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RESEARCH ARTICLE



U.S. livestock producer interest in alternatives to compensation programs for wolf depredation

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ABSTRACT

Interest in financial compensation programs for wolf-livestock conflict in the United States is growing, yet we know little about livestock producer perceptions concerning existing programs or potential alternatives. We surveyed producers to ask about challenges they perceive in applying for compensation and/or concerns about program rules and procedures. We then looked at whether they would choose alternatives like cost sharing for conflict management and habitat leasing rather than compensation. We found mixed levels of satisfaction with existing compensation, with about 75% of respondents believing that indirect losses caused from predator-induced stress are as, or more, financially damaging than when wolves kill livestock (depredation). Commonly selected perceptions included dissatisfaction with the depredation reporting and confirmation processes, inadequate compensation, and a lack of trust and satisfaction surrounding depredation confirmations. We found compensation was preferred to cost sharing and habitat leases.

KEYWORDS

Cost-sharing; discrete choice modeling; habitat leasing; human-wildlife conflict; nonlethal tools

With the continuing natural and assisted reestablishment of wolves (*Canis lupus*) across the Western United States (US), support programs for livestock producers are increasingly important (Ravenelle & Nyhus, 2017). Wolf-livestock conflict can result in direct economic losses to the producer in the form of depredation and indirect losses from predator-induced stress such as reductions in seasonal weight gain or reproductive rates, especially from pursuit predators like wolves that run their prey (Ramler et al., 2014). There can also be large time, energy, and resource investments required by livestock producers to monitor wolves and livestock and attempt to prevent conflict (Dickman et al., 2011; D. L. Hoag et al.,).

Compensation programs in the US are administered by government agencies, private businesses, and non-government organizations (NGOs) and aim to mitigate the negative impacts of wolf depredation by paying producers for confirmed depredations (Dickman et al., 2011). The primary objectives of most programs include: 1) improve tolerance for

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predators and foster coexistence (e.g. reduce predator killings, improve producer attitudes toward predators, and improve compliance with conservation protocols), and 2) improve the economic equity and viability of ranches facing predator conflicts by distributing costs over a larger group (Harris et al., 2020). However, little is known about how producers feel about compensation and its efficacy compared to other conflict payment programs such as cost sharing, wolf mitigation tools, or habitat leasing. Some suggest putting the emphasis on methods that reduce conflict (e.g. cost sharing for conflict management or paying for wolf habitat) instead of paying for losses (Macon, 2020; Nickerson, 2021). But there is little research available on how to implement these different programs in a way that producers would prefer over existing compensation programs.

The purpose of this research was to 1) survey producers to identify challenges in the process of receiving compensation and program policies, and 2) assess producer preferences for compensation compared to cost sharing for conflict management and habitat leasing. We provide insights on both implementation issues and payment types/amounts that can help policy makers and stakeholders develop more effective payment programs.

Compensation program challenges

Implementation of compensation programs presents a number of challenges (Harris et al., 2020). Programs vary widely, but most offer fair market value (FMV) for depredated livestock. Some also offer a portion of FMV for unconfirmed or undetected depredations, or for indirect losses caused by predator-induced stress (e.g. reductions in weight gain or reproductive rates - Ramler et al., 2014). These challenges can be exacerbated or alleviated through policy design, implementation failures, and lack of resources. To be eligible for compensation in the Western US, most programs require that producers detect a carcass they suspect to be a wolf depredation, report the carcass to the agency running depredation investigations, have the cause of death confirmed as wolf caused, and submit a compensation application. Finding carcasses to report can be difficult due to terrain, climate, weather, scavengers, grazing allotment size, and operational capacity. Oakleaf et al. (2003) found that for as many as eight calves killed by wolves, only one calf was detected by a producer. In some programs, a multiplier is used to account for wolf depredations never detected; however, the need and size of a multiplier remains hotly debated (Lee et al., 2017). At the time of publication, at least three western states use multipliers (Wyoming, Washington and Colorado).

The accuracy of depredation confirmations depends on the condition of the carcass, the skill of the investigator, and confirmation protocols that vary by state, agency, and compensation administration (Naughton-Treves et al., 2003). In addition, state agencies might lack staffing or funding which can extend delays. Seventy-six percent of landowners in Southwest Alberta reported significant dissatisfaction with their depredation program in part due to the burden of proof required to confirm a kill as wolf-caused (Lee et al., 2017). Lee et al. (2017) and Nickerson (2021) found that for producers in the American West that had utilized compensation for wolf depredation at least once, satisfaction was extremely mixed.

In the United States, federal and/or state dollars, hunting license revenue, or private groups fund most compensation programs for wolf depredation. Almost all programs are limited financially, which may occasionally result in producers waiting long periods of time

for payments, or producers being paid less than FMV when funding is limited (Muhly & Musiani, 2009). This can be a frustrating process for producers, resulting in a loss of faith in the system (Dickman et al., 2011). Additionally, FMV may underestimate the true financial losses associated with depredation. Though more research is needed (Hebblewhite, 2011), several studies found evidence of livestock suffering from predator-induced stress (Valerio et al., 2021), which can lead to reduced seasonal weight gain or reduced pregnancy rates (Steele et al., 2013). Ramler et al. (2014) found that the economic costs resulting from indirect losses exceeded those of direct losses/depredations by a multiplier of 7.5 in herds with at least one confirmed wolf depredation. Additionally, FMV only accounts for the value of the depredated animal as a consumption good (no future economic production), not their value as a capital good (having future economic production). Cows and heifers produce future marketable products through calving, which can be especially significant for animals bred for highly desirable traits (Anderson et al., 2014).

Finally, compensation eligibility is sometimes contingent on producers first implementing conflict reduction tools like fencing/fladry, range riding or carcass removal, or may require public hunting access. Even when tools are subsidized by wildlife agencies and/or conservation organizations, the resources, maintenance, monitoring, and technical assistance are often not.

