it", 2) "I would watch it", 3) "I don't know", 4) "I would call the authorities", 5) "I would try to kill it", 6) "I would try to scare it away", 7) "I would ignore it", and 8) "other"

Fig. 2. Conceptual model illustrating the four variables we combined to create an index of acceptance of red wolf recovery. Signs $(+/-)$ show how responses were added or subtracted from the total. Following Treves et al. (2013) and Hogberg et al. (2016) we measured acceptance as a simple sum of the three responses (Q8, Q12, Q17) that are positively correlated with acceptance and subtracted the one response that was negatively correlated (Q15).

weighted. The overall metric ranged from -2 to 6, with higher numbers indicating greater acceptance, and a midpoint of 2.

We created a behavioral inclination index by combining the behavioral inclination responses (Q11 and Q14) for a range of possible values from 0 to 9. Each response indicating a lethal choice to kill a red wolf was worth one point and all responses were added together with a 9 being the highest inclination to poach a red wolf.

2.6. Analysis

We separated each item or composite (attitude, acceptance, and behavioral inclination), and because our two samples were different demographically, we present all data for each sample separately and jointly when appropriate. We analyzed differences in attitude, acceptance, and behavioral inclination by comparing males to females, hunters to nonhunters, farmers (crops) to nonfarmers, and residents of the five-county RWRA (RWRA residents) to residents of the four adjacent counties (adjacent residents). We coded respondents as RWRA residents if they resided there or if they owned land in the RWRA but resided elsewhere for part or all of the year.

After attitude, acceptance, and behavioral inclination metrics were compiled as described above, the medians for each variable were calculated for all responses, for both samples. Median comparison tests were performed between the two samples and within stakeholder groups using the nonparametric Two-sample Wilcoxon rank-sum (Mann–Whitney) test and χ^2 analysis for binary variables such as individual behaviors. We tested for differences in socioeconomic characteristics of age and gender using χ^2 analysis. We tested correlations between attitude and behavioral inclination with Spearman's rank test.

We used STATA IC 15.1 for Mac (StataCorp, 2019) and R 3.5.1 (R Core Team, 2018) and set our alpha for significance to 0.05.

3. Results

3.1. Respondent characteristics

Overall, the median age for respondents was younger than the census estimate for the 9 county NENC (39 and 43 y respectively), however the probability sample was even younger with a median age of 33 and the convenience sample older at 54. Though our samples differed from the census data in age, there was no significant relationship between age classes and any of the response variables. Both the probability and convenience samples differed significantly from census in gender (χ^2 = 42.8, df = 1, $P < 0.001$ and χ^2 = 9.5, df = 1, $P = 0.002$) with more females in the probability sample (70%, $n = 203$ and 37%, $n = 41$ respectively) and more males in the convenience sample (60%, $n = 67$ and 27%, $n = 78$ respectively).

The probability sample contained more adjacent-county residents than the convenience sample (60% vs. 37% respectively), while the convenience sample brought more responses from RWRA residents (63% vs. 40%) (χ^2 = 17.8, df = 1, $P < 0.001$).

Hunters comprised 27% of the probability sample and 44% of the convenience sample, and 18% of all respondents reported using their land for hunting. The number of hunters from the survey were compared to the number of hunting licenses registered with the state of North Carolina from those counties (NC Wildlife Resources Commission, 2019). In our study, hunters are over-represented when compared with number of hunting licenses purchased in our 9-county study area (32% of respondents vs. 14% of population), however, respondents could identify as a hunter even if they do not have an active hunting license. Our probability sample contained 25% females and 35% males who identified as hunters. Our convenience sample contained 24% females and 54% males who identified as hunters.

Those who identified as farmers (crops) comprise 33% of both the probability and convenience samples. Additional group identification information can be found in Appendix 2, Table 1.

3.2. Attitude

3.2.1. Attitude toward red wolves

In our question, "How would you describe your general attitude toward red wolves?", responses consisted of a seven-point Likert-style scale ranging from "strongly like" (7), to "strongly dislike" (1) with "neutral" (4) and "I don't know". Pluralities of the probability and convenience samples, 55% and 47% respectively, reported positive attitudes toward red wolves ("slightly like" to "strongly like"), while 8% and 19%, respectively, reported negative attitudes (slightly to strongly dislike) (Fig. 3) (Appendix 2, Table 2). A Mann–Whitney median test indicated that attitude (using a 7-point Likert scale) toward red wolves was significantly more positive for the probability sample than for the convenience sample (medians 6 and 4 respectively, z = −2.56, $P = 0.011$).

