



Original Article

Recent Arrivals or Established Tenants? History of Wolf Presence Influences Attitudes Toward the Carnivore

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ABSTRACT Human dimensions are a critical part of large carnivore conservation. We investigated how the historical presence of wolves (*Canis lupus*) influences public attitudes toward the carnivore and its management in rural areas of Poland. From March 2016 to March 2017, we used a self-administered questionnaire to assess attitudes of rural residents ($n = 292$) and foresters ($n = 325$) in 6 regions where wolves have either been continuously present, or where they have recently recovered after a period of absence. While we found that attitudes toward wolves were generally neutral or positive, differences in attitudes did exist across target groups and regions with long and short histories of wolf presence. Foresters tended to have more negative attitudes toward wolves than did rural residents, and their attitudes remained stable across regions. In contrast, rural residents from the regions with an uninterrupted history of wolf presence, which also suffer greater rates of livestock depredation, tended to have less positive attitudes than did residents from regions where wolves have recovered more recently. Knowledge of wolves and wildlife value orientations were also positive predictors of attitudes. Negative attitudes among local residents and lower support for wolf conservation in response to wolf attacks on livestock could be a major obstacle for the continued recovery of wolves in Europe. Our results reinforce the need for proactive approaches, involving both information campaigns and actions to mitigate wolf predation on livestock, to maintain local support for wolf conservation. © 2019 The Authors. *Wildlife Society Bulletin* published by Wiley Periodicals, Inc. on behalf of The Wildlife Society.

KEY WORDS attitudes, *Canis lupus*, human dimensions, human–wildlife conflict, large carnivore conservation, Poland, wolf recovery.

Wolf (*Canis lupus*) recovery is often accompanied by intense debate (Carter and Linnell 2016). Whereas some people celebrate wolves as a symbol of wild nature (Fritts et al. 2003), others loathe the predator as a killer of livestock and competitor for game (Breitenmoser 1998, Linnell et al.

2000). Understanding public attitudes toward wolves is therefore essential to guide management decisions, address human–wildlife conflicts, and design effective education programs (Bath 2013). We investigated how the historical presence of wolves in a region influences local attitudes toward the carnivore and its management in Poland.

Previous research in North America and Europe shows that people's attitudes toward wolves are influenced by the presence and proximity of wolf populations. People living in regions where wolves occur tend to be less supportive of wolf conservation than people living far away from wolf populations (Williams et al. 2002, Ericsson and Heberlein 2003, Karlsson and Sjöström 2007, Hermann and Menzel 2013). Negative attitudes among people in areas where wolves are present may be driven by direct and indirect experience. Residents living close to wolf territories are more likely to be confronted with human–carnivore conflicts, either through first-hand experience, or perhaps more commonly, indirectly through personal contacts or local

Received: 28 November 2017; Accepted: 4 July 2019
Published: 1 December 2019

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media reports. Greater exposure to negative information about wolves is likely to reduce local residents' acceptance of the predator and erode their support for wolf conservation (Ericsson and Heberlein 2003, Karlsson and Sjöström 2007, Eriksson et al. 2015). As a major source of human–carnivore conflict, livestock depredation can mediate the link between wolf presence in a region, experience with the carnivore, and local attitudes.

In addition to direct effects of wolves, underlying cultural conflicts may shape local opinions about wolves and wolf policy in rural areas. For example, in many regions around the world, wolves have become a symbol of the rural–urban divide. Rural residents may view policies to reintroduce or protect wolves as a threat to agriculture, and thus to traditional rural ways of life (Eriksson 2016). Negative attitudes toward wolves and opposition to wolf conservation in rural communities may in part reflect resistance to an urban majority imposing its conservation values on a rural minority (Ericsson and Heberlein 2003, Fritts et al. 2003, Chapron et al. 2014, Eriksson et al. 2015).

The historical context of wolf presence may also influence both direct (e.g., depredation) and indirect (e.g., cultural) drivers of attitudes in wolf areas. It has been postulated that residents may be more accepting of large carnivores in regions where predators have been continuously present compared with regions where they recently returned after a period of extinction (Williams et al. 2002, Fritts et al. 2003). In places where wolves or other large carnivores have always persisted, local people may have retained adaptations to coexist and cope with the predators, such as animal husbandry practices that reduce depredation, thereby minimizing wolf–livestock conflicts and contributing to a local culture that is more accepting of large carnivores: evidence from Austria, Estonia, Italy, and Finland supports this hypothesis (Zeiler et al. 1999, Randveer 2006, Bisi et al. 2007, Bath 2009). In contrast, in regions where large carnivores have been absent for a long period, local traditions for coexistence may be lost and people may no longer accept predators as part of the natural system (Breitenmoser 1998, von Arx et al. 2004). The return of large carnivores to these regions is likely to spark social conflicts, which can contribute to hostility toward the new arrivals (Chapron et al. 2014, Dressel et al. 2014).

Studies investigating how local people's attitudes change over time after carnivores return to an area have yielded somewhat inconsistent findings. Studies in Norway, for example, suggest a peak in negative attitudes when large carnivores first arrive in a region, followed by a gradual improvement in attitudes as people become more familiar and experienced with living with predators (Zimmermann et al. 2001). However, other European studies suggest that people's attitudes toward wolves steadily become less positive the longer people coexist with them (Dressel et al. 2014).

In Poland, wolves have a history of persecution and recovery, providing the chance to explore how historical wolf presence can influence local attitudes toward the carnivore. By the early 1900s state-sanctioned eradication campaigns had eliminated wolves from most of Poland except a few forested regions in the east of the country (Wolsan et al. 1992,

Okarma 1993). During the world wars, wolf numbers began to recover (Wolsan et al. 1992), but renewed eradication efforts after WWII had reduced wolves in Poland to <100 individuals by the early 1970s (Okarma 1993). In 1975, the status of the wolf was upgraded from pest to game species, which allowed hunting with firearms only (no poisoning or trapping), with a nation-wide 4-month closed season introduced in 1981 (Okarma 1993). The wolf population subsequently recovered to an estimated 700–900 individuals by the mid-1990s, but wolves were still rare in western Poland (Okarma 1993, Gula 2008a, Nowak and Mysłajek 2017). In 1995, the wolf was declared a protected species in most of Poland, and full protection from hunting was extended to the whole country by 1998 (Gula 2008a). Since 2000, numbers in western Poland began to recover to the point where local people became aware of the presence of wolves in the forests (Gula 2008c, Nowak and Mysłajek 2017).

