LIVESTOCK PROTECTION

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Saddle Hills COUNTY

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Livestock Protection Program

MOTION 082.02.14.23

PREPARED BY: **Agricultural Services**
REFERENCES: *n/a*

COUNCIL APPROVAL DATE: **February 14th, 2023**
PREVIOUS REVISION: **077.01.28.20**

Signatures

Reeve

[redacted]

Alvin Hubert

Chief Administrative Officer

[redacted]

Cary Merritt

PURPOSE:

To protect livestock from wolf depredation within the County.

GUIDELINES:

1. The Livestock Protection Program will be activated and deactivated by resolution of Council.
2. Eligible registrants will be limited to Saddle Hills County:
   a. residents;
   b. registered landowners;
   c. grazing lease holders; and
   d. legally licensed trappers will also be eligible when a Damage Control License that states the wolves can be trapped is issued by Environment and Parks to the land owner or occupant of the land.
3. The Chief Administrative Officer or Designate shall:
   a. pay compensation of five hundred dollars ($500.00) per adult wolf taken by a registrant within the boundaries of Saddle Hills County in accordance with the listed conditions.
4. Participants shall:
   a. be registered in advance with Saddle Hills County;
   b. have executed an Schedule 1; and
   c. have completed a Livestock Protection Course.
5. Participants wishing to collect compensation shall:
   a. ensure Fish and Wildlife Officers are notified of the harassment or depredation of livestock;
   b. make an appointment to present the pelt and carcass or whole carcass from each wolf harvested for approval;
   c. present a completed Declaration of the Participant form;
   d. produce written verification from the landowner or occupant of the land declaring:
      i. the location that the wolf was harvested;
      ii. that the registrant is authorized to harvest the wolf at that location;
   e. provide a copy of the damage control license issued to the landowner if the wolf is trapped or snared;

f. dispose of all parts of the wolf carcass using provincially recognized carcass disposal methods; and
g. understand that pelts and/or carcasses received by designated representatives of the County will be marked.

6. Participants presenting carcasses harvested prior to the completion of all prerequisites and entry into the agreement will not receive retroactive payment.

7. Any Participant registered prior to March 8, 2017 must re-register by signing a new Contract of Participation and will not receive retroactive payment.

8. At the discretion of the Agricultural Fieldman, a harvest site inspection may be required to verify a compensation claim.

ATTACHMENTS:

Schedule 1 - Contract of Participation
Schedule 2 - Declaration of the Participant Form

Schedule 1
Contract of Participation
Livestock Protection Program between Registrants and Saddle Hills County

In an effort to manage predatory wildlife, the Saddle Hills County ("Municipality") has approved a Wolf Depredation Management program ("Program") for the purpose of removing wolves causing livestock depredation within the Municipality. Through this program, wolf hunters or trappers ("Registrants") will receive monetary compensation ("Compensation") for the carcass of a wolf hunted lawfully and according to Saddle Hills policy within the Municipality. The terms and conditions of participation in the Program are as follows:

STATUTORY ADHERENCE: While participating in the Program, the Registrant will, at all times, abide by all statutes, regulations, and bylaws enacted by the federal, provincial, and municipal governments, and the Registrant agrees not to violate any statutory or regulatory provision in any way. The relevant statutes include but are not limited to: the Firearms Act, the Petty Trespass Act, the Wildlife Act, and the Wildlife Regulations. Any Registrant who fails to strictly adhere to all relevant laws or Saddle Hills Policy will forfeit any right to compensation under the Program.

INDEMNIFICATION AND HOLD HARMLESS: The Registrant will indemnify the Municipality, its officers, representatives, agents and employees, against and hold them harmless from and against any and all liability for any and all claims, costs, damages and expenses or liability arising on account of injury or death to persons or damage or destruction to property resulting from or arising out of or in any way connected to the Program or participation in the Program.

PRECONDITIONS OF COMPENSATION: In order to obtain compensation, the carcass of a lawfully hunted or trapped wolf must be presented to an appropriate representative of the Municipality. Any carcass received by a representative of the Municipality will be marked. Any carcass that has been previously marked by a representative of the Municipality will be rejected and according to Article 9 of the policy, the Registrant will be removed from the program. To qualify for compensation, a wolf must be lawfully hunted or trapped within the boundaries of the Municipality. Any person who has not agreed to be bound by the terms and conditions of this Contract of Participation ("Contract") will be considered ineligible to receive compensation. The Registrant must state the location where each wolf was killed and must also produce appropriate documentation as follows:

If the wolf was hunted on private property, the Registrant must, at the time of presentation of the proof of carcass to a representative of the Municipality, **produce either**:

(i) a letter of permission, written and signed by the owner or occupant of the property, authorizing the Registrant to hunt wolf on the property;
(ii) proof that the Registrant is the owner or occupant of the property; and
(iii) proof of Damage Control License if wolf is trapped or snared.

If the wolf was hunted on grazing leases, the Registrant must, at the time of presentation of the carcass to a representative of the municipality, **produce one** of the following:

(i) proof that the Registrant is authorized to maintain livestock on that land;

(ii) a letter of permission, written and signed by the person authorized to maintain livestock on that land, authorizing the Registrant to hunt wolf on the land;

(iii) proof that the land is within 5 miles of property owned by the Registrant or lands on which the Registrant is authorized to maintain livestock, or lands for which the Registrant has a letter of permission as contemplated in (ii) just above and if the land is leased, a letter of permission, written and signed by the lessee and if the land is not leased, proof that it is not leased, and

(iv) proof of Damage Control License if the wolf was trapped or snared.

COMPENSATION: If and only if the representative of the Municipality is satisfied that the Participant has complied with the terms and conditions of this Contract, the Reward will be paid by the Municipality to the Participant. The Reward will be paid by the Municipality to a successful Registrant at rate established by Councillor each adult wolf.

SIGNED this_____day of_____, 20_____

Registrant (print):_____(sign):_____

Mailing Address: _____

Land Description:_____

Telephone:_____Cell:_____

Municipal Staff (print):_____(sign): _____

Witness: _____

"An appointment must be scheduled with Agricultural Services Personnel in advance of presenting a wolf. To schedule your appointment, phone (780) 864-3760"

Schedule 2

Declaration of the Participant – Wolf Compensation Authorization Form

1. I am presenting wolf carcass(es) under the Livestock Protection Program. I am requesting compensation for a Wolf hunted as per Policy AG17, Livestock Protection Program.

2. I have previously read and signed, or been identified as a person acting on behalf of a Landowner under Schedule 1 the Contract of Participation of Policy AG17. I agree that I have followed all rules noted in the Contract.

3. I understand that I am not entitled to receive any payment from the Program if I provide false or misleading information and will be removed from the program.

4. I declare that the carcass that I am presenting:
    a. was harvested in a lawful manner, in accordance with current legislation,
    b. that this wolf was behaving in a predatory manner towards my livestock
    c. was harvested as per a current Damage Control License if trapped or snared
    d. was killed at the location that I have reported to the Agricultural Fieldman; and
    e. that I am the legal landowner or authorized occupant of the land; and/or
    f. was harvested on behalf of a Landowner, and I had permission to harvest on said land.

5. I agree to provide further information if requested by the Agricultural Fieldman for the purpose of verifying my claim for compensation.

_____ _____ _____

Signature DD/MM/YY Witness

Name: _____

Address: _____

Phone: _____ Cell: _____

Landowner for whom the wolf/wolves were harvested: _____

The wolf was harvested from the legal description(s) below:

___Q ___ Twp ____ Rge ___W6M GPS Location _____Date harvested:_____

Estimated Age:_____ Male:_____ Female:_____

For Office Use Only_____

- ☐ Copy of Damage Control License
- ☐ Livestock Protection Course
- ☐ Contract of Participation Post March 2016
- ☐ Landowner Permission and confirmation if harvested on third party land private land
- ☐ Registered Trapper/Resident Trapper Trapper Number:_____

Authorizing Signature_____Date_____

Cheque no. _____ was sent on date: _____

THE PEST INSIDER

October 2017

A Potentially Good Rat

Mura, is a rat like rodent imported from Germany in the 1950s as a furbearing animal for the fur industry. Krings, a German breeder from Dortmund, developed this hybrid rat by crossing different rodents from South America, Africa, and Asia to get a thick furred rodent for pelting. Mura are similar in appearance to a white laboratory rat with good fur coverage and underfur. This fur bearing multicolored rodent looks like a rat, purrs like a kitten, nibbles food like a squirrel, multiplies faster than a rabbit, and produces a water repellant thick glossy short haired pelt. Mura garments and stoles were sold in Alberta in 1956 with anticipation that Mura would become a popular fur by the buying public. However, after the death of the only licensed Mura fur farm operator from Scapa in 1958, the industry collapsed. The following year, the inherited owners voluntarily exterminated the newly imported Mura.

Taken from 1956 Annual Report for Agriculture in Alberta

Rats!

They fought the dogs and killed the cats,

And bit the babies in the cradles,

And ate the cheeses out of the vats,

And licked the soup from the cooks own ladles,

Split open the kegs of salted sprats,

Made nests inside men's Sunday Hats…..

Robert Browning

In This Issue

Coyote

Tapeworm Parasite

Echinococcus multilocularis is a potentially nasty parasitic tapeworm that can attack humans who ingest the eggs found in dog and coyote feces. There have been four human cases diagnosed in Alberta over the past few years, which has raised significant concerns.

One concern is that by the time the parasite is recognized, treatment can be difficult. Since the incubation period is five to 15 years, infections identified now have developed many years ago, indicating there may be people unaware they are infected.

This foul tapeworm is believed to be well-established in Alberta, especially in the southern region. Eradication of this parasite is not practical since it is well entrenched in the wildlife population. Its life cycle includes infection of small mammals (usually rodents) that develop tumour-like lesions in their internal organs. When the animal is eaten by a canid, the tapeworm develops in the intestinal tract, where it produces eggs. These eggs are shed in feces and the life cycle continues when the eggs are ingested by another small mammal.

Dogs can be infected this way, usually after ingesting an infected rodent and then the shed eggs pose a risk to people and other animals. Echinococcus eggs are immediately infective when they are passed - even contact with fresh feces is a risk. These eggs survive very well in the soil and can remain infective for up to a year. Wash your hands thoroughly to prevent any tiny bits of soil from getting into your mouth. Keep rodent populations away from homes and keep dog feces cleaned up and disposed of promptly.

