



Paying for wolves in Solapur, India and Wisconsin, USA: Comparing compensation rules and practice to understand the goals and politics of wolf conservation

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ABSTRACT

With growing pressure for conservation to pay its way, the merits of compensation for wildlife damage must be understood in diverse socio-ecological settings. Here we compare compensation programs in Wisconsin, USA and Solapur, India, where wolves (*Canis lupus*) survive in landscapes dominated by agriculture and pasture. At both sites, rural citizens were especially negative toward wolves, even though other wild species caused more damage. Wisconsin and Solapur differ in payment rules and funding sources, which reflect distinct conservation and social goals. In Wisconsin, as wolves recolonized the state, some periodically preyed on livestock and hunting dogs. Ranchers and some hunters were more likely to oppose wolves than were other citizens. The Wisconsin compensation program aimed to restore an iconic species by using voluntary contributions from wolf advocates to pay affected individuals more for wolf losses than for other species. By contrast, wolves had been continuously present in Solapur, and damages were distributed amongst the general populace. Government-supported compensation payments were on offer to anyone suffering losses, yet claims registered were low. There were no significant differences in attitudes of any particular segment of the population, but those losing high value livestock applied for compensation. Residents at both sites did not report (Wisconsin) or expect (Solapur) a change in attitude towards wolves as a result of compensation, yet they support the existence of such programs. To assess the merits of any compensation program, one must disentangle the multiple goals of compensation, such as reducing wolf killing or more fairly sharing the costs of conserving large carnivores.

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1. Introduction

Parks and reserves are essential for conserving wildlife (Karanth et al., 2009, 2010), yet few protected areas are large enough to prevent far-ranging species found at low densities from moving or living outside the reserve. Large carnivores present special problems given their space requirements (Woodroffe and Ginsberg, 1998) and the political controversy these iconic species engender. Conserving wolves, bears, tigers, etc. becomes more difficult as landscapes are increasingly devoted to intensive agricultural use (Foley et al., 2005).

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Many conservationists endorse direct payments to encourage citizens to protect wildlife on their land (Ciucci and Boitani, 1998; Ferraro and Kiss, 2002; Cilliers, 2003; Hussain, 2003; Linnell and Broseth, 2003; Mishra et al., 2003; Zabel and Holm-muller, 2008). Such incentives often take the form of compensation payments for those suffering crop damage or livestock losses to wildlife. Paying for wildlife damage can ostensibly engender local support for conservation, reduce incentives for retaliatory action (Kumar and Rahmani, 1997; Khuukhenduu and Bidbayasakh, 2001; Verdade and Campos, 2004) and buy time for alternative management practices (Nyhus et al., 2005; Wang and MacDonald, 2006). If the direct cost of conserving public wildlife is felt by a narrow minority, compensation may be justified on moral grounds (Treves et al., 2009). Others draw on efficiency arguments. Compensation may be less costly than enforcing wildlife protection against the wishes of local landowners (Verdade and Campos, 2004). Yet there are persistent doubts about compensation, e.g. such payments may not improve local attitudes (Naughton-Treves

et al., 2003; AFESG, 2007), may create moral hazards (such as reduced incentives for animal husbandry: Rollins and Briggs, 1996; Montag, 2003; Bulte and Rondeau, 2005; Nyhus et al., 2005), and/or undermine non-monetary motivations to conserve (Rollins and Briggs, 1996; Hussain, 2003). Compensation payments are also costly and may be unfair or prone to corruption (Sukumar, 1994; AFESG, 2007). Further, compensation may even be unnecessary if the 'victims' are actually beneficiaries of subsidies from the protected area in the vicinity (Chhangani et al., 2008).

The merits of compensation have largely been appraised on the basis of North American and European experiences during recent decades (Wagner et al., 1997; Montag, 2003; Haney et al., 2007). More recent payment initiatives in other countries have generally received less attention, but see AFESG (2007). This research gap is potentially significant given that compensation is culturally and legally embedded in unique traditions about wildlife values and ownership (Treves et al., 2009). For example, responsibility for wildlife may lie entirely with the state (Blanco, 2003; Madhusudan, 2003). If the government refuses liability for wildlife, private advocates, such as conservation NGOs or agricultural cooperatives, may set up compensation programs (Defenders of Wildlife in the northern Rockies and the Great Bear Foundation in Montana: Wagner et al., 1997; Phillips and Smith, 1998; Haney et al., 2007), or help communities organize insurance schemes to reduce individual risk (Hussain, 2003; Mishra et al., 2003). By contrast, local communities may consider wildlife depredation a natural risk, particularly if no entity claims ownership or seeks to defend a threatening or destructive wildlife species (Promberger and Mertens, 2001). We aim to contribute to the growing set of international studies (e.g. Nyhus et al., 2005; Inskip and Zimmerman, 2009), by comparing the motives underlying such payments and the socio-political situations in which compensation takes place

(Cozza et al., 1996; Montag, 2003; Nyhus et al., 2005; Legendijk and Gusset, 2008). Rather than attempt a broad survey of compensation for various animals, we focus on two wolf compensation programs underway in disparate settings.

In restricting comparison to two sites: Wisconsin in USA and Solapur district in India, we are able to reveal the peculiarities of conservation norms regarding ownership and liability for wildlife. Neither Wisconsin nor Solapur contains large wilderness areas. At both sites, wolves must persist in human-dominated landscapes and their fate is largely determined by human activities and tolerances. Thus, we study the relationship between economic losses to wolves (and other wildlife), local attitudes toward conservation, and public participation in compensation schemes.

