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Longitudinal Analysis of Attitudes Toward Wolves

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Abstract: *Understanding individual attitudes and how these predict overt opposition to predator conservation or direct, covert action against predators will help to recover and maintain them. Studies of attitudes toward wild animals rely primarily on samples of individuals at a single time point. We examined longitudinal change in individuals' attitudes toward gray wolves (*Canis lupus*). In the contiguous United States, amidst persistent controversy and opposition, abundances of gray wolves are at their highest in 60 years. We used mailed surveys to sample 1892 residents of Wisconsin in 2001 or 2004 and then resampled 656 of these individuals who resided in wolf range in 2009. Our study spanned a period of policy shifts and increasing wolf abundance. Over time, the 656 respondents increased agreement with statements reflecting fear of wolves, the belief that wolves compete with hunters for deer (*Odocoileus virginianus*), and inclination to poach a wolf. Endorsement of lethal control of wolves by the state and public hunting of wolves also increased. Neither the time span over which respondents reported exposure to wolves locally nor self-reported losses of domestic animals to wolves correlated with changes in attitude. We predict future increases in legal and illegal killing of wolves that may reduce their abundance in Wisconsin unless interventions are implemented to improve attitudes and behavior toward wolves. To assess whether interventions change attitudes, longitudinal studies like ours are needed.*

Keywords: human–wildlife conflict, poaching, predator, recovery, restoration, survey, wolf tolerance

Análisis Longitudinal de las Actitudes Hacia Lobos

Resumen: *El entendimiento de las actitudes individuales y la forma en que predicen oposición abierta a la conservación de depredadores o acción directa encubierta contra depredadores ayudará a recuperarlos y mantenerlos. Los estudios de actitudes hacia animales silvestres se basan principalmente en muestreos de individuos en un solo momento. Examinamos el cambio longitudinal en las actitudes de individuos hacia lobos grises (*Canis lupus*). En Estados Unidos, en medio de controversia y oposición persistentes, las abundancias de lobos grises están en su mayor punto en 60 años. Utilizamos encuestas enviadas por correo para muestrear 1892 residentes de Wisconsin en 2001 o 2004 y posteriormente muestreamos nuevamente a 656 de esos individuos que residían en áreas con lobos en 2009. Nuestro estudio abarcó un período de cambios en las políticas e incremento en la abundancia de lobos. En el tiempo, 656 encuestados incrementaron su acuerdo con afirmaciones que reflejan el temor a lobos, su creencia de que los lobos compiten con cazadores por venados (*Odocoileus virginianus*) y su inclinación por cazar un lobo furtivamente. También incrementó el respaldo por el control letal de lobos por el estado, así como la cacería pública de lobos. No hubo correlación entre los cambios de actitud con el período de tiempo en el cual los encuestados reportaron exposición local a lobos ni con el reporte de pérdida de animales domésticos causada por lobos. Pronosticamos mayores incrementos en la matanza legal e ilegal de lobos, lo cual puede reducir su abundancia en Wisconsin a menos que se implementen intervenciones para mejorar las actitudes y comportamiento hacia los lobos. Para evaluar si las intervenciones cambian las actitudes, se requieren estudios longitudinales como el nuestro.*

Palabras Clave: Cacería furtiva, conflicto humanos-vida silvestre, depredador, encuesta, restauración, tolerancia a lobos

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Introduction

Top predators play essential roles in maintaining biological diversity (Terborgh & Estes 2010; Estes et al. 2011). Predators also compete with humans for space and resources and can threaten lives and livelihoods (Packer et al. 2005; Woodroffe et al. 2005). Local people may discount the long-term ecological effects of predators in the face of immediate, real or perceived costs of living alongside them. Hostility toward predators may lead to poaching and opposition to conservation efforts, and such hostility can be a major obstacle to recovery of predator populations (Woodroffe & Ginsberg 1998; Goodrich et al. 2008; Liberg et al. 2011). Yet top predators, such as gray wolves (*Canis lupus*), have rebounded in Europe and the United States following strict legal protection and changed attitudes toward predators.