BBC:

Rats Invade Villages in Southern Myanmar

In June this year, villages in southern Myanmar saw a flood of rats, damaging crops and leading to food loss.

To rectify the issue, authorities began offering a four-cent (US) bounty for each rodent.

Read the whole story here.

Rats in Myanmar

That time of the year...

It's that time of year when all rodents, especially mice and voles, will be on the lookout for shelter and food for the winter.

Removing cover as much as possible, cleaning up the area around premises, filling in any holes in foundations or under porches, and removing any possible food sources does a lot to discourage rodents from sneaking into homes or businesses.

Vole

Voles

A voles' ability to reproduce is outdone only by rat species. Because of their high reproductive capability when given heavy snow conditions and suitable forage, they can ruin lawns, shelter belt seedlings, shrubs, or small trees.

Prevention is key to reducing the risk of vole damage to your lawn or landscape trees. Keep the grass mowed as short as possible, and remove cover that voles can use for food and shelter under the snow. Not piling snow on your lawn may help reduce the snow cover available for a vole to make a safe home.

A new product, Ground Force Vole Pellets (anticoagulant Rozol bait) is registered for vole control as well, and can be used to help protect small trees, seedlings and shrubs when placed in bait stations in the fall. (See bait station below for suggested use.)

Vole Bait and Typical Vole Bait Station

Alberta Rat and Pest Update

Confirmed rat reports were limited to only one Norway rat found in a septic truck's discharge in Red Deer County. We suspect this rat was brought into Alberta as a feeder rat for reptiles. After investigating, no further activity or evidence in the area could be found. Thanks to all our Pest Control Officers who investigated this and other rat reports throughout the province. Without their help, we could not be sure we remain rat free.

The Rat Hotline, 310-RATS (7287), remains very active with hundreds of reports of misidentified rodents. PCOs are encouraged to educate the general public on proper identification of a rat to help reduce the number of false calls.

The muskrat is certainly the number one rodent to be mistaken for a rat. A small juvenile muskrat is so similar to a Norway rat that unless you can look closely, you can be fooled. The black flattened tail, large toes with visible claws on hind feet, and thick fur are some of the identifying physical features of the muskrat.

Norway rats absolutely do not want to be seen, especially in the open or in the daylight. If you have time to take a picture of the rodent, or are able to catch up to the rodent then it is not a healthy rattus rat. Norway and Roof rats are fast, elusive, and extremely nocturnal!

We had another successful City Slickers day in Stony Plain, with hundreds of Edmonton students from grade four and five learning about rats.

Grade 4 and Grade 5 Students Learning about Rats at Heritage Centre Stony Plain

Contact Us

310-RATS (7287)

OR

310-FARM (3276)

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METHODS OF INVESTIGATING PREDATION OF LIVESTOCK

Alberta Government

AGDEX 684-14

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FIGURES

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R.C.A., M.J.D.

INTRODUCTION

Alberta has a wealth of wild predatory mammals and birds including coyotes, wolves, bears, cougars, lynx, skunks, weasels, magpies, ravens, eagles and many species of hawks and owls. These animals prey on wildlife most of the time, but occasionally they attack domestic animals. Predation of livestock can cause significant losses to individual farmers.

Wildlife is under the stewardship of the people of Canada, and consequently the Alberta government has assumed certain responsibilities when wildlife conflict with human interests. The Alberta government assists farmers in the prevention and control of predation on domestic animals and under certain conditions provides compensation for livestock losses.

Judicious application of control techniques and the equitable administration of compensation require an accurate determination of the cause of death where predation is suspected.

While predation of healthy domestic animals is common, livestock can also be predisposed to predation from a variety of causes including sickness, malnourishment, inclement weather and poor management. Livestock also die from causes other than predation. Many dead animals are scavenged and sometimes completely consumed by predators. The presence of predators and predator sign, hair and feathers in droppings, and the disappearance of livestock does not necessarily mean that predation occurred. True predation should be separated from carrion feeding and the killing of animals predisposed to predation.

Predatory species exhibit a characteristic behaviour in the way that they chase, kill and feed on prey. Coyotes most frequently kill sheep with bites to the throat whereas black bears commonly kill calves with a bite on top of the neck, shoulders or back. Selection of appropriate control and preventive techniques or recommendations for changes in management depend upon accurate identification of the predator responsible for livestock losses.

The ease of investigating a complaint of predation will vary with the evidence available. You may find a live wounded animal, a fresh carcass, a few bones and clumps of wool or hair, or a report of a missing animal. Documentation of animals injured by predators may simply require an examination of the wounds, and possibly, the location of the attack site. A carcass in an advanced state of decay presents a more difficult problem and points up the importance of a prompt investigation. Evidence of predation disappears rapidly. Carcasses deteriorate rapidly in warm weather and are quickly consumed by insects, scavengers and predators. Other predation evidence can be trampled by livestock or obliterated during inclement weather.

An effective investigator knows:

- how to differentiate predation losses from other causes of death.
- which predators are in an area and how to identify their signs.
- the history of predator problems and livestock diseases in the area of the complaint.
- signs of common livestock diseases.
- how to identify common poisonous plants.

This manual provides information that will help you separate predation from carrion feeding and the killing of animals predisposed to predation. It will also help you identify the predatory species involved.

DETERMINE THE CAUSE OF DEATH

Cause of death can be classified as predation, pseudo-predation or death from other causes. Predation causes direct and indirect losses of healthy animals. Direct losses result from a physical attack by predators. Indirect losses include fatalities from predator harassment; animals may be chased onto thin ice and drown, or they may be fatally injured on broken boards or barbed wire during a predator attack. Pseudo-predation results from a predator attack on an animal in a weakened or vulnerable state, or of questionable viability. Losses from other causes include death from disease, bloat, starvation, poisonous plants and other poisonous substances, suffocation, pregnancy problems, ingestion of metal objects, self-impalement on metal or wooden "spears", theft, gunshot wounds, lightning and inclement weather.

The true cause of death is frequently obliterated when predators feed on a carcass. Thus, if you cannot respond to a complaint immediately, the producer should cover the carcass with a blanket or tarp to prevent scavenging by predators. Alternatively, the producer can remove small carcasses from kill sites and place them in buildings to keep them from being eaten or carried away.

The first priority for investigating an alleged attack is to determine whether predators were responsible or if only carrion feeding was involved. If a predator killed the animal, the next priority is to determine the predatory species involved and the state of health of the domestic animal at the time of attack.

Locate the carcass and kill site

The producer should maintain head counts and search for missing animals, because livestock disappear for many reasons. Locate and examine the attack and kill site if the carcass was moved by the producer or was dragged or carried away by predators. It may be necessary to examine a large area to find predator sign and the attack site if animals were wounded but not killed.

Look for signs of a struggle

Signs of a struggle are good evidence of predation. Broken foliage, trampled vegetation, tufts of wool or hair and a drag trail of blood show an encounter between predator and prey (Figures 1 and 2). However, the absence of these signs at a carcass or kill site does not always rule out predation.

Figure 1. *Signs of attack and struggle include trampled and broken vegetation, clumps of wool and patches blood.*

Figure 2. *A drag trail of blood suggests predation.*

Predators may kill small or newborn animals without evidence of a struggle. Furthermore, predators may carry prey from the kill site.

Note the position of the carcass

Animals dead from sickness are often found lying upright or on their side with their legs tucked under the body. Animals killed by predators are usually found on their side with legs extended, in thick cover, near cover or in rough terrain.

Look for predator sign around the carcass

Predators or predator signs near a carcass do not in themselves constitute evidence of predation because carrion feeding may have occurred. However, they do indicate that a particular predatory species is in the area. This will help substantiate a predation claim when direct evidence of predation exists. If predator tracks, scat and hair are not found in the immediate vicinity of a suspected predator kill, search for predator sign along nearby fence rows, trails and water-holes.

Examine the carcass for hemorrhage and general damage

The presence of hemorrhage (bleeding) and bruising are the most important factors in determining if an animal was killed by a predator (Figures 3 and 4). Bleeding can occur before death and for only a brief time afterwards. Examine the head and neck of smaller prey such as sheep and goats for hemorrhage; this area is most frequently attacked and is often the last part of the carcass consumed. Inspect the hindquarters and tail of calf and cattle carcasses for hemorrhage associated with tooth punctures. Look for signs of a broken neck, back or skull if a bear or cougar attack is suspected.

Figure 3. *Bleeding, bruises and tissue damage indicate a predator attack. A coyote killed this lamb with a throat attack.*

Figure 4. *Massive subcutaneous bleeding and tissue damage are revealed when the neck is skinned.*

Inspect for claw marks on the neck, back, sides and face of the carcass. Skin the areas where damage is evident or suspected, since blood may not permeate the hair or wool around a wound. Blood on the ground and vegetation at the site of the carcass suggests predation (Figures 1 to 3). Inspect remnants of hide for tooth punctures and hemorrhaging (Figure 4). Record the extent and description of body parts fed on by predators. Good clear photographs will help document predator investigations.

Caution: There are stages of decomposition in which the flesh appears to have been

bruised. Predator attacks often cause extensive damage to tissue beneath the skin. A bruise results from the rupture of tiny blood vessels and subsequent seepage of blood into surrounding tissue. A similar process occurs during decomposition; red blood cells break down and hemoglobin seeps from blood vessels into surrounding tissue. This process changes the appearance of fat, bone marrow and subcutaneous tissue (tissue beneath the skin); these areas may turn red, brown or reddish-brown in colour.

Decomposition does not occur at the same rate in all parts of the body. Normally, the side of a carcass exposed to the sun will decompose faster than the side nearest the ground. Thus, the flesh beneath the skin on the bottom side of a carcass may appear relatively normal, whereas the flesh beneath the skin on the top side of a carcass may appear reddened (Figure 5). These decomposed areas can be mistaken for bruises caused by a predator. Avoid this pitfall by skinning large areas of the carcass. Areas affected by decomposition will be similar in parts of the carcass exposed to the sun. Thin, watery blood may seep from the nose, mouth and anus of a decomposing animal. However, blood from the nose and mouth of an injured animal will be thick and clotted.