2. Methods and materials

2.1. Study areas

Solapur district is a semi-arid and drought-prone district (14 844 km²) in Western Maharashtra, India (Fig. 1), with a human population density of ~259/km² (Census of India, 2001). The study area partially overlaps the Great Indian Bustard Sanctuary (GIBS; Fig. 2). Within the Sanctuary, as in the broader study area, most of the land is privately managed grazing areas and agricultural fields, interspersed with a few government-owned forest plots. Wolves persist in Solapur where they coexist with humans. Many wolves den in agricultural berms (Agarwala, unpublished data) and livestock forms an important component of their diet, including goats (*Capra hircus*), sheep (*Ovis aries*) and cattle (both *Bos indicus* and *Bubalus bubalis*). Based on scat analysis, an estimated 63% of the diet of wolves in North Solapur was comprised of livestock,



Fig. 1. Map of Solapur in India.

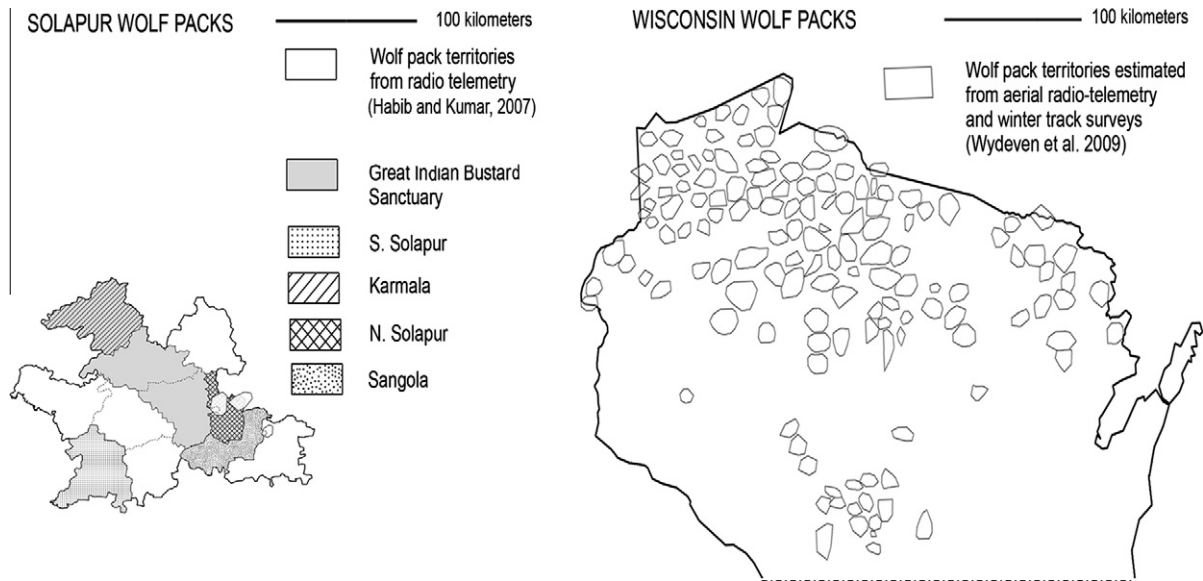


Fig. 2. Map of field sites in Solapur and Wisconsin.

and 100% in Sangola, where no wild ungulates remain. Wolves more often feed on goats and sheep than on cattle (in North Solapur, 71% wolf scats contained goats and sheep, and 14% cattle: Agarwala, unpublished data). Previous studies in the area found a similar high dependence on livestock (Kumar and Rahmani, 2000).

Bounty hunting during colonial rule significantly depleted wolf numbers (Rangarajan, 2001), but wolves have since been protected under the Wildlife (Protection) Act of 1972. This law prohibits killing wild animals (except as self-defense), and favors translocation of problem animals (Chellam and Johnsingh, 1993; Karanth and Madhusudan, 2002). Along with the establishment of protected areas, the Wildlife Act allowed a resurgence in wild populations in some parts of India, including wolves in Solapur (Kumar and Rahmani, 2000), and Velavadar National Park (Jhala, 1991). The Forest Department census in 2005 estimated 103 wolves in Solapur, versus a 1993 count of 53–85 wolves (Kumar and Rahmani, 1997). Most recent estimates include 40 wolves in a subset of areas of Solapur (Habib and Kumar, 2007), and 82 wolves in a different subset of areas (Appendix A). Wolves' persistence in Solapur lies in contrast to other Indian regions, especially Uttar Pradesh and Bihar where conflict between humans and wolves, including lethal attacks on children (Jhala and Sharma, 1997; Rajpurohit, 1999; Kumar, 2003), led to a retaliation (Outlook, 1996) that nearly eliminated wolf populations.

In Wisconsin (140 662 km²), wolves mainly inhabit the northern half of the state, within a mosaic of forests, pastures and agriculture. Wisconsin's human population density is an order of magnitude less than Solapur (<12/km² in wolf range versus 40/km² for the entire state). Publicly held land exceeds 16% of northern areas. In Wisconsin, too, bounty hunting led to extirpation of wolves, but protection under the Endangered Species Act of 1973, allowed wolves to recolonize the state and 640 were present in the winter of 2009 (Wydeven et al., 2009). Wolves first recovered in northern, wooded areas, but have since spread into agricultural fields and encountering livestock. Roughly 20–30 farms annually suffer wolf attacks on domestic animals (<<0.1% of total Wisconsin livestock farms), typically losing one beef calf each. By comparison, each adult wolf is predicted to eat 25 white-tailed deer (*Odocoileus virginianus*) annually.

Solapur and Wisconsin both began formal compensation programs within the past 30 years (details in Table 1). Although such payments were recorded in India as early as the 19th century (for

lion depredation: Rangarajan, 2001), most official programs began more recently. Maharashtra initiated compensation in 1994, the fourth of at least 12 states to do so (unpublished report of Ministry of Environment and Forests (MoEF)-Indian Institute of Public Administration (IIPA), 2001). Compensation rules vary between Indian states (Sekhar, 1998) – e.g. one offers payment only for tiger depredation on cattle around protected areas, while another compensates all wildlife depredation on cattle anywhere. Maharashtra's policy is among the most generous. At the urging of the local Forest Department, in 1999 Maharashtra extended compensation to all livestock listed in 2[(18-A)] of the Wildlife (Protection) Act 1972 (Conservator of Forests, Pune Wildlife Division, 2009, Personal Communication).