In the lower 48 United States, abundances of gray wolves have reached their highest levels in 60 years (USFWS 2009, 2011). The federal government has removed protections afforded the species under the Endangered Species Act and claims "... public attitudes toward wolves *now and in the foreseeable future will not be threats* sufficient to cause gray wolves ... to be in danger of extinction [in the Western Great Lakes distinct population segment]" (emphasis added) (USFWS 2009). The assumption that public attitudes are stable and nonthreatening deserves quantitative evaluation.

Responding to a call by Williams et al. (2002), we examined individuals' attitudes, beliefs, and emotions toward gray wolves. Psychological theory thus far suggests changes in beliefs (cognition) and emotions (affect) predict changes in behaviors, although causality may be weakened by intervening factors (Ajzen 1991). Heretofore, researchers studying attitude changes toward large carnivores have used cross-sectional approaches (different individuals sampled at different times). Results of their early studies were somewhat contradictory. Attitudes of residents of Scandinavia and Minnesota (U.S.A.) toward carnivores appear to have improved as their perceived fear decreased or familiarity increased (Kellert 1999; Zimmermann et al. 2001). However, subsequent, larger surveys in Sweden showed attitudes toward wolves became more negative, particularly among hunters, after wolves returned (Ericsson & Heberlein 2003). Results of a comparative study of residents of Utah (U.S.A.) before and after wolf restoration in nearby states showed long-term stability of attitudes toward wolves (Bruskotter et al. 2007). In Croatia, support for wolf conservation decreased and approval for killing of wolves increased from 1999 to 2003 (Majic & Bath 2010) and acceptance of brown bears (*Ursus arctos*) decreased from 2002 to 2008, even though perceived risk from brown bears was unchanged (Majić et al. 2011). In these studies, the possible causes of reported changes in attitudes are difficult to determine without knowledge of how individuals in the 2 samples changed over time. For example, Houston et al. (2010) showed that attitudes reflected in media content about wolves changed over time, but the authors could not distinguish between changes in attitudes and changes in cohorts of reporters, editors, or interviewees. In all cross-sectional studies of change in cognitive attributes it is difficult to disentangle the effects of policy interventions from demographic changes in respondents. Differences among individuals sampled at different times may simply reflect differences among samples.

By contrast, longitudinal data on individuals (panels of respondents resampled at 2 or more times) can distinguish individual histories that may help explain change or detect whether interventions affected attitudes (Henderson et al. 2000). Hence, longitudinal studies allow one to make stronger inferences about the causes of change in individuals' attitudes, beliefs, and behavioral intentions and who has changed.

We studied attitudes, beliefs, and emotions associated with gray wolves, the inclination to kill wolves illegally, and the approval of management interventions from 2001 to 2009 in Wisconsin (U.S.A). We tested 4 hypotheses. First, individual responses to questions change as exposure to wolves increases (familiarity). Some researchers predict familiarity with large carnivores reduces negative attitudes (Kellert 1999; Zimmermann et al. 2001). Others predict negative attitudes increase over time as more individuals report negative experiences (Ericsson & Heberlein 2003; Karlsson & Sjostrom 2007). Second, individuals reporting negative or positive experiences with wolves show greater changes in attitude than other individuals and in the logical direction (direct experience) (Naughton-Treves et al. 2003; Karlsson & Sjostrom 2007; Treves et al. 2009). Third, attitude changes are associated with change in approval for lethal management of wolves (lethal) (Williams et al. 2002; Treves & Naughton-Treves 2005; Treves 2009). Fourth, individuals with more volitional control over killing wolves (e.g., recent hunters) change more in their intention to kill wolves illegally than others (illegal). Although individuals may not behave as they report (Ajzen 1991; Fishbein & Manfredo 1992), widespread and substantial change in reported intentions may correlate with the behavior of other individuals who have opportunity to act as they intend. Finally, because it is often assumed that illegal killing of wolves is driven by fear, competition for game, or economic loss (Goodrich et al. 2008; Sanchez-Mercado et al. 2008; Marchini & Macdonald 2012), changes in fear of wolves, belief in competition for deer, and blaming wolves for domestic animal losses change the inclination of people to kill wolves illegally.