Figure 5. *Parts of a carcass exposed to the sun will decompose faster than the shaded parts. This lamb died from causes other than predation. The reddened flesh is a result of decomposition.*

There is another stage of carcass decomposition in which blood collects on the side of the carcass closest to the ground due to gravity. All flesh beneath the skin on the bottom side of the carcass will appear darker when the blood flows to lower areas. Skin large areas of the carcass to identify this condition. The areas discoloured by decomposition will be much more extensive than the localized bruises and damage caused by a predator attack.

If the abdomen and digestive tract are not punctured, the carcass will distend (grow larger) from gases formed during decomposition. Do not confuse this with bloat, which is caused by eating excessive amounts of grain or fresh legumes. Distension of a carcass from internal gas will cause slashes, cuts and puncture wounds in the hide to change shape. As the carcass becomes larger, the skin stretches and tightens and tends to even out the slight irregularities in a rip or tear. In general, an opening in the hide will become larger and more round and even in shape as the carcass distends.

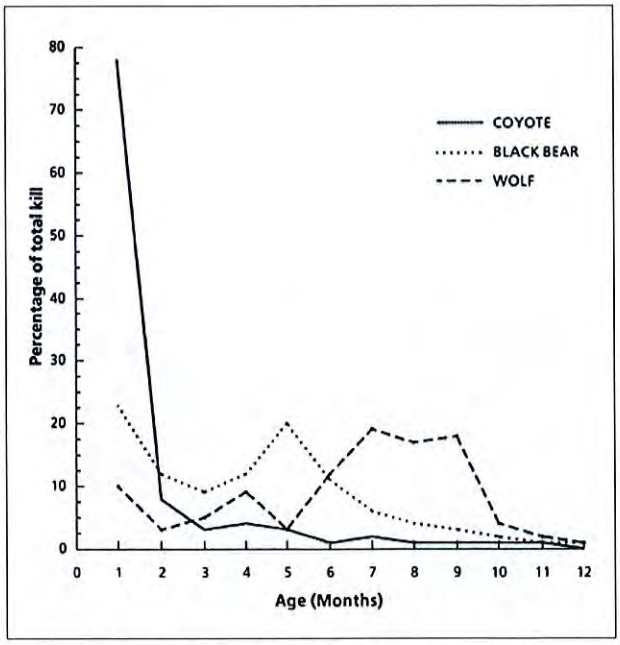

Figure 6. *Age distrubution of calves killed by predators in Alberta.*

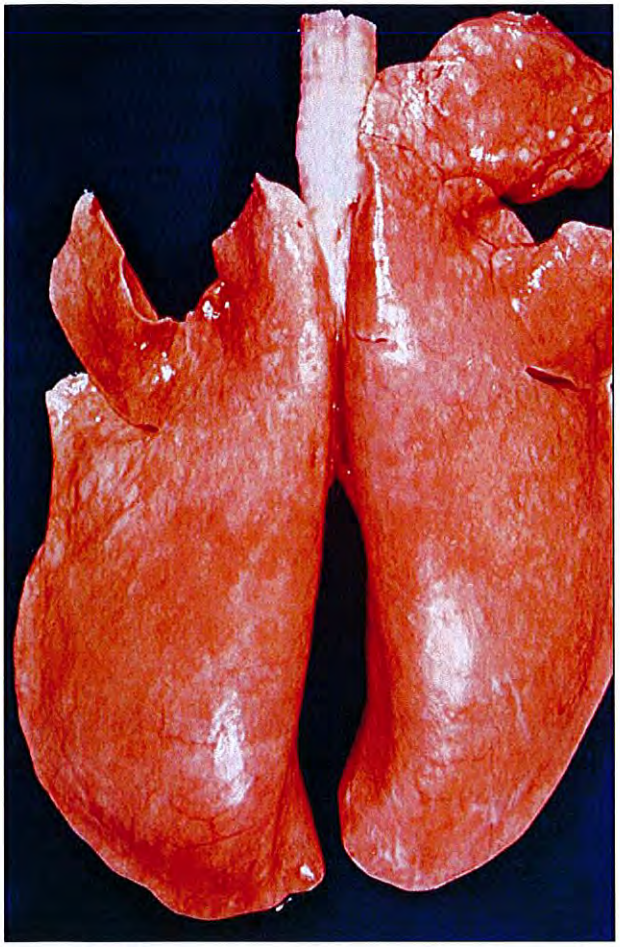

Figure 7. *A new-born calf that has breathed will have spongy, light-pink to orange coloured lungs.*

Examine the carcass for general signs of health

Generally, a dead "healthy" animal suggests predation, and a dead "unhealthy" animal suggests pseudo-predation or death from other causes. "Unhealthy" may be any deviation from normal such as starvation, poisoning by plants, bloat and disease.

Consider the age and condition of the dead animal

Determine the general age category of dead livestock from tooth wear. Older animals in poor condition have reduced vigor and viability. They are predisposed to sickness and death from many causes, including predation.

Young animals are also very susceptible to predation. For example, about one-third of the calves killed by coyotes in Alberta are one day old and about 80 per cent are less than one month of age (Figure 6). Very young animals present a special problem because they can quickly be consumed or carried away by predators. Frequently there is little or no evidence to determine whether a newborn animal was stillborn, of low viability, or normal and healthy.

A viable new-born animal should have breathed, walked, fed and been healthy. Use the following methods to determine if these activities have occurred.

- Animals born alive have spongy, light-pink to orange coloured lungs (Figure 7); stillborn animals have hard, purplish-red coloured lungs (Figure 8). Determine whether or not an animal breathed by placing a piece of lung in water. Lung tissue from an animal that has breathed will float. Lungs from stillborn animals will not float. **Caution:** If the carcass has decomposed the lungs may fill with post-mortem gas and may float.

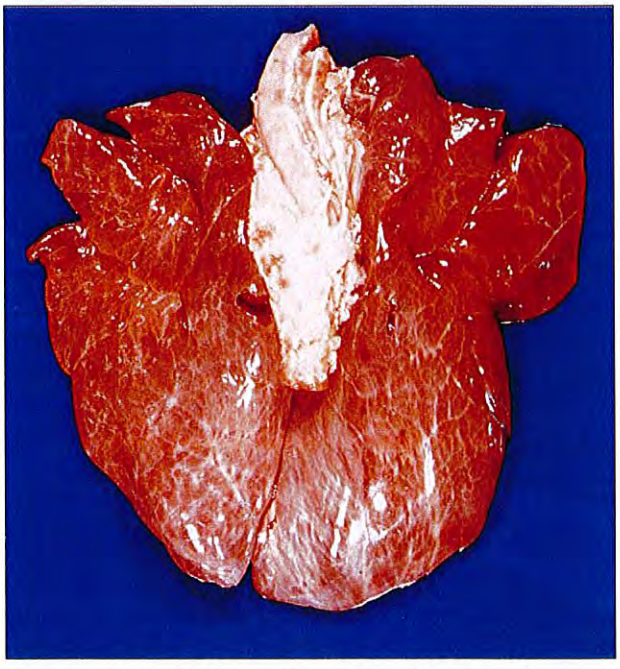

Figure 8. *Stillborn animals have hard, purplish-red lungs.*

- The soft membrane on the hooves wears away soon after a newborn starts to walk (Figures 9 and 10); under special conditions (for example wet, soft grass or straw) the membrane may resist abrasion. **Caution:** Magpies and crows may pick off the soft membrane of the hoof. This may create a false impression that the animal actually walked. If the membrane is eaten by birds, there will be a stippled appearance to the remaining tissue on the hoof.
- Milk in the stomach and gut indicates feeding (Figures 11 and 12).
- Firm, white fat on the heart and kidneys denotes health; gelatinous, red, or completely metabolized fat indicates poor nutrition or starvation (Figures 13 and 14).
- Mothers usually lick live newborn animals to remove birth secretions and tissue. A dead newborn animal that was not licked was likely dead at birth.

Figure 9. *The soft membrane remains on the hoof of a new-born calf that has not walked.*

Figure 10. *The soft membrane is worn off the hoof when an animal walks.*

- The size of a newborn affects viability; newborn animals that are small are less likely to survive than larger ones.

Newborn animals may be killed before the events described take place. Predators, particularly coyotes, may attack cows in the process of calving and the cow and calf may be lost. Expectant mothers and newborn young less than one week old should be closely guarded to prevent predation. Failure to do so may reflect poor management if predation occurs.

Consider possible pregnancy problems

Pregnancy can predispose livestock to reduced viability and possible death from complications. Abnormally large fetuses and fetuses in abnormal positions may cause birth difficulties and internal injuries.

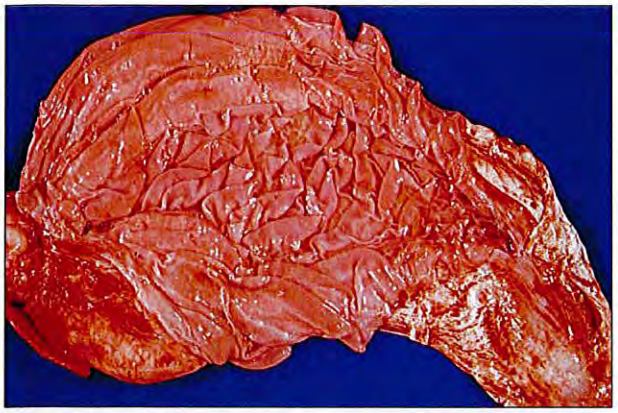

Figure 11. *There is no milk in the stomach of a calf that has not nursed.*

Figure 12. *Milk is present in this calf's stomach.*

Observe the general health and behaviour of the herd or flock

Livestock in poor condition or health are more predisposed to disease and other complications that increase mortality. Poor nutrition during pregnancy can cause abortion, fetal death, stillbirth or a weak newborn.

Herds and flocks become alert, nervous and flighty when they are repeatedly harassed or preyed upon. Unusual livestock behaviour, including mothers that urgently call and search for their young, is strong indirect evidence of predation.

Look for injured animals, old wounds and missing tails on calves. These suggest predation.

Consider weather conditions at the time of the animal's death

New-born and young animals are very susceptible to exposure and hypothermia, a cooling of the body core below normal body temperature. Calves or lambs that are born outside in cold weather and without adequate protection can quickly be injured by the cold.

If a calf or lamb is born and dies quickly from exposure (that is, within 1 to 1 1/2 hours), there may be no obvious signs of cold injury. However, if a calf or lamb gets cold and lives for several hours, lesions characteristic of cold injury will develop at the base of the ears, tail or limbs below the knees and hocks. A watery fluid, clear to yellow in colour (edema), will accumulate in these areas. If the animal survives, the frozen parts of the body will exhibit a mixture of edema and hemorrhage that should be evident after the ears, tail or legs are skinned. These injuries can predispose calves and lambs to predation.

