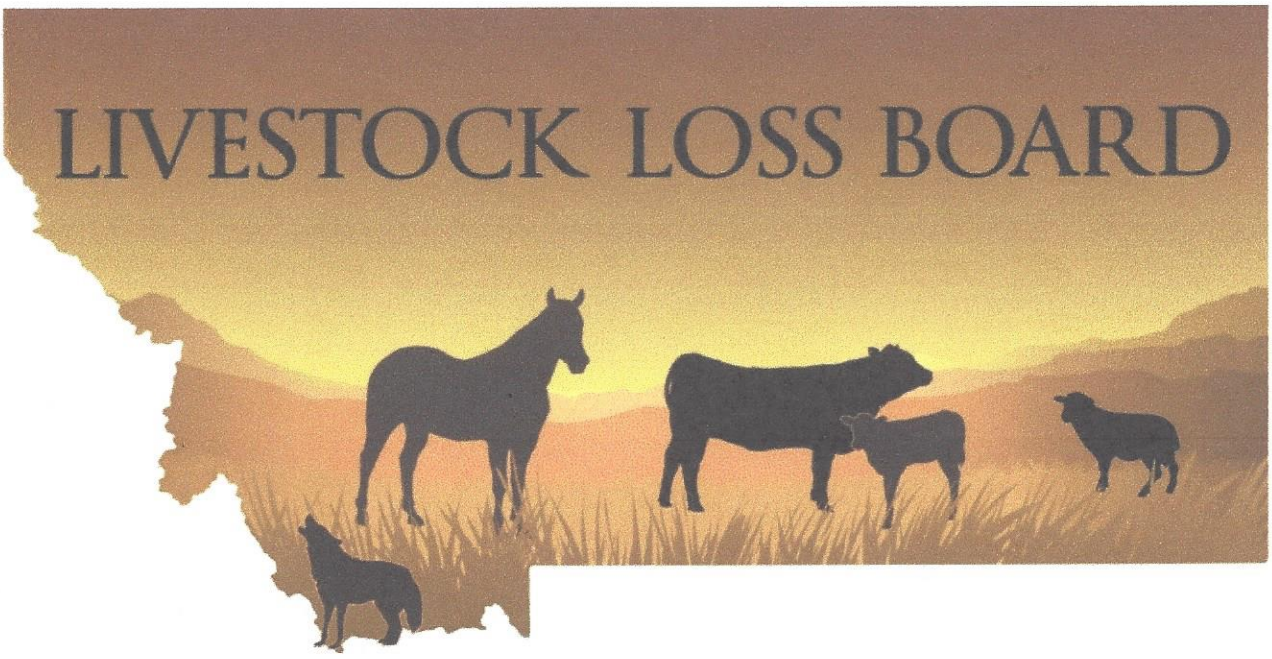
LIVESTOCK LOSS BOARD
2014 ANNUAL REPORT



A report to
Legislative Economic Affairs Interim Committee
2013-2014 Interim

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Livestock Loss Board

www.llb.mt.gov

Board Members

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406-444-5609
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Overview

The Livestock Loss Board is a component of Montana's Wolf Conservation and Management Plan. This board is responsible for two elements of the plan, livestock loss prevention and livestock loss compensation.

During the 2013 legislature grizzly bear caused losses were added to the board's programs via HB 323 introduced by Mike Cuffe. Defenders of Wildlife had been paying for livestock losses due to grizzly bears until October 1, 2013. This organization had also been paying for wolf caused losses until April 15, 2008. Indications were that they would be discontinuing payments for grizzly bear caused losses due to impending delisting of grizzly bears. Since the delisting of wolves Defenders of Wildlife does not pay for livestock losses in the states where delisting occurred. Defenders of Wildlife has faith in the board and provided LLB with $25,000 this past December. The funds are dedicated to grizzly bear caused livestock loss prevention grants. The board and their staff person have been seeking livestock loss prevention projects that will cover large areas similar to what has been done by the Blackfoot Challenge.

Board programs are overseen by the Livestock Loss Board (LLB). LLB is a five member board appointed by the governor. Changes were made during the 2013 legislative session via HB 395 introduced by Kirk Wagoner. This bill reduced the number of board members from seven to five. Prior to this law change the board consisted of seven members, three members are selected from a list of names submitted by the Department of Livestock, three board members are selected from a list of names submitted by the Department of Fish, Wildlife & Parks and one public member. LLB is administratively attached to the Department of Livestock.

Currently three board members must be actively involved in the livestock industry and have knowledge and experience with regard to wildlife impacts or management; and two members of the general public who are or have been actively involved in wildlife conservation or wildlife management and who have knowledge and experience with regard to livestock production or management.

The smaller board has been well received by everyone and the process to find replacement board members is much less cumbersome. A five member board has streamlined overall operations as well as reducing expenses to operate the board.

LLB Mission Statement

To help support Montana livestock communities by reducing the economic impacts of wolves and grizzly bears on individual producers by reimbursing their confirmed and probable wolf or grizzly bear caused losses and helping to reduce their losses by

approving projects and funding programs that will discourage wolves or grizzly bears from killing livestock.

Board Meetings

LLB holds at least two full board meetings each year. During the time covered by this report, the board has met six times for full board meetings. Prior to each board meeting the board holds a listening session with livestock owners and other interested parties. The purpose of the listening sessions is to for members of the public to become acquainted with the board and for board members to listen to their concerns. Information from the listening sessions has helped board members with future decisions and as a basis for the best use of available funds. Meeting agendas are posted on the board's website www.llb.mt.gov prior to each meeting.

LLB also has a fundraising committee consisting of agriculture, environmental and hunting groups as well as representatives from local, tribal and federal governments. All committee members helped the board to try to obtain federal funds via the farm bill but were unsuccessful. These same groups identified state funding as the next best option. The thought behind this is that individuals who want greater numbers of wolves and grizzly bears within the state should help fund the losses caused by these predators.

The board has received sporadic funding from the federal government. In 2013 the board received a grant for $170,000 from the U.S. Fish & Wildlife Service. This grant came with the conditions that the board would ensure a fifty percent cost share to match the federal funds. $100,000 of the grant is to be used for livestock loss prevention projects (wolf only). Board members selected six applicants to receive loss prevention funding. Grants were awarded to Madison County, Big Hole Watershed Committee, Dahl Ranch, Hillary Anderson, Blackfoot Challenge, and the Lazy Daisy Ranch. Board members received additional applications but there was not enough funding for every applicant. Board members focused the grant awards towards areas that have both wolves and grizzly bears as well as those applying that were using proven loss prevention methods. Four of the applicants will be using the funds to either begin or maintain carcass removal and composting sites. Currently carcass removal programs in Granite and Powell Counties have reduced predation by over 96 percent. The board's greatest obstacle was finding a way to provide a 50 percent cost share match in order to receive any federal loss prevention funding. One of the board's fundraising committee members helped with finding organizations who could guarantee they would be able to provide a matching funds if the board was able to award them a grant.

Tribal Agreements

2-15-3113 (2), MCA, states The Livestock Loss Board may enter into an agreement with any Montana tribe, if the tribe has adopted a wolf management plan for reservation lands that is consistent with the state wolf management plan, to provide that tribal lands within reservation boundaries are eligible for mitigation grants pursuant to 2-15-3111 and that livestock losses on tribal lands within reservation boundaries are eligible for reimbursement payments pursuant to 2-15-3112.