As in India, compensation programs vary between regions within the United States. Although neither the federal nor state government is legally liable for wildlife damages, in 1982, Wisconsin began paying for livestock losses to wolves and soon after extended payments to cover wolf attacks on hunting dogs (1986) and farmed game animals (1990). The responsible agency, Wisconsin Department of Natural Resources (WDNR, hereafter), set payment rules and amounts via public consultation. Funding came from state citizens' voluntary contributions to WDNR's Endangered Resources (ER) program (Treves et al., 2009). The Wisconsin wolf population eventually surpassed recovery targets, and in 2005, the federal government began efforts to delist wolves, each time countered by litigation from animal advocacy groups to relist (Treves, 2008). However, state compensation for wolves is guaranteed by a state budgetary rule revision regardless of listing until wolves are reclassified as a game species. For the last 5 years, total payments for wolf damage have averaged USD 98 829 annually (R. Jurewicz, WDNR, unpublished data, January 28, 2010). These high payment costs have created budget shortfalls for the ER, and compromised the agency's ability to conserve other threatened and endangered species (Treves et al., 2009).

2.2. Data collection and analysis

In Solapur, we surveyed attitudes towards compensation with one-on-one interviews. The study site was divided into three sub-sectors: Karmala, Sangola and Solapur (North and South) (Fig. 2). Sangola lay outside the GIBS, and contained no wild ungulates that wolves could prey on. Karmala lay within GIBS. Solapur

Table 1
Comparison of wolf compensation programs in Solapur, Maharashtra and Wisconsin, USA.

	Solapur, India	Wisconsin, USA ^{a,b}
State administrative unit	Maharashtra Forest Department	Wisconsin Department of Natural Resources, Bureau of Endangered Resources
Date of inception	1994	1982
Type of losses compensated	All livestock (cattle, goats and sheep)	All livestock Commercially raised game animals (e.g. pheasants and deer) Hunting dogs Pets Veterinary bills for injured animals
Qualifying locations	Not government-owned land	Livestock and commercial game: private lands only unless owner paying grazing fee for use of public land, or in case of livestock breaking out of fenced private land as they flee wolves Pets and hunting dogs: public or private land
Unique features of wolf compensation vs. other carnivores	None	Pays for non-livestock No cap, except on hunting dogs No deductible Lower threshold of evidence (pays for missing livestock at sites where depredation previously confirmed during same season)
Requirements for compensation		
Site visit by official	Yes	Yes, except for sites of previously confirmed depredation
Verification of carnivore identity	Yes	Yes, except for sites of previously confirmed depredation
Absence of crimes against wildlife in the area ^c	Yes	No
Claimant must comply with carcass disposal requirements on property	No	Yes
Claimant must comply with fencing requirement in case of commercial game animals	NA	Yes
Mark and verify ownership of domestic animal	No	Yes, for missing cattle
Amount compensated		
Mechanism for determining value of prey compensated	Forest Department Officer's judgment, based on Livestock Development Officer's (official government veterinarian) affidavit	Livestock: based on fall market prices Pets and hunting dogs: veterinarian or breeder's affidavit
Percentage of value compensated	75%	100% for livestock Up to \$2500 per hunting dog (some claimants report losses of dogs valued at \$10 000)
Maximum compensation payment to individual claimant in 1 year		
Cattle	Potentially none	\$21,083 ^d
Game animals	NA	\$48,000 ^d
Dogs	NA	\$10,000
Other livestock such as goat, sheep	Potentially none	NA
Maximum compensation payment per animal (Purchasing Power Parity ^f)		
Cattle	\$544.23	\$602 ^d
Game animals	NA	\$4000–5000 ^e
Dogs	NA	\$2500
Other livestock such as goat, sheep	\$181.41	NA
Source of funding	Maharashtra Forest Department obtains funds from the Central Government under the budget head for natural resources and wildlife protection	Wisconsin DNR obtains funds from voluntary contributions via tax check-offs, and state license plate sales, and 1/3 match from state tax revenue
Sunset clause	No	Yes, compensation by Bureau of Endangered Resources will stop when wolves are designated game animals

^a WOLF COMPENSATION RULES from official site, <http://dnr.wi.gov/ORG/LAND/ER/mammals/wolf/wolvesinfarms.htm>.

^b GOW (2008).

^c For Solapur, there must be no incidences of poisoning of wild animals within a 10 km radius of the site.

^d Figure for 2004.

^e \$200 if the game animal was farmed for meat.

^f Purchasing Power Parity (PPP) calculated from Millenium Development Goals Indicators, which reported that one international dollar is equivalent to INR 16.537 <http://mdgs.un.org/unsd/mdg/SeriesDetail.aspx?srid=699>.

sub-sector was more mixed, with North Solapur county lying within the GIBS, and remaining areas of Solapur sub-sector outside it. We conducted 164 interviews, with 50–60 residents per sub-sector. Households were randomly selected for interviews, which included both structured and open-ended questions. Structured

questions quantified the respondents' perception of livestock depredation by wolves, crop depredation by blackbuck (*Antelope cervicapra*), application for compensation, livestock mortality and a three point ordinal rating of agreement with a given statement. Parameters such as education, occupation, and agricultural assets

were also recorded. Open-ended questions delved into perceptions of wolves, blackbuck, compensation schemes, and traditional management of wildlife damage (Agarwala, unpublished Masters thesis). Additionally, respondents were asked how many wolves they saw in different seasons, where and how often. The median of these numbers were used to estimate wolf abundance at each site (Appendix A). We relied on our field interview data for wolf abundance, as they were available at a finer resolution of village. We sought relative abundances at different sites, not precise counts. Data on compensation records for wolf depredation was also obtained from the Forest Department (1999–2008). Village-level census data on people and livestock came from the District Council (Zilla Parishad) (2001) and the Department of Animal Husbandry (2005), respectively.