There were no significant differences in attitude toward red wolves in the probability sample among groups when split by gender, residency, hunters, or farmers (medians of 5–6 (range 4–7), $P = 0.07$–0.83 for all groups). However, within the convenience sample, nonhunters were significantly more positive toward red wolves than hunters (medians of 6 (range 4–6) and 4 (range 2–5.5) respectively, z = 4.202, $P < 0.001$), and females more positive than males (medians of 6 (range 2–2) and 4 (range 1–2) respectively, z = −2.489, $P = 0.013$).
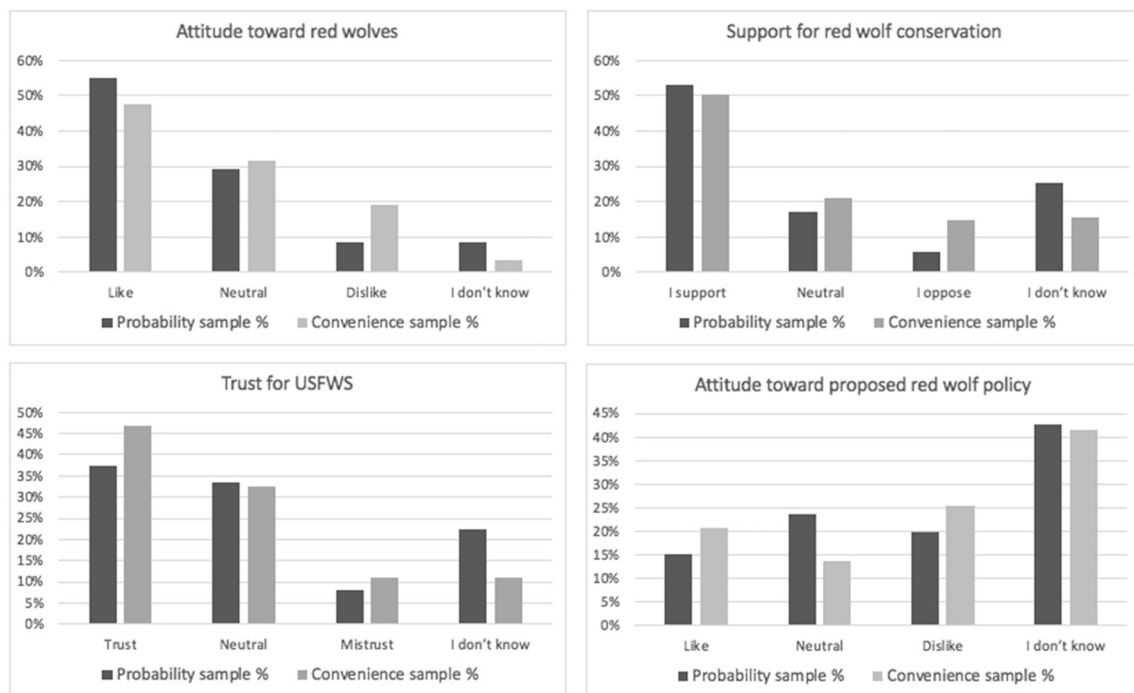
3.2.2. Support for red wolf conservation

In our survey we asked respondents to "please state your level of support for conserving red wolves" as "support" (2), "neutral" (1), "oppose" (0), or "I don't know enough". Majorities of both the probability (53%) and convenience (50%) samples supported conserving red wolves, while 6% and 14%, respectively, "opposed" (Fig. 3) (Appendix 2, Table 2). In our probability sample, the only significant difference in support for any identity or demographic groups was between nonhunters who were more supportive than hunters (medians of 2 and 2 (range 1–2) respectively, z = 4.254, $P < 0.001$). However every group tested within the convenience sample were significantly different in their support from non-group members, with nonhunters more supportive than hunters (medians of 2 and 1 (range 0–2) respectively, z = 4.579, $P < 0.001$), nonfarmers more supportive than farmers (medians of 2 (range 1–2) and 1 (range 0–2) respectively, z = 2.199, $P = 0.028$), adjacent-county residents were more supportive than RWRA residents (medians of 2 and 1 (range 1–2) respectively, z = 2.985, $P = 0.003$), and females more supportive than males (medians of 2 and 1 (range 1–2) respectively, z = −3.26, $P = 0.001$).