Previous studies provide some insight into public attitudes toward wolves in different regions of Poland. A study of residents in northeast Poland, a region where wolves have always persisted, reported high acceptance of wolves, although only 24% of respondents would accept wolves within 10 km of their home (Balčiauskas et al. 2007). Another study targeting farmers, hunters, foresters, and teenagers found no relationship between wolf presence in a region and local attitudes (Olszańska 2012). However, this measure of attitudes did not include beliefs about the negative effects of wolves or support for wolf conservation. Studies have not yet targeted rural communities in Poland in areas where wolves have recently recovered after being rare or absent for a long period. Understanding public attitudes toward wolves in these areas is particularly important because these communities may be more likely to face wolf-related conflicts.

We investigated attitudes toward wolves and wolf management in regions with different histories of wolf presence in Poland. We focused on the attitudes of people living in the areas where wolves occur, including foresters working directly in wolf habitat, and aim to answer the following research question: is there a difference in attitudes between regions where wolves have been continuously present and regions where wolf recovery has occurred more recently?

STUDY AREA

Six study areas were included in the survey (Fig. 1): 3 regions in the far east of Poland where wolves, despite eradication efforts, had been continuously present (regions 1–3); and 3 regions west of the Vistula River where wolf populations had recently recovered after being rare or only sporadically present for a long period (regions 4–6). We defined regions east of the Vistula River as having a “long history of wolf presence” (meaning wolves have been continuously present in relatively high numbers), and regions west of the Vistula as having a “short history of wolf presence” (meaning sporadic wolf presence until around the year 2000, after which wolf presence became conspicuous to the public).

Estimated wolf densities were similar across the study sites: between 2.7 and 3.7 wolves/100 km² (Gula 2008b, Jędrzejewski et al. 2008, Gula et al. 2018; K. Bojarska and

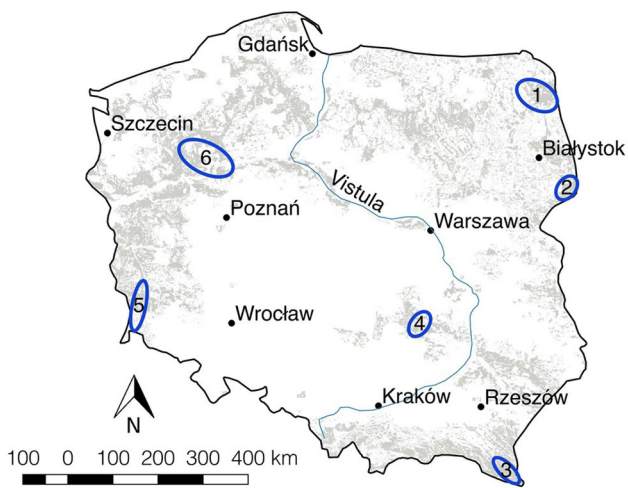


Figure 1. Locations of the 6 study areas in Poland in which we measured local attitudes toward wolves in March 2016 to March 2017: 1 = Augustów, 2 = Białowieża, 3 = Bieszczady, 4 = Świętokrzyskie, 5 = Bory Dolnośląskie, and 6 = Drawsko. Grey shaded areas indicate forests occupied by wolves in 2012–2015 (R. Gula and K. Bojarska et al., unpublished data).

R. Gula et al., Polish Academy of Sciences, unpublished data), except for Drawsko where the density was lower (1.1 wolves/100 km²; Mysłajek et al. 2018), but this may be due to differences in estimation methods. Both human population and livestock density were greater in regions west of the Vistula River compared with the 3 eastern regions. Despite more livestock being present, depredation rates were negligible west of the Vistula, partly because livestock in these regions tend to be kept indoors, which reduces the risk of wolf depredation. In contrast livestock usually graze outdoors in the 3 eastern regions, where wolf attacks on livestock were common. For example, from 2014 to 2016 wolves killed an average of 192 animals/year in Bieszczady (Central Statistical Office 2014, 2015, 2016).

METHODS

We used a factorial design (2 × 2) to investigate the influence of wolf history of a region (short, long) on attitudes toward wolves and wolf management of 2 interest groups (rural residents, foresters) in Poland. We define rural residents as people living in villages within the study areas, and foresters as employees of the State Forests National Forest Holding whose duties involve regularly working in the forest.

Foresters were included in the study because they represent a key interest group for wolf conservation. Foresters are responsible for managing the majority of wolf habitat in Poland and the only organized service present on an everyday basis in wolf territories across Poland (Gula 2008a). In some regions, foresters are also responsible for game management (including wolf prey), further underlining the relevance of this interest group for wolf conservation efforts. Foresters in this survey also lived in the study areas, so they can be viewed as a subset of rural residents. In light of foresters' close ties to wolf habitat and

management, however, and coupled with the strong organizational culture of the State Forests Holding, we expected to find differences in attitudes toward wolves between foresters and other rural residents.

We measured attitudes using a self-administered questionnaire. Within each region, we targeted approximately 50 rural residents and 50 foresters. The minimum age for participation in the survey was 16 years. We were concerned that a postal survey would result in a very low response rate, so we distributed questionnaires to rural residents via wolf biologists working in each area. These biologists used a mix of methods to distribute the survey either personally or, in most cases, via people not associated with wolf research, including contacting neighbors and acquaintances in person, going door-to-door in the villages, and distributing the questionnaire at community meetings and local businesses. We sampled foresters via forestry district offices; questionnaires were either distributed to and completed by foresters during meetings or given to the forest district manager for distribution among employees and collected at a later date. We added to the forester group 31 rural residents who identified themselves as a forester in the questionnaire. Before they completed the questionnaire, we provided respondents with information about the purpose of the research and informed them that their participation was voluntary and all responses were anonymous and confidential. We collected data from March 2016 to March 2017.