Methods

Background

From 2001 to 2009, Wisconsin's wolf population rose from 257 to 655 animals, and it was widely reported that wolf abundance exceeded the state and federal targets (Refsnider 2009; Wydeven et al. 2009). Authority for wolf management or lethal control oscillated between state and federal agencies (Treves 2008; Ruid et al. 2009; Wydeven et al. 2009). Both wolves and encounters between wolves and people occurred in the upper half of the state (Wydeven et al. 2009; Treves et al. 2011), and the number of wolf attacks on domestic animals, including pets, more than doubled from 358 (1982–2000) to 736 (2001–2008) (Treves et al. 2002; Ruid et al. 2009; Treves et al. 2011). Many deer hunters expressed dissatisfaction with deer harvests (Heberlein 2004; Jacques & Van Deelen 2010), and some blamed predators, including wolves, that prey predominantly on deer (DelGiudice et al. 2009).

Data collection

From 2001 to 2009, we surveyed Wisconsin state residents with 3 mail-back, self-administered questionnaires (see Supporting Information and Naughton-Treves et al. [2003], Treves et al. [2009], and Shelley et al. [2011]). We sent questionnaires to one set of respondents (high-exposure panel, 528 people) in 2001, another set (low-exposure panel, 1364 people) in 2004, and in 2009 resampled only those members of both panels who lived in wolf range. Our justification for targeting this population was interest in those with greater opportunity for exposure to or personal experience with wolves. The high-exposure panel comprised 67 landowners whose domestic animals had been verifiably attacked by wolves, 312 landowners from the same counties selected randomly from commercially available address lists, 48 bear hunters whose hunting dogs had been verifiably attacked by wolves, and 101 randomly selected members of the Wisconsin Bear Hunters Association (Naughton-Treves et al. 2003). In 2004, we randomly sampled members of the low-exposure panel living in 3 urban and 3 rural postal codes selected to span a range of donations to the Endangered Resources Fund (Treves et al. 2009). Half the postal codes were in wolf range and half were outside. In 2009 we resampled only the 687 members of the low-exposure panel with residential addresses in wolf range (3 postal codes for Butternut, Owen, and Wausau townships).

Our 2 panels did not represent all residents living in wolf range. Compared with the latter group, the high-exposure panel contained a higher proportion of bear hunters and people with verified losses to wolves (22%). By contrast, the low-exposure panel was more representative of residents in wolf range (Census 2000), but was biased toward males because commercially available address lists generally provided head of household. The methods we used to address nonresponse and other potential biases are described in Supporting Information.

In 2009, we mailed 1107 questionnaires and 79 (7%) were returned unanswered, 230 (21%) were not returned, and 798 (72%) were returned with data. Nine of the 798 (1%) surveys had identity codes removed, and sex and age of 133 respondents (17%) did not match sex and age of the original respondent. Thus, we had 142 (18%) unintended recipients (Supporting Information) and 656 resampled respondents contributed data twice (253 of 528 [48%] that first responded in 2001 and 403 of 687 [59%] in 2004). Overall response rate was 74% when we discounted undeliverable and unintended recipients (656/[1107 – 79 – 142]).

In 2001 and 2009, we posed 2 statements of belief about wolves and deer (one positive and one negative), 1 about wolf ecology (positive), and 2 about emotion (1 positive and 1 negative) to survey respondents (for wording see Table 1). These 5 statements were not in the 2004 survey. Every year we posed a statement of behavioral intention or inclination to poach a wolf, "If I were out hunting and saw a wolf I might shoot it." Although previous researchers (Kellert 1985; Ericsson & Heberlein 2003) did not use the term *tolerance*, we used it to refer collectively to responses to our survey statements that were measures of beliefs, emotions, attitudes, and inclinations to act. There is an active, unresolved debate about this term (Bruskotter & Fulton 2012; Treves 2012). We used tolerance or intolerance to refer to a disposition to an event or action. Hence, we consider them attitudinal terms, following (Manfredo & Dayer 2004), and do not assume they imply action. When constructing a multi-item scale variable, it is convenient to refer to the scale variable (and direction) with one term that is understandable without reference to methods. Tolerance and intolerance are readily understood as opposites.