3.2.3. Attitude toward red wolf policy proposal

In our survey, we listed the proposed policy, "The US Fish and Wildlife Service proposes that wolves outside of the new (non-essential experimental population, NEP) management area would remain part of the NEP but take of these animals on non-federal lands would be allowed" and asked whether respondents "liked" (2), were "neutral" (1), or "disliked" (0) the policy, or "don't know enough to decide". Pluralities of the probability and convenience samples 43% and 41% respectively did not know their attitude toward the proposed policy allowing for more freedom to kill red wolves. Of the remaining 57% probability and 59% convenience respondents the two samples varied in their responses. The probability sample reported mostly neutral attitudes (23%), followed by dislike (19%) and like (15%) (Fig. 3) (Appendix 2, Table 2). The convenience sample reported more negative attitudes of dislike (25%), followed by like (21%) and neutral (13%). Within the probability sample, hunters were significantly more positive than nonhunters (median of 1.5 (range 1–2) and 1 (range 0–1) respectively, z = −4.536, $P < 0.001$) and farmers were more positive than nonfarmers (median of 1 (range 1–2) and 1 (range 0–1) respectively, z = −3.624, $P < 0.001$). In the convenience sample, hunters were significantly more positive than nonhunters (median of 1 (range 1–2) and 0 (range 0–1) respectively, z = −3.577, $P < 0.001$), farmers were more positive than nonfarmers (median of 2 (range 1–2) and 1 (range 0–2) respectively, z = −2.303, $P = 0.021$), and males were more positive than females (median of 1 (range 0–2) and 0 (range 0–1) respectively, z = 2.274, $P < 0.023$).

3.2.4. Trust for USFWS

In our survey, we asked respondents to, "Please state your attitude toward the US Fish and Wildlife Service", with answer choices including

Fig. 3. Attitude measures by sample including attitude toward red wolves (condensed from 7 to 3 categories and don't know), support for red wolf conservation, trust for USFWS, and attitude toward proposed red wolf policy.

Table 2
Behavioral inclination index by sample and group. Scores sum questions 11 and 14 with possible values 0–9, higher scores reflecting a higher number of situations in which a respondent would choose to kill a red wolf.

	Group	Probability Sample, n = 288					Convenience Sample, n = 112				
		n	%	Median	IQR	z, P	n	%	Median	IQR	z, P
Behavioral Inclination Index	Sample	288	100.0%	0.0	0–1		112	100.0%	1.0	0–1	4.44, <0.001
	Hunters	79	27.4%	1.0	0–1	−3.09, 0.002	49	43.8%	1.0	1–2	-3.69, <.001
	Nonhunters	209	72.6%	0.0	0–1		63	56.3%	0.0	0–1	
	Farmers	94	32.6%	1.0	0–1	−3.24, 0.001	37	33.0%	1.0	0–1	-0.89, 0.38
	Nonfarmers	194	67.4%	0.0	0–1		75	67.0%	1.0	0–1	
	RWRA Residents	115	39.9%	0.0	0–1	−1.15, 0.25	71	63.4%	1.0	0–1	0.57, 0.57
	Adjacent residents	173	60.1%	0.0	0–1		41	36.6%	1.0	0–1	
	Males	78	27.1%	0.0	0–1	0.46, 0.65	67	59.8%	1.0	0–2	3.65, <.001
	Females	203	70.5%	0.0	0–1		41	36.6%	0.0	0–1	

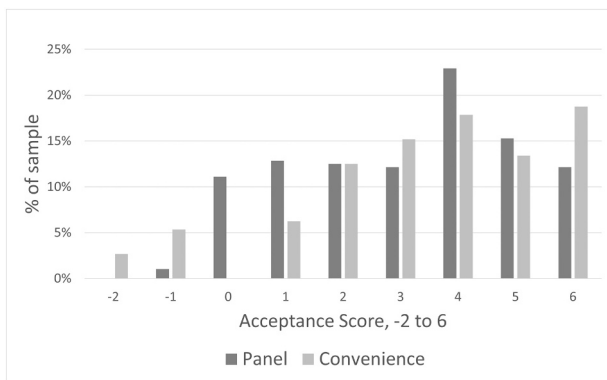*Shaded areas are significant at $p \leq 0.05$ when comparing groups using Mann–Whitney median test.
*% is out of respondents identifying in that group.