Although we did not measure the response rate among rural residents and foresters, we expected it to be very high. Persons distributing the questionnaire reported that few people declined to do the survey. Furthermore, the hierarchical nature of the Polish forestry authority coupled with foresters' long tradition of following requests from authorities (Lawrence 2009, Olszańska 2012) make it likely that they would have completed the questionnaire when asked by their manager.

Questionnaire Design

The questionnaire contained 54 questions in 6 sections, printed as an A5 booklet (English version available online in Supporting Information). We adapted questions from previous human dimension studies (e.g., Kaczensky et al. 2004, Bath et al. 2008, Majić and Bath 2010, Glikman et al. 2012, Slagle et al. 2012). The first 20 questions measured affective and cognitive components of attitudes toward wolves, fear of wolves, and intent to support or oppose wolf conservation (Table 1). The next 8 items measured attitudes toward specific management options. Respondents answered each question on a 5-point scale. We coded answers to the 20 wolf attitude items so that 1 = very negative attitude (or very high fear), and 5 = very positive attitude (or very low fear). Responses to the management options were coded as 1 = strongly disagree, and 5 = strongly agree. The middle options of the response scale were labeled 'no opinion,' 'neutral,' and in 2 cases 'I am indifferent to it.'

Five questions measured respondents' knowledge of wolf biology and ecology. These questions were mostly multiple-choice, with 2–4 answer choices and a 'not sure' option to

Table 1. Summary of exploratory factor analysis (using a direct oblimin rotation) for the 20 wolf attitude items in the questionnaire. Data were collected from foresters and rural residents in 6 regions of Poland between March 2016 and March 2017 ($n = 548$). Dashes represent factor loadings < 0.40 .

Item	Rotated factor loadings		
	Affect and benefits	Costs and conservation support	Fear of wolves
Attitude toward wolves in Poland	0.78	–	–
It is important to have wolves in Poland for future generations	0.74	–	–
Wolves are an important and natural part of forest ecosystems	0.73	–	–
Attitude toward wolves in the region	0.72	–	–
Attitude toward wolves in general	0.68	–	–
Having wolves in Poland helps preserve the wolf as a wildlife species	0.66	–	–
There is no need to have wolves in Poland because they already exist in other parts of Europe	0.57	–	–
Wolves restore the environment to a more natural state	0.51	–	–
If I were hunting and I saw a wolf I would shoot it	–	–	–
The presence of wolves in the forest attract tourists	–	–	–
Wolves cause farmers to lose money	–	0.75	–
Wolves cause too much damage to livestock	–	0.74	–
Wolves limit ungulate populations	–	0.64	–
There are too many wolves in Poland	–	0.57	–
I would sign a petition to support wolf conservation	0.40 ^a	0.57 ^a	–
I would support an increase in wolf numbers in Poland	–	0.50	–
I would sign a petition to oppose wolf conservation	–	0.48	–
Wolves have a negative impact on hunting opportunities in Poland	–	–	–
I would be afraid to walk in a forest where wolves are present	–	–	0.65
In areas where wolves live close to people, wolves are dangerous to humans	–	–	0.61
Eigenvalues	8.36	1.66	1.40
% Variance	41.81	8.28	7.00
α	0.89	0.83	0.74

^a These items loaded highly on the same factor and were excluded from the analysis.

eliminate guessing. Answers were coded as dichotomous variables, using 1 for the correct answer and 0 for incorrect, not sure, and missing answers. We summed correct answers to compute a knowledge score. Five questions (with dichotomous yes–no responses) measured respondents' experience with wolves: whether they had ever observed traces of wolves in the wild, observed a wolf in captivity or in the wild, observed livestock or pets attacked by a wolf, or personally killed a wolf. Responses were coded as 1 if the respondent had experienced a particular situation and 0 if they had not; we then summed answers to produce an experience score.

Next, we included 10 items based on Teel et al. (2010) to measure domination and mutualism wildlife value orientations, with a 5-point response scale from strongly disagree (coded as 1) to strongly agree (coded as 5): the middle option was labeled 'neutral.' The last part of the questionnaire asked respondents about their gender, age, education level, and whether they are a hunter, forester, or own livestock.

Data Analysis

We carried out all analyses using SPSS (IBM SPSS Statistics for Macintosh Version 24.0, released 2016; IBM Corp., Armonk, NY, USA) and Microsoft Excel (Microsoft Excel for Mac 2011, Version 14.6.9; Microsoft Corp., Redmond, WA, USA) and excluded cases with missing data list-wise from analyses. All statistical tests were 2-sided, with $\alpha = 0.05$. We used t -tests and 2-way analysis of variance (ANOVA) with simple effects analysis to compare

groups, using Cohen's d and η^2 to measure effect size (Vaske 2008).

We used exploratory factor analysis with an oblique rotation (direct oblimin) to examine the structure of the 20 wolf attitude items. We extracted factors with eigenvalues > 1 and used loadings > 0.40 to identify items belonging to each factor (Field 2013).

We fitted a linear regression model to predict each of the 3 wolf attitude subscales identified through the factor analysis and included 11 potential explanatory variables in each model. Explanatory variables comprised 5 integer–continuous variables: knowledge and experience scores (ranging from 0 to 5), mutualism and hunting beliefs scores (ranging from 1 to 5) and age (in years); and 6 dummy variables: wolf history of region (1 = respondent lives in a region with a long history of wolf presence), gender (1 = female), hunter (1 = respondent is a hunter), livestock (1 = respondent owns livestock), forester (1 = respondent is a forester), and education (1 = respondent has a tertiary education). Models only included the main effects of each explanatory variable. For each regression model, all Variance Inflation Factors were < 2 and the largest correlation between independent variables was $r = 0.48$; therefore, multicollinearity was not a concern.