Livestock losses from lightning do occur in Alberta. Scorch marks and bulging eyes are indications of death by electrocution. Normally hair lies flat against the body, but hair or wool on the underside of the body will point directly into the ground if the animal was lying down at the time of a lightning strike; knee joints (under the skin) may be darkened in colour if the animal was standing. These signs are not always evident. A recent thunderstorm and the location of the carcass are most important in identifying deaths from lightning. Deaths from lightning commonly occur on hill tops, along fences and near lone trees in the middle of fields.

Look for poisonous plants in the pasture

Poisonous plants can cause livestock losses. With few exceptions however, livestock will not be poisoned by plants unless unusual conditions force them to eat toxic quantities. Thus, losses from poisonous plants are often associated with poor management including: a) failure to provide salt and minerals that

results in depraved appetites, b) overgrazing and grazing too early in the spring when there is a scarcity of palatable forage, and c) an inadequate water supply which can cause livestock to graze plants that would otherwise be rejected.

Young animals are more likely to be poisoned than adults. Animals recently imported into an area are also more susceptible to poisoning. Cattle and sheep that are being driven tend to grab and swallow any green plants along the trail and may be poisoned.

The poisonous plants that cause the most problems in Alberta include:

- Water-hemlock (*Cicuta* spp.) commonly grows in moist areas, meadows, marshes and stream banks. Roots, rootstocks and early leaves are the most poisonous; small amounts kill livestock.
- Tall larkspur (*Delphinium glaucum*), common in the foothills and northern bush pastures, is frequently fatal to cattle but seldom affects sheep. Larkspur starts to grow earlier in the spring than associated plants and is palatable except in mature stages. Consequently, larkspur is most dangerous in May and June. Toxicity normally declines later in the season and is usually negligible by mid-August.
- Death camas (*Zygadenus gramineus*) starts to grow early in the spring in moist depressions. It is palatable and causes losses in sheep but rarely in cattle. All parts are poisonous, particularly the bulb. Animals may remain in a coma for some time before death. Consequently, they could be attacked and appear as a "normal" predator kill.
- Arrow-grass (*Triglochin* spp.) grows in salt marshes and alkaline sloughs. It starts to grow earlier than associated species and may be attractive to livestock in early spring. In addition, arrow-grass has a salty taste and may be eaten when salt is absent or craved.
- Narrow-leaved milk-vetch (*Astragalus pectinatus*) starts to grow early on the dry prairies of southern Alberta and affects all livestock, particularly lactating females. It is unpalatable and normally eaten only when forage is extremely short.

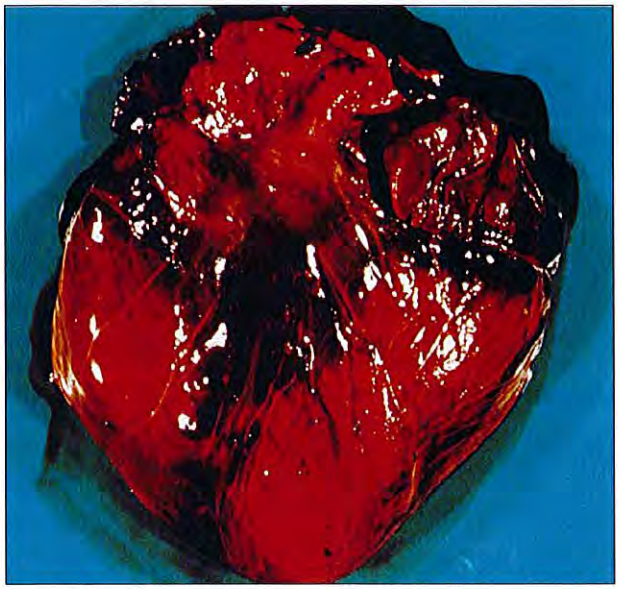

Figure 13. *The heart is devoid of fat in an animal that has died of starvation.*

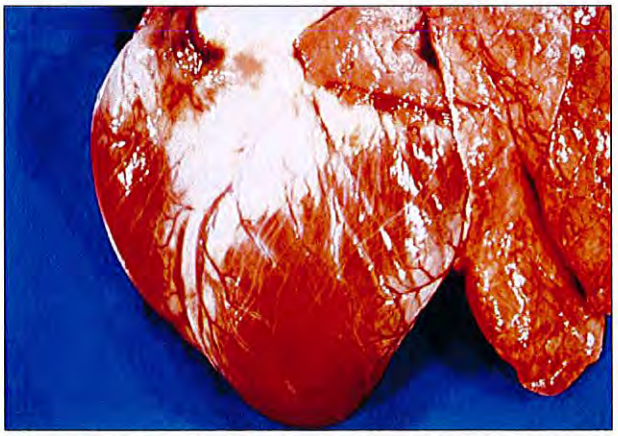

Figure 14. *The heart from a healthy animal shows normal amounts of fat.*

Descriptions and photographs of these plants are in *Weeds of the Prairies*, Agdex 640-4. If you suspect death from poisonous plants, submit a rumen sample to a regional veterinary laboratory. Take the rumen sample from the area where the esophagus (the passage for food into the stomach) enters the rumen, because the effects of the poison can be extremely rapid.

Examine the area near the carcass for other poison sources

Used crank case oil, antifreeze, fertilizer bags, storage batteries, paint cans and small metal parts are potential sources of poison. Danger also exists from pesticides such as carbofuran, warfarin and strychnine. Lush legume pastures can cause bloat and high-concentrate feed can cause grain overload. Moldy sweet clover can affect the blood clotting mechanism and cause hemorrhage that is most evident over boney prominences.

Consider other possibilities for dead, damaged or missing livestoch

Severe and fatal injuries can be inflicted in ways which appear to be predator caused but are not. Horses and cattle spooked by noise or predators can run into and be cut on barbed wire fences. Wire cuts may be confused with claw marks (Figure 15). Barbed wire causes lateral cuts on the chest and sides of animal. In comparison, claw marks of predators usually occur on the upper parts of the neck, shoulders or back. Livestock can also impale themselves on broken boards and posts.

Figure 15. *This horse was injured on a barbed wire fence.*

Young animals may be stepped on, causing internal damage and hemorrhage. Boar pigs can slash other pigs and livestock with their tusks. This damage may be confused with the claw marks of bear.

Theft may have occurred when large animals are missing without a trace. Theft is most likely to occur when human and vehicular access to livestock is easy. Cattle can be butchered in a pasture and the remains can be scavenged by predators, confounding the evidence. A knife cut will show a clean, smooth separation of the hide, and cut hairs and root hairs (Figure 16). In contrast, a tear made by a predator will have an uneven separation of the hide and no cut or shaved root hairs (Figure 17). A magnifying glass will aid any examination of suspected cuts.

Non-predator related deaths of livestock have occasionally been altered to feign predation in attempts to collect compensation. Wounds not conforming to typical bite or claw marks and without associated hemorrhage should be suspected.

Livestock near the Athabasca River, downstream of the town of Athabasca, and near the Peace River, in the area of Fort Vermilion, can be severely attacked by black flies, *Simulium arcticum*, leading to death. Livestock near the river are most susceptible; however, winds can move large numbers of black flies to livestock a considerable distance away. Attacks can occur from late spring through to fall. New-born calves, milk cows and stock previously unexposed to black fly bites are most susceptible. Black flies generally attack the lower parts of animals where the hair coat is thin, such as the belly, inner legs, udder, scrotum, lower neck and nose. External evidence of black fly attack shows as pinhead sized marks and dried blood droplets on exposed skin areas. Death results from toxins injected by flies during blood feeding. Subcutaneous edema (swelling and

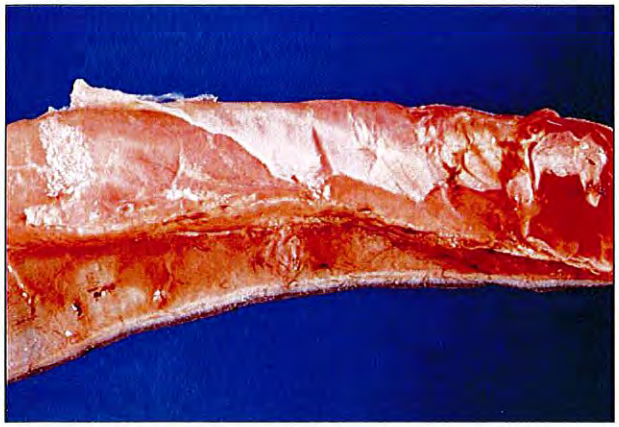

Figure 16. *A knife cut shows a clean even separation of the hide, cut hairs and cut root hairs.*

Figure 17. *A rip in a hide made by a predator is unevenly spearated in an irregular pattern.*

fluid beneath the skin) along the underline of affected cattle is a common sign. Fluid also collects in the lungs and body cavity. Death can occur quickly once signs develop. If black flies are suspected of causing death, have a necropsy performed by a veterinarian.

Confirm your suspicions on the cause of death

Cattle, sheep and hogs rarely die of fright (shock). Thus, predation losses of large animals must result from major physical injury such as a fractured skull, a broken or crushed neck or spine, or massive tissue damage and bleeding. Tooth punctures or claw marks are usually associated with subcutaneous bruising and tissue damage.

Conduct the following:

- Carefully inspect the carcass for external signs of attack (i.e., bites, claw marks) and skin back these sites. Subcutaneous bruising and tissue damage should be apparent at injury sites if an attack occurred while the animal was alive.
- Inspect the head for a fractured skull.
- Skin back the hide along the top of the neck and backbone and examine for severe hemorrhage and broken vertebrae.

If you suspect shock, disease or other non-predator related loss, the carcass can be submitted to a regional veterinary laboratory or to a local veterinary practitioner to determine the cause of death.

INDICATORS OF HEALTH

Coat Condition

A healthy animal has a thick, shiny coat of hair. The coat of an unhealthy animal is usually thin with dry, dull hair.

Hydration

The eye of a normal animal completely fills the socket, whereas the eye of a dehydrated animal will be sunken (Figure 18). However, the eye is a reliable indicator of health only in a fresh carcass. The carcass dehydrates as it deteriorates. Dehydration is often associated with scours in young animals (Figure 19). Examine the rear end of calves for physical evidence of diarrhea.