Agreements have been renewed with the Blackfeet and CSKT tribal governments. Livestock owners within these reservation boundaries are eligible to participate in LLB's compensation and loss prevention programs.

Program Funding

2-15-3114, MCA. Funding of programs -- contingency. The awarding of grants and reimbursements and the performance of duties pursuant to 2-15-3111 through 2-15-3113 are contingent upon the amount of money available in the accounts provided for in 81-1-110 and 81-1-111.

The board began accepting loss applications on April 15, 2008. Loss payments were made until the beginning of December 2008 when the board ran out of available funds. Available funds for this time frame were the $30,000 provided by a legislative appropriation and a $50,000 donation from Defenders of Wildlife. Livestock owners were given a letter stating future loss payments would be made when additional funding was secured. Small donations started to come in and payments were continued as the donations were received. In the spring of 2009, Defenders of Wildlife provided an additional $50,000 donation which allowed LLP to become current with livestock loss payments. Legislators provided a biennial $150,000 appropriation for fiscal years 2010 and 2011. This fund was depleted by the end of the 2010 fiscal year. Federal funds became available about the same time that state funds were depleted. The federal funds allowed the board to stay current on death loss payments during fiscal year 2011. HB 622 was passed by the 2011 legislature. This bill provided the board with a statutory appropriation of $200,000 per year. Funds are restricted to pay producers for confirmed and probable livestock losses and may not be used for administrative purposes or livestock loss prevention projects. These funds have allowed the board to stay current on all death loss payments.

Beginning in 2008, the board's executive secretary worked with Senator Jon Tester's staff to obtain federal funding. Senator Tester's legislation provided for a fifty percent

federal cost share with states that have wolves. This legislation was signed by the President on March 30, 2009. The U.S. Fish and Wildlife Services had not developed final rules for the use of the funds for the first appropriation of $140,000. Because of the lack of federal rules, latitude was granted to states in how the funds would be used. Board members elected to use all of the federal funds for death loss payments. These funds allowed the board to stay current on death loss payments in fiscal year 2011. Senator Tester's legislation was for a five year demonstration project. At the time of this report no additional federal legislation is in place to extend the project.

LLB has a specialty license plate that became available in February 2012. Revenue from license plate sales will be used towards loss prevention efforts and a loss multiplier factor in the future. A total of $5,360 has been received by the board as of August 21, 2014.

Loss Payment Process

Step 1: Contact USDA Wildlife Services to request an investigation.
West District (406) 458-0106 or State Office (406) 657-6464

Step 2: USDA WS investigator will send your investigation report to USDA's state director in Billings.

Step 3: USDA's Billings office will send a copy of the investigation and LLB's claim form to the livestock owner.

Step 4: The livestock owner may now submit a claim to the Livestock Loss Board's office. If the livestock are contracted at a greater value, the owner must supply a copy of the contract or if an animal is registered, proof of registration is required.

Step 5: The Board's Executive Secretary prints a USDA Market Report from Billings, Montana to determine current animal values or values as determined by the board.

Step 6: Brand ownership and bank mortgages are researched and applied.

Step 7: Typical claims are processed that same day. Non-typical claims are presented to the full board to determine values.

Step 8: Livestock owners will receive a letter stating what the payment amount will be and a copy of this letter is given to the Department of Livestock's accounting staff.

Step 9: Payment is sent to the livestock owner by Department of Livestock accounting staff.

Step 10: If a livestock owner disputes the value of the livestock, the owner must submit a letter to the board office and provide proof of the greater value. Appeals will be presented to the full board for review. (Note: Appeals on the cause of death must be made to USDA Wildlife Services.)

(Loss Reimbursement Application – Appendix A)

Payments

LLP began accepting livestock loss claims on April 15, 2008 and has received 551 claims through June 30, 2014. Payments for 1,129 head of livestock with a value of $647,885 has been provided to livestock owners for claims during this time period. Studies have indicated that for every animal verified as killed by wolves, there are seven additional animals that are not verified. If a 7X multiplier was used similar to our neighboring states, the total value of livestock losses due to wolves would be $5,183,080 since April, 2008. (Loss payments by county are listed in Appendix B, C, D, E, F, G, H)

2008-2014 loss claims have been for cattle, sheep, horse, goats and guard animals. Animals eligible for coverage for losses by wolves and grizzly bears are cattle, swine, horses, mules, sheep, goats, llamas, and livestock guard animals on state, federal, and private land and on tribal land that is eligible through a formal agreement. Payments are provided to livestock owners when livestock losses are verified by USDA Wildlife Services personnel as being confirmed or probable wolf or grizzly bears caused livestock loss. USDA Wildlife Services personnel are experts in performing investigations and necropsies to determine the type of predator causing livestock losses. Payments are not provided for livestock losses due to any other predators.

Due to limited available funds, LLB has not authorized payments for additional losses suffered by livestock owners. Examples of additional losses are veterinary bills, livestock weight loss, missing livestock, lower pregnancy rates, loss of pasture usage, damaged fences, etc..... A report conducted by the University of Wyoming states " When all direct and indirect effects are cumulatively included, the implied compensation ratio increases threefold to 21:1." "The implied compensation ratio with direct and indirect wolf effects ranges from 18:1 when wolf effects are fixed at the low level, to 24:1 when they are fixed at the most severe level observed in the region." (Appendix I)

Animal Values

Cattle and sheep values are determined by using a Montana Weekly Auction Summary report compiled by USDA Market News, Billings, MT. Registered animal values are calculated by using sales receipts for registered animals of a similar age and sex. Horse values have been determined using Billings Livestock Commission horse sales averages. LLB reviewed an American Sheep Industry study on guard dogs to help determine livestock related dog values. Pets and hunting dogs are not covered under LLB's compensation program.

Reported Livestock Loss Numbers

Livestock loss numbers reported by LLB are only for claims submitted by livestock owners that have been investigated by USDA Wildlife Service. Although most livestock owners submit a loss claim for livestock killed by wolves, there are a few that do not. LLB reported loss numbers are for losses listed as confirmed or probable by USDA Wildlife Services.

In order to provide the public current loss claim activity, LLB posts the type of animal and the county it was killed in on a Facebook page "Livestock Loss Board". This page can be easily accessed from the board's website www.llb.mt.gov . Additionally a report "Livestock Loss Statistics" is available for each calendar year on the board's website listing losses by county, animal type and total dollar amounts paid in each listed county. Current year losses are updated as the claims come in.

Trust Fund

All funds either donated or governmental appropriations have been used to pay livestock loss claims with the exception of six grants used for loss prevention. No funds have been deposited into the trust fund. LLB established a fundraising committee to work on obtaining funds for the trust fund. The board has fundraising listed on every meeting agenda and continues to look for revenue sources.