We measured the 6 preceding questionnaire items on a 5-point scale (1, strongly agree; 2, agree; 3, neutral; 4, disagree; 5, strongly disagree). When reporting, we condensed the responses into disagree (disagree and strongly disagree), agree (agree and strongly agree), and neutral for ease of comprehension. However, we used all 5 levels in χ^2 tests run in JMP (SAS Institute 2010).

Within individuals we ran Spearman rank correlations between responses to the same survey statements at the 2 periods (5 tests for the survey statements repeated in 2001 and 2009, 1 test for statements repeated in 2001, 2004, and 2009). We also tested internal reliability between survey statements with Cronbach's alpha within years.

We constructed a multiitem scale variable (change) from the 6 statements described above to measure change in tolerance from 2001 to 2009 for the high-exposure panel only. (The low-exposure panel in 2004

Table 1. Changes in responses to survey statements about wolves in 2001 and 2009 within the high-exposure panel of respondents[a] ($n = 250$).

	No change in response (%)			*Changed response (%)*	
Statement[b]	*agree*[c]	*neutral*	*disagree*[c]	*shift toward strongly agree*	*shift toward strongly disagree*
Seeing a wolf in the wild would be one of the greatest outdoor experiences of my life.	11	9	27	18	35
I think wolves are essential to maintaining the balance of nature.	19	7	27	19	28
Wolves keep deer herds healthy by killing the sick and weak animals.	18	5	22	18	37
I think Wisconsin's growing wolf population threatens deer hunting opportunities.	27	4	12	44	13
I would be afraid if wolves lived near my home.	18	9	16	33	24

[a] *Residents of Wisconsin's wolf range first sampled in 2001 because of higher probability of exposure to wolves (see Methods for selection criteria).*
[b] *These statements were not included in our 2004 survey of the low-exposure panel (random residents of Wisconsin's wolf range from Butternut, Owen, and Wausau townships; see Methods for selection criteria).*
[c] *Agree and disagree include strongly agree and strongly disagree responses, respectively.*

was presented with only one scaled statement analyzed here, but see below for other statements.) We measured change as a simple sum of responses to the 3 positive statements about wolves minus the sum of responses to the 3 negative statements about wolves, such that positive values of change indicated higher tolerance over time and negative values lower tolerance over time. Using the same method, we calculated 2 additional multiitem scale variables: endpoint for all panelists' responses in 2009 and startpoint for responses of the high-exposure panel in 2001.

Net change in responses for individual items refers to the percentage of respondents who shifted toward strongly agree minus the percentage of respondents who shifted toward strongly disagree (i.e., percentages of individuals whose responses changed irrespective of amount of change). Our estimates of change in response over time were conservative because we did not alter our measurement scale (it was bounded) and thus limited those who initially responded in the extreme from subsequently responding more extremely. We assessed this potential bias by comparing the respective percentages of respondents who initially chose strongly agree and strongly disagree.

In addition, we analyzed 3 items measured as categorical variables with a forced-choice response. The first forced-choice question, "Do you believe there should be a public hunting/trapping season on wolves?" (i.e., public wolf hunt), had 4 response options ("Yes immediately," "Yes as soon as biologists think the wolf population can sustain annual harvests," "Yes but only when depredations become unmanageable," and "No never"). The second and third items presented conflict scenarios. For "If a wolf kills livestock," and "If a wolf kills a family pet (e.g., dog or cat)," we offered 4 response options in the following order: (1) "authorities should take no immediate action toward the wolf, but monitor the situation"; (2) "authorities should try to frighten the wolf away or deter it from approaching" either "livestock" or "residential areas" (word presented depended on whether the livestock or pet scenario was at issue); (3) "authorities should capture and relocate the wolf to a wilderness area"; and (4) "authorities should kill the wolf" (following Manfredo et al. 1998).

