What shapes the public's view of coyotes in Rhode Island?

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Introduction

Since the turn of the 20th century, over 50% of the Earth's land surface has been altered by anthropogenic developments (Ellis et al. 2010). Although this land conversion has negatively impacted wildlife, some species such as the coyote, have learned to adapt to a new age of human dominated landscapes (Carter et al., 2012; Gehrt, 2007). Coyotes (*Canis latrans*), a native North American canid, have largely expanded their range since the 1900's and are now found across anthropogenic landscapes such as agricultural land, suburbs, and urban areas (Hody et al. 2017; Jackman et al 2015). Although their flexibility has made them one of the most successful carnivores in the United States, it has also made their presence contentious (Bekoff et al., 1986; Elliot et al, 2016). Concerns of their presence and activity stems from their ability to transmit diseases, disrupt property, attack or harass livestock or pets, or even attack or harass humans (Elliot et al. 2016; Sponarski et al 2018).

Although coyotes have the potential to negatively impact people, they may also serve important ecological roles as top-down enforcers on primary consumers (Benson et al 2017; Henke et al 1999). These paradoxical roles have thus made management of coyotes controversial and variable. Coexisting with coyotes has been a challenge for residents and wildlife managers, especially in urban areas (Elliot et al 2016). Human's attitude and perception of wildlife can greatly impact the success of wildlife management which is why the concept of 'managing people' has become a prominent tool in the conservation of apex carnivores (Decker et al 1997).

In Rhode Island, efforts to understand the relationship between coyotes and people have already begun through coyote behavior and demographic studies as well as human dimension surveys on the islands of Narragansett Bay (Mitchell et al 2015; Thomas 2005). These studies, however, are primarily descriptive and do not encapsulate human-coyote relationships across the entirety of Rhode Island. Across the state, roughly 50% of all calls or inquiries concerning nuisance wildlife regard coyotes (Brown, 2020, personal communication, October). Given strong concerns about the presence and activity of coyotes and limited information on human-coyote relationships in the state of Rhode Island, we seek to gain insight on people's attitudes and interactions with coyotes in the state. We use an electronic survey tool to measure these variables and evaluate how people's value of coyotes is shaped by their demographics and interactions with coyotes. Specifically, we hypothesis that 1) participants will have an increasing *attitude* (e.g. more positive attitude) of coyotes given they have a higher education 2) participants will have an decreasing *attitude* (e.g. more negative attitude) of coyotes with increasing age and 3) participants who have experienced pet or livestock-coyote interactions will have a decreasing *attitude* of coyotes. To address the above hypotheses, we analyzed survey responses using Kendall's rank coefficient and ordinal regression.

Methods

Dataset

Data was collected through Qualtrics Survey Software and advertised widely through news articles and promotional social media pages across Rhode Island. The self-selected survey

was conducted over four months, October 6th 2020 to January 31st 2020 with a total of *n* = 974 participants. Only participants over the age of 18 were permitted to take this survey.

To quantify our dependent variable, attitude of coyotes, we used two five-point Likert scales, one which addressed the benefits of coyotes while the other, risks of coyotes. The five-point scale ranked: strongly disagree, disagree, neither agree or disagree, agree, and strongly agree. To test our above hypothesis, we used binary, multiple-choice, and continuous questions to collect data on participant's education, pet/livestock-coyote interactions, and age. Here, we summarize any pet/livestock interactions which refers to an interaction where a pet/livestock interacted, was attacked or was killed by a coyote.

Statistical analyses

We first use a non-parametric correlation test, Kendall's tau coefficient (Bernard. 2000), to determine the relationship between individual value questions (fig. 2) and our hypothesis. Kendall's rank coefficient uses ranked pairs to determine the association direction (positive or negative) and strength (stronger as tau approaches ±1). We then use a Cronbach's Alpha to determine the correlation between all questions used to assess participant's value of coyotes. This was done by unclassifying factorized Likert data. The resulting alpha allows us to determine the reliability of multi-item scales (Bruskotter et al., 2009). Questions which address risk were reverse-coded so that all questions scaled (factored 1-5) unidirectionally. Finally, we use the median from each participant's responses as a continuous responsive variable (combining benefits and risks) to conduct an ordinal logistic regression analysis (Larasati et al., 2011). We tested multiple models which included all or some of our variables of interest.

Results

Demographics of participants were well distributed amongst sex and age (figure 1A) with bias toward certain counties (specifically Washington and Providence; figure 1B) which might be explained by high advertising through the University of Rhode Island and Providence journals. The participants' high level of education (figure 1C) might also reflect this bias. Roughly 80% of the respondents own a pet and 8% livestock, although less than 4% have experienced a killing or an aggression of a coyote on their pet or livestock.