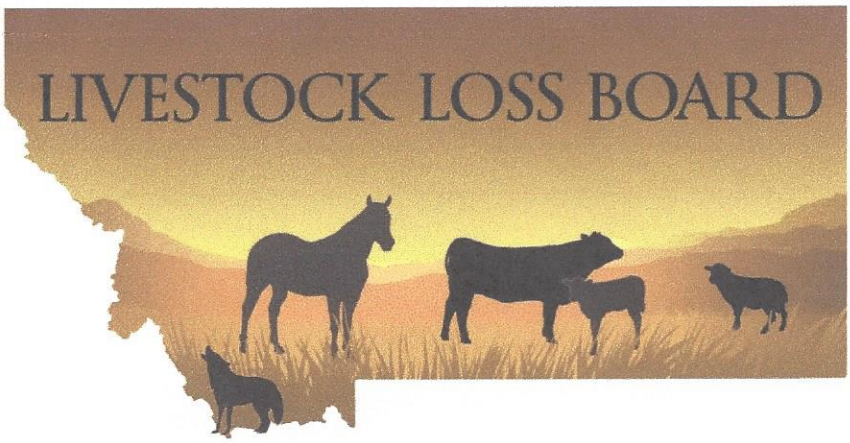
81-1-111. Livestock loss reduction and mitigation trust fund. (1) The legislature shall provide for a fund, to be known as the livestock loss reduction and mitigation trust fund, to be funded with gifts, grants, reimbursements, appropriations, or allocations from any source.

(2) The principal of the livestock loss reduction and mitigation trust fund shall forever remain inviolate in an amount of $5 million unless appropriated by a vote of three-fourths of the members of each house of the legislature.

(3) The interest and income generated from the livestock loss reduction and mitigation trust fund must be deposited in the livestock loss reduction and mitigation state special revenue account provided for in 81-1-110. The interest and income may be appropriated by a majority vote of each house of the legislature and may be used only to fund the livestock loss reduction program and the livestock loss mitigation program as provided in 2-15-3111 and 2-15-3112.

(4) (a) Until the principal of the fund reaches $5 million, at the end of each biennium, any amount of interest and income from the trust fund that is not used for the livestock loss reduction program or the livestock loss mitigation program must be used to reimburse the state general fund up to $120,000. Any remaining interest and income must be deposited in the trust fund as principal.

(b) After the principal of the trust fund reaches $5 million, at the end of each biennium, any amount of interest and income that is not used for the livestock loss reduction program or the livestock loss mitigation program must be deposited in the general fund.



APPENDIX

STATE OF MONTANA
STEVE BULLOCK, GOVERNOR

LIVESTOCK LOSS BOARD
PO BOX 202005
HELENA, MONTANA 59620-2001

BOARD OFFICE (406) 444-5609
FAX (406) 444-5606

LIVESTOCK LOSS PAYMENTS

(only wolf or grizzly bear caused losses)

Step 1: Contact USDA Wildlife Services to request an investigation. West District (406) 458-0106 or State Office (406) 657-6464

Step 2: USDA WS investigator will send your investigation report to USDA's state director in Billings.

Step 3: USDA's Billings office will send a copy of the investigation and LLB's claim form to the livestock owner.

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Step 6: Brand ownership and bank mortgages are researched.

Step 7: Typical claims are processed that same day. Non-typical claims are presented to the full board to determine values.

Step 8: Livestock owners will receive a letter stating what the payment amount will be and a copy of this letter is given to Department of Livestock's accounting staff.

Step 9: Payment is sent to the livestock owner by Department of Livestock accounting staff.

Step 10: If a livestock owner disputes the value of the livestock, the owner must submit a letter to the board office and provide proof of the greater value. Appeals will be presented to the full board for review.

MONTANA LIVESTOCK LOSS BOARD
PO BOX 202005
HELENA MT 59620-2005
(406) 444-5609 FAX(406) 444-5606
Website: www.llb.mt.gov

LOSS REIMBURSEMENT APPLICATION

PLEASE PRINT

LIVESTOCK OWNER NAME:_____
Name of business entity or individual applying for payment

ADDRESS:_____
PO Box or Street

_____
City State Zip Code

TELEPHONE #_____ FAX#_____

ADDITIONAL CONTACT NAME:_____
Name of person in charge or authorized agent

DEPREDATION INFORMATION: *(Only losses due to gray wolves or grizzly bears)*

Date of depredation:_____ County:_____
Depredation location _____Township _____Section _____Range

Type of animal: ☐ Cattle ☐ Sheep ☐ Horse ☐ Mule ☐ Swine ☐ Goat or
☐ Livestock Guard Animal (list animal type)_____

Number of animals_____ (Use a separate form if animals are different sex and age.)
Breed of animal_____ *(If registered, must include proof of registration)*
Age of animal_____ (months/years)
Sex of animal_____ (male/female) _____(gelded, spayed, neutered)
Average weaning weight _____lbs. (calves or lambs less than one year old)
Estimated weight of animal _____lbs. (animals greater than one year old)

Was the animal branded ☐ Yes ☐ No

If yes, brand location_____ ***and*** draw brand

Was the animal mortgaged ☐ Yes ☐ No

_____
If yes, name and address of financial institution

Was the animal insured ☐ Yes ☐ No

_____
If yes, name and address of insurance carrier

Optional: Were any loss prevention methods used? ☐ Yes, method_____ ☐ No

ATTACH A COPY OF THE WS DEPREDATION INVESTIGATIVE REPORT & IRS W-9 FORM TO THIS APPLICATION. Claims will not be processed without this form attached.

_____ _____
Signature of Applicant or Authorized Agent ***Date***

State of Montana
Department of Administration
SW9 (4/2009)

State Accounting Division
PO Box 200102
125 North Roberts Street
Mitchell Bldg – Room 255
Helena, MT 59620
Phone: 406-444-3092
Send faxes to: 406-444-2812

Substitute **W-9**

DO NOT send to IRS

Taxpayer Identification Number (TIN) Verification

Print or Type
Please see attachment or reverse for complete instructions.

Legal Name
(as entered with IRS) If Sole Proprietorship, enter your Last, First, MI

Trade Name
If doing business as (DBA) or enter business name of Sole Proprietorship

Primary Address (for 1099 form)
PO Box or Number and Street, City, State, ZIP + 4

Remit Address (where payment should be mailed, if different from Primary Address) PO Box or Number and Street, City, State, ZIP + 4

Entity Designation (check only one type)

- ☐ Corporation
  - ☐ S-Corp ☐ C-Corp
  - Do you provide medical services?
  - ☐ Yes ☐ No
- ☐ Individual
- ☐ Sole Proprietorship
- ☐ Partnership
  - ☐ General ☐ Limited
  - ☐ LLC (for federal tax purposes taxed as)
    - ☐ S-Corp ☐ C-Corp
- ☐ Estate/Trust
- ☐ Other Groups of Individuals
- ☐ Organization Exempt from Tax (under Section 501 (a)(b)(c)(d)(e))
- ☐ Government Entity

Exempt from Backup Withholding

☐ Yes ☐ No

Taxpayer Identification Number (TIN) (Provide Only One) (If sole proprietorship provide FEIN, if applicable)

Social Security Number	Federal Employer Identification No

Certification

Under penalties of perjury, I certify that:

1. The number shown on this form is my correct taxpayer identification number, AND
2. I am not subject to backup withholding because (a) I am exempt from backup withholding, or (b) I have not been notified by the Internal Revenue Service (IRS) that I am subject to backup withholding as a result of a failure to report all interest or dividends, or (c) the IRS has notified me that I am no longer subject to backup withholding.
3. I am a U.S. person (including a US resident alien).