Testing Hypotheses

Our test of the familiarity hypothesis relied on the survey question, "During which years do you think you have seen or heard wolves around your land?" To equilibrate sample sizes, we coded 1970–1999 as familiar, 2000–2009 as less familiar, and never as unfamiliar. We compared the scale variables, change and endpoint, for different respondents in the 3 categories of familiarity.

Our test of the direct-experience hypothesis relied on self-reported losses to wolves. We analyzed responses only from individuals who responded affirmatively to the question, "Have any of your animals been injured or killed by wildlife in the last 5 years?" (lost domestic animals). We compared those who, when given a choice of wildlife, blamed wolves for such losses with those who did not. We compared all 3 multi-item scale variables between the 2 subgroups.

To test the lethal hypothesis, we examined change in response to the public wolf hunt question and the 2 conflict scenarios in relation to the scale variables, change and endpoint. We compared the proportions of respondents who chose any of the lethal response options to the proportion who chose any of the nonlethal options. We found nonresponse bias in the 2 conflict scenarios (Supporting Information) and so drew conclusions conservatively for the test of lethal.

We tested the illegal hypothesis by comparing change in inclination to shoot wolves among past hunters, recent hunters, and nonhunters. We defined hunters as those who responded, *yes* to one of the following questions:

"Have you hunted in the past 2 years?" and "Have you regularly hunted at any other time in your life?" Recent hunters answered in the affirmative to the former question and past hunters answered in the affirmative to the latter question only. Hunters dominated both panels (Supporting Information). Using Spearman rank correlations, we examined changes in agreement with statements relating to poaching, competition for deer, and loss of domestic animals.

Sample sizes for different questions varied because not all respondents answered all questions. Respondents left blank 2.5% of questionnaire items (Supporting Information). We set the criterion for significance of all tests at $p < 0.025$ because the data from 2001 and 2004 were analyzed previously.

Results

Panel Characteristics

Resampled respondents reported living in Wisconsin an average of 52 years (SD 18, range 5–93). Those in the high-exposure panel lived in the state slightly longer than those in the low-exposure panel ($t = 1.9$, $p = 0.06$). In 2009, 34% of resampled respondents were familiar, 41% were less familiar, and 25% were unfamiliar with wolves. As expected, high-exposure panelists were more familiar than low-exposure panelists (df = 2, $\chi^2 = 40$, $p < 0.001$). Hunters, by our definition, comprised 88% of the high-exposure panel and 78% of the low-exposure panel. Our resampled respondents included 554 males, 97 females, and 5 respondents of unknown sex. Ninety-three percent of hunters were male, and 51% of nonhunters were male.

Within individuals, responses to the 3 positive statements about wolves were positively correlated ($r_s > 0.55$, $p < 0.001$ in all 3 pairwise correlations), as were responses to the 3 negative statements ($r_s > 0.25$, $p < 0.001$ in all 3 pairwise correlations). Our survey statements were internally reliable (3 negative statements, Cronbach's alpha = 0.61 in 2001 and 0.62 in 2009; 3 positive statements, Cronbach's alpha = 0.83 in 2001 and 0.86 in 2009).

By 2009, a net 9–19% fewer high-exposure panelists agreed with the positive statements about wolves than in 2001. By 2009 a net 9–31% more high-exposure panelists agreed with the negative statements about wolves than in 2001 (Table 1). By 2009, agreement with the statement, "If I were out hunting and saw a wolf I might shoot it," increased a net 6% among hunters ($n = 535$ from both panels). Median change in response to this statement did not differ between panels ($n = 626$, $Z = -0.3$, $p = 0.79$): 46% were unchanged, 35% changed to strongly agree, and 19% changed to strongly disagree by 2009 (average change = 0.22 [SD 1.1], significantly nonzero: $t = 4.1$, $p < 0.001$). The multi-item scale variable change showed a significant nonzero decline since 2001 (df = 252, mean [SD] = −0.27 [0.67], Wilcoxon one-sample test, $p < 0.001$).