Despite the growing number of programs and their increasing expenses, most research exploring the efficacy of compensation programs has focused on their ability to improve tolerance for predators and foster coexistence while ignoring whether programs improve the economic viability of ranches (Dickman et al., 2011; Ravenelle & Nyhus, 2017). The distribution of costs and benefits is highly asymmetric (D. Hoag et al., 2022), with costs distributed mostly to livestock producers and benefits accruing mostly to non-producers, which raises concerns about economic inequity. Hoag et al. (2022) found that the economic benefits related to a wolf population (e.g. existence, hunting, and recreational viewing) can be as high as 150 times greater than compensation and management costs, but most states pay only for direct losses (depredation) or a small portion of indirect losses. While not everyone sees this asymmetry as an inequity, it is important to consider that producer perceptions of existing support programs will be critical to ensuring that programs are utilized, sustainable, and effective for the producers they aim to support. Additionally, there is little to no research exploring alternatives to traditional compensation programs, or whether livestock producers are interested in these alternatives (Macon, 2020; Naughton-Treves et al., 2003; Montag et al., 2003). Evaluating interest in alternative support programs may help wildlife managers and policy makers improve or rethink existing programs to better represent the needs of livestock operations.

Alternatives to compensation programs

Compensation programs are not the only financial instruments available to mitigate the negative impacts of wildlife on agricultural communities, although alternatives are rare. Insurance schemes are programs where those at risk of depredation pay a premium at the start of the season. Those funds are then distributed across participating producers when they experience depredation (Morrison et al., 2013). Depending on the program, a potential benefit is more consistent funding provided by producers than would normally be provided by the government (Harris et al., 2020), but includes the drawback that participating

producers must fund the program themselves, and during high-conflict years, funding may deplete quickly (Morrison et al., 2013). Most attempted insurance programs for predation have not been successful (Harris et al., 2020).

Cost-sharing can also be used for technical and/or material assistance providing or deploying conflict reduction tools. For example, Defenders of Wildlife provided 50% of the funding needed to support the implementation of nonlethal tools as part of the Wolf Livestock Demonstration Project (Harris et al., 2020). One fear about these programs is that producers will overstate their use to qualify for compensation programs. Karlsson and Sjöström (2011) found that having access to subsidized tools in Sweden increased tolerance for wolves among producers, while Larson et al. (2016) found producers were unhappy with a similar cost-share option for coyote (*Canis latrans*) predation on domestic sheep (*Ovis aries*) in California. Notably, the Natural Resource Conservation Service (NRCS) under the U.S. Department of Agriculture (USDA) now offers cost sharing through both the Regional Conservation Partnership Program and the Environmental Quality Incentives Program for certain management practices including nonlethal tool use like range riding (Natural Resource Conservation Service, 2023).

Similar to payment for ecosystem services (Bogezi et al., 2019), payment for presence is an alternative to traditional depredation compensation where livestock producers are paid proactively based on coexisting with predators (Nelson, 2009). A potential benefit to this type of program is that producers are paid whether they face depredation or not (Zabel & Holm-Müller, 2008), which means some of the indirect losses associated with wolf presence can be compensated (Dickman et al., 2011) while the potentially beneficial direct and indirect ecosystem and economic effects of wolves are maintained (Ramler et al., 2014; Ripple et al., 2022). From a carnivore conservation perspective, incentivizing producers to manage for carnivore abundance may sound like an effective solution. However, this model may not align with the values or needs of some livestock producers who would rather focus on their livestock. Operating alongside carnivores can be dangerous, time consuming, and require operational flexibility that an operation simply may not have, especially while facing increased drought, wildfire, and other market stressors. Incentivizing carnivore coexistence without addressing conflict may feel like a one-sided tolerance request, leading to increased cultural divides and decreased satisfaction and engagement from the agricultural community (Åhman et al., 2022; Cheatum et al., 2011; Montag et al., 2003).

Habitat leasing is an alternative option that recognizes the value that well-managed working lands provide to public wildlife. Habitat leasing compensates producers for the costs of providing quality habitat, particularly when doing so comes at significant personal cost to the producer. Costs can include competition for forage, disease transmission to livestock, damages to hay and fencing, or required changes in grazing protocols to accommodate wildlife needs or livestock depredation (Nelson, 2009). Although not currently organized around predator-livestock conflict, the Grasslands Conservation Reserve Program (GCRP) run by the USDA Farm Service Agency serves as a model for this alternative, where grazing operations are paid by the acre based on habitat quality and quantity assessments. Unlike payment for presence programs, this approach acknowledges the potential ecosystem services grazing operations can provide for rangeland habitats both through management and preventing development (Krausman et al., 2009), indirectly benefiting predator species at local, community, even regional scales while maintaining relevance to the producer. We designed a survey to explore producer's ideal perceptions of

existing compensation programs, adding a modified discrete choice question to explore perceptions of alternative programs.

Methods

Study Area and participant recruitment

We distributed a survey across the Western, contiguous U.S. states with active wolf populations: Washington, Oregon, California, Idaho, Montana, Wyoming, Colorado, Arizona, and New Mexico. We also included Alberta, Canada due to its proximity and similar socio-ecological system of wolf-livestock conflict but did not have any responses from neighboring British Columbia. In this situation where it was difficult to create a representative probability-based sample and to reach the sample population, we selected a non-probability sampling technique. The snowball method uses a seeded start of likely known appropriate participants and then recruits further subjects from referrals. The method provides a cost-effective way to identify subjects that are difficult to reach and can be useful for exploratory research (Kirchherr et al., 2018). It can, however, result in sample bias as there would be limited diversity in personal networks. Kirchherr et al. (2018) conducted a medium-*N* analysis to enhance sample diversity of a snowball sample. Four recommendations from his study were used to enhance the diversity and representativeness of our sample. First, to utilize prior personal contacts for generating new contacts we worked with Western Landowners Alliance (WLA), an organization specializing in sustainable ways to manage working landscapes, and with the Center for Human-Carnivore Coexistence at Colorado State University. Second, to utilize sample seed diversity, we emailed an anonymous link of our survey to all of WLA's constituents (more than 1,000) followed by e-mails to state and county-level Cattlemen's, Wool, and Beef Growers' Associations, State and Tribal Farm Bureaus, Extension agents from western universities, and wildlife agency personnel. Third, to use face-to-face interviews when possible, we started our process with interviews and focus groups (see Survey Design and Implementation below) but decided we wanted a larger sample size than interviews alone could provide. Fourth, to be persistent in securing interviews or surveys, participants were encouraged to share the survey link with other livestock producers west-wide. We also sent two reminder e-mails in January and March of 2021, before closing the survey on May 2021 (Dillman et al., 2014).