Printed Name	Printed Title	Telephone Number

Signature	Date

Optional Direct Deposit Information (used at agency discretion) (all fields required to receive electronic payments) (Must Include a Voided Check, No Direct Deposit Slips Accepted)

Your Bank Account Number	☐ Checking ☐ Savings	Name on Bank Account	Bank Routing No. (ABA)

THIS IS A:

☐ New Direct Deposit ☐ Change of Existing ☐ Additional Direct Deposit ☐ Email Change Only

Email Address (Please make this LEGIBLE)

If you provide bank information and an email address, we will send a message notifying you when an electronic payment is issued. We will **NOT** share your email address with anyone or use it for any other purpose than communicating information about your electronic payments to you. **If you have questions about completing this form, please call the Warrant Writer Unit at 406-444-3092.**

2008 Year End Report

Montana LLB
PO Box 202005
Helena MT 59620
www.llb.mt.gov

George Edwards
Executive Secretary
(406) 444-5609
gedwards@mt.gov

Counties	Cattle	Sheep	Goats	Guard	Horse	Llama	Totals	Payments
Beaverhead	14	121						$33,885.37
Flathead	12					1		$9,521.42
Glacier	2							$1,248.00
Granite	6	5						$4,257.17
Judith Bas	2							$1,436.50
L&C	6		3	2				$5,236.28
Lincoln	9							$6,035.49
Madison	8							$8,091.86
Mineral	1							$777.10
Park	1							$677.28
Powell	4							$2,673.80
Ravalli	4					3		$2,392.52
Sanders	5				1			$7,079.89
Stillwater		17	1					$2,625.00
Sweet Gr		6	4					$1,380.00
Totals	74	149	8	2	1	4	0	$87,317.68

Confirmed	69	149	7	2	1	4
Probable	5		1			
Branded	58	17				
Mortgaged	21	127				
Owners	38	7	2	1	1	2

May to December
First payments made by the board began in May 2008

2009 Year End Report

Montana LLB
PO Box 202005
Helena MT 59620
www.llrmb.mt.gov

George Edwards
Executive Secretary
(406) 444-5609
gedwards@mt.gov

Counties	Cattle	Sheep	Goats	Guard	Horse	Llama	Totals	Payments
Beaverhead	28	184					212	$75,448.63
Cascade		10					10	$1,295.00
Flathead	2						2	$1,361.00
Glacier	14				1		15	$8,809.42
Granite	5			1			6	$5,742.41
Jefferson	2						2	$1,118.25
Lake	7						7	$5,152.77
L&C	12	7		2			21	$11,153.58
Lincoln	4	1					5	$2,861.00
Madison	12	14					26	$10,979.41
Meagher		24					24	$3,690.00
Missoula	1						1	$684.00
Park	2						2	$2,525.00
Pondera	1						1	$707.06
Ravalli	1						1	$732.88
Powell	9	1					10	$5,437.58
Sanders	5						5	$3,566.53
Stillwater		2	1				3	$375.00
Sweet Gr		1	2				3	$300.00
Teton	2						2	$1,316.25
Wheatland		12					12	$ 1,740.00
Totals	107	256	3	3	1	0	370	$144,995.77

Confirmed	85	214	3	3	1	
Probable	22	42				
Branded	76	184				
Mortgaged	42	199				
Owners	45	11	1	2	1	

2010 Year End Report

Montana LLB
PO Box 202005
Helena MT 59620
www.llb.mt.gov

George Edwards
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(406) 444-5609
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Counties	Cattle	Sheep	Goats	Guard	Horse	Llama	Totals	Payments
Beaverhead	29	15					44	$22,725.74
Carbon	1						1	$696.95
Cascade		29					29	$8,286.25
Deer Lodge	1						1	$754.00
Jefferson	2						2	$1,390.59
L&C	3	12	2				17	$5,145.31
Lake	1						1	$704.00
Lincoln	8						8	$8,459.07
Madison	25	10					35	$20,633.40
Mineral					4		4	$5,250.00
Missoula	3	1					4	$2,324.03
Park	6	2					8	$4,847.05
Powell	5				1		6	$6,339.78
Ravalli	2						2	$1,509.63
Sanders	11						11	$9,144.43
Silver Bow	2						2	$1,344.00
Totals	99	69	2	0	5	0	175	$99,554.23

Confirmed	90	65	2		5	
Probable	8	4				
Value	$76,752.32	$13,481.91	$1,370.00		$7,950.00	
Owners	55	10	1		2	

2011 Year End Report

Montana LLB
PO Box 202005
Helena MT 59620
www.liv.mt.gov

George Edwards
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(406) 444-5609
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Counties	Cattle	Sheep	Goats	Guard	Horse	Llama	Totals	Payments
Beaverhead	23						23	$20,848.06
Broadwater	3						3	$2,852.84
Carter		2					2	$700.00
Glacier	5						5	$4,673.38
Granite	1						1	$941.85
Jefferson	3						3	$2,829.55
Lincoln	7						7	$6,799.38
L&C	1	5					6	$4,206.84
Judith Basin	1						1	$797.50
Madison	13						13	$13,132.96
Park	2						2	$1,803.13
Powell	21	2		1			24	$18,911.70
Ravalli	3	1			1		5	$7,357.71
Totals	83	10	0	1	1	0	95	$85,854.90

Confirmed	65	9		1	1	
Probable	18	1				
Value	$75,389.31	$4,327.59		$1,500.00	$4,638.00	
Owners	37	4		1	1	

Remainging funds: $156,217.52

2012 Year End Report

Montana LLB
PO Box 202005
Helena MT 59620
www.liv.mt.gov

George Edwards
Executive Secretary
(406) 444-5609
gedwards@mt.gov

Counties	Cattle	Sheep	Goats	Guard	Horse	Llama	Totals	Payments
Beaverhead	12	24					36	$27,625.51
Broadwater	1						1	$799.12
Cascade	2						2	$3,129.69
Deer Lodge	1						1	$1,006.25
Flathead	5						5	$5,118.57
Gallatin	1						1	$901.55
Glacier	7				2		9	$6,975.13
Jefferson	4						4	$3,809.06
Lake	4						4	$3,886.25
Lincoln	4						4	$3,928.89
L&C	9	1		1			11	$10,373.68
Madison	9	15					24	$13,148.12
Missoula	2						2	$1,884.00
Park	4						4	$3,892.56
Pondera	3						3	$2,925.00
Powell	5						5	$5,192.63
Sanders	6						6	$6,707.09
Stillwater		2					2	$470.00
Sweet Gras	1						1	$941.08
Totals	80	42	0	1	2	0	125	$102,714.18

Confirmed	59	36		1	2	
Probable	21	6				
Value	$78,089.93	$22,524.25		$1,500.00	$600.00	
Owners	48	8		1	1	