Finally, we used the second generation of the Potential for Conflict Index (PCI₂) and associated graphing technique to analyze and compare respondents' support for the 8 wolf management options (Vaske et al. 2010). This approach is increasingly used in human dimensions research to communicate the support for different wildlife

management options among different interest groups (e.g., Needham et al. 2004, Frank et al. 2015, Sponarski et al. 2015). The maximum potential for conflict ($PCI_2 = 1$) suggests an issue is highly controversial and occurs when responses to a particular management action are split equally between the 2 extremes of the response scale (e.g., 50% strongly agree and 50% strongly disagree). The minimum potential for conflict ($PCI_2 = 0$) occurs when all answers fall on the same point of the response scale, indicating a high level of consensus on an issue (Vaske 2008; see also Vaske et al. 2010 for a detailed description of how the index is computed). We calculated PCI_2 values using the software available at <http://warnercnr.colostate.edu/~jerry/PCI2/index.htm> (Accessed 17 Apr 2017).

RESULTS

The sampling method resulted in 617 completed questionnaires, comprising 292 rural residents (59% female, average age 43.6 yr) and 325 foresters (16% female, average age 45.5 yr). Greater than a third (35%) of the sampled foresters were hunters, compared with just 3% of rural residents. Fifty-two percent of foresters had a university education compared with 36% of residents, while the rate of livestock ownership was similar between the 2 groups (29% for residents and 32% for foresters).

Attitude Subscales Derived from Factor Analysis

The factor analysis produced 3 factors that together explained 57% of the variance (Table 1). Items that cluster on each factor suggest that Factor 1 represented affection for wolves and beliefs about their benefits. Factor 2 represented beliefs about the negative effects of wolves and support for wolf conservation. Factor 3 represented fear of wolves.

Three items—‘If I were hunting and I saw a wolf I would shoot it,’ ‘The presence of wolves in the forest attracts tourists,’ and ‘Wolves have a negative impact on hunting opportunities in Poland’—did not load highly on any factor. A fourth item—‘I would sign a petition to support wolf conservation’—loaded highly on Factors 1 and 2. These 4 items were excluded from further analysis.

We treated the extracted factors as 3 wolf attitude subscales, which we labeled ‘Affect and benefits,’ ‘Costs and conservation support,’ and ‘Fear of wolves.’ These subscales showed acceptable reliability: Cronbach’s alpha (α) ranged from 0.74 to 0.89. We computed a respondent’s mean score for each attitude subscale by averaging their responses to the items belonging to that subscale.

The 5 items measuring mutualism values also showed acceptable reliability ($\alpha = 0.76$), but the reliability of the 5 domination items was poor ($\alpha = 0.60$). Deleting 3 domination items resulted in a 2-item scale with adequate reliability ($\alpha = 0.68$). The 2 remaining items—‘Hunting is cruel and inhumane to the animals’ (which was reverse coded) and ‘People who want to hunt should be provided with the opportunity to do so’—reflect beliefs about hunting, which is one dimension of a domination value orientation (Teel et al. 2010). We computed a ‘mutualism’ score for each respondent by averaging their responses to the 5 mutualism

items and a ‘hunting beliefs’ score based on the mean response to the 2 hunting-related items.

Attitudes Toward Wolves

On average, respondents expressed neutral to positive attitudes toward wolves. The mean score (3.6) for the ‘Affect and benefits’ subscale suggests that most respondents liked wolves, valued them as a species, and believed that they have positive effects on ecosystems. The mean score (3.0) for the ‘Costs and conservation support’ subscale suggests that, on average, respondents were undecided about the potential costs of wolves and neither supported nor opposed wolf conservation. Finally, the mean score (3.2) for the ‘Fear of wolves’ subscale suggests that, on average, respondents were not afraid of wolves.

For the ‘Affect and benefits’ attitude scores, the ANOVA did not produce main effects of interest group (forester vs. rural resident) or wolf history (long vs. short). Main effects, however, were observed for ‘Costs and conservation support’ and ‘Fear of wolves,’ representing minimal to typical effect sizes (Table 2). For both ‘Affect and benefits’ and ‘Costs and conservation support’ there was an interaction (albeit minimal in effect size) between group and wolf history ($P < 0.01$). This indicates that the effect of historical wolf presence on local attitudes was different for rural residents than it was for foresters. Simple effects analysis shows that residents from regions with a long history of wolf presence (east of the Vistula River) held less positive attitudes than did residents from regions where wolves have recovered more recently (west of the Vistula River) for both ‘Affect and benefits’ ($F_{1,605} = 11.10$, $P = 0.001$, $d = 0.39$) and ‘Costs and conservation support’ ($F_{1,609} = 24.50$, $P < 0.001$, $d = 0.60$), representing minimal to typical effect sizes. In contrast, foresters from each side of the Vistula River did not differ in any of the wolf attitude subscales.

When comparing foresters and residents in regions with a similar history of wolf presence (i.e., from regions either east or west of the Vistula River), foresters expressed more negative attitudes for ‘Cost and conservation support’

Table 2. Results from a 2-way analysis of variance for group (rural resident, forester) and wolf history (short, long) for the 3 wolf attitude subscales: “Affect and benefits” ($n = 609$), “Costs and conservation support” ($n = 613$), and “Fear of wolves” ($n = 603$). Data were collected from foresters and rural residents in 6 regions of Poland between March 2016 and March 2017.

Attitude	df	Mean square	F	P	η^2
Affect and benefits					
Group	1	0.00	0.01	0.941	0.00
Wolf history	1	0.66	1.27	0.261	0.00
Group \times Wolf history	1	7.19	13.84	<0.001	0.02
Costs and conservation support					
Group	1	24.86	40.42	<0.001	0.06
Wolf history	1	12.47	20.27	<0.001	0.03
Group \times Wolf history	1	4.51	7.32	0.007	0.01
Fear of wolves					
Group	1	33.29	28.59	<0.001	0.05
Wolf history	1	7.90	6.79	0.009	0.01
Group \times Wolf history	1	0.00	0.00	0.958	0.00

Table 3. Regression model of possible predictors for 3 measures of attitudes toward wolves: “Affect and benefits” ($n=574$), “Costs and conservation support” ($n=576$), and “Fear of wolves” ($n=567$), where b = unstandardized coefficients and β = standardized coefficients. Data were collected from foresters and rural residents in 6 regions of Poland between March 2016 and March 2017.