While a probabilistic sampling frame is preferred, we are confident that our survey contained responses across most common viewpoints. We cannot be certain that an important viewpoint was under-represented; however, we are confident that our data is extensive enough and diverse enough to provide useful exploratory research toward our objective to better understand producer perceptions about compensation.

Survey design and implementation

To assess producer interest and needs regarding wolf conflict, we facilitated 12 informal, virtual focus groups, and five unstructured interviews with livestock producers in Wyoming, Montana, New Mexico, Arizona, Oregon, and California from June through October 2020 (Weiss, 1995). Through these sessions, we explored what aspects of

traditional compensation programs and characteristics of alternative programs producers were interested in. Based on these interviews and the literature, we structured our survey utilizing a modified mixed-methods version of the tailored design method (Dillman et al., 2014). The survey contained five sections: 1) questions about operational characteristics, 2) questions about the reporting process and reporting intention, 3) questions about the compensation process and compensation intention, 4) questions about an ideal compensation program with the discrete choice question, and 5) demographic questions. This analysis was part of a larger survey and not all sections listed above were used in this analysis (see Nickerson, 2021).

Similar to the findings of Dickman et al. (2011), our participants believed an ideal program would have various support and/or payment options that a producer could choose to participate in. For this reason, we chose to include a question that focused on preferred payment options. The three most popular types of producer payment programs identified by participants were: compensation for direct losses (depredation compensation), a habitat lease, and a cost-share with financial and/or technical assistance with nonlethal tools (described in Table 1). We also used these focus group sessions to identify reasonable and actionable levels for each of the three types of payment. As described in Table 1, for depredation compensation we offered no payment for depredation, payment at FMV, and payment at FMV with a multiplier of three. To vary the habitat lease payment option, we adjusted the dollar amount per acre, ranging from no habitat lease, a habitat lease paying five to nine dollars per acre annually, and a habitat lease paying ten or more dollars per acre annually. Finally, the levels for the cost-share option were cost-share available, and cost-share unavailable.

In a modified discrete-choice inspired question shown in Table 1 (M. D. Clark et al., 2014), survey participants were asked to choose one out of five possible payment combinations (programs) from the three payment types based on the option they associate with their highest utility, benefit, or satisfaction from a series of potential options. These options were coded and presented in a way that required the participant

Table 1. Choice question with five alternative producer support programs.

Programs	Payment Option 1: Payment for Direct Losses	Payment Option 2: Habitat Lease that does not displace livestock	Payment Option 3: Cost Share Program for wolf conflict prevention tools
1	Fair Market Value with a multiplier of 3	Not available	Financial assistance and technical assistance provided with cost sharing
2	Fair Market Value	\$5-\$9/acre annually based on geographic location	Financial assistance and technical assistance provided with cost sharing
3	Not available	\$10/acre annually based on geographic location	Financial assistance and technical assistance provided with cost sharing
4	Fair Market Value	\$10/acre annually based on geographic location	No assistance available
5	Fair Market Value with a multiplier of 3	\$5-\$9/acre annually based on geographic location	No assistance available

Payment options descriptions.

- (1) Payment for Direct Losses – confirmed livestock depredations can receive a fair market value payment per depredated animal. May include a multiplier for depredations never found.
- (2) Habitat Lease that does not Displace Livestock – annual payment for operating on landscapes with wolves (public and private lands). Participation requires an initial evaluation.
- (3) Cost Share Program for Wolf Conflict Prevention Tools – financial and technical assistance for voluntary implementation of proactive conflict prevention and/or non-lethal management tools via a shared pool of investments. Producer contributions may be in-kind or cash.

to weigh tradeoffs, allowing our team to measure the relative importance of individual attributes and the take-up probability of certain combinations of attributes (M. D. Clark et al., 2014; Holmes et al., 2017). Our modified question was not a traditional choice experiment because we did not ask about economic value, which was felt to be beyond the scope of this study. However, forcing participants to choose the best of five options in one question was appealing because it simultaneously highlighted tradeoffs of programs and program levels.

In addition to the modified choice question, we included 19 questions – 17 before the choice question to gauge perceptions of existing compensation programs and two following immediately after the choice question to improve our understanding of respondent satisfaction with the alternative program they selected. Fourteen of the questions prior to the choice question were asked on a seven-point Likert Scale (Joshi et al., 2015), and three were asked as open-ended, text-entry responses. The 14 Likert Scale questions addressed the following aspects of traditional compensation programs: overall satisfaction (one question), the compensation process (five questions), compensation amount (six questions), and program management (two questions). For the compensation process, we were interested in the extent to which participants perceived the carcass detection, reporting/confirmation, and application processes as time consuming or difficult. For compensation amount, we wanted to gauge producer perceptions on whether compensation for depredation prevented operational vulnerability, was representative of their actual losses to wolves, and whether compensation for indirect losses or a multiplier would more accurately represent their losses. For program management, we wanted to know who participants preferred to administer and fund compensation programs (see Table 2 for details). The two questions following the choice question were: 1) “To what extent would you be satisfied with the program you selected as most preferable?” presented on a five-point Likert scale ranging from “extremely satisfied” to “extremely unsatisfied,” and 2) “Keeping in mind that resources are limited, what could be changed about the program you selected as your most preferred option to make the program even more preferable?” presented as an open-ended, text-entry response.