In Wisconsin, we used a self-administered, mail-back questionnaire to reveal attitudes toward wolves and compensation (Treves et al., 2009). Six postal codes were selected to include residents in three rural and three urban areas, three within and three beyond wolf population range, and spanning high to low levels of voluntary donation to the ER fund; 1364 state residents responded to a 7-page questionnaire mailed to 2202 residents with a \$2 incentive, yielding a response rate of 61.9%.

Test of proportions were used to determine the differences between categories of people such as victims of depredation and all people in Solapur. In Wisconsin, multivariate tests were used to compare attitudes to socioeconomic indicators as well as experience with wolf depredation and compensation payments.

3. Results

3.1. Are public attitudes towards wolves more negative than for other wildlife?

At both sites, wolves were responsible for less damage than other wildlife species such as blackbuck (in Solapur) or bears (in Wisconsin), yet residents viewed wolves more negatively. In Wisconsin, wolves injured or killed only a small fraction of domestic animals, far less than annual losses to other wildlife and feral dogs (USDA-WS annual tables accessed 2008). For example, the federal agency responding to wildlife complaints received 1458 about bears in the same period that wolves were blamed in 206 complaints (USDA-WS 2007 unpublished data). Systematic data on public complaint are unavailable for Solapur, but a similar pattern emerges from our interview data. Respondents experienced a greater intensity of loss to other wildlife (especially blackbuck: 51% respondents, at a median of \$ 250 (n = 93), as opposed to wolf figures. Yet, significantly more respondents approved blackbuck conservation than wolves (Table 2a).

3.2. Are negative attitudes correlated with livestock losses at the household level?

Within the wolf range of Solapur, livestock losses to wolves did not appear to alter attitudes toward the species. Namely, attitudes of those livestock herders who reported depredation were statistically the same as their counterparts who did not (Column 7–8, Table 2a), and no different than non-herders (Column 5–6, Table 2a). Yet, respondents with no education (a category that over-represents livestock herders) claimed depredation was the reason for their attitude (Column 9, Table 2a). Generally, livestock depredation affected a majority of people in the entire study region (64%, n = 116). But annual losses were relatively low at a median of \$60 per person as wolves disproportionately preyed on smaller livestock with lower economic value (goats and sheep are worth \$60). Higher losses due to depredation on cow calves

Table 2a Pattern of responses to questions about wolves among stakeholder groups, Solapur, India, 2008. Numbers in brackets indicate sample size.

	Total (% agree)	Inside PA (% agree)	Outside PA ^a (% agree)	Livestock producers ^b (% agree)	Non-livestock producer (% agree)	No depredation (% agree)	Faced depredation ^c (% agree)	No education (0 years) (% agree)	Primary education (1–5 years) (% agree)	Middle school education (6–9 years) (% agree)	Metric education (>9 years) (% agree)	Blackbuck (for comparison) (% agree)
I do not want wolves to be conserved	0.55 (117)	0.62 (50)	0.50 (66)	0.59 (54)	0.52 (63)	0.53 (36)	0.57 (61)	0.68 (25)	0.48 (27)	0.60 (25)	0.45 (29)	0.15**** (67)
I want wolves to be conserved	0.37 (117)	0.34 (50)	0.39 (66)	0.33 (54)	0.40 (63)	0.39 (36)	0.34 (61)	0.24 (25)	0.44 (27)	0.36 (25)	0.45 (29)	0.78**** (67)
Wolves have a negative effect on my life	0.35 (116)	0.35 (48)	0.37 (63)	0.37 (54)	0.32 (62)	0.19 (36)	0.39 (61)	0.35 (26)	0.27 (26)	0.44 (25)	0.29 (28)	0.17* (69)
Wolves kill dogs	0.61 (115)	0.62 (47)	0.58 (67)	0.55 (53)	0.65 (62)	0.51 (35)	0.67 (61)	0.69 (26)	0.58 (26)	0.50 (24)	0.52 (29)	NA
Wolves kill humans	0.30 (116)	0.46 (48)	0.19 (67)	0.33 (54)	0.29 (62)	0.33 (36)	0.27 (60)	0.23 (26)	0.31 (26)	0.32 (25)	0.28 (29)	NA
Depredation is responsible for my feelings	0.50 (119)	0.48 (52)	0.48 (67)	0.46 (56)	0.54 (63)	0.46 (37)	0.52 (62)	0.73* (26)	0.56 (27)	0.48 (27)	0.45 (29)	0.26* (69)
My feelings are determined by wolves scaring me	0.44 (119)	0.17** (52)	0.55 (67)	0.27 (56)	0.38 (63)	0.38 (37)	0.53 (62)	0.62 (26)	0.33 (27)	0.45 (29)	0.45 (29)	NA
Wolves are part of the natural cycle	0.20 (119)	0.21 (52)	0.18 (67)	0.18 (56)	0.29 (63)	0.30 (37)	0.23 (62)	0.04 (26)	0.37 (27)	0.30 (27)	0.31 (29)	0.16 (69)

^a PA: Protected area.

^b Livestock producers in Solapur defined as those reporting livestock as a primary occupation and those with more than 20% dependence on livestock for income.

^c Respondents alleged depredation.

* p-Value < 0.05 in a statistical test of equal proportions where the null hypothesis is that the proportion of respondents in the given subcategory is equal to the proportion of total respondents (using R version 2.9.2 prop.test).

** p-Value < 0.01 in the same test.

*** p-Value < 0.001 in the same test.

**** p-Value < 0.0001 in the same test.

(5% of respondents, adult cows are worth \$180–\$300) and multiple goat or sheep (39%) do occur but are much less prevalent. These are also over-represented in claims filed for compensation (Fig. 3).