"trust" (2), "neutral" (1), or "mistrust" (0) and "I don't know enough". A plurality of both the probability sample and the convenience sample chose trust for the USFWS (37% and 46% respectively), more than neutral or mistrust (Fig. 3) (Appendix 2, Table 2). The only group with significant differences in trust for the USFWS in the probability sample was between farmers who responded they trusted the USFWS more than nonfarmers (median of 2 (range 1–2) and 1 (range 1–2) respectively, z =

−2.268, P = 0.023). In the convenience sample, females chose trust more than males (median of 2 (range 1–2) and 1 (range 1–2) respectively, z = −2.361, P = 0.018).

3.2.5. Acceptance
We combined the four attitude variables into one acceptance variable to represent overall acceptance for the red wolf program. There

Fig. 4. Acceptance for red wolves, the recovery program, and trust for USFWS summing four survey items by sample (probability vs convenience). The acceptance scale ranged from −2 to 6 where higher values indicate higher acceptance.

were no significant differences between the two samples, but within the convenience sample, hunters had a lower median acceptance score than nonhunters (median of 2 (range 0–4) and 4 (range 3–5) respectively, z = 3.68, P < 0.001) and males had a lower median acceptance score than females (median of 3 (range 1–4) and 5 (range 3–6) respectively, z = −3.39, P < 0.001). With a midpoint of 2.0, 63% of the probability sample and 65% of the convenience sample had acceptance scores above 2.0 showing a high overall acceptance of the red wolf program (Fig. 4) (Appendix 2, Table 3).

3.3. Behavioral inclination

We measured behavioral inclination using two items (Q11 and Q14) (Appendix 1) summed for a range of possible values from 0 to 9. Question 11 asked, "It's currently against the law for a private citizen to kill a red wolf except in defense of life (human, livestock, or pets). Are there any other situations you might try to kill a red wolf anyway?" and the respondent could select all that applied, adapted from (Browne-Nuñez et al., 2015). Options included (1) "any wolf I encounter on my own", 2) "the wolf did not run away from me when I was on foot", 3) "the wolf did not run away from my vehicle", 4) "the wolf was on my property", 5) "the wolf came too close to my home", 6) "the wolf approached my pet or farm animals", 7) "I would not kill a red wolf", 8) "I would support someone else killing a red wolf", and 9) "other". If the latter indicated a situation in which the respondent would kill a wolf, we scored it as a one and added one point for each and every response other than (7), which scored zero. Therefore Question 11 ranged from 0 to 8. We then summed that with the result of question 14 which asked, "What would you do if you saw a red wolf on your property?" Choices included 1) "I would try to protect it", 2) "I would watch it", 3) "I don't know", 4) "I would call the authorities", 5) "I would try to kill it", 6) "I would try to scare it away", 7) "I would ignore it", and 8) "other". We counted each response to Q14 as "non-lethal" (zero), but for response (5) which added one to the sum of Q11 above to make our composite score with a potential maximum score of 9.

For behavioral inclination index, participants' scores ranged from 0 to 9 with higher numbers representing a higher number of situations in which they would make a lethal choice. The probability sample had a significantly lower index than the convenience sample, meaning they would choose to kill a red wolf in fewer situations (Table 2) (Appendix 2, Table 4). Hunters showed a significantly higher inclination to poach than nonhunters in both the probability sample and the convenience sample. Males had a significantly higher score than females only in the convenience sample.