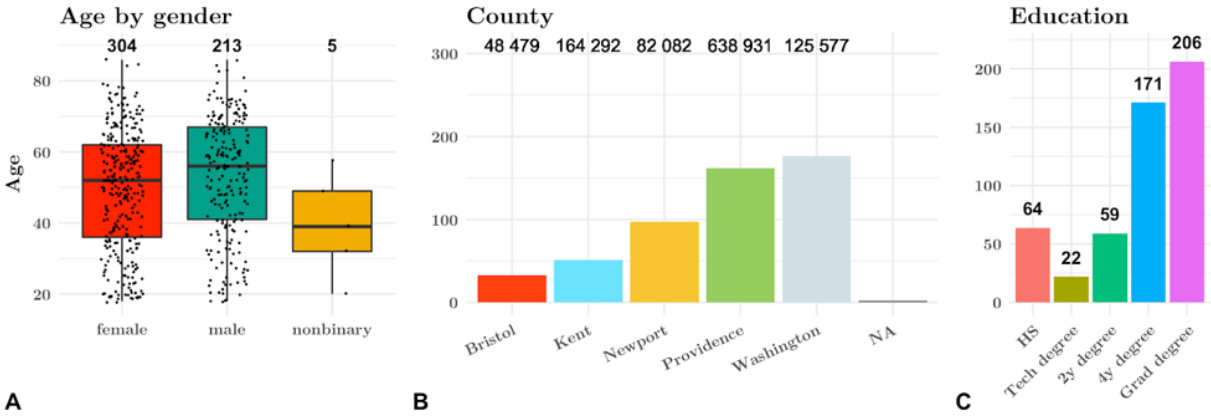

Figure 1. *Answers from the survey for the age and gender (A), county of residency (B), level of education (C). The counts for each level of answer are shown in bold on top of the bars, except for the counties, showing the population by county.*

The results of the Likert scale questions show that Rhode Islanders mostly consider coyotes beneficial to humans, wildlife and important for the ecosystem in general, but less so for hunters (fig 2A). Despite participants positive attitudes towards coyotes, they believe coyotes present risks for humans and pets.

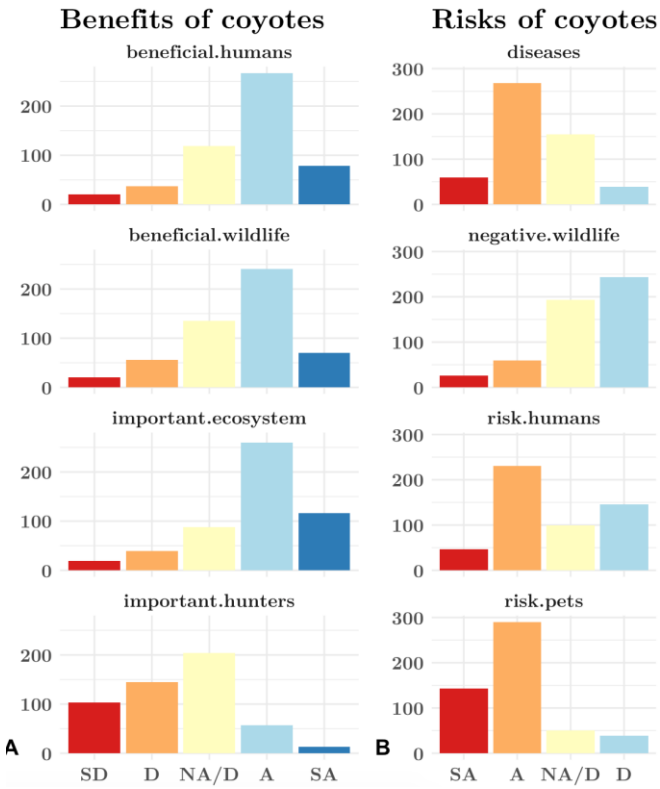

Figure 2. *Histogram of the eight Likert questions - 5-point score with rank - which address participants value of coyotes as beneficial to humans, beneficial to wildlife, important for the ecosystem or important for hunters (A) and the risks of coyotes as spreaders of diseases, negative for wildlife, a risk for humans and a risk for pets (B). The Likert scale takes the values Strongly Disagree (SD), Disagree (D), Neither Agree nor Disagree (NA/D), Agree (A) and Strongly Agree (SA).*

Based on Kendalls' rank coefficient outputs, all questions which address *attitude* were weakly correlated to the categorical independent variables of interest (education and pet/livestock-coyote interactions). All questions with the exception of 'important.hunters' are positively correlated with education, meaning as people's *attitude* of coyotes increases, education also increases. The opposite effect was found for high pet/livestock-coyote interactions; as people experience high pet/livestock-coyote interactions, their value of coyotes decreases, with the exception of question 'important.hunters'.