	Affect and benefits		Costs and conservation support		Fear of wolves	
Adjusted R^2	0.27		0.35		0.17	
F	20.08		29.00		12.10	
P	≤ 0.001		≤ 0.001		≤ 0.001	
Possible predictors	b	β	b	β	b	β
Knowledge	0.17	0.30*	0.13	0.19*	0.27	0.30*
Experience	0.03	0.04	-0.02	-0.04	0.16	0.18*
Mutualism	0.31	0.36*	0.28	0.26*	0.05	0.03
Hunting beliefs	-0.04	-0.06	-0.18	-0.22*	-0.06	-0.05
Wolf history of region	-0.00	-0.00	-0.19	-0.11*	-0.27	-0.12*
Gender	-0.01	-0.01	-0.03	-0.02	0.08	0.04
Age	-0.01	-0.10*	-0.01	-0.09*	-0.00	-0.00
Education (degree)	0.16	0.11*	0.07	0.04	0.14	0.06
Hunter	-0.19	-0.10*	-0.34	-0.17*	0.11	0.04
Livestock	-0.15	-0.10*	-0.09	-0.05	-0.16	-0.07
Forester	0.12	0.00	-0.16	-0.01*	0.16	0.07

* $P < 0.05$

than did rural residents (west: $F_{1,609} = 40.69$, $P < 0.001$, $d = 0.71$; east: $F_{1,609} = 6.73$, $P = 0.010$, $d = 0.31$), again representing minimal to typical effect sizes. For ‘Affect and benefits,’ a cross-over effect was evident: west of the Vistula River foresters expressed more negative attitudes than did rural residents ($F_{1,605} = 7.13$, $P = 0.008$, $d = 0.28$), but east of the Vistula the reverse was true ($F_{1,605} = 6.70$, $P = 0.010$, $d = -0.33$), representing minimal effect sizes. There were no interaction effects for ‘Fear of wolves.’ Here the main effects indicated that foresters expressed lower levels of fear, mean score 3.4 ± 1.1 (SD), than did rural residents (2.9 ± 1.1), while respondents west of the Vistula River were less fearful (3.3 ± 1.1) than were respondents from the east (3.1 ± 1.1).

The 3 regression models predicting wolf attitudes explained 17–35% of variation in the subscale scores (Table 3). ‘Affect and benefits’ was positively influenced by knowledge, mutualism values, and education level, and negatively influenced by age, being a hunter and owning livestock. ‘Costs and conservation support’ was also positively influenced by knowledge and mutualism values and negatively influenced by hunting beliefs, a long history of wolf presence in a region, age, and being a hunter or forester. Finally, knowledge and experience tended to increase scores for ‘Fear of wolves’ (i.e., were associated with lower levels of fear), while a long

history of wolf presence was associated with greater levels of fear.

Attitudes Toward Wolf Management

Only 32% of respondents agreed that wolves should be completely protected, 47% disagreed, and 21% had no opinion. Greater than half (55%) of respondents would support seasonal wolf hunting, and 50% agreed that wolf hunting should be restricted to specific areas. Support for unrestricted hunting, however, was very limited—only 11% of respondents believed that wolves should be hunted all year round.

West of the Vistula River, where wolf recovery is a more recent phenomenon, foresters disagreed, on average, that wolves should be completely protected; however, rural residents tended to agree, the difference between groups representing a typical to substantial effect size (Table 4; Fig. 2a). Similarly, foresters, on average, agreed that wolf hunting should be allowed in restricted seasons and restricted areas, whereas rural residents tended to oppose these management options (typical effect size). On average, foresters and rural residents both opposed year-round wolf hunting; relatively low PCI_2 values for this management action (0.16 and 0.10 for foresters and rural residents, respectively) suggest a high degree of consensus within each

Table 4. Comparisons of attitudes between rural residents ($n = 141$ – 142) and foresters ($n = 161$ – 162) west of the Vistula River for the 8 wolf management options. Data were collected from 3 regions of Poland between March 2016 and March 2017.

Management option	Mean		t	df	P	d
	Residents	Foresters				
Complete protection	3.47	2.70	5.88	301	<0.001	0.68
Hunting in restricted season	2.88	3.51	-4.77	302	<0.001	-0.55
Year round hunting	2.06	2.18	-1.10	301	0.272	-0.13
Hunting in restricted areas	2.81	3.27	-3.43	301	0.001	-0.39
Killing a wolf that killed livestock	3.35	3.50	-1.22	301	0.225	-0.14
Compensate farmers for livestock losses	3.88	4.19	-3.25	301	0.001	-0.37
Only compensate farmers if they use methods to prevent losses	3.37	3.07	2.35	301	0.019	0.27
Subsidies for farmers in wolf areas	3.10	3.43	-2.87	302	0.004	-0.33