2013 Year End Report

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Counties	Cattle	Sheep	Goats	Guard	Horse	Llama	Totals	Payments
Beaverhead	14	1					15	$22,170.86
Carbon	2						2	$1,745.59
Deer Lodge	1						1	$903.62
Flathead	5						5	$5,634.68
Glacier	6		1		3		10	$9,814.34
Granite	2						2	$1,762.00
Jefferson	2						2	$2,759.27
Lake	2						2	$2,858.44
Lincoln	2						2	$1,920.00
L&C		7					7	$11,200.00
Madison	7						7	$7,169.01
Meagher	1						1	$945.01
Mineral	1						1	$933.78
Missoula	6						6	$6,068.96
Park	5	23					28	$11,129.65
Powell	2						2	$1,917.96
Ravalli	1						1	$700.00
Sanders	4						4	$3,793.01
Teton	1						1	$959.86
Totals	64	31	1	0	3	0	99	$94,386.04

Wolves

Confirmed	45	24	1		3	
Probable	13	7				
Value	$66,813.49	$15,863.26	$125.00		$3,938.70	
Owners	35	4	1		1	

Grizzly Bears

Confirmed	6					
Probable						
Value	$7,645.59					
Owners	2					

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Counties	Cattle	Sheep	Goats	Guard	Horse	Llama	Totals	Payments
Beaverhead	5						5	$6,215.39
Deer Lodge	5						5	$6,165.55
Flathead		1					1	$156.80
Glacier	12						12	$16,876.93
Lincoln	1						1	$1,339.44
L&C	1						1	$1,268.04
Missoula	1						1	$1,373.71
Park	1						1	$1,305.00
Powell	1						1	$1,554.69
Pondera	1						1	$1,265.60
Ravalli	1						1	$1,069.08
Sanders	1						1	$1,162.28
Sweet Gras	2						2	$2,273.13
Totals	32	1	0	0	0	0	33	$42,025.64

Wolves

Confirmed	15					
Probable	5					
Value	$25,717.47					
Owners	13					

Grizzly Bears

Confirmed	11	1				
Probable	1					
Value	$16,151.37	$156.80				
Owners	7	1				

Wolf (*Canis lupus*) Predation Impacts on Livestock Production: Direct Effects, Indirect Effects, and Implications for Compensation Ratios

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Wolf (*Canis lupus*) Predation Impacts on Livestock Production: Direct Effects, Indirect Effects, and Implications for Compensation Ratios

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Abstract

Growing wolf (*Canis lupus* L.) populations in the US Rocky Mountain Region have increased conflicts between livestock production and wolf conservation. Given that the costs of large carnivore conservation are disproportionately borne by local livestock producers, the United States uses compensation for wolf damage to reduce conflicts and mediate negative attitudes toward the predators. Current compensation programs, however, only consider the direct effects of wolf predation. Indirect effects, such as wolf effects on weaning weights, and conception rates, may also reduce profitability. By not including indirect wolf effects, compensation programs may systematically undercompensate ranchers. We use a stochastic budget model of a representative cow–calf ranch in northwest Wyoming to estimate the economic impact of both direct (death loss and injured calves) and indirect effects (decreased weaning weights, decreased conception rates, and increased cattle sickness) of wolf predation. Our results suggest that short-run (i.e., year-to-year) financial impacts of wolf indirect effects may be as large as or larger than the direct effects. Including indirect effects implies that the compensation ratio (i.e., number of calves compensated per confirmed depredation) necessary to fully offset the financial impacts of wolves would need to be two to three times larger than current 7:1 compensation ratio used in Wyoming.

Key Words: cattle production, compensation, economics, predation, wildlife damage, wolves

INTRODUCTION

Controversy over the reintroduction of wolves (*Canis lupus* L.) remains a frequent newspaper headline across the US Rocky Mountain region. Much of the controversy stems from wolf depredation of livestock, which has steadily increased since reintroduction in 1995 (e.g., USFWS 2011). Given that the costs of large carnivore conservation are disproportionately borne by local livestock producers, the United States—following the example of other countries—uses compensation for wolf damage to reduce conflicts and mediate negative attitudes toward the predators (Schwerdtner and Gruber 2007, Dickman et al. 2011).

Though their ability to achieve conservation goals has been questioned (Boitani et al. 2010), designing effective compensation schemes requires a more thorough accounting of the costs large carnivores impose on livestock producers. Most compensation programs only attempt to offset the direct effect of livestock losses (e.g., animals predated). Wolves and other large carnivores can also have a variety of indirect effects (e.g., causing inefficient livestock weight gain) that are not captured in estimates of direct losses (Rashford et al. 2010). We use a stochastic budget model of a representative cow–calf operation in northwestern Wyoming to estimate the potential economic impact of both direct and indirect effects of wolf predation. Given the estimated economic impact, we then infer the compensation rates necessary to fully offset the direct and indirect effects of wolves.

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Programs that compensate for livestock predation are common where large predators have been reintroduced or are protected by public policy (Dickman et al. 2011). Though compensation mechanisms differ, most programs only compensate livestock owners for confirmed or verifiable losses. Confirming compensatory losses, however, can be difficult. Evidence of the predator at fault can disappear quickly or be contaminated by scavengers (Nyhus et al. 2005). Addressing unverified losses is one of the most critical problems for compensation programs since these losses further fuel negative attitudes toward predators and potentially toward conservation/compensation programs. Many programs therefore use compensation ratios (or similar mechanisms) to address unverified losses. Compensation ratios explicitly recognize that for every verified predation event there are likely several unverified events. In the case of wolves in the northwestern United States, compensation programs currently compensate at a ratio of seven to one for cattle; for each cow or calf verified as being predated by wolves, the owner is compensated seven times the market value (USFWS 2011). This ratio is justified by studies of detection probability in the Rocky Mountain region (Oakleaf 2003), and thus is clearly intended to offset unverified losses.

Compensation ratios greater than one attempt to accurately compensate landowners for the full cost they bear in predator conservation. Even if compensation ratios are chosen carefully, however, programs that only compensate for the direct effect of predation may still undercompensate livestock owners. The value of cattle, for example, may not be accurately captured by market prices because of the timing of predation relative to the cattle price cycle, or because market rates do not reflect producer investments in genetics and acclimation (Ashcroft et al. 2010).

There is also mounting scientific evidence that large predators can have other more subtle effects on free-ranging cattle. Cattle

exposed to large carnivores increase their vigilance behavior, may avoid certain areas (e.g., small pastures surrounded by dense cover), and are more prone to flight events (Kluever et al. 2008; Ashcroft et al. 2010; Sommers et al. 2010; Breck et al. 2012). The extent to which these behavioral changes affect financial returns is unclear. Some evidence suggests that cattle exposed to predators forage less efficiently and thus experience lower average daily weight gain (Ashcroft et al. 2010). Cattle herds exposed to predators can also have lower conception rates, either due to stress (Howery and DeLiberto 2004) or because cattle used as replacements do not breed as efficiently as those lost to predators (Ashcroft et al. 2010). There is also evidence that predation-related stress and injuries increase cattle vulnerability to sickness and disease (Howery and DeLiberto 2004; Lehmkuhler et al. 2007; Laporte et al. 2010), which can increase producer expenditures on medicine and veterinary services (Ashcroft et al. 2010). Producers in wolf country may also experience increased management costs due to checking animals or repairing fences more frequently, and due to management time expended to confirm depredations (Lehmkuhler et al. 2007; Sommers et al. 2010).