Figure 18. *The eye of a dehydreated animal is sunken.*

Figure 19. *This calf has scours as shown by yellow watery excreta.*

Body Fat

Large deposits of firm, yellow or white fat indicate good health. If an animal is ill and not feeding well, or if food is simply not available, the fat will soon be metabolized and a semi-transparent, reddish, gelatinous substance will remain. Fat deposits are metabolized first around the heart and then around the kidneys. Fat deposits in the bone marrow are metabolized before death from starvation. Break the large leg bones and examine the bone marrow. Again, firm white deposits denote health, while gelatinous, semi-transparent, reddish deposits denote starvation (Figure 20).

Digestive Abnormalities

The amount of food in the stomach and the condition of the feces are health indicators. A normal, healthy ruminant will always

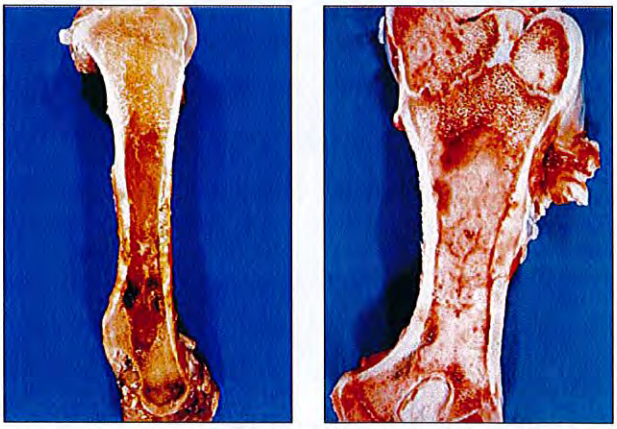

Figure 20. *Fat deposits have metabolized in the leg bone from a calf that died of starvation (left). The leg bone from a normal, healthy calf contains fat (right).*

have food in the stomach (at least one-half full). However, calves and lambs under three months of age do not have a fully-developed rumen. Thus, a small, empty rumen may be quite normal in suckling animals. The feces will be firm, although exceptions do occur, for example cows on grass. Little or no food in the stomach and diarrhea denote ill health. Signs of vomiting also suggest unhealthy animals. If grain overload, poisoning or hardware disease is suspected, take careful note of stomach contents and the condition of the animal. The rumen wall may be injured by these abnormalities. Submit a sample of stomach contents and rumen wall to a regional veterinary lab.

Respiratory Abnormalities

Pneumonia is a major cause of livestock mortality in Alberta. Normal lung tissue is soft or spongy, pinkish in colour and light in weight. The lobes of normal lungs have rather sharp edges (Figure 7).

In pneumonia caused by bacterial infections, infected tissue is firmer and denser, much like the liver. The lung tissue lacks sponginess. Affected areas are usually dark red, but may be covered with a white or pale-yellow coating of fibrin (exudate or inflammatory product) (Figure 21). Fibrin has a "cheesy" appearance and usually can be peeled off, leaving the darker coloured lung exposed. An infected lung will be dark red or "marbled" when cut open, and often pus can be squeezed from the bronchi (tubes in the lungs). Areas of lung affected by pneumonia usually sink in water.

Figure 21. *Areas of lung affected by pneumonia are hard, with dark red tissue. A pale yellow fibrin coating may also be present if pneumonia is severe (lower left). Tissue in the upper right portion of this lung appears more normal.*

The trachea (windpipe) should be opened to examine for dead tissue, blood clots and fibrinous material, which can be signs of disease.

Circulatory Abnormalities

Paleness is an indicator of poor blood circulation, hemorrhage or anemia. Bloated animals commonly die from circulatory problems and asphyxia (suffocation). Cattle and sheep may bloat if they feed on highly nutritious second-growth alfalfa and clover or if they eat excessive amounts of grain. Excessive gas is produced in the rumen and the rumen distends. Thereafter, the blood supply is restricted to the posterior end of the animal, including the liver and kidneys and the flesh of the hindquarters becomes pale. Examine the rumen contents and record the amount of grain in the stomach if you suspect bloat or grain overload. Alternatively, you may submit the carcass to a regional veterinary laboratory if you are uncertain as to the cause of death.

Bloat should not be confused with the normal carcass distention that occurs when the digestive tract fills with gases as the carcass deteriorates.

General Irregularities

Any abnormalities in the carcass or secretions such as pus or blood from the eyes, nose, mouth, or anal region should be noted. Other animals in the herd should be examined for abnormalities if death is suspected from causes other than predation. Submit the carcass to a regional veterinary laboratory if an abnormality exists and you do not know whether the abnormality could cause death.

Some diseases and poisonous plants act quickly and affected animals will die suddenly with few obvious signs. In these situations, you must rely on a lack of evidence of predation, and possibly the presence of other dead or disabled livestock.

Summary

Death can be classified as predation on healthy animals, predation on animals unlikely to survive anyway (pseudo-predation) and other causes. Reconstruction of the events leading to the death of the animal is necessary because predation is seldom witnessed. Signs of a struggle and bleeding from wounds on the carcass of a healthy animal suggest predation. However, you should confirm the cause of death. Predation losses of large animals must result from a major injury. Examine the carcass for a fractured skull, a broken neck or back, or massive tissue damage and bleeding. The absence of signs of a struggle at a kill site of an animal in poor condition suggest pseudo-predation. Pseudo-predation is often difficult to distinguish from predation. A familiarity with livestock diseases can simplify the assessment. Obtain advice from a veterinarian if you are unfamiliar with livestock diseases. In the final assessment, the producer should probably be given the benefit of the doubt. Death from pseudo-predation should be assigned only to those animals that were obviously ill, seriously injured or debilitated at the time they were attacked by a predator.

IDENTIFYING THE PREDATOR

A variety of methods of attacking and killing prey have evolved among the different species of predators. Each species has a characteristic feeding behaviour and shows a preference in its choice of domestic prey. There are certain times of the year when predation by a particular species is most prevalent. Furthermore, each species has a preferred habitat type; there are certain areas where conflicts between livestock and predators are most common. These differences, although most obvious in family groups, are distinctive even among different species of the same family. Individual animals sometimes diverge from the characteristic pattern of their species, but the identity of the predator involved can usually be determined by a combination of signs (tracks, scats, killing and feeding behaviour) left at a kill site. The following sections describe predator signs and the feeding and killing behaviour of predatory species that commonly or occasionally prey on livestock. Tracks and scats are not discussed in detail. This information is covered comprehensively in *A Field Guide to Mammal Tracking in North America* by James Halfpenny and Elizabeth Biesiot (1986) and *A Field Guide to Animal Tracks* by Olaus Murie (1954).

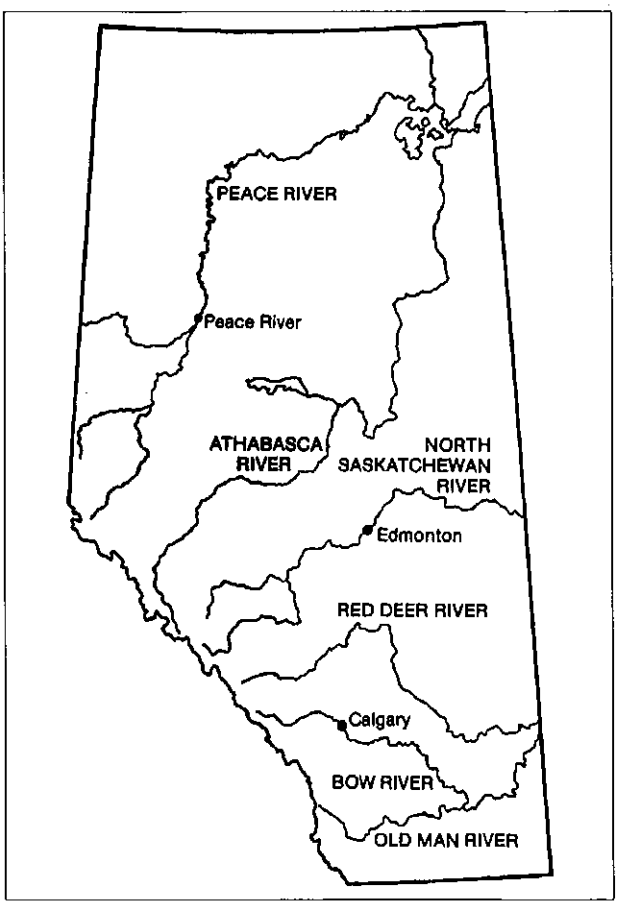

Figure 22. *Grizzly bear distribution in Alberta.*

Family Ursidae – Bears

Grizzly Bear

Grizzly bears (*Ursus arctos*) inhabit western and north-central Alberta (Figure 22). Conflicts with livestock occasionally happen. Problems normally occur in fringe areas where human settlement borders on wilderness. Grizzly bear-livestock problems are most common in June and July in Alberta. Predation may increase during food shortages.

Cattle are the most common domestic prey, likely because cattle are more common on grizzly bear range than other livestock. Grizzlies seem to prefer younger animals but do kill adult cattle. Of 17 recorded cattle kills in Wyoming, four were yearlings and 13 were calves. Similarly, 15 calves, 10 yearlings and one cow were reported killed by grizzlies in southern Alberta during 1986-87. Sheep, goats, swine and poultry are taken occasionally. Grizzly bears do not select for any age or size of sheep, probably because even the largest sheep are easy prey for bears.

Figure 23a. *This cow was wounded by a grizzly bear. Grizzly bears typically bite cattle on the top of the back or neck and often on the withers.*

Figure 23b. *Skin removed from area of back reveals damage from Grizzly bear bites. Also damage on face.*

Grizzlies are larger and stronger than black bears and have less trouble killing prey. Thus, grizzly bears normally make cleaner kills than black bears. Grizzlies usually capture prey with a bite to the back near the withers or to the top of the neck (Figure 23). This causes extensive damage to the spine and surrounding tissues. Tooth wounds on the head or lumbar region of the back are less common. Cattle may have claw marks on the face, neck, shoulders, and other body parts.