Results

Satisfaction with the compensation process

Our first goal was to understand challenges that might affect producer perspectives about compensation and to compare across producers with compensation use experience (CU producers) and those without (NU producers). Of $n = 119$ total usable responses, about $n = 42\%$ had experienced at least one wolf depredation in the past, and $n = 68\%$ of those respondents had applied for compensation at least once. Perspectives on the compensation process, compensation amount, and program management varied between the CU and NU producers. CU producers were more trusting of the confirmation process, but more negative about the time and effort it takes to detect kills than the NU producers. Overall, CU participants “strongly agreed” or “agreed” (agreed from here forward) that they could trust the depredation confirmation process more than NU participants (Table 2: 76% compared to 31%). More CU producers agreed that detecting depredated carcasses was time consuming (82% compared to 64%). Few producers in either subcategory agreed that

Table 2. Comparison of survey responses between the compensation (comp.) user subgroup (CU) and the non-compensation user subgroup (NU).

Construct	Comp.User Subgroup n = 35	Non-user Subgroup n = 84
Comp. Process: (Agree – Strongly Agree)		
I trust the personnel investigating a wolf depredation to investigate fairly	76%	31%
Detecting carcasses depredated by wolves is time consuming	82%	64%
Having carcasses confirmed by the required personnel as wolf depredations is time consuming	79%	75%
The process of applying for wolf depredation comp. is difficult	18%	34%
The process of applying for wolf depredation comp. is time consuming	26%	49%
Are direct or indirect losses more financially damaging?	Direct-14% Indirect-20% Equal-60%	Direct-5% Indirect-23% Equal-56%
Comp. Amount: (Agree – Strongly Agree)		
Without comp. for wolf depredations, my business would be financially vulnerable	26%	39%
The amount of comp. available to me for wolf depredations is representative of my actual losses	26%	6%
In addition to comp. for direct losses, (depredations) I believe livestock producers should receive comp. for indirect losses	58%	72%
I believe a multiplier would more accurately represent my losses	82%	58%
Which of the following do you consider part of economic losses to wolves? (most selected to least selected)		
Comp. User Subgroup:		Non-user Subgroup:
1. Depredations		1. Depredations
2. Undetected depredations and stress induced reductions in weight gain (tied)		2. Stress induced lower reproductive rates
3. Stress induced lower reproductive rates		3. Stress induced reductions in weight gain
4. Injuries and vet care		4. Injuries and vet care
		5. Undetected depredations

The construct column represents survey questions. Columns represent the percentage of respondents who “agreed” or “strongly agreed” out of the total surveyed subpopulation ($n = 119$).

the application process was difficult (34% for NU and 18% for CU respectively) or time consuming (49% for NU and 26% for CU).

Satisfaction with compensation amount and program management

Levels of agreement were moderate across both surveyed populations regarding the degree of financial vulnerability caused by depredation. Only about one quarter of the CU producers and one-third of the NU producers felt that compensation was a key to their financial vulnerability, but only 26% of CU producers and 6% of NU producers felt that the compensation available to them was commensurate with their actual depredation costs. The majority in both populations felt that a multiplier was needed, and that compensation for indirect losses was also needed (Table 2). Both groups agreed that their main economic losses were caused by depredation, but the CU producers cited undetected losses second, compared to stress induced losses for the NU producers. Interestingly, the CU group cited stress losses in reproduction more often than those in weight gains. Both also cited injuries and veterinary care. Both surveyed populations agreed on who should fund and who should administer compensation programs and conflict mitigation strategies starting with wolf advocates as the primary funders, followed by federal tax dollars, recreationists, state tax dollars, hunting licenses, private insurance, and least responsible the livestock producers themselves. State agricultural departments were most selected for administering programs,

followed by the USDA, state wildlife agencies, Fish and Wildlife Service, elected county officials, elected local volunteers, and finally NGOs. Finally, we asked the CU group their level of overall satisfaction with the compensation programs they have participated in and found mixed results, with 35% reporting they were somewhat to completely dissatisfied and 60% reporting that they were somewhat to completely satisfied.

Modified choice results

We analyzed which of the five hypothetical alternative programs producers selected (Figure 1). $N = 102$ respondents answered the modified choice question, $n = 32$ CU producers, and $n = 70$ NU producers. For the CU producer subgroup, program five was the most popular selection (31%) followed by program two (29%), program one (26%), program four (14%) and finally program three (0%). For the NU producers, program one was the most selected (36%), followed by program two (31%), program five (20%), program four (7%), and program three (6%). Although similar, programs five and one swapped positions between our two subgroups. To further explore our findings, we decided to divide the NU producers into two subgroups – those with depredation experience (DNU; $n = 14$) and those without it (No DNU; $n = 56$). Although our n-values were too small to make strong categorical references, we did find some interesting differences. For the DNU producers, program two was the most popular (36%), followed by program five (29%), one (21%), three (14%), and four (0%). For the No DNU group, program one was the most popular (39%) followed by program two (30%), five (18%), four (9%) and three (4%) which was identical to the findings from the original NU group.

Programs one, two, and five were the most popular across all subgroups, and levels of self-reported satisfaction varied minimally across programs and subpopulations. Program three was the only exception, which none of the CU producers selected, and selectors from the NU