Although some studies have considered the economic impacts of wolf predation on cattle production, they have generally focused on the direct effects of predation (Muhly and Musiani 2009; Sommers et al. 2010; Hebblewhite 2011). The comprehensive economic impact, including direct and indirect effects, is largely absent in the literature, most likely because of the lack of scientific data required to quantify indirect effects. Rashford et al. (2010) attempted to estimate more comprehensive effects by including reductions in calf weaning weights and increases in management costs in a profit maximization model of a representative cow–calf ranch facing general predation. They found that reduction in weaning weights could have as large or larger of an effect on profitability as direct predation. Their model, however, only considered three effects of predation (i.e., death loss, reductions in weaning weights, and increased management costs), used largely hypothetical guesses at the size of the effects (e.g., straight percentage reductions in weaning weights), and only considered each effect in isolation, not cumulatively.

We simulated the potential economic impact on cow–calf production of a broad suite of direct and indirect effects of operating in areas inhabited by wolves. Since there is insufficient scientific research to precisely quantify all of the direct and indirect effects, we use available literature and anecdotal reports to quantify a suite of wolf effects in a stochastic budget model. The stochastic budget model allows us to simulate the economic impact of alternative levels of direct and indirect effects, both in isolation and cumulatively.

METHODS

Representative Ranch Enterprise Budget

We use an enterprise budget of a representative 400 head cow–calf ranch to simulate how wolves may affect ranch profitability. The budget model is specified using assumptions (e.g., bull-to-cow ratios, conception, cull and natural death rates, and sale weights) consistent with cow–calf production in northwest Wyoming (see Steele 2012 for a detailed budget description). Within the budget model, we divide the fiscal year into five seasons according to natural breaks in the cattle production process: winter feeding, calving, breeding, late summer grazing, and weaning. During each season, the budget model tracks activities (e.g., checking cattle) and their associated costs and revenues. The model operates on an annual basis, and thus represents a short-run model. We therefore do not consider fixed costs (e.g., interest on debt) and other long-run decision-making factors, which allows us to focus on the potential year-to-year impacts of wolves without considering the possibility of significant changes in ranch management (e.g., switching from a cow–calf to a stocker operation to reduce predation impacts). Since it is a short-run model, our primary measure of economic effects is the representative ranch's annual gross margin (i.e., revenue minus variable cost).

Specifying Wolf Effects

We model five potential effects of wolves on the representative ranch, including two direct effects: death loss (i.e., confirmed predated and missing cattle) and injured calves; and three indirect effects: decreased weaning weights, decreased conception rates, and increased cattle sickness. Though not inclusive of all the ways in which wolves can affect cattle production, these effects capture a range of possible direct and indirect effects and there exist data or reasonable assumptions to quantify them. Each effect is captured in the budget model through changes in specific production parameters or activities (Table 1). Death loss and injured calves are modeled by changing the death rate and veterinary expenditures, respectively. For death rates, we model natural deaths (e.g., during calving) separate from predation to isolate the wolf effect. The budget model also includes compensation for confirmed predations—we assume, following the literature and current policy, that one out of seven depredated animals is confirmed. Thus, by construction, our baseline model is designed to fully compensate for death loss.

We similarly adjust model parameters to incorporate indirect effects in the budget model. Decreases in weaning weights are modeled by changing the weights of heifer and steer calves at the end of the grazing season. We model decreased conception rates by adjusting the number of bred cows (i.e., at pregnancy testing in November). To maintain the annual characteristics of the model, we assume that all unbred cows are culled and replaced; thus, lower conception rates implies revenue from cull cow sales and costs associated with purchased replacements. Lastly, we model increased sickness by adjusting the number of calves that require medical treatment. Contrary to injured calves, we assume that stress-related increases in sickness can be treated by ranch employees (e.g., administering penicillin); thus, costs associated with medicine increase but there is no additional veterinary expenses.

There is relatively little scientific literature available to quantify many of our modeled wolf effects (i.e., determining the size of changes in model parameters). We therefore use a variety of sources to specify potential ranges in model parameters to capture each wolf effect. We use US Department of Agriculture data to parameterize nonwolf death loss (USDA-NASS 2011). We derive ranges for wolf predation rates from the published data in Sommers et al. (2010) and unpublished producer-collected data from Alberta, Canada (C. Sears,

Table 1. Direction of change for model parameters used to simulate wolf effects in the cow–calf enterprise budget representative of production in northwestern Wyoming (June 2012).

	Wolf effect				
Budget parameter	Death loss	Injured calves	Weaning weight	Conception rate	Sickness
Marketable calves	–				
Calf weights			–		
Owner labor hours	+	+			
Truck use	+	+			
Truck/haul expenses	–			+	
Veterinary expenses		+			
Cull cows				+	
Replacement cows				+	
Medicine expense					+
Brand inspections	–			+	

unpublished data, 2008). Lastly, we derive ranges for indirect-effect parameters through interviews with five producers in northwest Wyoming; one producer in Alberta, Canada; and two wildlife services officials. The ranges are defined as percentages of difference from a "baseline" with no wolf effects (Table 2). The low scenario corresponds to the lowest reported value of each effect, and severe corresponds to the highest reported value. Each scenario implies different values for critical budget parameters (Table 3), which in turn affect output and cost and thus ranch gross margin.

Simulating Wolf Effects on Short-Run Ranch Profitability

Given that the literature measuring wolf effects is lacking and that no study has comprehensibly measured multiple wolf effects simultaneously, we use a Monte Carlo–style simulation to estimate the impact of wolves on short-run profitability. Specifically, we use the software @Risk (Palisade 2005) to define triangular distributions for each wolf effect. For each effect, we set the minimum value of the triangular distribution at zero (i.e., baseline parameter levels), the most likely value consistent with the average reported in the literature, and the maximum value consistent with the highest value observed in the literature. With each wolf effect defined by a distribution, we can randomly draw an observation for each wolf effect and calculate ranch gross margin. It would be counterintuitive, however, to treat separate wolf effects as independent—i.e., it would be unlikely to observe high death loss and low sickness. We therefore assume the individual wolf effect distributions are 50% correlated.

Table 2. Percentages of change from baseline used to simulate wolf effects in the cow–calf budget model representative of production in northwestern Wyoming (June 2012).

	Level of effects		
Wolf effect	Low	Moderate	Severe
Death loss	1.50%	3.60%	7.50%
Injured calves	0.25%	0.50%	2.75%
Weaning weights	2.00%	3.80%	10.0%
Conception rates	1.00%	3.00%	6.00%
Disease/sickness	0.25%	0.50%	2.75%

Table 3. Model parameters for representative cow–calf budget in northwestern Wyoming corresponding to different levels (baseline, low, moderate, and severe) of wolf effects (June 2012).

Budget parameter	Baseline	Low	Moderate	Severe
Calves to market	380	375	367	352
Injured calves	0	1	2	11
Weaning weights	S[1] 545	S 534	S 524	S 491
	H 525	H 515	H 505	H 473
Cull cows	60	64	72	84
Treated calves	2	3	4	13

[1]S indicates steers; H, heifers.