Characteristically, grizzlies seize cattle with their forelegs and bite them on top of the neck or back. Bears are reluctant to pursue prey, so signs of a long chase are seldom evident. A grizzly bear kill often occurs in cover or close to cover. Bears usually drag their kill into cover before feeding. Grizzly bears cover their prey with leaves, grass and other debris (Figure 24). Sometimes, however, the carcass is not covered (Figure 31). Grizzly bears

Figure 24. *Grizzly bears usually cover the remains of a carcass with debris. This cow was almost completely covered, except for the hind feet (on the left) and head (on the right).*

generally leave many signs around a carcass (tracks, scats, etc).

Grizzly bear feeding behaviour has not been well documented in Alberta. However, they appear to prefer meat over viscera. Removal of the stomach and intestines from a kill is normal for grizzlies. In Wyoming, grizzlies will often first consume flesh on the brisket and ribs of cattle. Bears do not chew and scatter bones as do members of the dog family. The skeleton including the ribs will frequently be left intact. Grizzlies readily feed on carrion.

Tracks of grizzly bears are generally larger than black bears (Figure 25). Tracks wider than 13 cm (5 in.) are most likely from a grizzly bear. However, bears of similar size display tracks of similar size. Claw marks are usually more prominent on grizzly tracks than on black bear tracks.

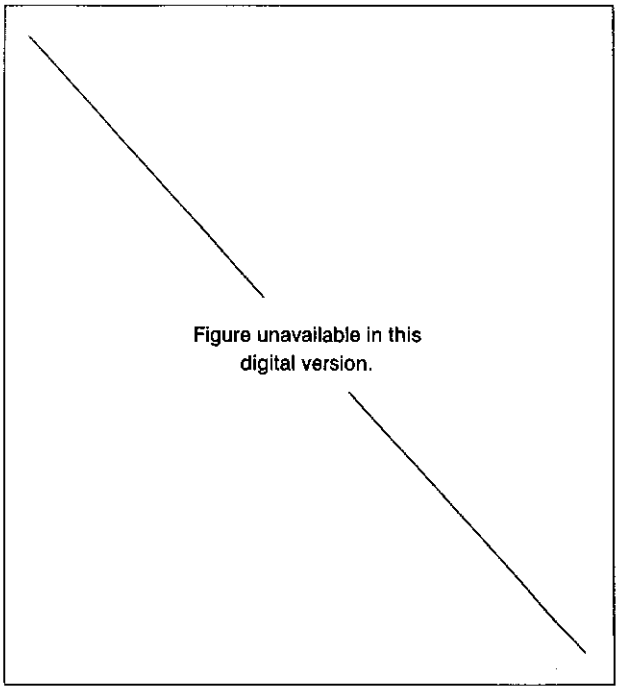

Figure 25. *Bear tracks.*

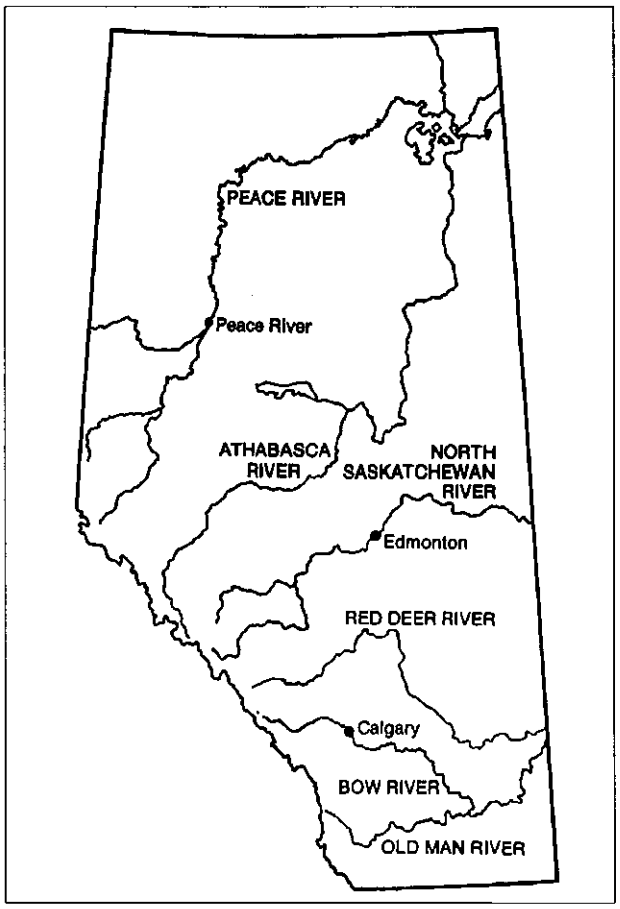

Figure 26. *Black bear distribution in Alberta.*

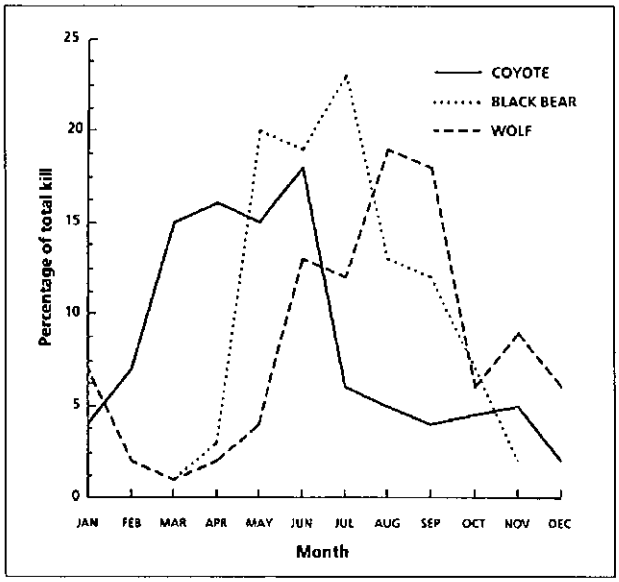

Figure 27. *Monthly chronology of cattle predation in Alberta.*

Black Bear

Black bears (*Ursus americanus*) inhabit the western and northern forest areas of Alberta (Figure 26). They are better adapted to living near people than grizzly bears. Predation on livestock commonly occurs on farms that are close to forests. Black bears prey on cattle, swine, sheep and poultry. Cattle are taken more often than other livestock. Black bears tend to prey on calves less than 6 months of age (Figure 6). Calves, yearlings and adults comprised 71, 11 and 18 per cent, respectively, of the 466 cattle killed by black bears in Alberta from 1974 to 1978. Multiple kills are common when sheep, swine or poultry are attacked in a pen or other confined area. Black bear/cattle problems peak during May-July in Alberta (Figure 27). Predation in late summer may be dependent on the berry crop. Fewer livestock problems develop if berries are readily available.

Black bears bite and claw the top of the neck and back of cattle, pigs and sheep (Figures 28 and 29). Smaller prey are usually bitten or sometimes killed by a blow to the head or neck. Inexperienced bears may rip open the underparts of prey and expose the viscera. Black bear kills usually have more claw marks on them than on grizzly bear kills. Black bears are generally not as large as grizzly bears, and probably have more difficulty killing larger animals. Black bears do not pursue prey to any great length; consequently, larger stock are often severely wounded with claw marks along the shoulders and back and tooth marks on the back and neck. The dulled, unretractable claws of a bear do not pierce and cleanly cut the hide of prey like the sharp, retractable claws of cougar, lynx and bobcat.

Black bears and grizzly bears have a similar feeding behaviour. Generally, meat is consumed before viscera and the bones are not broken and scattered (Figures 30 and 31). Bears readily feed on carrion. Black bears kill most prey near cover, then drag the carcass to cover before feeding. Unlike grizzly bears,

Figure 28a. *This calf was bitten on the back by a black bear*

Figure 28b. *Hide stripped away to show black bear injuries to calf.*

Figure 29. *This pig was bitten on the top of the neck and back and had flesh eaten from its back by a black bear.*

Figure 30. *This calf was killed and fed upon by a black bear.*

Figure 31. *This cow was killed by a grizzly bear. This bear made no attempt to bury the carcass as most grizzly bears do.*

black bears rarely attempt to cover prey. Many signs are left around a black bear kill; that is, tracks, scat, trampled grass and trails.

Black bear tracks are similar to those of grizzly bears (Figure 25). However, black bear tracks are generally smaller than those of a grizzly bear. As a rule, tracks less than 13 cm (5 in.) in width will be from black bear. Claw marks are usually more evident with grizzly bear tracks than black bear tracks.

Family Canidae – Dogs

Wolf

Wolves (*Canis lupus*) range throughout northern and western Alberta (Figure 32). Wolf predation of livestock is common and normally occurs on forested grazing leases and farmland at the forest fringe.

Wolves prey on a variety of domestic animals including cattle, sheep, swine, horses, poultry and dogs. Cattle and other livestock in grazing leases and private pastures are readily available to wolves and other predators. Cattle, primarily calves, are the most common livestock prey. Alberta data suggest that wolves select young, inexperienced or disabled cattle as prey much more often than healthy

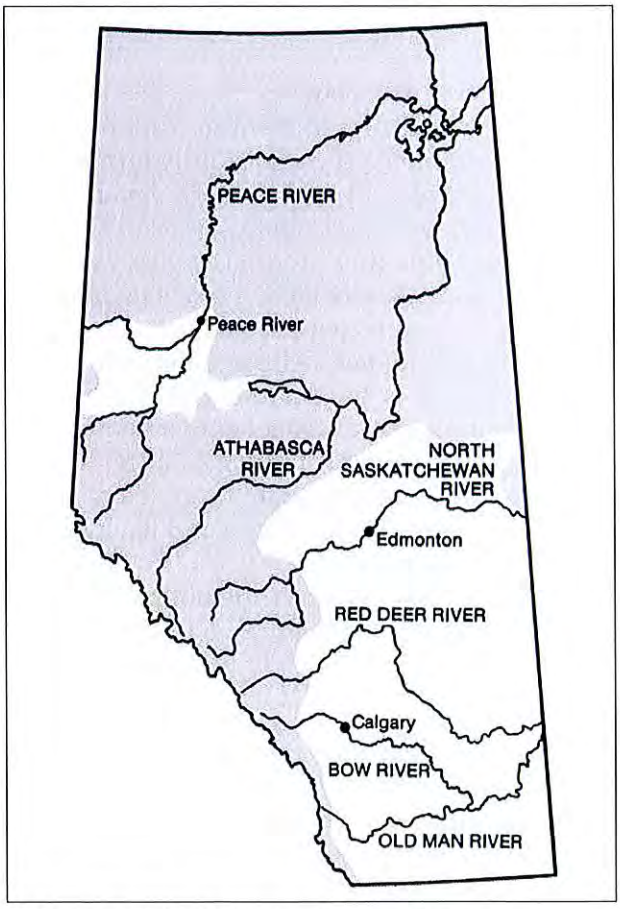

Figure 32. *Wolf distribution in Alberta*

adult cattle. Calves comprised about 70 per cent of 1581 cattle killed by wolves in Alberta from 1980 to 1987.