By 2009 the 2 panels differed in the multi-item scale variable endpoint (Wilcoxon $Z = -3.4$, $p < 0.001$) because of differences in responses to statements about deer hunting, balance of nature, and outdoor experiences (Table 1) ($p < 0.01$ for each test). Endpoint did not differ on the basis of responses to statements related to fear of wolves ($p = 0.34$) or poaching wolves ($p = 0.08$). By 2009, 43% of panelists said they feared wolves, and 18% of hunters said they would poach a wolf (including 25% of the 159 bear hunters).

Hypothesis Tests

Reported inclination to poach a wolf did not differ on the basis of familiarity with wolves when panels were pooled ($n = 614$, df = 2, $F = 1.2$, $p = 0.29$). The high-exposure panelists who were unfamiliar with wolves changed tolerance as much as respondents who were familiar and less familiar with wolves (Wilcoxon df = 2, $\chi^2 = 4.9$, $p = 0.09$). By 2009 unfamiliar respondents were more tolerant of wolves than familiar or less familiar respondents (endpoint 3.3, 2.8, and 2.7, respectively; $\chi^2 = 42$, $p < 0.0001$). These results do not support the familiarity hypothesis.

By 2009, 98 panelists (30% of the high-exposure panel and 7% of the low-exposure panel) responded affirmatively to the question, "Have any of your animals been injured or killed by wildlife in the last 5 years?" These respondents most often blamed wolves (58%) for these losses, but they also blamed black bears (*Ursus americanus*) (27%), coyotes (*Canis latrans*) (16%), wolf-dog hybrids (4%), and feral dogs (3%). High-exposure panelists who reported lost domestic animals did not differ in the change variable from those reporting no such loss ($Z = -1.5$, $p = 0.12$), and the subset of respondents who blamed wolves did not differ from the subset who blamed other wildlife (change $Z = -1.2$, $p = 0.21$). Those alleging a loss had lower endpoint than those alleging no loss ($Z = 5.5$, $p < 0.001$), but those who blamed wolves did not differ in endpoint from those who blamed other wildlife ($Z = 1.5$, $p = 0.15$). This result does not support the direct-experience hypothesis for negative interactions with wolves.

By 2009 the response "Yes, immediately" to the question "Do you believe there should be a public hunting/trapping season on wolves?" increased in both the high-exposure and low-exposure panels by a net 19% and 15%, respectively. Corresponding declines occurred in the responses, "Yes as soon as biologists think the wolf population can sustain annual harvests" (–10% and –12%, respectively), "Yes, but only when depredations become unmanageable" (–4% and –2%, respectively), and "No never" (−4% and −1%, respectively). We found no evidence of acquiescence bias or order effects

(Supporting Information). The responses of 58% and 53% of panelists did not change over time, but the 2 panels differed in pattern of response in 2009 (df = 7, $\chi^2 = 28$, $p < 0.001$) (e.g., "Yes, immediately" responses were 58% for high-exposure panelists and 40% for of low-exposure panelists).

Presented with the scenarios "If a wolf kills livestock" and "If a wolf kills a pet" approval for lethal control increased in both panels since 2001 or 2004. The percentage of high-exposure panelists who chose the lethal response ("Authorities should kill the wolf") increased by 11% and 16% with the 2 scenarios, respectively. Similarly, in the low-exposure panel, the increase was 13% and 14%, respectively. Approval of lethal control in the livestock scenario reached 74% and 57% by 2009 in the high- and low-exposure panels, respectively. Approval of lethal control in the pet scenario reached 74% and 60% by 2009 in the high- and low-exposure panels, respectively. We found some nonresponse bias in these questions (Supporting Information), but the pattern of change was consistent among panels so the results seem robust.