In addition to stochastic wolf effects, we also incorporate random output prices in our simulation. Cattle prices can vary substantially both within and across years, and previous research has noted the important role of prices in determining the magnitude of predation impacts (Ashcroft et al. 2010). We therefore use weekly prices from the Torrington, Wyoming, livestock auction from the period 1992–2011 to define cattle price distributions. All prices are adjusted to 2011 dollars using the producer price index (St Louis Federal Reserve 2011). We then use the distribution-fitting tool in @Risk to define distributions for all cattle prices in our representative ranch budget (i.e., prices for steer calves, heifer calves, cull cows, and cull bulls). Based on χ^2, Kolmogorov-Smirnov, and Anderson-Darling statistics, we use triangular distributions to model steer and heifer calf prices and log-logistic distributions to model cull cow and cull bull prices. We also use the historical price data to define correlations between all prices to assure that simulations draw realistic price sets.

Given the distributions described above, we randomly draw observations on wolf effects and prices to derive distributions over ranch gross margin for each wolf effect individually and all effects cumulatively. To assure that our results are not driven by extreme draws, we determine the number of draws necessary for the simulations to converge following Ross (2002). At 10 000 iterations, average gross margin converges with a standard deviation approximately equal to the price of one calf, and additional draws do not significantly alter results. We therefore use 10 000 iterations to derive gross margin distributions. To compare alternative scenarios, we use standard two-sided t tests to test the statistical difference of estimated average gross margins, where variances are derived from the 10 000 iterations.

Lastly, we use the simulation results to calculate compensation ratios that include both direct and indirect wolf effects. To be consistent with current policy, we define the compensation ratio in terms of confirmed predated calves. We calculate the compensation ratio for each iteration, and then average across the 10 000 iterations to determine the expected fair compensation ratio. For each iteration the compensation ratio is calculated as

$$\text{Compensation Ratio} = \frac{\left(\frac{\text{Gross Margin Difference from Baseline}}{\text{Confirmed Depredated Calves}}\right)}{\text{Average Price per Calf}} \quad [1]$$

We determine the number of confirmed depredated calves by multiplying death loss (i.e., number of predated claves determined in each iteration) by the assumed detection rate of 14.3% (i.e., one out of seven predated calves are confirmed). The

calculated compensation ratio is therefore the number of calves that must be compensated to equate the gross margin with wolf effects to the baseline gross margin with no wolf effects.

RESULTS

In the baseline scenario with no wolf effects, the representative ranch had an average gross margin of $47 803. Price variability, however, caused substantial variation, with a standard deviation in gross margin of approximately $40 000. The price variability implies that the representative ranch covers variable costs (i.e., has a positive gross margin) for most alternative price scenarios (85.4%).

Each individual wolf effect decreases the representative ranch's gross margin and generally increases the variability in gross margin (Table 4). Increased disease/sickness, death loss (i.e., direct predation) with compensation, and injured calves have small negative impacts, with both decreasing average gross margin by 1% to 2% and causing no measurable change in variability. Wolf-induced reductions in conception rates and death loss without compensation decrease average gross margin by approximately $10 000 (20%) and cause the variability in gross margin to increase. Reductions in weaning weights have the largest effect, decreasing average gross margin by nearly 27% and increasing the variability in gross margin. The wolf effects that increase variability in gross margin (conception rates, death loss, and weaning weights) also increase the proportion of simulated years when the ranch's gross margin is negative. In each case, the percentage of years with negative gross margin increases from approximately 15% in the baseline to 20% with each wolf effect. In all of the individual effects cases, the difference in average gross margin is different than the baseline ($P < 0.001$).

Cumulatively, wolf effects shift the entire distribution of gross margin toward negative values and increase the relative variability in gross margin (Fig. 1). Thus, for the same set of randomly drawn prices, the distribution of gross margin with cumulative wolf effects has a maximum, minimum, and average value less than the baseline, and has more observations that generate negative gross margin. Average gross margin decreases by approximately 52% (from $47 803 to $23 106). Gross margin decreases across the full range of simulated prices, with a minimum decrease of $4 738 and maximum decrease of $51 446 when compared the baseline for the same

Table 4. Summary of individual wolf effects impact on gross margin for a representative cow–calf enterprise in northwest Wyoming, USA (June 2012).

Wolf effects	Average gross margin	Coefficient of variation	% Negative gross margin
Baseline	$47 803.00	0.85	14.6%
Disease/sickness	$47 533.21	0.85	14.8%
Death loss with compensation	$47 352.60	0.85	14.8%
Injured calves	$46 942.01	0.85	14.8%
Conception rates	$37 535.83	1.09	20.1%
Death loss without compensation	$37 025.32	1.05	19.4%
Weaning weights	$34 948.81	1.11	20.4%

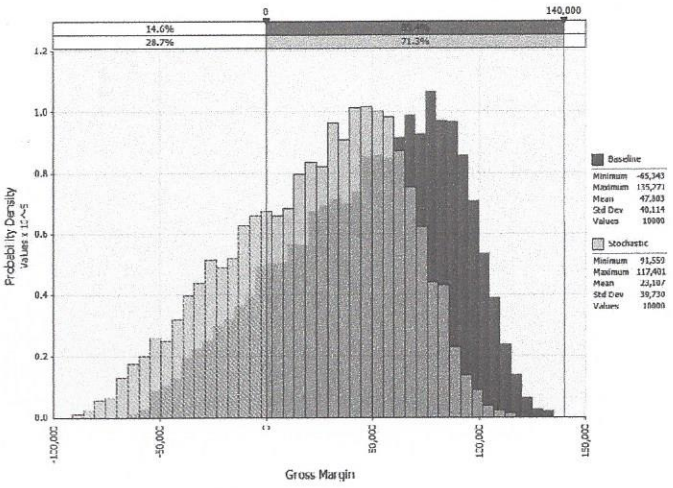

Figure 1. Comparison of gross margin distributions between the baseline scenario (i.e., no wolf effects) and cumulative stochastic wolf effects estimated using a representative cow–calf budget for northwestern Wyoming (June 2012).

set of prices. The variability in gross margin also increases substantially with a coefficient of variation of 1.72 compared to 0.85 in the baseline. Consequently, the proportion of negative years with cumulative stochastic wolf effects increases to 28.4% compared to 14.6% in the baseline.

The implied compensation ratios respond to wolf effects (Table 5). As designed, the budget model implies a compensation ratio equal to current policy (i.e., 7:1) when only death loss is considered. When all direct and indirect effects are cumulatively included, the implied compensation ratio increases threefold to 21:1. The implied compensation ratio with direct and indirect wolf effects ranges from 18:1 when wolf effects are fixed at the low level, to 24:1 when they are fixed at the most severe level observed in the region.

DISCUSSION

Our results suggest that the indirect effects of wolves on cow–calf production can be financially significant. Relative to a baseline with no wolf effects, the indirect effects of decreased conception rates and decreased weaning weights each have a negative effect on short-run profitability (average decrease of $10 250 to $12 855) that is comparable to, or larger than, direct predation (average decrease of $10 778). The indirect

Table 5. Comparison of compensation ratios across alternative wolf pressure scenarios derived using a stochastic budget model of cow–calf production in northwest Wyoming, USA (June 2012).