Wisconsin residents living within wolf range (Table 2b), with livestock as major income, and those who hunted bears with dogs were more likely to hold negative attitudes toward wolves. Assuming only one calf is taken, each commercial livestock producer experienced an annual loss of \$602. Even this low estimate is potentially substantial given livestock producers' median annual household incomes are \$30 000–40 000 (vs. \$40 000–50 000 for all respondents). Worse, wolf depredations tended to be clustered, and thus a few individual operations have suffered disproportion-

ately and claimed losses of up to \$25 000 in a single calving season. Ultimately, however, social identity and livelihood more powerfully predicted individual attitudes toward wolves than did individual experience with depredation (Naughton-Treves et al., 2003).

3.3. What factors shape public participation in compensation?

More Wisconsin residents filed complaints for compensation than did in Solapur. Given the relatively small landholdings (livestock farms in wolf range average 86 head and 136 ha; Treves et al., 2004), herd owners' vigilance and the state's financial incentives to report depredations, we estimate that number of compensations is nearly equal to the cases of depredation. At worst, the Wisconsin compensation data may modestly underestimate depredations. The best predictor for those who indicated that they had suffered a loss but chose not to register a claim was education level, this was negatively correlated with inclination to file a claim (Naughton-Treves et al., 2003). Several respondents who reported personal losses to wolves, objected to the requirement of evidence for compensation. And of those who filed a complaint, not all were compensated. From 1999 to 2006, the WDNR logged 768 complaints about wolves. Of these 251 (32.7%) could not be confirmed, 174 (22.7%) were judged to be unrelated to wolves, 289 (37.6%) were verified cases of wolf damage, and 54 (7%) were verified to involve wolves but no damage (WDNR unpublished data). However, compensation was provided for 629 livestock, 12 pet dogs, 115 hunting dogs and 44 farmed white-tailed deer from 1982 to 2008 (Treves et al., 2009).

Similar figures were difficult to obtain for Solapur. Forest Department records do not include the education level of claimants, yet our field interviews revealed that those with no education were less likely to request compensation, and these individuals were especially concerned about lacking evidence to prove their claim (Table 3). From the records available, in Nannaj 38 applicants filed claims from 2004 to 2008, and 37 were compensated, while 50 individuals filed claims in Sangola from 2001 to 2008, and 36 were compensated. Of these, the last 10 cases still awaited a decision at the time of the study. From the interviews, low awareness of the compensation scheme and difficulty in applying led to non-participation of most residents in the area (Table 3). By contrast,

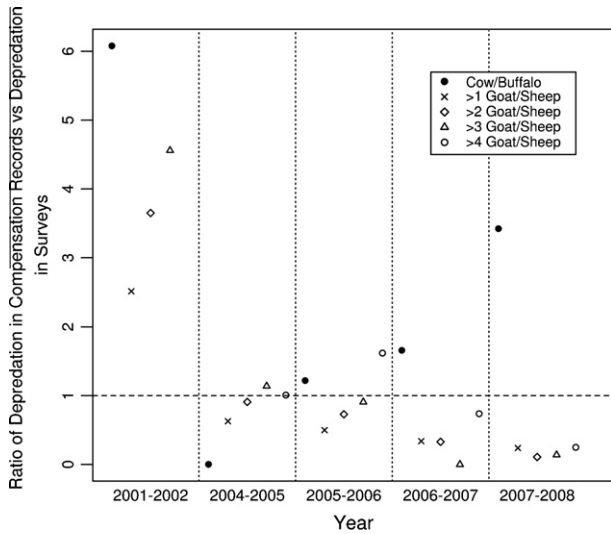


Fig. 3. Over-representation of large cattle in Forest Department compensation records for North Solapur and Sangola districts. Values represent ratio of proportion of number of large cattle in compensation records to proportion of number of large cattle depredation in interview survey, which are consistently above one. In contrast, wolf attacks on multiple goat and sheep (>1, >2, >3, >4) is consistently under-represented. Large cattle are valued at over INR 10 000 (\$200, or \$604.1 in PPP, as calculated from the conversion rate in the Millennium Development Goals Indicators: <http://mdgs.un.org/unsd/mdg/SeriesDetail.aspx?srid=699>), while the monetary values of smaller livestock are lower than INR 3000 (\$60, or \$181.4 PPP).

Table 2b
Pattern of responses to questions about wolves among stakeholder groups, Wisconsin, USA, 2005. Numbers in brackets indicate sample size.

	Inside wolf range (n = 689) (% agree*)	Outside wolf range (n = 625) (% agree*)	Contingency test (likelihood ratio) (df = 4)	Livestock producers ^a (n = 180) (% agree*)	Non-livestock producers (n = 1066) (% agree*)	Contingency test (likelihood ratio) (df = 4)	Never faced loss to wildlife (n = 1280) (% agree*)	Faced loss to wildlife (n = 56) (% agree*)	Contingency test (likelihood ratio) (df = 4)
I think it is wrong to kill wolves because they seem so intelligent and emotionally sensitive	25.1	36.5	66.6, p < 0.0001	21.1	31.9	27.7, p < 0.0001	30.8	23.2	15.8, p = 0.0032
The presence of wolves brings prestige to Wisconsin	33.5	46.0	66.9, p < 0.0001	27.1	41.8	31.6, p < 0.0001	40.0	24.5	12.9, p = 0.011
Our state is in bad shape when we choose to protect wolves instead of hard-working farmers	50.1	23.2	122.9, p < 0.0001	59.4	33.6	53.1, p < 0.0001	36.6	55.4	13.7, p = 0.0084
I may never see a wolf in the wild but it is important to me to know they exist in Wisconsin	49.4	73.3	116.5, p < 0.0001	45.3	63.5	36.4, p < 0.0001	61.1	50.0	4.8, p = 0.30

^a Livestock producers in Wisconsin answered Yes to "Has raising livestock ever been a major source of income for you?".