Those who approved of lethal options showed greater change in the direction of lower tolerance since 2001 than those who approved of nonlethal options (public wolf hunt, $Z = 1.6$, $p = 0.13$; livestock scenario, $Z = 3.2$, $p = 0.002$; pets scenario, $Z = 2.7$, $p = 0.006$). Those choosing lethal options differed significantly in endpoint ($Z > 6.9$, $p < 0.001$ in all 3 tests). These results support the lethal hypothesis.

Recent hunters, past hunters, and nonhunters did not significantly differ in their changes in reported inclination to poach a wolf (equal variances $F = 1.7$, $p = 0.17$). The 409 recent hunters and 112 nonhunters both increased agreement by 0.25, whereas 104 past hunters did not change (average change –0.03). This result does not support the illegal hypothesis. Recent, past, and nonhunters differed significantly in their response to this question in 2009 (df = 2, $\chi^2 = 14$, $p = 0.008$). Reported inclination to poach a wolf changed in correlation with changing agreement with the statement that wolves threaten deer hunting ($r_s = 0.18$, $p = 0.005$), but not with fear of wolves ($r_s = -0.05$, $p = 0.45$) or blaming wolves for loss of domestic animals ($r_s = -0.06$, $p = 0.55$).

Bias

To assess bias, we analyzed the scale variable, change, for underestimation, hunter, and male biases. For all survey statements except one, the extreme negative responses outnumbered the extreme positive responses by 12–14% in 2001, so we underestimated declines in tolerance (conservative bias). The exception was inclination to poach a wolf, for which strongly disagree responses exceeded strongly agree responses by 27% in 2001 or 2004. In 2009 that value was 18%, a net 9% shift toward agreement, which is consistent with our finding of an overall net 6% change in this measure. Therefore, we did not overestimate the increasing inclination to poach wolves. The scale variable, change, did not differ between hunters and nonhunters ($Z = 1.5$, $p = 0.12$) or between men and women ($Z = -1.1$, $p = 0.26$). Therefore, we conclude our tests of hypotheses were not biased by underestimation, hunter, and male biases.

Endpoint differed for nonhunters and women compared with hunters and men, respectively ($Z = 7.2$ and 4.1, respectively, $p < 0.001$ for both tests). In 2009 nonhunters and women were more tolerant than hunters and men, respectively. Presumably this reflects different initial attitudes. Startpoint for the high-exposure panel revealed the expected hunter and gender difference in 2001 ($Z = 4.4$ and 4.8, $p < 0.001$ for each).

Discussion

Studying how people think about wildlife aids conservation because attitude and intention may predict behavior, both legal and illegal. Longitudinal studies are especially important for revealing trends in cognitive and emotive measures associated with conservation interventions. Over time residents living in the range of Wisconsin's gray wolf became less tolerant of wolves. Our longitudinal study of the same individuals yielded insights into whose attitudes changed and why. Fear of wolves increased, a sense of competition for deer increased, inclination to poach wolves increased, approval of lethal control of wolves involved in livestock and pet attacks increased, and endorsement of regulated public hunting or trapping of wolves increased. The strongest correlation with increased inclination to poach wolves was competition over deer, an icon of the hunting culture in Wisconsin, not fear or lost domestic animals. Familiarity with wolves (length of exposure) was not correlated with change in attitude. Direct negative experiences with wolves—reported as allegations of lost domestic animals—were weakly and inconsistently associated with diminished individual tolerance for wolves. Approval of public hunting and trapping and official, lethal control of wolves implicated in domestic animal attacks were associated with diminished individual tolerance for wolves.

From 2001 to 2009, a panel of respondents with high levels of exposure to wolves and verified economic losses (Treves et al. 2002; Treves et al. 2009) shifted away from valuing wolves' ecological role and became more inclined to emphasize wolves' negative effects on deer hunting and human safety (Table 1). In 2009, the panel of low-exposure respondents began to converge on the attitudes of the high-exposure panel despite experiencing one-third fewer losses of domestic animals.