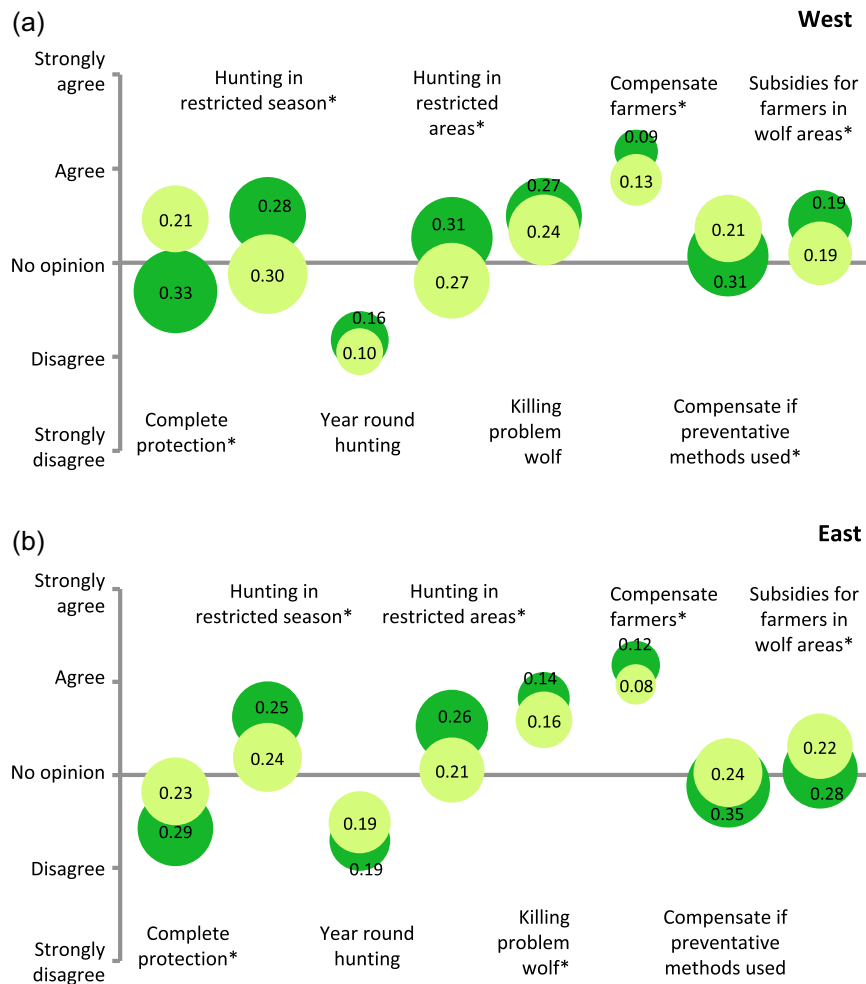


Figure 2. Potential for Conflict Index (PCI₂; Vaske et al. 2010) for attitudes toward wolf management options for foresters (dark green) and rural residents (light green) in Poland a) in 3 regions west, and b) in 3 regions east of the Vistula River. Asterisks indicate management options for which the opinions of foresters and rural residents differed (Tables 4 and 5). Sample size varied by group and question: for rural residents west $n = 141-142$, for rural residents east $n = 147-149$, for foresters west $n = 161-162$, and for foresters east $n = 160-162$. Data were collected between March 2016 and March 2017.

group. Both foresters and rural residents also agreed, on average, with killing a wolf that had killed livestock.

East of the Vistula River, foresters expressed similar views to their counterparts in the west (Fig. 2b); they tended to oppose strict protection of wolves and agree with hunting in specific seasons and areas. Interestingly, east of the Vistula rural residents also, on average, opposed strict protection and agreed with seasonal hunting, with neutral attitudes toward allowing wolf hunting in specific areas. Both groups also supported, on average, killing a wolf that had killed livestock: relatively low PCI₂ values (0.14 and 0.16 for foresters and rural residents, respectively) and a lack of a difference in the views of each group suggest united support for lethal control of problem wolves (Table 5).

When asked about compensation, both foresters and rural residents from west and east of the Vistula River agreed, on average, that farmers should be compensated for losses caused by wolves; low PCI₂ values for this item indicate a high level of consensus within each group (Fig. 2a-b). In comparison, proposals to limit compensation to farms that use methods to minimize predation or to provide subsidies

to farms within wolf areas were met with more neutral attitudes.

DISCUSSION

Our study provides evidence that despite increasing wolf abundance and substantial livestock depredation in the eastern study areas, neutral to positive attitudes toward wolves have persisted in rural areas of Poland. Scores for the 'Affect and benefits' subscale suggest that foresters and rural residents on both sides of the Vistula River tend to like wolves as a species and value their role in ecosystems, matching previous research that reported positive attitudes toward wolves among foresters and residents in Poland (Balčiauskas et al. 2007, Olszańska 2012). However, results uncovered differences in the attitudes of foresters and rural residents, and between residents from regions with different histories of wolf presence. Furthermore, it appears that positive attitudes toward wolves as a species do not necessarily correspond with support for the current ban on wolf hunting.

Table 5. Comparisons of attitudes between rural residents ($n = 147\text{--}149$) and foresters ($n = 160\text{--}162$) east of the Vistula River for the 8 wolf management options. Data were collected from 3 regions of Poland between March 2016 and March 2017.

Management option	Mean		<i>t</i>	df	<i>P</i>	<i>d</i>
	Residents	Foresters				
Complete protection	2.82	2.43	3.15	308	0.002	0.36
Hunting in restricted season	3.19	3.63	-3.61	307	<0.001	-0.41
Year round hunting	2.49	2.29	1.69	306	0.092	0.19
Hunting in restricted areas	3.05	3.53	-3.96	308	<0.001	-0.45
Killing a wolf that killed livestock	3.59	3.83	-2.31	306	0.022	-0.26
Compensate farmers for livestock losses	3.97	4.18	-2.22	308	0.027	-0.25
Only compensate farmers if they use methods to prevent losses	3.03	2.88	1.11	306	0.266	0.13
Subsidies for farmers in wolf areas	3.31	3.04	2.10	309	0.036	0.24

Rural residents from the 3 regions with an uninterrupted history of wolf presence expressed less positive attitudes and lower support for wolf conservation than did residents from the 3 regions where wolves have recovered more recently. This finding, which represents a medium effect size, does not fit the hypothesis that a long history of coexistence will lead to greater acceptance of wolves among local inhabitants (Williams et al. 2002, Fritts et al. 2003). Instead, results align with studies from Europe and the United States that found local attitudes tend to become more negative the longer wolves have been abundant in a region, which is usually attributed to residents' greater exposure to wolf-related conflicts (Treves et al. 2013, Dressel et al. 2014).

In the current study, the substantial rates of livestock depredation in the 3 eastern study areas are likely to be an important factor shaping local residents' attitudes toward wolves. Any acceptance generated from an uninterrupted history of wolf presence may be negated by residents' greater exposure to negative information about wolf attacks on domestic animals (Ericsson and Heberlein 2003, Karlsson and Sjöström 2007). However, given that in our study all regions with a long history of wolf presence also suffer substantial rates of depredation, we are not able to isolate the individual effects of direct wolf-livestock conflicts and more indirect cultural factors (e.g., acceptance of carnivores born of a long history of coexistence). It seems likely that exposure to livestock depredation is a major driver of local residents' more negative attitudes in the eastern study areas, given the high livestock losses in each region. We cannot directly demonstrate this link through our analysis, however, because experience score was not a significant negative predictor of attitudes in the regression models. This suggests that the more negative attitudes in the eastern study areas are more likely the result of second-hand knowledge of local human-wolf conflicts, for example from talking to neighbors about wolf attacks on livestock, than the result of personal experiences. This aligns with a Swedish study that found indirect experiences drive negative attitudes of residents living in or near wolf territories (Karlsson and Sjöström 2007).