Unlike coyotes, wolf predation on livestock is less common in spring and early summer. This is probably due to reduced movement of wolves during the May to June denning period. The bond and protective instinct of cattle herds to young calves may also make predation on calves more difficult at this time. Most calves of domestic cattle killed by wolves are from 6 to 9 months old (Figure 6) because wolf predation on cattle is greatest from July to September (Figure 27). Wolves apparently prefer the young of cervids but will prey on domestic cattle in late summer when family packs become mobile and more closely associated with the cattle that are in their territory.

In Minnesota, wolf predation of livestock tends to decrease following severe winters. Presumably, this is related to the availability of young moose and deer. Following a severe winter, fawns are weaker and easier for wolves to catch. Consequently, wolves prey less frequently on livestock.

After a long chase, packs of wolves usually attack moose by lunging and biting at the flanks and hindquarters. A trail of blood and patches of hair are often evident. A few wolves distract the moose by biting at the nose and throat; the rest of the pack attacks the hindquarters and flanks. Wolves attack their prey on the flank, high on the shoulder and high on the hind leg.

Individual wolves and small packs concentrate on the flank and hind legs of ungulates. The prey is often left to become weak and stiff before the kill is made. Wolves begin to feed when the prey is knocked over, lies down or falls from weakness.

Wolves attack and kill large domestic animals in a manner similar to predation on moose. The focal point of attack on cattle is the hindquarters, including the tail, thighs and rectal area (Figure 33). The face, front legs,

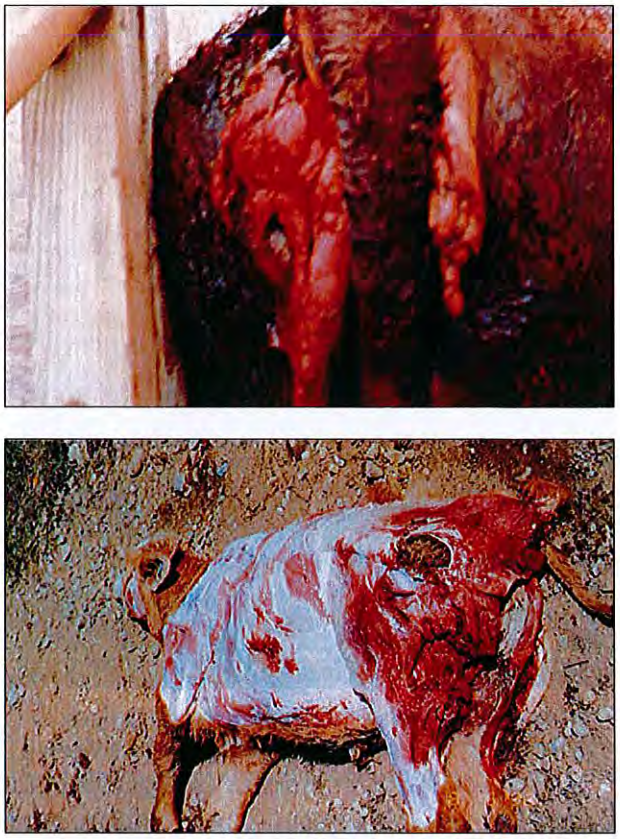

Figure 33. *The hindquarters of cattle are the focus of attack by wolves.*

flanks and upper shoulders may also be attacked. The powerful bite of a wolf usually causes damage deep in the underlying tissues. Cattle will often exhibit severe pain and trauma when wounded by wolves (Figures 34).

Wolves usually do not select for age, size, or a particular attack area on smaller livestock prey such as sheep (Figure 35). Multiple kills often occur. Bites to the head, neck, back, flanks and hindquarters are common. Injuries may include a crushed skull, severed spine, disembowelment and massive tissue damage. Wolves often attack the throat and neck of sheep in a manner similar to coyotes, but wolves damage the underlying tissue much more extensively. Wolves may carry or drag small prey away to be eaten, or they may totally consume their prey at the kill site. Wolves feed on large prey at the kill site. Parts of prey are sometimes carried off and buried. Bones are often chewed and broken.

Figure 34. *Animals severely injured by wolves appear dazed and exhibit a characteristic stance. They are reluctant to move because it is painful.*

Figure 35. *This ewe was killed by wolves with bites to the base of the skull and back. Flesh from the neck and the udder were eaten.*

Wolves easily break and consume bones of young or small livestock and eat the hide along with other tissues (Figure 36).

Wolves prefer to feed on the viscera and hind legs of large domestic prey in Alberta (Figure 37). Similarly, wolves feed on the neck, throat, tongue, intestines and hind legs of caribou. In Minnesota, wolves seem to prefer the pelvic and abdominal regions and

Figure 36. *Sheep leftovers after a wolf attack.*

nose of moose; wolves feed first on the rump area, then the intestinal fat, heart, lungs, liver and other viscera except for the stomach contents.

Wolves in Alaska eat the viscera, except for the stomach contents, before other parts of moose calves and caribou. The soft parts of the neck and ribs are preferred over the fore and hind limbs. However, preferential feeding patterns are not obvious on prey killed by packs; the prey is most often completely consumed. Wolves readily feed on carrion, especially during the winter months when food is scarce or harder to secure.

Tracks of wild and domestic canids are similar (Figure 38). Track sizes of domestic dogs vary widely. Therefore, you may not be able to identify a wolf from a large dog at a kill site by considering only tracks. Use all available evidence to identify the predator at the kill site. Wolf tracks are larger than coyote tracks and the pace (the distance between hind and front foot prints) is longer. The stride (distance between imprints of the same foot, normally every other imprint) on level ground is approximately 100 cm (40 in.). Foot prints measure about 12 cm (4 3/4 in.) long and 10 cm (4 in.) wide, although the front-foot prints are sometimes longer and wider than the back-foot prints. In deep snow, members of a pack will commonly follow in the exact footprints of the pack leader.

Wolf scats are usually larger than those of a coyote. Scats 2.5 cm (1 in.) or larger in

Figure 37. *Wolves consumed all viscera except the rumen on this cow. They also fed on the hind legs and neck.*

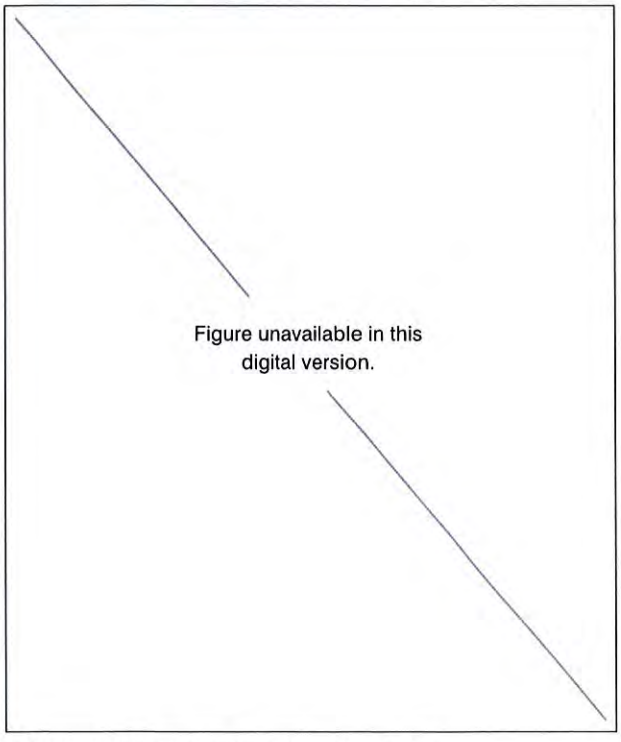

Figure 38. *Canid tracks – front foot.*

diameter are probably from wolves; smaller scats may be from either wolves or coyotes because overlap in size does occur. The size of dog scats overlaps that of wolves and coyotes. Wild canid scat usually contains hair and is blackish from digested meat.

Wolves and other dog family members use scat and urine to mark territories. They also leave scratch marks with their hind feet near scent posts.

Coyote

Coyotes (*Canis latrans*) are found throughout Alberta and are highly adapted to human presence. Consequently, coyote predation on domestic animals may occur in a backyard or miles from human habitation. Coyotes prey on sheep, goats, cattle, pigs, poultry, dogs and cats.

The coyote is the major predator of sheep in Alberta. Coyotes kill lambs in preference to ewes or rams. Lambs comprise about 70 per cent of the sheep killed by coyotes in Alberta. Bottle-fed or disabled lambs, lambs from old or crippled ewes and the smallest lambs in the flock are the most susceptible to coyote predation. Single lambs, which are more active, may be preyed on more often than twin or triplet lambs.

Young calves are also vulnerable to coyote predation (Figure 6). About 80 per cent of calves killed by coyotes are one month old or less and one-third are killed at one day of age. Calves less than a week old should be carefully guarded. Coyotes rarely attack adult cattle unless they are predisposed to attack due to birthing problems, illness or injury.

Most coyote predation of cattle happens during the spring through fall pasture season (Figure 27). Few losses occur in winter when livestock are generally kept and fed at close quarters. Sheep losses due to predation varied as follows in Alberta:

Winter 1%	Summer 40%
Spring 26%	Fall 33%

Coyote predation usually occurs in the early morning, although sheep may be attacked by coyotes at any time of day. Sheep kills may occur at any location, however, coyotes seem to prefer to kill in the open near bush or under cover of a hollow, ravine or other rough terrain. Once predation begins, coyotes generally approach and attack sheep at will. Sheep on range or large pastures are often attacked near bedgrounds. In Montana, many coyote kills occur in ditches, stream bottoms and ravines around the higher bedgrounds of sheep flocks on range.

Over 70 per cent of the sheep are killed by a throat attack (Figures 3, 4 and 39). During a throat attack, the coyote's grip is usually readjusted several times, which causes many tooth punctures and much tissue damage and hemorrhage. Coyotes attack and wound white-tailed deer, mule deer and elk calves in a similar manner.