However, Euro-American hunters were numerically dominant and the sex of hunters was biased toward males in our samples. We had almost 6 times as many hunters in our panels as one widely cited measure of the number of hunters in Wisconsin (USDOI & USDOC 2006). Part of this difference is due to a flaw in the methods of the latter study (Supporting Information) and part is due to the broader definition of hunting we used. Furthermore, within Wisconsin's wolf range a much higher proportion of the human population hunts than outside the wolf's range. Given our survey topic may have triggered disproportionate hunter interest and thus brought about the male bias, our main conclusion of a decline in tolerance could be wrong. However, our results showed no gender bias or hunter bias. Moreover, our measures of tolerance for wolves underestimated changes given that 12–14% of respondents expressed extreme views initially and they could not respond more extremely in 2009. Therefore, our conclusion of a decline in tolerance for wolves seems robust.

Contrary to the claim by the U.S. Fish and Wildlife Service (USFWS 2009), we found unstable attitudes toward, declining tolerance of, and a growing threat of poaching wolves. In Wisconsin and beyond, we predict widespread, increased calls for lethal control and high quotas in public harvests of wolves. In 2012, lawsuits were filed by the Humane Society of the U.S. to restrict methods used in wolf harvests and to eliminate wolf harvests in Wisconsin. State and federal lawsuits were filed against the Wisconsin wolf harvest in 2012 to limit the methods and implementation respectively. However our panelists supported wolf hunting. Familiarity did not spur tolerance, and it seemed to reduce aesthetic appreciation. Those who had seen or heard wolves around their land shifted significantly toward disagreement with the statement "Seeing a wolf in the wild would be one of the greatest outdoor experiences of my life" (Table 1). In 2009 only a quarter of all respondents reported such appreciation. In 2009 almost half of all respondents agreed with the statement, "I would be afraid if wolves lived near my home." Although there have been no documented cases of wild wolves attacking people in Wisconsin, apparently many individuals found it disconcerting to share land with wolves. Another change was the net 31% increase in agreement with "I think Wisconsin's growing wolf population threatens deer hunting opportunities," such that by 2009, 62% of all respondents agreed with this statement. Thus, the strongest changes in tolerance for wolves reflected fear and competition over deer. Neither view necessarily stemmed from personal experience. The individual shifts in attitude could have reflected family, colleagues', and neighbors' experiences, which we did not measure, but our results cast doubt on the strength of personal experience in changing attitudes to wolves.

Efforts to convey the benefits of wolves (Smith et al. 2003; Rooney & Anderson 2009) may not have compensated for negative media coverage (see Background in Methods). The broadly consistent decline in tolerance across genders and interest groups suggests factors beyond individual experiences of wolf behavior or perceived increases in range size and population size account for declining tolerance of wolves in Wisconsin. Our data suggest a possible public backlash against wolves (Mech 1998) across several interest groups residing in wolf range and among men and women. Had we sampled more urban residents our results may have been different (Heberlein & Ericsson 2005). We did not aim for proportional representation of source populations in our panels because we wanted to shed light on key interest groups, such as hunters, who may kill wolves illegally or oppose protectionist agendas via legislative action. States with gray wolves have felt political pressure to implement public wolf hunts (Treves 2008; Bruskotter et al. 2011; Treves & Bruskotter 2011). The responses we received suggest allowing regulated public hunting of wolves will raise public tolerance. Nearly half (46–47%) agreed with a new question posed in 2009, "My tolerance for Wisconsin wolves would increase if people could hunt them." In October 2012 Wisconsin launched its first regulated wolf hunt. Wisconsin Act 169 allows for a statewide, 5-month, 24-hour hunting season that includes the periods of wolf mating and gestation and permits hunting with dogs, bait, and traps. Subsequent to this first hunt, we suggest longitudinal measures of individual attitude among hunters and nonhunters will be needed to test respondents' anticipated increase in tolerance.

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Supporting Information

Our survey instruments for 2001, 2004, and 2009 (Appendices S1, S2, and S3) and additional details of our methods for matching respondents over time, assessing nonresponse bias, imputing item nonresponses, defining hunters, asking about poaching, and asking about public wolf hunting are available online. The authors are solely

responsible for the content. Queries (other than absence of the material) should be directed to the corresponding author.

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