Our two samples differed significantly in self-reported inclinations to kill red wolves. The majority of the probability sample and a plurality of

the convenience sample chose the nonlethal choices of "I would not kill a red wolf" (65% v 41% respectively, $\chi^2 = 18.30$, df = 1, P < 0.001), and the direction of difference between the two samples was the same for the minorities who chose "I would try to protect it" (15% v 6% respectively, $\chi^2 = 5.91$, df = 1, P = 0.015). The probability sample self-reported a significantly lower inclination to kill red wolves in each of the following lethal options: "the wolf did not run away from me when I was on foot" (19% v 7% respectively, $\chi^2 = 12.22$, df = 1, P < 0.001), "the wolf came too close to my home" (18% v 7%, $\chi^2 = 9.79$, df = 1, P = 0.002), and "the wolf approached my pet or farm animals" (47% v 17%, $\chi^2 = 37.86$, df = 1, P < 0.001).

Hunters in the probability sample were significantly less likely to choose "I would not kill a red wolf" than nonhunters (62% v 66% respectively, $\chi^2 = 9.47$, df = 1, P = 0.002) and more likely to choose "any wolf I encounter on my own" (11% v 2%, $\chi^2 = 10.04$, df = 1, P = 0.002). However, in the convenience sample hunters are significantly more likely than non-hunters to choose, "the wolf did not run away from me when I was on foot" (29% v 11%, $\chi^2 = 5.52$, df = 1, P = 0.02), "the wolf came too close to my home" (31% v 8%, $\chi^2 = 9.66$, df = 1, P = 0.002), "the wolf approached my pet or farm animals" (61% v 37%, $\chi^2 = 6.75$, df = 1, P = 0.009), and "I would support someone else killing a red wolf" (10% v 0%, $\chi^2 = 6.73$, df = 1, P = 0.009).

3.4. Correlations between attitude and behavioral inclination

Attitude toward red wolves (using the Likert scale of "strongly dislike" to "strongly like") and behavioral inclination index (0–9) above showed a significantly negative relationship to each other in both the probability sample ($r_s = -0.25$, P < 0.001) and convenience sample ($r_s = -0.54$, P < 0.001), meaning that respondents with positive attitudes toward red wolves had lower inclinations to poach them (Appendix 2, Table 5).

4. Discussion

Our goal was to measure attitudes toward red wolves and red wolf management along with respondents' behavioral inclinations to protect or kill red wolves they encountered, among those who live in and around the RWRA. Anthropogenic mortality is the largest threat to the survival of the only wild population of this species, and by understanding how people think about red wolves and their conservation, decisions can be made about how and where to concentrate outreach efforts and interventions. The USFWS explicitly states that the current regulations are not effective in fostering coexistence between people and red wolves (Kurth, 2018), and since the known population size is down to 7 wolves (USFWS, 2020b), urgent action is necessary to ensure survival. However, in our study we found a majority liked wolves, a plurality supported the recovery program, trusted the USFWS, disliked policy that would limit protections, and would not shoot wolves illegally. There is also a large percent who don't know or are neutral about the recovery program. Our interviews and survey responses reflect a distinction between attitudes toward red wolves and attitudes toward the recovery program which is important and leaves an opening for education and cooperation.

4.1. Sample characteristics

Our two samples were demographically different, and though complementary in age and other identity variables, both samples were also different from the census. While neither is representative of the general population, we believe their responses provide valuable information for conservation. Across a broad range of questions on social and political issues, Goel et al. (2015) estimates responses from a non-representative survey were generally well-aligned with GSS and Pew Research Center studies. Even representative surveys can suffer from non-response bias and sampling errors (Shirani-Mehr et al., 2018), and matching

demographics does not guarantee absence of bias on the variables of interest (Couper, 2000). Our study supports findings from different researchers using a variety of data-collection methods with different samples including two red wolf studies, which we believe adds support for the interpretation of our findings (Quintal, 1995; Rosen, 1997).

As with past wolf surveys in Wisconsin (Browne-Nuñez et al., 2015), salience of surveys about wolves to older respondents might explain the higher average age of our convenience sample and lower average age of our Qualtrics panel. Qualtrics panels "tend to be younger with 62% of the nationwide panel under the age of 34" according to an email from Qualtrics. Our results align with studies that show females to be more involved in animal advocacy than males (Herzog et al., 1991; Kellert and Berry, 1987; Peek et al., 1996), more self-reported advocacy in the younger generations (Bryan, 2008; Firkins, 2017), and more positive attitudes in those living outside wolf range (Karlsson and Sjöström, 2007; Treves et al., 2009). As expected, this resulted in differences between our two samples in measures of attitude with the probability sample being more positive toward red wolves and their conservation, a higher level of acceptance for the program and lower salience of our survey questions.