* The summed percent of respondents who chose "Strongly agree" or "Agree" on a 5-point Likert scale (df = 4).

Table 3Respondents' awareness and use of compensation program, and explanations for those not using compensation scheme in Solapur, India ($n = 133$).

	Knew	Used it	Too much work to make a claim	No proof	Unaware of exact procedure	No depredation since learning of the scheme
<i>Respondents by sub-sector</i>						
North Solapur ($n = 24$)	0.54**	0.08	0.08	0.00	0.00	0.46
Karmala ($n = 40$)	0.23	0.13	0.13	0.13	0.25	0.00
Sangola ($n = 43$)	0.16	0.02	0.14	0.29	0.14	0.43
South Solapur ($n = 26$)	0.15	0.00	0.25	0.50	0.50	0.00
All ($n = 133$)	0.24	0.03	0.12	0.15	0.15	0.27
<i>Respondents according to local wolf density</i>						
Upto 2 ($n = 16$)	0.06	0.00	0.00	0.00	0.00	0.00
2–4 ($n = 24$)	0.13	0.00	0.00	0.33	0.00	0.33
4–6 ($n = 44$)	0.23	0.10	0.10	0.40	0.30	0.20
High ($n = 17$)	0.24	0.00	0.25	0.00	0.25	0.00
Total ($n = 101$)	0.18	0.06	0.11	0.28	0.22	0.17
<i>Respondents according to education</i>						
No education ($n = 26$)	0.19	0.00	0.00	0.80*	0.20	0.00
Primary school (left school between Classes 1 and 5) ($n = 27$)	0.33	0.14	0.29	0.14	0.14	0.57
Middle school (left school between Classes 6 and 9) ($n = 28$)	0.21	0.50	0.25	0.00	0.00	0.50
High school (completed Class 10, and may have higher degrees) ($n = 28$)	0.25	0.00	0.00	0.00	0.40	0.60
All ($n = 109$)	0.25	0.13	0.13	0.21	0.17	0.38

* p -Value < 0.05 in a statistical test of equal proportions where the null hypothesis is that the proportion of respondents in the given subcategory is equal to the proportion of total respondents (using R version 2.9.2 prop.test).

** p -Value < 0.01 in the same test.

knowledge of compensation scheme was greater in areas of Solapur where presence of wolves is publicized due to tourism as in Nannaj, in protected areas (North Solapur and Karmala), in instances where depredation caused higher monetary losses (Fig. 3), and in areas with higher abundance of wolves (Table 3).

In Wisconsin, livestock owners and bear hunters compensated for their losses were not more tolerant than those who alleged a loss but were not compensated (Naughton-Treves et al., 2003). In Solapur, this is difficult to ascertain as only three of 116 people interviewed had successfully received compensation (vs. 74 of 116 surveyed had suffered a depredation). However, 64% ($n = 39$) of respondents said that compensation was unlikely to alter their attitude towards wolves. In Wisconsin, only 16–28% of respondents agreed with the statement, “My tolerance for wolves would decrease if compensation were no longer available” (Treves et al., 2009). In Solapur, there was no difference in responses to the question “Will compensation schemes alter your attitude towards wolves” between those who faced depredation (63%) and those who did not (67%). Despite respondents' doubts that compensation payments would improve local attitudes toward wolves, the majority approved such programs, both in Wisconsin and Solapur (Wisconsin: survey data, Naughton-Treves et al., 2003; Treves et al., 2009; Solapur: open-ended conversations and public meetings, Agarwala, unpublished thesis).

4. Discussions and conclusions

4.1. Methodological challenges

Cross-cultural surveys of attitudes toward wildlife present methodological problems due to varying literacy levels and familiarity with research protocol (Teel et al., 2007). In-depth, face-to-face interviews were most appropriate in Solapur, whereas mailed, self-administered questionnaires were feasible in Wisconsin. Krosnick (1999) concluded that data produced by open and closed questions may be compared, although closed questions limit answers. Our use of open questions in face-to-face interviews in Sola-

pur protected against misunderstandings and recording errors hence they had high reliability (Krosnick, 1999) and allowed us to notice aural cues and nuances (Dillman, 1991). Also, we suspect that social desirability bias (pleasing the interviewer) in face-to-face interviews was not prevalent given the high negative response to wolf conservation. This is consistent with Krosnick's (1999) conclusions as well. Our use of few forced-choice questions in either survey also prevented acquiescence bias (Krosnick, 1999; Dillman, 2007; Smyth et al., 2006) and reduced the possibility of option formation through the questions, such as the idea that killing wolves may be an option. However, differences remain between the surveys, such as ability to see the questions and respond at individual pace as in a self-administered questionnaire (Dillman, 1991) remains. Given Solapur residents were not consistently literate and Wisconsin's residents were found across a huge area and few welcome door-to-door solicitations (as also described in Tourangeau (2004)), the methods were appropriate to the socioeconomic and cultural context.

Second, although data on wolf abundance was collected using very different techniques at the two sites, both used accepted protocols for their sites. In Wisconsin, wolves are radio-collared and systematically studied by the WDNR leading to reasonably accurate estimates of numbers (Wydeven et al., 2009). In India, the protocol of asking local residents has been used by wolf researchers for large-scale census (Jhala and Giles, 1991; Kumar and Rahmani, 1997). Shortage of funds for long term and large-scale field studies often makes this the only viable technique in certain areas (Gros et al., 1996; Rabinowitz, 1997; Wingard and Zahler, 2006).