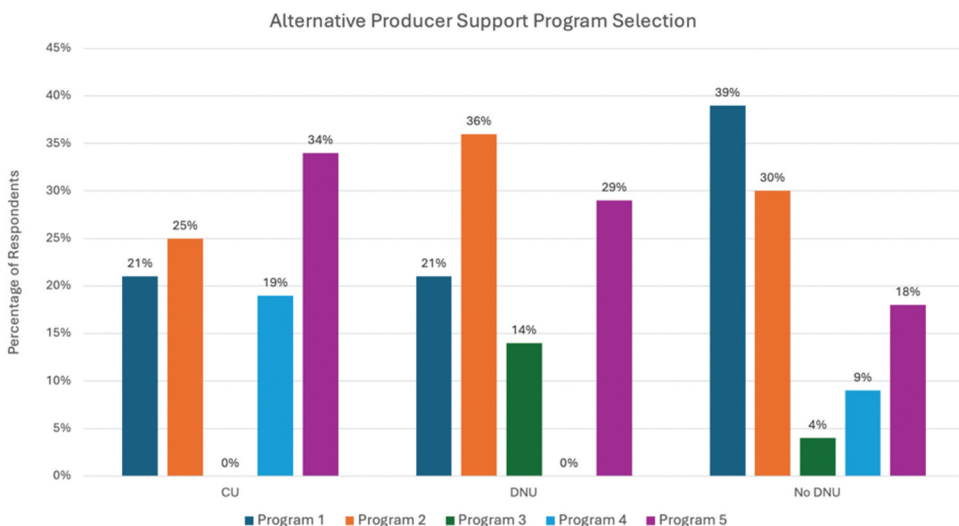


Figure 1. Alternative Producer support program preferences: compensation user subgroup (CU – $n = 32$), non-compensation user with wolf depredation (DNU – $n = 14$) and non-compensation user with No wolf depredation Experience (No DNU – $n = 56$).

group ($n = 4$) where low and withlow reported levels of satisfaction. Eighty-one respondents answered the open-ended question following the choice question asking what changes they would make to their selected option to increase satisfaction. After thematic analysis (Marshall & Rossman, 2014), the most common responses were an increase in lethal control for wolves ($n = 15$), a higher multiplier ($n = 12$), improved access to conflict reduction tools/nonlethal tools ($n = 8$) and ensuring that funding for programs comes from the demographics most intent on having wolves ($n = 8$). Other common responses included making sure programs were adaptive and flexible ($n = 7$) having compensation for indirect losses or a higher overall payment ($n = 6$), no changes needed ($n = 6$) and not sure ($n = 6$). Responses with fewer frequency included a higher price/acre on a habitat lease ($n = 5$), anything that provides sustainable funding ($n = 4$), ensuring that programs are run by local authorities ($n = 2$), adding a cost-share to an option without it ($n = 1$), and not interested ($n = 1$).

Discussion and management implications

Our first research question asked what concerns producers have about existing compensation programs. Overall, we found that satisfaction with existing programs among our CU producer subpopulation was mixed. For respondents who had experienced wolf depredation, compensation utilization was 68%. This could suggest that although not completely satisfied with existing programs, some producers still apply for compensation because they value being compensated for direct losses to wolves (Lee et al., 2017). This could also explain why a small proportion of producers in both the CU and NU producer groups agreed that without compensation for wolf depredation, their business would be financially vulnerable, yet usage is considerable. These data suggest that compensation for direct losses may provide value to a producer support program regardless of whether producers feel it adequately represents their actual losses to wolves.

Overall, our CU group agreed more strongly that they could trust the depredation investigation and confirmation process. This may imply that increased interactions between producers and investigating agency personnel can build trust in the depredation investigation process, or alternatively, that producers without existing trust in the confirmation process are less willing to report depredations and apply for compensation at all. The majority of respondents in each group did not feel the compensation process was time consuming, but did find the carcass detection and reporting processes time consuming (the CU group more so than the NU group). This could suggest programs that do not rely exclusively on carcass detection and confirmation for financial support (like habitat leasing) may see better program utilization.

There was general and strong agreement across both groups that the amount of compensation available for wolf depredation was too low, and that compensation for indirect losses and/or a multiplier would improve representation of losses. The CU group was more interested in compensation for indirect losses, whereas the NU group in a multiplier. This, combined with our finding that about 75% of both subpopulations agreed that indirect losses were as, or more damaging than direct losses suggests that support programs that compensate for indirect losses and/or undetected depredations may better support producers. This data support the findings of Dickman et al. (2011) who argue wolf-related conflict can have significant, and varied financial impacts on producers including direct losses from depredation, indirect losses from predator-induced stress in livestock, and time and

resource requirements needed to monitor conflict, all of which should be considered in the development of a compensation/producer support program. This finding is significant since so few programs offer financial or technical support for losses other than confirmed depredation.

Both subpopulations agreed on who they preferred to fund compensation programs (primarily wolf advocates and federal tax dollars - Table 2). This finding supports other research arguing that livestock producers bear the largest cost of large carnivore conservation and reintroduction (D. Hoag et al., 2022; Van Eeden et al., 2020). Both subpopulations also agreed on who should administer these programs, preferring their State Agricultural Department or the USDA over wildlife agencies and NGOs. Our findings could represent a lack of trust in federal wildlife agencies and NGOs specifically (Bonnie et al., 2020; Roche et al., 2015) but could also represent a desire to simplify reporting and compensation processes. Producers often work closely with their state Agricultural department on a variety of operational needs and are required to submit paperwork to both state and federal agricultural departments (see Montana Loss Board: <https://liv.mt.gov/Attached-Agency-Boards/Livestock-Loss-Board/index>). Adding another agency or NGO to the coordination requirements (often wildlife related) can add additional work. When designing compensation programs and their administration, considering which agencies or NGOs producers already work with, and feel comfortable working with, may improve program utilization overall.

Our second research question asked about preferences for compensation for wolf depredation compared to alternative support programs. Programs one, two, and five were the most popular across all subgroups. Programs one and five provide high levels of compensation and a way to account for losses outside of detectable losses, like indirect losses or undetected carcasses. In program two, where there is no multiplier to cover indirect losses, habitat leases are included, which provide financial support regardless of whether there are any losses. Which payment option is most effective at providing needed support – a habitat lease or multiplier – may be specific to the context of an individual operation. However, the option that offered no compensation, program three, generated little interest from producers in the NU group ($n = 2$ from both the DNU and No DNU subgroups). Interest in program four improved when FMV was added to the high habitat payments in program three but was anemic comparably; it offered no assistance for cost-sharing. This might reflect that compensation and cost sharing are perceived to be critical, in that order, (particularly by those with experience pursuing compensation for losses) and habitat leases can complement but less so substitute for payments more focused on the livestock rather than wolves. That our surveyed population was willing to sacrifice some compensation for cost sharing (popularity of programs one and two) contradicts concerns expressed in other studies that paying producers for losses (instead of incentivizing producers to prevent conflict) will result in a lack of motivation to coexist with predators (Chervier et al., 2019; Dickman et al., 2011). If that had been the case in our surveyed population, we would have expected a strong preference for programs four and five that paid more overall without the necessary implementation and upkeep associated with nonlethal conflict prevention tools. This was also reflected in our thematic analysis responses where access to nonlethal tools was one of the highest responses to how to improve selected programs. However, we did find a slight preference for program five over programs one and two in our CU subgroup. This could reflect a preference for