Differences between these two samples of respondents have practical implications for the USFWS and red wolf protection. This includes identifying who or what groups of people are most interested and knowledgeable about red wolves and those who are not, and results could inform the type of outreach and action needed in which locations. Reaching these different groups of stakeholders would be helpful to balance interests and seek reasonable solutions. When considering what actions to take, it may be useful to separately consider the attitudes and inclinations of a smaller population who know a lot about an issue compared to the majority who do not (Decker et al., 2002). An experimental study of tolerance for black bears conducted in Ohio found that information interventions did little to raise tolerance, but interventions that described the benefits that bears offered to people and to ecosystems were associated with tolerance for a larger bear population (Slagle et al., 2013). That same experiment revealed that if informational interventions included information on risks and prevention of damages by bears alone, tolerance declined, but combined with positive information on benefits, tolerance was higher than when presented with costs alone. These results have obvious implications for how the USFWS should lead with positive messaging on red wolves when they approach concerned or skeptical residents of the RWRA.

Because of constraints imposed by survey methods, we were unable to completely estimate response rate and non-response bias for both samples. Therefore, our results have some limitations we discuss in this paragraph, and we recommend future research account carefully for rate and bias to additionally validate our findings. A consequence of ignorance of non-response bias is the assumption that respondents represent non-respondents reached by our survey (which by itself is different from non-respondents' not reached by our survey). We have detected differences in salience between our two samples, suggesting that payment by Qualtrics to reach the probability sample of respondents could have elevated response among respondents for whom the material was not very salient or for topics those respondents knew little about. That makes our probability sample from Qualtrics possibly less relevant to the applied conservation problems facing the USFWS recovery program for red wolves because those respondents who knew little, or for whom the issue was not salient, are unlikely to influence the conservation program directly. In short, our samples emphasize the role of interested and informed individuals in influencing red wolf recovery, as opposed to the broad public, which may only influence it indirectly if at all. This is a limitation of our study for two reasons. First, the scientific limitation is that we are unsure of the accuracy and precision of our measurements for predicting the response of an individual, group, or the public. That imprecision and inaccuracy is somewhat mitigated by using closed questions (fixed responses), so we know we have not qualitatively distorted results. The second limitation is an applied one because our

uncertainty about non-response bias could lead the agency to assume its public meetings are equally biased. We urge caution in jumping to that conclusion. Because public meetings are broadcast, attendees are self-selected, and interest group leaders may marshal large numbers of constituents to attend, public meetings are likely more biased to non-response than our surveys. Therefore, the limitations of our study imposed by unknown levels of non-response bias should not be construed as cause for dismissal, but instead viewed as a question of precision of estimates and systematic bias in one direction or another. By comparing our two samples of respondents, we address the issue of systematic bias in either sample. Finally, response rate sheds light on non-response bias. For example, if a small minority of individuals reached by the survey completed it, then our results might easily be overwhelmed by the attitudes of the larger majority non-respondents. Such a phenomenon could push our results in any direction, but we do have a safeguard against massive bias caused by low response rates. The safeguard is that Qualtrics paid its survey respondents to respond to this and other surveys. Therefore, the probability sample is likely to be representative of Qualtrics panel, albeit not of census population. In general, animals have high salience for people (Manfredo, 2008; Wilson, 1984), therefore our study with its two different samples provides a basis for comparison (convenience sample most biased by non-response and probability sample least biased by non-response). That comparison provides a degree of confidence that a low response rate does not equate to massive non-response bias.

4.2. Attitude, acceptance, and behavioral inclination

In their 2018 red wolf 5-year review, the USFWS stated they would not be able to recover the red wolf without private landowner support (Weller, 2018). Our results show that pluralities of both our samples had positive attitudes toward red wolves and their conservation. Compared to Quintal (1995), our study 23 years later shows positive attitudes toward red wolves have increased by 19%, negative attitudes decreased by 4%, and those who are neutral or don't know have also decreased by 19%, if one can compare the two surveys directly. Among our respondents, even high levels of support did not correlate with zero behavioral inclination to poach, and so the lack of success for this reintroduced species may include a broader range of factors that includes trust for the agency, policy, and other factors.