According to Chapron et al. (2014), animal husbandry practices that reduce depredation (such as livestock-guarding dogs and electric fences) are a prerequisite for the coexistence of people and carnivores in regions with an

uninterrupted history of wolf presence. In 2 of the eastern study regions (Augustów and Białowieża), livestock protection measures are not widely implemented and cattle are often left unattended on pastures overnight. Therefore, programs to improve animal husbandry on vulnerable farms in these regions (e.g., through electric fencing or the use of night corrals), as well as wild ungulate harvesting regimes that ensure a stable density of natural prey for wolves, could be important strategies to reduce wolf-livestock conflicts and help build local acceptance for the carnivore (Gula 2008c, Chapron et al. 2014). However, in the third eastern study area (Bieszczady) electric fencing, shepherds, and guarding dogs are routinely used to protect sheep on pastures, but predation rates remain high. It is clear that minimizing livestock depredation is essential to foster local acceptance of large carnivores in rural areas (Chapron et al. 2014), but the situation in Bieszczady suggests a caveat that the adoption of farming practices that aim to reduce depredation does not alone guarantee positive attitudes toward the predators.

Unlike rural residents, foresters' attitudes toward wolves did not vary across regions with different histories of wolf presence, aligning with previous research (Olszańska 2012). The consistency of foresters' attitudes may partly reflect that foresters are employees of the same government agency and their views toward wildlife are likely to be influenced by the professional culture of that agency (Kaltenborn et al. 1999). This may be particularly pertinent for Polish forestry, which has a strong cultural identity (Lawrence 2009). Other studies have also reported a strong effect of profession on attitudes toward wolves (Kaltenborn et al. 1999, Naughton-Treves et al. 2003). However, it should be noted that because the occupation of rural residents is unknown, our results do not provide any insights into the influence of profession on attitudes beyond that of being a forester.

On both sides of the Vistula River, foresters tended to be more critical of the costs of wolves and less supportive of wolf conservation than were rural residents (representing a moderate effect size). By the nature of their occupation, foresters in this study frequently work in forests inhabited by wolves and are therefore likely to be more aware of the presence and impacts of the predator (e.g., by encountering remains of prey in the forest). This familiarity may heighten concerns about the abundance and costs of wolves and

temper support for strict protection. Nonetheless, foresters could also be expected to view wolves favorably because of the carnivore's potential to reduce browsing damage in forests by reducing red deer (*Cervus elaphus*) and roe deer (*Capreolus capreolus*) numbers. The strong ties between hunting and forestry in Poland may be an important factor influencing foresters' attitudes. For example, the Polish Hunting Association mostly hunts in forests managed by the State Forests Holding, with a formal agreement between the 2 organizations to collaborate closely on wildlife management (State Forests National Forest Holding [State Forests] and Polish Hunting Association [PHA] 2016). Greater than a third of the sampled foresters were also hunters, making them more likely to have an interest in hunting wolves as a trophy species, but also to be concerned about the effect of a growing wolf population on hunting opportunities for wild ungulates in Poland (although the item related to hunting effects was not included in the analysis). Hunters in Poland claim they already incur economic losses from reduced hunting sales in areas where wolves are present (Okarma et al. 2011). Our regression model confirmed that being a hunter is associated with more negative attitudes toward the carnivore.

Consistent with Olszańska (2012), we found low support for the ban on wolf hunting in Poland. Results indicate that >20 years after wolves were declared a protected species, more than half of respondents would support seasonal wolf hunting. Again, there appears to be important differences in the attitudes of foresters and rural residents, and between residents from either side of the Vistula River. Support for hunting was strongest among foresters, whose attitudes appear to have remained stable over time; in 2006, approximately 60% of foresters agreed with seasonal hunting (Olszańska 2012), compared with 65% in the current study. Given that foresters tended to be critical of wolves' effects on livestock and game, their opposition to strict protection may reflect a desire to curb the negative effects of the carnivore by regulating wolf numbers through hunting.

Rural residents were less supportive of strict protection and more supportive of hunting in regions with continuous wolf presence, compared with residents from regions where wolves have recently recovered. This could indicate that rural residents may become less accepting of wolf protection the longer wolves have been abundant in a region, matching other European studies that report a decline in positive attitudes over time (Dressel et al. 2014). However, it is also possible that opposition to wolf protection (and more negative attitudes) have simply persisted in areas where wolves have been continuously present, but been 'forgotten' in regions where wolves were rare or absent for a long period. In each case, we would argue that livestock depredation is likely to be an important driver of attitudes. Frequent livestock depredation east of the Vistula River may promote (or maintain) more negative attitudes toward wolves, whereas the absence of livestock depredation in the western study areas may have allowed more positive attitudes to persist (or negative attitudes to fade over time). As large carnivore recovery continues across Europe, livestock depredation and

human-wolf conflicts are only likely to intensify (Mech 2016), posing a key challenge for maintaining local support for wolf protection in rural areas.

Differences in attitudes, however, could also reflect different cultural and socio-economic factors in regions with long and short histories of wolf presence. For example, population density was lower in the 3 eastern areas, and rural areas in eastern Poland also tend to be poorer and less industrialized than rural areas in the west (Rosner and Stanny 2017). It is conceivable that people living in these more remote and sparsely populated regions may feel more marginalized than those living in the more densely populated and industrialized west. This attitude may heighten the perceived urban-rural divide in these communities, fueling feelings of political alienation, which could manifest in collective resistance to wolf conservation and subsequently in more negative attitudes among residents (Eriksson 2016).