compensation over technical and financial assistance with nonlethal tools; however, our understanding of the effectiveness of nonlethal tools is still severely limited (Moreira-Arce et al., 2018; Scasta et al., 2017) and as mentioned above, cost sharing introduces challenges regarding equitable distribution of resources (Larson et al., 2016). Producers may prefer guaranteed payments for confirmed losses and habitat leasing over time and financial investment into tools that may not suit their needs.

Ninety-six percent of all respondents regardless of subgroup wanted access to depredation compensation, even at the expense of higher payments per acre as part of a habitat lease, or access to a cost-share. This was also reflected in the slight preference for program four over three, potentially reflecting the importance of compensation for direct losses and the critical role depredation payments play in an effective producer support program. Unlike payment for presence or habitat lease options, depredation compensation provides measurable, mostly guaranteed support when wolf depredation happens. The challenge with providing only incentive-based options like habitat leasing that does not include compensation for direct losses/depredation is that wolf depredation varies significantly on spatial and temporal scales (P. E. Clark et al., 2020; Lee et al., 2017). Lee et al. (2017) found that in Alberta, calf depredations ranged from 0% to 25% across all producers in the province, but 2.6% of producers experienced calf depredation losses greater than 10% annually, meaning a single producers' experience with depredation may differ greatly from their neighbor one year, and not at all the next. Depredation compensation as one part of a flexible program with diverse payment and engagement options protects the producers hit hardest by wolves through providing additional support when nonlethal strategies are not enough (Moreira-Arce et al., 2018). This is a critical finding that highlights the vulnerability involved with a "one size fits all" approach to producer support.

Part of the challenge with designing an effective producer support program may be the unique, contextual needs of each operation. Compensation for direct losses alone may not be effective for a producer grazing on large, remote landscapes with difficult terrain that makes carcass detection and reporting incredibly difficult. Alternatively, producers may feel hesitant relying exclusively on a habitat lease that requires regular reevaluation in states where wildlife, drought, or year-round grazing permits make evaluating forage and habitat health difficult across annual timeframes. Although no one program will work for every livestock producer facing carnivore conflict, programs with diverse payment and engagement options can provide flexibility for the unique needs of each operation, while also helping to cover additional conflict-related costs. This flexibility may also help to support landowner autonomy and ownership over wolf-related management needs, addressing the problematic top-down nature of most compensation program development and wolf-related conservation policies (Boitani et al., 2010). Finally, some research suggests that differing livestock management and husbandry may influence livestock susceptibility to depredation risk (Louchouart & Treves, 2023; Ramler et al., 2014). While more research is desperately needed, livestock producer support programs that accommodate and bolster the use of these techniques could be increasingly valuable.

One limitation of this study is that we are unable to ascertain how representative our survey is of producers that have or may experience conflict with wolves. We followed recommended best practices and are confident that the concepts we assessed are inclusive for the pool of producers that face or could face conflicts with wolves. A second limitation is that due to the focus and length of the study, we were unable to conduct a formal choice

experiment. Future research could utilize a full discrete choice experiment to evaluate producer interest in not only different payment methods but also the relative importance of individual attributes (e.g., what multiplier best represents my losses), tradeoffs between attributes (e.g., how low am I willing to go on a multiplier for a higher payment per acre on a Habitat Lease), and the probability of take-up of certain combinations of attributes (M. D. Clark et al., 2014). Future research should also focus on quantifying the impact of wolves on indirect losses like seasonal gain and reproductive rates and evaluate the effectiveness of conflict reduction tools. Finally, for our second research question, we were unable to collect information on whether respondents had experience with specific payment options. Experience may have influenced which support program each respondent selected as preferred and future research should capture this metric. For a more detailed explanation of caveats related to our survey distribution, see Nickerson (2021).

Conclusion

Overall, our findings show that producers who have tried compensation seem to have more trust in the personnel managing compensation and are less concerned about problems with the process. However, their experience also increases their trepidation about the difficulty in detecting and confirming carcasses. That less than half of respondents felt that they would be financially vulnerable without compensation may explain why compensation use was not closer to 100% among our depredation experienced respondents. However, other factors may include that wolf depredation may make up a relatively small proportion of total losses for some producers compared to other causes like illness/disease, or could reflect that the amount of compensation available is not representative of a producers' actual losses, and therefore not worth the application, reporting, and confirmation time. Both the CU and NU groups generally agreed that indirect losses were as, if not more damaging than direct losses, and indirect payments and/or a multiplier would help. Results suggest that our surveyed population of livestock producers will consider adoption under a variety of flexible support programs for wolf-livestock conflict with diverse payment and engagement options that effectively address the needs of different operations. While respondents expressed interest in alternatives, 96% of respondents preferred a support program with depredation compensation; interest in habitat payments appeared conditional on compensation and/or cost sharing. Wildlife managers and policy makers should strongly consider depredation compensation as part of producer support programs to protect against the uneven, and often unpredictable influence of wolf depredation.

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Data Availability Statement

The participants of this study did not give written consent for their data to be shared publicly.