When considering tolerance for a particular species, trust increases perceptions of benefits and lowers risk perception (Zajac et al., 2012). While trust for the USFWS was relatively high, participants were more positive toward red wolves than toward the agency. There was also a high percentage of neutral attitudes, suggesting respondents had little basis for approving or disapproving of USFWS. In survey comments from the online questionnaire and interviews, participants shared frustration for the continued lack of communication between managers and the residents who are living near red wolves. Daley et al. (2004) showed that models of successful wildlife management programs in NC emphasized personal relationships with agency personnel and we echo their recommendation. Those authors concluded any management considerations would need to include local and regional attitudes (Daley et al., 2004). Increased communication and relationship building, when implemented both broadly and intentionally should reach the very small group willing to violate social norms by poaching.

The new USFWS red wolf policy proposal would limit protections of red wolves to federal lands on the Albemarle Peninsula, allowing take of red wolves on private land, whereas the current policy does not limit protection geographically. This gave us an opportunity to ask residents their attitudes toward that policy, and we found that a high number were either not aware of the policy proposal or did not understand it. Ultimately, we found limited support reported for this policy that would allow the killing of red wolves on private property. Recent work on the endangered Mexican wolf indicates loosening ESA protections for wolves resulted in more poaching and slower population growth

(Louchouarn et al., 2021). Further research would be needed to show if a more favorable policy toward red wolf survival would increase acceptance.

With the combination of the attitude measures discussed here, our acceptance variable, reflecting the current state of red wolf management, shows a high level of acceptance across all groups of our survey respondents even though the most recent policy proposal decreased acceptance scores. These types of acceptance measures are useful as a general indicator of the tolerance for a species in a particular location and context.

With such a small population of wolves, the loss of just one adult can have devastating effects on the wild population. Our respondents expressed an extremely low inclination to poach with medians of 0 to 1 out of a possible 9 for both samples and all groups and when compared to the Wisconsin study using the same behavior choices (Browne-Nuñez et al., 2015). This supports our belief that poaching is carried out by a small minority. However, male hunters had the highest mean behavioral inclination to poach and the lowest level of acceptance of any interest group. Hunters also have opportunity during hunting season where they will likely be carrying a firearm in areas with red wolf prey, and potentially red wolves. Therefore, communication, personal relationships and management interventions should focus on this interest group to reach the few who would kill a wolf illegally.

4.3. Recommendations beyond North Carolina, USA, and beyond red wolves

Many protected areas such as those found in the North Carolina RWRA, are usually too small and fragmented to contain wide-ranging species such as large carnivores (Woodroffe and Ginsberg, 1998), that will disperse into surrounding land, seeking territory as their population grows. As red wolves continue to move outside of protected areas and onto private lands, poaching has inhibited recolonization (Agan et al., 2021). For endangered species in small ranges or reintroduced to small, protected areas, we recommend prioritizing investment in the major cause of mortality for such populations. As resources for enforcement are often very limited, we recommend a focus on poaching and the social norms that seem to promote it.

Trust of the surrounding community will probably be essential to identifying poachers and succeeding in law enforcement. Several studies report that poachers are a small minority with specialized skills or habits such as in tropical lowlands (Naughton-Treves et al., 2003) and for drier savannas (St John et al., 2012), or that would-be poachers seem numerous, yet the opportunity to poach elusive species is rarely encountered as with gray wolves (Treves et al., 2017) and Jaguars (Marchini and Macdonald, 2012).

Some hypothesize that targeted communications by agencies and support within communities is key to reducing poaching. For example, a 2019 study of Swedish hunters found that poaching was rare compared to the number of hunters afield and a high percent of hunters would report poaching to the authorities (Peterson et al., 2019). Both suggest community support for protection and opposition to poaching. Appealing to law-abiding hunters and the community in which poachers are embedded may help to reach that small group of hunters who engage in this illegal activity or encounter an opportunity (Treves et al., 2017; Peterson et al., 2019). Bergseth et al. (2017) also recommended targeted communication that influenced the belief or perception surrounding illegal activity for those who care about fish reserves and other approaches that increased the perceived likelihood of detection by law enforcement for more opportunistic poaching. An African primate study showed sanctuaries have moved toward implementing development activities aimed at poverty reduction coinciding with poaching, and identifying hotspots of poaching to strengthen law enforcement (Kahler and Gore, 2012).Authorities should beware of incentives to stop poaching that only stop a subset of the poaching (Persson et al., 2015) and should be particularly wary of policies that ignore hidden poaching

in favor of reported poaching (Louchouarn et al., 2021; Santiago-Ávila et al., 2020; Treves et al., 2017). These examples reinforce our conclusion that targeted communication and enforcement along with agency trust is critical to acceptance of the red wolf program.