The Cronbach's Alpha analysis resulted in an alpha of 0.83 for the eight-question scale aimed at addressing people's *attiude* of coyotes. This determined that the scale items were reliably related (Cronbach's Alpha > 0.7; Bruskotter et al., 2009). The question, 'important.hunters' most influenced the performance of this analysis and with it's removal would result in an alpha of .86. We separately analyzed questions which referred only to benefits of coyotes which resulted in an alpha of 0.8 and again, the question,

'important.hunters' most influenced the performance of this analysis and with its removal, resulted in an alpha of 0.93. We then separately analyzed questions which referred only to risks of coyotes which resulted in an alpha of 0.74. All questions were important for this measure and dropping of any item decreased the performance of the analysis. Based on Cronbach's analysis, we analyzed means of questions related to benefits and risks in the ordinal logistic regression analysis. The best performing model included all independent variables of interest (age, education, pet/livestock-coyote interactions; Table 1).

Model	**df**	**AIC**
coyote.attitude ~ age + education + pet.int + livestock.int	16	1577.485
coyote.attitude ~ education + pet.int + livestock.int	15	1812.162
coyote.attitude ~ age + pet.int + livestock.int	11	1586.350
coyote.attitude ~ pet.int + livestock.int	10	1891.521

Table 1 Logistic ordinal regression outputs of four different models

The best performing logistic ordinal regression model revealed a negative relationship between age and pet/livestock-coyote interactions, meaning as people's age increased and pet/livestock-coyote interactions increased, their attitude of coyotes decreased. Of these predictive variables, only age was a significant variable (p = 0.03465698).

```
Call:
polr(formula = coyote.attitude ~ age + education + pet.int +
    livestock.int, data = coyote, Hess = TRUE, method = "logistic")

Coefficients:
```

	Value	Std. Error	t value	p value
age	-0.01168245	0.005530564	-2.11234366	0.03465698
educationHigh School	1.17543328	1.508567730	0.77917170	0.43587858
educationTechnical or vocational degree	0.10356884	1.527437098	0.06780563	0.94594036
education2-year college degree or certificate	1.07104405	1.502576305	0.71280510	0.47596637
education4-year college Degree	1.24233973	1.486652270	0.83566262	0.40334473
educationGraduate Degree	1.15516312	1.481792088	0.77957166	0.43564304
pet.int	-0.33718587	0.202449468	-1.66553102	0.09580686
livestock.int	-0.29482858	0.391045332	-0.75394989	0.45087931

Figure 2. *Values of each coefficient, standard errors, t-values, and p-values for the best fit model which includes all independent variables of interest*

Discussion

Overall, Rhode Islander's have positive attitudes towards coyotes. However, they still believe there are risks to having coyotes on the landscape and are especially worried about diseases coyotes may carry, the risk coyotes pose to pets, followed by risk to humans.

The Kendall rank coefficient for each *attitude* question was weakly correlated with our variables of interest, age, education and pet/livestock-coyote interactions. However, the direction of the relationship (positive vs. negative) between *attitude*, age, education, and pet/livestock-coyote interactions were as we hypothesized. Despite these findings, it is important to note the

variable significance between questions and weak correlations indicating that education and pet/livestock-coyote interaction may not be important predictors of coyote *attitude*. However, these questions were also presented on the survey as a Likert scale, so analyzing individual questions may not be an accurate representation of *attitude*.

Bias due to survey advertisements and self-selected participation may also have been introduced in this data collection. The majority of advertisements were distributed in Providence and Washington Counties. Respondents were also highly educated with the majority of respondents having a 4-year college degree or graduate degree. These results are likely tied to repeated advertisements published through the University of Rhode Island.

Results from the ordinal logistic regression analysis found that education and pet/livestock-coyote interactions were not significant predictors to the best performing model which incorporated all independent variables of interest. Rather, age has a significant effect on the performance of the model. The effect of age might be related to this age group having more experience with coyotes or perhaps a higher number of interactions than younger people.

Based on directional results, mitigating and educating on coyote conflict with pets and/or livestock should be an important focus for future management. Educational materials or programs about coyotes would be especially useful when targeted to an older audience. Our research implicates that there are measurable variables which may impact people's value of coyotes in Rhode Island. Given the success and adaptability of coyotes to urban settings, coyotes will likely continue to be common mesocarnivores across Rhode Island. Therefore, it is important to understand what shapes the relationship of people and coyotes so we can better manage conflict with coyotes.

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