References

- Åhman, B., Rasmus S., Risvoll, C., Eilertsen, S. M., & Norberg, H. (2022). Large predators and their impact on reindeer husbandry In T. Horstkotte, Ø. Holand, J. Kumpula, & J. Moen (Eds.), *Reindeer Husbandry and Global Environmental Change* (pp. 118–130). Routledge.
- Anderson, A., Gebhardt, K., Kirkpatrick, K. N., Bergman, D., & Shwiff, S. (2014). *Economic analysis of indemnity payments for wolf depredation on cattle in a wolf reintroduction area*. USDA Wildlife Services - Staff Publications.
- Bogezi, C., van Eeden, L. M., Wirsing, A., & Marzluff, J. (2019). Predator-friendly beef certification as an economic strategy to promote coexistence between ranchers and wolves. *Frontiers in Ecology and Evolution*, 7, 7. <https://doi.org/10.3389/fevo.2019.00476>
- Boitani, L., Ciucci, P., Raganella-Pelliccioni, E., Boitani, L., Ciucci, P., & Raganella-Pelliccioni, E. (2010). Ex-post compensation payments for wolf predation on livestock in Italy: A tool for conservation? *Wildlife Research*, 37(8), 722–730. <https://doi.org/10.1071/WR10029>
- Bonnie, R., Diamond, E. P., & Rowe, E. (2020). Understanding rural attitudes toward the environment and conservation in America. *Duke Nicholas Institute*. <https://nicholasinstitute.duke.edu/publications/understanding-rural-attitudes-toward-environment-and-conservation-america>
- Cheatum, M., Casey, F., Alvarez, P., & Parkhurst, B. (2011). *Payments for ecosystem services: A California rancher perspective*. Nicholas Institute for Environmental Policy Solutions, Duke University.
- Chervier, C., Le Velly, G., & Ezzine de Blas, D. (2019). When the implementation of payments for biodiversity conservation leads to motivation crowding-out: A case study from the cardamoms forests, Cambodia. *Ecological Economics*, 156, 499–510. <https://doi.org/10.1016/j.ecolecon.2017.03.018>
- Clark, M. D., Determann, D., Petrou, S., Moro, D., & de Bekker-Grob, E. W. (2014). Discrete choice experiments in health economics: A review of the literature. *Pharmacoeconomics*, 32(9), 883–902. <https://doi.org/10.1007/s40273-014-0170-x>
- Clark, P. E., Chigbrow, J., Johnson, D. E., Larson, L. L., Nielson, R. M., Louhaichi, M., Roland, T., & Williams, J. (2020). Predicting spatial risk of wolf-cattle encounters and depredation. *Rangeland Ecology & Management*, 73(1), 30–52. <https://doi.org/10.1016/j.rama.2019.08.012>
- Dickman, A. J., Macdonald, E. A., & Macdonald, D. W. (2011). A review of financial instruments to pay for predator conservation and encourage human–carnivore coexistence. *Proceedings of the National Academy of Sciences of the United States of America*, 108(34), 13937–13944. <https://doi.org/10.1073/pnas.1012972108>
- Dillman, D., Smyth, J., & Christian, L. (2014). Internet, phone, mail, and mixed-mode surveys: The tailored design method. In D. Dillman, J. Smyth, & L. Christian (Eds.), (pp. 1–445). Wiley.

- Harris, R. B., Fish, M., Grizzly, P., Coordinator, B. P., & Freeman, S. (2020). Literature review of livestock compensation programs: Considering ways to assist livestock producers with grizzly bear conservation efforts in Montana. *Science Advances*, 6(24). <https://doi.org/10.1126/sciadv.aaz5687>
- Hebblewhite, M. (2011). Unreliable knowledge about economic impacts of large carnivores on bovine calves. *The Journal of Wildlife Management*, 75(8), 1724–1730. <https://doi.org/10.1002/jwmg.206>
- Hoag, D., Breck, S., Crooks, K., & Niemiec, B. (Eds.). (2022). Economic consequences of the wolf comeback in the Western United States. *Wildlife Economics in the American West, Spring 2022 edition of the Western Economic Forum*, Western Agricultural Economics Association, 20–21.
- Holmes, T. P., Adamowicz, W. L., Carlsson, F., Holmes, T. P., Adamowicz, W. L., & Carlsson, F. (2017). Choice Experiments. In P. Champ, K. Boyle, & T. Brown (Eds.), *The Economics of Non-Market Goods and Resources (ENGO, volume 13)* (pp. 133–186). Springer.
- Joshi, A., Kale, S., Chandel, S., & Pal, D. (2015). Likert scale: Explored and explained. *British Journal of Applied Science & Technology*, 7(4), 396–403. <https://doi.org/10.9734/BJAST/2015/14975>
- Karlsson, J., & Sjöström, M. (2011). Subsidized fencing of livestock as a means of increasing tolerance for wolves. *Ecology and Society*, 16(1). <https://doi.org/10.5751/ES-03878-160116>
- Kirchherr, J., Charles, K., & Guetterman, T. C. (2018). Enhancing the sample diversity of snowball samples: Recommendations from a research project on anti-dam movements in Southeast Asia. *PLoS One*, 13(8), e0201710. <https://doi.org/10.1371/journal.pone.0201710>
- Krausman, P. R., Naugle, D. E., Frisina, M. R., Northrup, R., Bleich, V. C., Block, W. M., Wallace, M. C., & Wright, J. D. (2009). Livestock grazing, wildlife habitat, and rangeland values. *Rangelands*, 31(5), 15–19. <https://doi.org/10.2111/1551-501X-31.5.15>
- Larson, S., Mcgranahan, D. A., Timm, R. M., & Org, E. (2016). The Marin County livestock protection program: 15 years in review. *Escholarship Org*, 27(27), 59–68. <https://doi.org/10.5070/V427110695>
- Lee, T., Good, K., Jamieson, W., Quinn, M., & Krishnamurthy, A. (2017). Cattle and carnivore coexistence in Alberta: The role of compensation programs. *Rangelands*, 39(1), 10–16. <https://doi.org/10.1016/j.rala.2016.11.002>
- Louchouart, N. X., & Treves, A. (2023). Low-stress livestock handling protects cattle in a five-predator habitat. *PeerJ*, 11, e14788. <https://doi.org/10.7717/peerj.14788>
- Macon, D. (2020). Paying for the presence of predators: An evolving approach to compensating ranchers. *Rangelands*, 42(2), 43–52. <https://doi.org/10.1016/j.rala.2020.03.001>
- Marshall, C., & Rossman, G. (2014). Designing qualitative research.
- Montag, J., Patterson, M. E., & Sutton, B. (2003). Political and social viability of predator compensation programs in the West. *University of Montana school of forestry*.
- Moreira-Arce, D., Ugarte, C. S., Zorondo-Rodríguez, F., & Simonetti, J. A. (2018). Management tools to reduce carnivore-livestock conflicts: Current gap and future challenges. *Rangeland Ecology & Management*, 71(3), 389–394. <https://doi.org/10.1016/j.rama.2018.02.005>
- Morrison, K., Victorine, R., & Mishra, C. (2013). *Lessons learned, opportunities and innovations in human wildlife conflict compensation and insurance schemes*. <https://library.wcs.org/doi/ctl/view/mid/33065/pubid/DMX1509800000.aspx>
- Muhly, T. B., & Musiani, M. (2009). Livestock depredation by wolves and the ranching economy in the northwestern U.S. *Ecological Economics*, 68(8–9), 2439–2450. <https://doi.org/10.1016/j.ecolecon.2009.04.008>
- Natural Resource Conservation Service. (2023, November 1). *FACT SHEET: USDA streamlines regional conservation partnership program, invests unprecedented \$1 billion in 81 conservation projects* [Press release]. <https://apastyle.apa.org/style-grammar-guidelines/references/examples/press-release-references>
- Naughton-Treves, L., Grossberg, R., & Treves, A. (2003). Paying for tolerance: Rural citizens' attitudes toward wolf depredation and compensation. *Conservation Biology*, 17(6), 1500–1511. <https://doi.org/10.1111/j.1523-1739.2003.00060.x>
- Nelson, F. (2009). Developing payments for ecosystem services approaches to carnivore conservation. *Human Dimensions of Wildlife*, 14(6), 381–392. <https://doi.org/10.1080/10871200903045228>