Wolf pressure scenario	Compensation ratio
Current policy	7:1
Only stochastic death loss	7:1
Cumulative stochastic effects	21:1
Low wolf effects	18:1
Moderate effects	21:1
Severe effects	24:1

effects of decreases in weaning weights and conception rates have large impacts because, like predation, they directly reduce the ranch's primary revenue source—calf production. The limited data available on weaning weight effects suggest predation pressure can decrease average calf weaning weights by 2% to 10% (i.e., 4–22 kg), which at average prices ($0.55 · kg) corresponds to substantial losses per affected calf. Our model, however, may tend to overestimate the weaning weight effects since it applies the same weight reduction (i.e., drawn randomly from the distribution in each simulation) to every calf in the herd. It is conceivable that calves would be affected differentially, but there is no literature or data available to model differential effects. Nevertheless, our bootstrapped approach should generate effects that are akin to a long-term average. Our results for weaning weight effects are also less severe than those estimated by Rashford et al. (2010), who found that a 5% reduction in weaning weights could reduce average ranch profits by 40% (compared to our average estimate of a 27% reduction in gross margin).

In contrast, our model suggests that the indirect effects of increased disease/sickness and injuries have only small effects on short-run ranch profitability. These effects, and the expenditures associated with them, are often mentioned as potentially important indirect effects of large predators (Ashcroft et al. 2010). Although they do increase expenditures (e.g., costs of vaccines and veterinary care), from a financial perspective, these indirect effects have only minimal impacts on short-run profitability. Even in the worst-case scenarios included in our simulations (i.e., severe effects), disease/sickness reduced gross margin by only $688 (1.4%) and injured calves decreased gross margin by $2 210 (4.6%). These results suggest that future efforts to quantify the indirect effects of large predators on livestock production should focus on how predator-induced stress affects weaning weights (e.g., forage efficiency and weight gain) and conception rates.

Our result that indirect effects can cause substantial financial losses has important implications for wolf compensation programs. The current compensation ratio of .7:1 may substantially underestimate the compensation necessary to fully offset the financial effects of wolves on livestock production. Our results indicate full compensation would require ratios ranging from 18:1 to 24:1 depending on the severity of indirect wolf effects. In 2012, wolves were confirmed to depredate 44 cattle in Wyoming (USFWS 2012). Using the average price from our data ($729), the current 7:1 compensation ratio would imply total compensation costs of $224 544. Full compensation, however, would imply total compensation costs of $577 399 to $769 865.

Our estimated compensation ratios and total compensation costs depend on the limited data and assumptions we used to quantify indirect effects. To explore the importance of our assumptions, we also derived compensation ratios for a range of more conservative assumptions (Table 6). If we assume that there are no indirect effects on weaning weights and conception rates, then (as expected) the current compensation ratio is reasonably accurate since the remaining indirect effects have only small financial impacts. With no weaning weight effects (the largest and most difficult effect to quantify), the full compensation ratio is still nearly twice the current policy due to the effect of reduced conception rates. Alternatively, if we use conservative estimates of the weaning weight and conception rate effects (i.e., define the indirect effect distribution over the range from zero to the average effect), the full compensation ratios range from 13:1 to 16:1. Thus, even with conservative assumptions, compensation ratios approximately twice as large as the current policy are necessary to fully offset both the direct and indirect effect of wolves on livestock production. As a result, total compensation costs would increase from $224 544 using 7:1 compensation to approximately $417 000 to $513 000 using our conservative compensation ratios that account for direct and indirect effects.

Table 6. Compensation ratios derived from a representative cow–calf budget in northwest Wyoming, USA using alternative assumptions about the magnitude of indirect wolf effects (June 2012).

Wolf pressure scenario	Compensation ratio
Baseline (i.e., current policy)	7:1
Zero weaning weights and conception rates	8:1
Zero weaning weights	13:1
Conservative weaning weights	16:1
Conservative weaning weights and conception rates	13:1

Because we used a simulation approach, our results also highlight how variability in prices and wolf effects can impact livestock production. Livestock production is inherently risky, with profit margins continually fluctuating due to output price cycles and input cost changes. Random wolf effects add another source of risk (i.e., coefficient of variation increases); however, our results clearly indicate that output price variability is the most significant driver of risk. Though wolf effects increase the proportion of years with negative gross margin, the distribution of gross margin with and without wolf effects show similar variability. This implies that random prices, not random wolf effects, drive the variability in gross margin. High prices can even offset the most severe wolf effects (Table 7). Thus, years with severe wolf effects and high prices can be more profitable than years with no wolf effects and low prices. These results are consistent with landowner surveys in other regions that indicate nonpredation factors, such as market fluctuations and extreme weather, are greater threats to livestock production than wolves (Chavez et al. 2005).

Lastly, our short-run modeling approach may overestimate predation impacts because it does not account for potential changes in management. Alternative grazing practices, increased trapping or shooting efforts, and the use of guard dogs are common management practices to reduce the effects of predation (Woodroffe et al. 2005). Economic theory suggests that ranchers would adopt new management practices in the long run if the benefits outweighed the costs. Our short-run budget model approach, however, assumes that management practices and other long-run factors remain fixed. Thus, if alternative management practices could cost-effectively reduce the direct or indirect effects of wolves, our estimates of gross margin losses could be reduced. Any reduction in wolf effects would improve the long-run financial feasibility of our representative ranch. There is limited literature evidence, however, of the extent to which management practices can cost-effectively reduce the effects of wolves on cattle (Bjorge and Gunson 1986), and therefore our estimates likely represent

Table 7. Comparison of gross margins between a scenario with no wolf effects (i.e., baseline) and low output prices, and a scenario with severe wolf effects and high output prices derived from a representative cow–calf budget for northwest Wyoming, USA (June 2012).

		Output prices ($/cwt)			
	Gross margin	Steer	Heifer	Cow	Bull
Baseline	−$64,543.54	$92.41	$80.01	$45.09	$52.72
Severe wolf effects	$71,051.71	$173.81	$164.28	$79.06	$90.16

a conservative upper bound of the annual gross-margin impacts of wolves in both the short and long run.

IMPLICATIONS

Indirect predator effects have been identified for a variety of other predator and prey species (e.g., wolves have indirect effects on sheep, elk, and deer), and in other regions (e.g., from the US Southwest and Canada to Africa and India; Howery and Deliberto 2004; Muhly et al. 2010; Lehmkuhler et al. 2007; Ashcroft et al. 2010). Our finding in northwestern Wyoming that total financial impacts of wolves on cattle production can be much larger than just the direct predation losses therefore likely apply very broadly. Since compensation schemes are applied across the globe to encourage landowner support of, and participation in, carnivore conservation (Dickman et al. 2011), policy-makers need to consider the indirect effects of predators on local livestock production to design effective compensation schemes.

Current compensation schemes, which ignore the indirect effects of predators, may significantly undercompensate landowners for their role in predator conservation. In an era of high subsidies, full compensation for predator losses would still be small relative to other agricultural subsidies (e.g., total US corn subsidies in 2012 of $3 billion is nearly 5 000 times larger than the total amount spent on wolf-related compensation). Fully compensating, or even overcompensating using a fixed payment scheme, may be justified if it enlivens landowner participation (or reduces litigation) by making predators an asset rather than a liability. Such participation is critical to carnivore conservation, especially in the developing world. The tradeoff between full compensation and the moral hazard it could create (i.e., the disincentive to undertake private management actions to reduce predation), however, needs further research if compensation schemes are to be economically efficient.

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