Although we focused on comparing attitudes across regions and interest groups, results from the regression analysis suggest that respondents' attitudes toward wolves were partly influenced by their knowledge of the species and their underlying values toward wildlife (i.e., mutualism values). This corroborates previous studies that found a positive relationship between knowledge and support for wolves (Ericsson and Heberlein 2003, Glikman et al. 2012), and an inverse relationship between knowledge and fear (Majić Skrbinišek et al. 2015), and which have linked wildlife value orientations with attitudes toward large carnivores (e.g., Zinn and Pierce 2002, Hermann and Menzel 2013, Hermann et al. 2013). These findings support the use of regionally targeted awareness campaigns to help improve attitudes toward wolves in rural areas (Bath 2013). Such campaigns could focus on factual information about wolf biology and habitat, and aim to address misconceptions about wolf-human conflicts that may contribute to negative attitudes. For example, educational messages should emphasize that wolf attacks on humans are extremely rare (Linnell et al. 2002), and that if wolves exist near livestock in areas where wild ungulates are abundant, wolves still selectively predate on wild prey (Meriggi and Lovari 1996, Gula 2008b). Perceived competition between hunters and wolves for wild ungulates could be addressed by communicating that in human-dominated landscapes, large carnivores only have a very limited effect on the density of their prey (Kuijper et al. 2016). These fact-based messages could also be complemented by messages that appeal to people's values (such as messages that focus on the rights of wolves to exist) to further help to foster support for wolf conservation.

Limitations

A key limitation of our study relates to differences between regions with long and short histories of wolf presence. This creates a confounding effect, where it is not possible to isolate the influences of livestock depredation, socio-economic factors and historical wolf presence on local attitudes toward wolves. Therefore we cannot judge whether residents in the study regions with a short history of wolf

presence expressed more positive attitudes because a) they have had less time to develop negative opinions, b) they have been exposed to fewer wolf–livestock conflicts, or c) they feel less marginalized. Unfortunately, the geographic history of wolf presence in Poland makes it difficult to avoid such confounding effects in the study design. In times of persecution, wolves persisted in more remote (and less densely populated) areas of easternmost Poland (Okarma 1993). The prevalence of outdoor cattle and sheep grazing in these regions leads to a greater risk of wolf–livestock conflicts (Jędrzejewski et al. 2008). Here it should be noted that the greater predation rates at the eastern study areas are not the result of greater livestock density (which was generally greater west of the Vistula River), but can instead be ascribed to greater overlap between wolf territories and grazing land (Gula 2008b). Nevertheless, including other regions in Poland where wolves are not present (or present in very low numbers) in the survey design would help future studies to tease out the separate effects of wolf presence and livestock depredation on local attitudes toward wolves.

Another weakness of our study is the possible bias associated with our sampling of rural residents. While a lack of a reliable sampling frame prevented us from conducting true probability sampling, we made special effort to reach a wide range of people and make the selection process as random as possible (e.g., by distributing questionnaires via individuals not associated with wolf research and at community meetings and local businesses), to minimize bias and achieve a representative sample. To help assess the representativeness of the rural resident sample, we used census data to compare the gender and age profile of respondents with that of the population in the communes where the survey was carried out: results (not shown) suggest that elderly residents were underrepresented in the sample. This could contribute to more positive attitudes because attitudes toward wolves are often found (also in our study) to correlate negatively with age (Zimmermann et al. 2001, Dressel et al. 2014, Majić Skrbinišek et al. 2015). While the skewed sex ratio of the forester sample reflects that forestry is still a male-dominated profession in Poland (Bath et al. 2008), the ratio of females in our rural resident sample (59%) is greater than that of the population (47%). This may contribute to less positive attitudes, given that many studies have found that women tend to be more negative than men are toward large carnivores (e.g., Bath et al. 2008, Olszańska 2012, Dressel et al. 2014). Although the neutral to positive attitudes revealed in our study are consistent with other Polish studies (Balčiauskas et al. 2007, Olszańska 2012), given the non-probability sampling method, care is needed in generalizing our results to the wider population of rural residents living in wolf areas in Poland. Future studies could consider alternative sampling frames to target rural residents (e.g., randomly selecting houses identified from aerial photographs); or, if this is not feasible, use quota sampling based on age classes and gender.

Finally, it should be noted that in this study, age and time lived in a wolf area may affect the validity of our measure of direct experience of wolves. We did not measure time lived

in a wolf area, but there was a minimal ($r=0.14$) but relevant ($P<0.001$) correlation between age and experience score.

MANAGEMENT IMPLICATIONS

Our study provides evidence that residents' attitudes are less positive in regions where wolves have been abundant for a longer period and that suffer high rates of wolf depredation on livestock. Results reinforce the importance of curbing wolf–livestock conflicts (e.g., through improving animal husbandry practices on vulnerable farms) to increase local acceptance of the carnivore. Our results are relevant to other regions experiencing wolf recovery, and point to the need for a proactive approach to counteract a potential shift toward more negative attitudes and reduced support for wolf conservation if depredation rates are high. Relationships between knowledge, mutualism values, and attitudes suggests that targeted educational campaigns involving both fact- and value-based messages could be an effective means of fostering and maintaining support for wolf conservation, in areas with both long and short histories of wolf presence.

ACKNOWLEDGMENTS

This study was funded by the Polish National Science Centre (grants NCN2011/01/B/NZ8/04233, NCN2012/05/N/NZ8/00860), SAVE Wildlife Conservation Fund, and Technical University of Munich. M. Hardej helped translate the questionnaire. A. Adamowicz, K. Kochanowicz, M. Kwiatkowska, A. Milanowski, D. Myczkowski, T. Pietrzykowski, B. Pirga, J. Harmuszkiewicz, and A. Laskowska-Ginszt distributed the questionnaires among foresters and rural residents in the study area. We also thank all of the forestry districts that participated in the survey: Baligród, Cisna, Człopa, Krzyż, Mirosławiec, Pieńsk, Ruszów, Skarżysko, Stąporków, Suchedniów, Tuczno, Wałcz, and Wymiarki. Finally, we would like to thank the Associate Editor and 2 anonymous reviewers for their insightful and constructive feedback on our manuscript.

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Associate Editor: Miller.

SUPPORTING INFORMATION

Additional supporting information may be found in the online version of this article at the publisher's web-site. The full questionnaire (in English) is provided.