- Nickerson, R. (2021). *Exploring compensation programs and depredation reporting for wolf-livestock conflict across the North American West*. <https://search.proquest.com/openview/49dad7c633a9e9cc7509b90c8580261a/1?pq-origsite=gscholar&cbl=18750&diss=y>
- Oakleaf, J. K., Mack, C., & Murray, D. L. (2003). Effects of wolves on livestock calf survival and movements in Central Idaho. *The Journal of Wildlife Management*, 67(2), 299–306. <https://doi.org/10.2307/3802771>
- Ramler, J. P., Hebblewhite, M., Kellenberg, D., Sime, C., Neudecker, G., Cleveland, S., Steuber, J., Slaughter, W., Mannix, D., Bodner, J., Baker, K., Evjene, J., Carlstrom, R., Lannen, J., Sarchet, A., Tanner, J. P., Pauley, J., Bangs, E., Dalenberg, D., & Mitchell, M. (2014). Crying wolf? A spatial analysis of wolf location and depredations on calf weight. *Wiley Online Library*, 96(3), 631–656. <https://doi.org/10.1093/ajae/aat100>
- Ravenelle, J., & Nyhus, P. J. (2017). Global patterns and trends in human–wildlife conflict compensation. *Conservation Biology*, 31(6), 1247–1256. <https://doi.org/10.1111/cobi.12948>
- Ripple, W. J., Wolf, C., Phillips, M. K., Beschta, R. L., Vucetich, J. A., Kauffman, J. B., Law, B. E., Wirsing, A. J., Lambert, J. E., Leslie, E., Vynne, C., Dinerstein, E., Noss, R., Wuertner, G., DellaSala, D. A., Bruskotter, J. T., Nelson, M. P., Crist, E., Darimont, C., & Ashe, D. M. (2022). Rewilding the American west. *BioScience*, 72(10), 931–935. <https://doi.org/10.1093/biosci/biac069>
- Roche, L. M., Schohr, T. K., Derner, J. D., Lubell, M. N., Cutts, B. B., Kachergis, E., Eviner, V. T., & Tate, K. W. (2015). Sustaining working rangelands: Insights from rancher decision making. *Rangeland Ecology & Management*, 68(5), 383–389. <https://doi.org/10.1016/j.rama.2015.07.006>
- Scasta, J. D., Stam, B., & Windh, J. L. (2017). Rancher-reported efficacy of lethal and non-lethal livestock predation mitigation strategies for a suite of carnivores. *Scientific Reports*, 7(1). <https://doi.org/10.1038/s41598-017-14462-1>
- Steele, J. R., Rashford, B. S., Foulke, T. K., Tanaka, J. A., & Taylor, D. T. (2013). Wolf (*Canis lupus*) predation impacts on livestock production: Direct effects, indirect effects, and implications for compensation ratios. *Rangeland Ecology & Management*, 66(5), 539–544. <https://doi.org/10.2111/REM-D-13-00031.1>
- Valerio, A., Borrego, C. S., Boitani, L., Casadei, L., Giuliani, A., Wielgus, R. B., Simek, S. L., & Valerio, M. (2021). Detecting the effects of predator-induced stress on the global metabolism of an ungulate prey using fecal metabolomic fingerprinting. *Scientific Reports*, 11(1). <https://doi.org/10.1038/s41598-021-85600-z>
- Van Eeden, L. M., Slagle, K., Crowther, M. S., Dickman, C. R., & Newsome, T. M. (2020). Linking social identity, risk perception, and behavioral psychology to understand predator management by livestock producers. *Wiley Online Library*, 28(4), 902–910. <https://doi.org/10.1111/rec.13154>
- Weiss, R. S. (1995). *Learning from strangers: The art and method of qualitative interview studies*. Simon and Schuster.
- Zabel, A., & Holm-Müller, K. (2008). Conservation performance payments for carnivore conservation in Sweden. *Conservation Biology*, 22(2), 247–251. <https://doi.org/10.1111/j.1523-1739.2008.00898.x>