4.2. Negative bias toward wolves

The fact that people were more hostile towards wolves than other animals at both sites accords with studies elsewhere. For example, Kellert et al., 1996 documented unique antipathy to wolves in North America and Himalayas. This may be due to an inflated perception of losses, which the data from Solapur seems to suggest (Conforti and Azevezo, 2003; Marker et al., 2003; Inskip

and Zimmerman, 2009) but livestock owners enduring the most depredations do not necessarily differ in their attitude from others (Lagendijk and Gusset, 2008; Vynne, 2009). Strong sense of responsibility for animals (Wisconsin: Wagner et al., 1997; Montag, 2003) or fear (as in Solapur) may be equally important, and may need to be addressed in the objective of managing conflict through economic compensation (Montag, 2003). This result complicated the reductionist view where 'culture' in India is used to explain away differences in attitudes towards wildlife. Cultural values in India have been cited as a reason for tolerating wildlife in many studies (Woodroffe, 2000; Mishra et al., 2003; Karanth et al., 2009). Thus, the religious importance of blackbuck may possibly explain their higher approval. Wolves remained present in mainland India while they were extirpated in all but two states in the United States (Wydeven et al., 2009). Yet, it fails to highlight other reasons, and studies have shown reducing tolerance for wildlife in India with altering conditions (Gureja et al., 2002; Sillero-Zubiri et al., 2007; Barua et al., 2010) which may become critical to conservation in the future. While it is generally acknowledged that western traditions have cast wolves in the role of the villain (e.g., Schanning, 2009), even Indian archives, which include ancient texts as well as colonial proceedings, depict wolves as gluttonous and lacking nobility (Rangarajan, 2001). Both traditions also display pro-wolf historical narratives: in Salem, south of Solapur, shepherds considered wolf depredation a good omen (Rangarajan, 2001) while a she-wolf nursed Romulus and Remus who then grew strong enough to found the city of Rome in Italy (Jila, 2006). That residents within protected areas under-reported fear as the reason for antipathy towards wolves in comparison with all respondents may also indicate that contextual factors such as possible land tenure issues that are generally present within protected areas can cause attitudes to diverge.

In a similar vein, if we treat 'culture' as only one reason for respondents being indifferent to depredation, other possibilities emerge such as lack of an economic incentive for filing compensation. For most Solapur residents raising livestock, wolf depredation was not a more probable cause of death of livestock than natural mortality (Table 4). Therefore, risk of wolf depredation and damages were low, which may explain that no differences in attitude were detected. Further, in Wisconsin, wolf prey comprises calves, in comparison with the preponderance of goat and sheep in the wolf diet in Solapur. Their higher value may have prompted greater interest in compensation in Wisconsin, just as individuals were more inclined to demand compensation for cattle depredation in Solapur. But ascribing causality is risky given that in both Solapur and Wisconsin, poorer or less formally educated citizens may feel less entitled to seek compensation and have less confidence in their ability to do so. They may be more likely also to own lower value animals.

Other possible explanations for greater participation in Wisconsin's program include ease of filing complaints and greater citizen

awareness due to publicity campaigns. In Wisconsin, the procedure to obtain compensation is simpler: the claimant telephones a 24-h help-line. A federal agency responds to verify wolf involvement under a cooperative contract with the state. If a wolf is the probable or verified culprit, compensation is obtained within an average of 80 days (Treves et al., 2002). Further, since 2003, verification requirements have been relaxed for claimants with previously verified depredation, and compensation is also available for missing animals (Treves et al., 2009). In Solapur, the procedure is more rigorous to prevent malpractice: the applicant must contact the local forest department office in person within 48 h. Since livestock kills in government-owned land are ineligible for compensation, the village revenue officer must confirm the extent of the applicant's property. Further, the local Livestock Development Officer must certify that the livestock was victim to wolf depredation (GOM, 2003). Therefore, the reasons cited for non-participation are not unique to Solapur: lack of knowledge about exact procedure (Ogra and Badola, 2008), lack of proof as animal attacked in or dragged to forest area by wolves (similar to Madhusudan (2003), who reported this for felids) or ambiguity as carcasses are also eaten by wolves (Blanco, 2003; Montag, 2003) and the time and expenditure involved in traveling and meeting with necessary officials (Madhusudan, 2003) with no guarantee of compensation. Unlike other studies (Mishra, 1997; Madhusudan, 2003; Montag, 2003; Ogra and Badola, 2008), inadequate remuneration was not cited as a reason for non-participation.

Another reason for higher public participation in Wisconsin may be the presence of a pro-wolf constituency in Wisconsin. Wolves' high political significance in Wisconsin is reflected in the state's unique compensation rules for wolves, namely that compensation payments are higher and include more types of losses than payments for other wildlife (Treves et al., 2009). Compensation constitutes a political mechanism for bridging those who place strong importance in wolf restoration (mainly urban citizens, many of whom contribute to compensation fund) with those who oppose wolves (especially rural citizens at risk of losing livestock or hunting dogs). Not only is the active pro-wolf constituency a source of contributions and political action, 'wolf-huggers' may also engender greater resentment by rural citizens who feel wolves represent the interests of outsiders. By contrast, even though strong constituencies exist for animals in India such as tigers, elephants and birds (Karanth et al., 2008), citizens of Solapur were largely unconcerned with wolves and the compensation program did not privilege wolf payments over those for other animals. Further, residents of Solapur did not identify wildlife as a major concern. Only four villages (of 18) mentioned wildlife, or the Forest Department, when asked to speak about their concerns, and only two of those mentioned wolf depredation specifically, although they were primed by a lengthy interview on wolf depredation. Wolves do not have a strong constituency in India, nor do they hold the iconic status they do elsewhere. Avid pro- and anti-wolf constituencies in Wisconsin (and in US, generally) (in 1 year, 5000 letters were written to WDNR about compensation policy (Treves et al., 2009), which created media awareness and lobbied with their local representatives) may also result in increased publicity of the scheme.