Communities may not know exactly where poaching is highest-risk and not all communities may evince social norms for or against poaching (Kahler et al., 2013; Kahler and Gore, 2012), but the alternative to community outreach and trust-building programs seems to us to be intensive patrolling and interdiction campaigns by authorities that are not based in the community. If poachers come from outside the range of the controversial species, financial incentives promote poaching, or internal community norms favor the poachers (Clarke and Rolf, 2013; Pohja-Mykrä and Kurki, 2014; Sharma et al., 2014), more militaristic responses may be needed. While it is tempting for an agency like the USFWS to turn a blind eye to poaching for the sake of the agency's reputation and relationships, there are alternative views of community-based conservation. Namely, fair, and consistent law enforcement that seeks justice for all, emphasizes partnerships, and can anticipate problems before a red wolf is killed, may provide another path to successful recovery and support for the USFWS. The ESA is the law of the land and many communities pride themselves on being law-abiding (Cheng and Sturtevant, 2012; Partington, 1990; Peterson et al., 2019). Indeed, we do not think the USFWS needs to militarize against poaching in the red wolf recovery area because the majority of our respondents view red wolves favorably. Yet loosening ESA protections sends the wrong signal that red wolves have less value now, when in fact each one has greater value due to their scarcity (Chapron and Treves, 2016; Louchouarn et al., 2021; Santiago-Ávila et al., 2020).

Whether recovery in North Carolina is a success or failure, we need to understand how management can be improved in the future based on the experience of those in current recovery areas. For all wildlife populations where poaching is a problem, managers need to understand who is poaching, why they poach and why the problem continues to persist in order to make good decisions to stop such behavior and enhance future recovery of the species. Our study revealed that even with high acceptance and positive attitudes, negative attitudes and the behavioral inclination to poach of a small minority of the human population could lead to negative consequences for recovery of a critically endangered population.

5. Conclusion

Outlook should be favorable for red wolf recovery if attitudes of the general public were strongly influential. However, even though our study reflected a majority hold positive attitudes, our results show a small group of people are driving the species to extinction through illegal killing even without normative support. Some interest groups and individuals are pushing the USFWS to loosen ESA protections or even abort the recovery (Kurth, 2018).

Our study highlights the importance of relationship between agency personnel and residents, not only in response to wolf-human interactions but throughout the entire process of recovery including decision-making. It is also evident that illegal killing is acceptable to reveal in a survey and so might be an acceptable social norm among a minority of residents in the RWRA. This makes it particularly important to focus interventions such as outreach, law enforcement, and anti-poaching interventions generally on those groups with the negative attitudes and the inclination to poach. Most critical are proven interventions that mitigate poaching while building human-wolf coexistence. We do not yet understand why red wolf poaching has been a problem for so long, and solutions to it have been ineffective. Since this study focused on those living in and around the RWRA, perhaps a next step would be an anonymous survey among USFWS personnel and others who have worked in red wolf recovery over the last 30 years to gain a more holistic perspective.

Currently we do not know what the future for red wolves in NENC

will be. If future policy allows them to remain protected throughout the current RWRA, then management will need to include not only continued support for and communication with residents, but also more targeted interventions, as well as continued research into the underlying motivations for poaching to reduce anthropogenic mortality.

CRediT authorship contribution statement

Suzanne Agan: Conceptualization, Data curation, Formal analysis, Methodology, Project administration, Visualization, Writing – original draft, Writing – review & editing. **Adrian Treves:** Conceptualization, Methodology, Supervision, Writing – review & editing. **Lisabeth Willey:** Supervision, Writing – review & editing, Formal analysis.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendices. Supplementary data

Supplementary data to this article can be found online at https://doi. org/10.1016/j.biocon.2021.109321.

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