A third reason for the indifference towards wolves in Solapur may be due to a history of presence. Wolves have been continuously present in Solapur, even though scarcely mentioned in pre-colonial archives regarding wild animals in India (Rose, 1887; Guha, 1999; Rangarajan, 2001). In contrast, in Wisconsin, as in other US states, it is only with strict legal protection under the Endangered Species Act of 1973 that wolf populations have rebounded through recolonization. Interestingly, wolf depredation was also ranked low among perceived threats and concerns in rural Minnesota where wolves have persisted throughout the 20th cen-

Table 4

Solapur respondents' reported livestock losses ($n = 164$). For each person surveyed, ratio of losses to wolves in the past year to losses to natural mortality in the past year was calculated. This table reports their means.

	Goat	All livestock
Karmala	0.67	0.13
Sangola	0.63	0.31
South Solapur	0.83	0.35
All	0.71	0.28
<i>Wolf abundance wise differences</i>		
Upto 2	0.00	0.00
2–4	0.50	0.08
4–6	0.76	0.34
High	1.00	0.35

tury (Chavez et al., 2005). Blanco, 2003, also reported lower conflict levels in areas in Spain with continued presence of wolves.

4.3. Lessons about compensation

Lower utilization of compensation scheme in Solapur is not necessarily negative as the goal is to maintain and possibly increase wolf populations. In fact, heavy promotion of conservation payments may inflate public perception of wolves or other target species as 'depredators' or (Montag, 2003), state wards (Hazzah and Dolrenry, 2007), or can create expectation that the default landscape is predator free (Doremus, 1999).

Ultimately our comparison underscores Wagner et al.'s (1997) call to address motivations for compensation schemes. In both our case studies, the government did not accept liability for wildlife depredation and offered compensation as voluntary ex-gratia relief. Motivations have been analyzed for USA; compensation programs were introduced to alleviate wildlife related problems of recent origin, conflict situations exacerbated by government action such as reintroduction, or to protect highly valued species (Wagner et al., 1997). American culture values private property and utility, and the state felt a sense of responsibility for reduction in property values of areas affected by re-colonizing wolves and found compensation more economical than relocating highly valued species (Wagner et al., 1997). In India, motivations are more difficult to ascertain as wolf depredation was not a political issue due to their continued presence, lower monetary losses, public acceptance of these losses as an environmental risk, and concentration of losses amongst livestock owners who are usually more marginalized than the general public and may have less political say. As a welfare state, India undertook to look after its human (Article 38: COI, 2010) and wild inhabitants (Article 48: COI, 2010) in its guiding principles (Directive Principles of State Policy). In instituting a policy of providing compensation for more devastating predators e.g. tigers and elephants, conservation payments were made for less contentious wolves as well. With these motivations in mind, Wisconsin's compensation scheme strives to compensate its afflicted populations, as well as the most vocal and politically powerful rural constituents. In its social context, Solapur aims to appease its residents and pledges that its citizens find no fault in the intention of the state with regard to wildlife damages. Therefore, compensation mechanisms exist for individuals who may demand such redressal due to high losses, and do not exist (as they are not publicized) for others. Although compensation fails in altering individual perception of wolves at both sites, residents may feel gratified that the state offers a mechanism to appeal for relief. However, other studies in India have shown that more marginalized groups bear the brunt of depredation and are less likely to be aware of scheme (Ogra and Badola, 2008). Reluctance of migrant shepherds to speak with us makes this more difficult to ascertain in this study, and more focused studies may highlight this. High endorsement for existence of compensation scheme in both Wisconsin and Solapur suggests that the local residents approve state concern on this issue.

5. Conclusion

Whereas both regions' compensation programs aim to distribute the costs of wolf damages and prevent retaliatory action, the ways in which each program are designed reflect the position of the wolf in local and national politics and conservation goals for the wolf.

Strong presence of pro-wolf and anti-wolf constituencies in Wisconsin shaped wolf policy, and the Wisconsin program aims to win over potentially powerful rural opponents (Treves, 2008;

Treves et al., 2009). The government mandate is to reach a numerical target for wolf presence. As a result, Wisconsin's compensation scheme pays more for wolf damage and sets fewer conditions than comparable losses to other wildlife. By contrast, wolves are not a flagship species in India, and most Solapur residents were indifferent to wolves, even if they had experienced a depredation event. The compensation scheme for wolf depredation was instituted in the absence of any strong constituency. Rather than numerical targets, the government mandate is to protect all wild populations. As a result, compensation program in Solapur pays damages for depredation by all species and is less generous in its compensation.

Despite these contextual differences, in both places, people viewed wolves more negatively than other animals such as black-buck and bears, which caused far greater property damage. Further, despite the popularity of compensation at both sites, residents did not report or expect a change in attitude towards wolves as a result of payments.

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Appendix A

Number of wolves reported in Solapur district, India in 2008. Numbers are based on recall surveys.

	Tehsil (county)	Median number of wolves reported	Maximum number of wolves reported
Deolali	Karmala	3.5	10
Khadki- Kamoni	Karmala	2	3
Korti	Karmala	10	15
Poplaj	Karmala	3	5
Nannaj- Vadala	North Solapur	6	8
Chikmuhud	Sangola	8	20
Dahiwadi	Sangola	8	17
Dhayati	Sangola	1	5
Gaudbavi	Sangola	5	10
Junoni	Sangola	5	5
Katfal	Sangola	2	5
Hangirge- Gherdi	Sangola	4	15
Achegaon	South Solapur	2	4

(continued on next page)

Appendix A (continued)

	Tehsil (county)	Median number of wolves reported	Maximum number of wolves reported
Boramani	South Solapur	5	9
Chapalgaon	South Solapur	5	8
Gangewadi	South Solapur	5	10
Musti	South Solapur	4.5	6
Sangvi	Tuljapur (Osmanabad)	3.5	4
Total		82.5	159

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