In penned studies, a coyote would consistently run alongside fleeing sheep and bite the sheep laterally or dorsally just behind the ear. The coyote then braced its feet to stop the sheep. The coyote's grip would then shift to the throat. The grip was maintained for as long as 20 minutes until the sheep died, usually from suffocation. In tests with two coyotes, one coyote held a sheep by the throat while the other attacked the rear of the sheep. Occasionally both coyotes would grip the neck from opposite sides. A similar pattern of throat attack on sheep occurs in Alberta. However, inexperienced or pup coyotes may on occasion chase prey and bite at the sides and rear of the animal.

Very young lambs are often bitten on top of the head, fracturing the skull (Figure 40). Coyotes immediately consume young lambs or carry them away without a trace. Without careful supervision and head counts, several small lambs can disappear before a predator problem is recognized.

The helpless nature of new-born calves makes them easy prey for coyotes. It is often difficult to determine if young calves were killed by

Figure 39. *This lamb was killed with a throat attack by coyotes. Coyotes fed on the viscera and hind leg.*

Figure 40. *This small lamb was bitten on the top of the skull by a coyote.*

coyotes or died from other causes and were eaten by coyotes. There is usually little evidence of a struggle. New-born calves are generally attacked in the flank. The abdomen is ripped open and the internal organs are eaten. Calves killed by coyotes may also have bites on top of the back (Figure 41). The hindquarters and flanks are the focal point of attacks on older calves, however the neck, nose, shoulders and tail may also be damaged. Cows unable to stand while birthing can have their unborn calf and rectal area eaten by coyotes. Expectant mothers, especially first-term heifers, should be closely watched when delivery is due. Attacks on larger cattle by packs of coyotes are rare but are similar to wolf attacks on moose (distraction from the front and attack from the rear). Coyotes attack elk calves in a similar manner.

Figure 41a. *This calf was killed by coyotes by an attack to the flank.*

Figure 41b. *Skinned back area of calf showing attack on area of back (on withers).*

Multiple kills of poultry are common, especially when attacks occur in confinement. Coyotes usually kill birds by a bite on the back or neck. Unconfined poultry are killed individually, carried off and consumed elsewhere.

The killing and feeding behaviour of coyotes varies among individuals. For example, some coyotes kill one or more sheep and do not feed or feed very little on a carcass, returning later to repeat the process. Other coyotes may kill one sheep and repeatedly feed on the carcass until it is consumed. A coyote feeding on sheep or calves typically begins with entry into the abdomen (Figures 39 and 41). Most of the viscera is eaten with the exception of the stomach contents of older animals. Occasionally, feeding begins on the front leg or rib cage. Coyotes usually eat flesh on the hindquarters first and continue forward on the carcass until only the skeleton, head and hide remain (Figure 42). Adult coyotes regurgitate

Figure 42. *Only the skeleton, head and hide remain of this lamb killed and eaten by coyotes.*

consumed prey items as food for their young pups. Carcass parts and unconsumed flesh may be taken and hoarded especially when food is scarce. The hides of sheep and calves are often left more or less intact during the initial stage of feeding (Figure 42). Unlike wolves, coyotes cannot break and consume the larger, harder bones of older prey, such as the skull, spine, pelvis and leg bones. Scattered bones, stomach contents and wool or hair are often all that remains at a coyote kill site.

Coyotes may clean themselves after feeding by rubbing their muzzle, chin and throat on ground near a kill site. They may also leave scat, tracks and scratch marks.

Coyote tracks are smaller than wolf tracks (Figure 38) and are similar to those of domestic dogs of the same size. A coyote has a walking stride of about 75 cm (30 in.). The front foot measures approximately 6 cm (2 1/2 in.) long and 6 cm (2 1/2 in.) wide.

Domestic Dog

Domestic dog (*Canis familiaris*) attacks on livestock occur throughout Alberta's farming community. Cattle, sheep, goats, swine, horses and poultry may be attacked. Several stray or neighborhood dogs, occasionally accompanied by the livestock owner's dog, are usually involved. Livestock attacks by feral dogs or coy-dogs (coyote crossed with domestic dog) are less common. Of the sheep killed by dogs in Alberta, only 25 per cent are killed by dogs whose owner is unknown. Livestock near

urban centres or residential sub-divisions are generally more vulnerable to dog attacks than in less populated rural areas. In Alberta, most dog attacks on livestock occur during late fall and winter. Dogs most frequently attack adult sheep and poultry. During one year in Alberta, dogs were responsible for 15 per cent of the ewe and three per cent of lamb deaths attributed to predators.

Dog attacks on livestock are typified by many dead and wounded animals. Attacks are usually prolonged and most often occur near building sites. Dogs are usually motivated by the enjoyment of the chase rather than the need for food. Dogs normally chase and bite any part of their prey. Sheep, goats and pigs attacked by dogs are usually mutilated. Prey may have torn ears and hide, protruding organs and bite marks on the neck, head, hindlegs and flank (Figure 43). Dogs seldom feed on kills. Dogs often chase horses and cattle through fences. Harassment of livestock may cause indirect losses from self-inflicted injury, exhaustion, smothering, abortion or drowning. Multiple kills are typical of poultry attacks.

You will generally find dead animals and attack sites in various locations. You will also find many dog tracks and blood, wool or hair scattered throughout the site of dog predation.

The size of dog tracks varies widely (Figure 38). Different sizes of canid tracks made by several dogs of different size at a predation site help substantiate domestic dog involvement.

Figure 43. *Dog attacks show excessive multilation. These ewes were disembowelled and bitten on the head, nose, ears, legs, shoulders and hindquarters.*

Red Fox

Red foxes (*Vulpes fulva*) are distributed throughout Alberta. Fox predation of poultry, especially chickens, is common in the southern half of Alberta. Newborn lambs, cats and other small domestic animals are occasionally killed. Most poultry predation occurs in early summer when adults secure food for pups in their den and in late summer by family groups and young foxes. Foxes generally carry prey away from the kill site to their den or another secluded spot to feed. There is often no evidence of predation at the kill site. Consequently, many small animals may be killed and carried away before predation is noticed by the farmer. Remains of prey are often found around fox dens.

Foxes kill poultry by bites on the back or neck. Multiple kills may occur among confined poultry. Unconfined poultry are usually taken individually and carried away.

Foxes normally kill small lambs by multiple bites to the head, neck or throat. Small lambs may be injured. Foxes will carry or drag dead lambs to a secluded spot or take them to their dens to feed pups. Foxes usually feed on lambs by entry into the abdominal cavity behind the ribs. Viscera is eaten in preference to meat.

The spacing between canine tooth punctures on the hide of prey will help determine if a fox or coyote was responsible. Canine teeth of fox are 1.9 to 2.5 cm (3/4 - 1 in.) apart, while coyote canine teeth are 2.9 to 3.5 cm (1 1/8 - 1 3/8 in.) apart.

Tracks of red fox are generally smaller than those of coyotes (Figure 38). The stride distance is also shorter. The stride of a walking fox is about 64 cm (25 in.).

Family Felidae – Cats

Cougar

Cougars (*Felis concolor*) live in the mountains and foothills of western Alberta (Figure 44). They are elusive and solitary except when mating or when a female is accompanied by kittens. Cougars primarily prey on deer; however, they will occasionally kill cattle, colts, sheep, goats, swine, dogs and cats. In Arizona, 80 per cent of the cattle killed by cougars were under six months of age. Cougar predation of livestock usually occurs along the agricultural-forest fringe in Alberta.

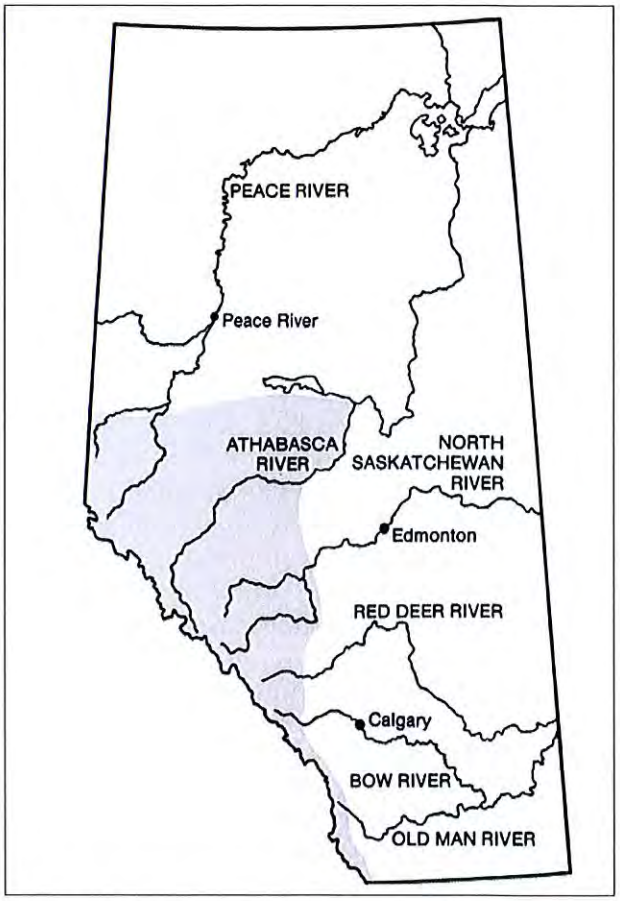

Figure 44. *Cougar distribution in Alberta.*

While primarily nocturnal, cougars may attack prey during the day. Cougars hunt by stalking like a domestic cat. Attacks generally occur in or near cover, allowing the cougar to approach within striking distance. Little evidence of a chase is apparent at a cougar predation site. Confined livestock are often attacked. Corrals and fences offer little resistance or discouragement to cougars, which easily jump or climb. Multiple kills may occur, with feeding on only one or two animals. There may be drag marks at a kill site. Cougars usually drag or carry smaller prey to cover before feeding.

Cougars typically kill small prey such as sheep, goats or calves with a bite to the top of the neck or head, usually severing the spinal column. Cougars leap on the back or shoulders of larger animals such as cattle, horses, elk and deer and kill with a bite to the neck. Claw marks are usually on the shoulders, neck and back of larger prey (Figure 45). Occasionally, bite marks may also be on the throat area. The massive canines and powerful jaw structure of cougars cause severe damage during a bite, often breaking the neck.

Figure 45. *This calf was attacked and bitten on the neck by a cougar.*

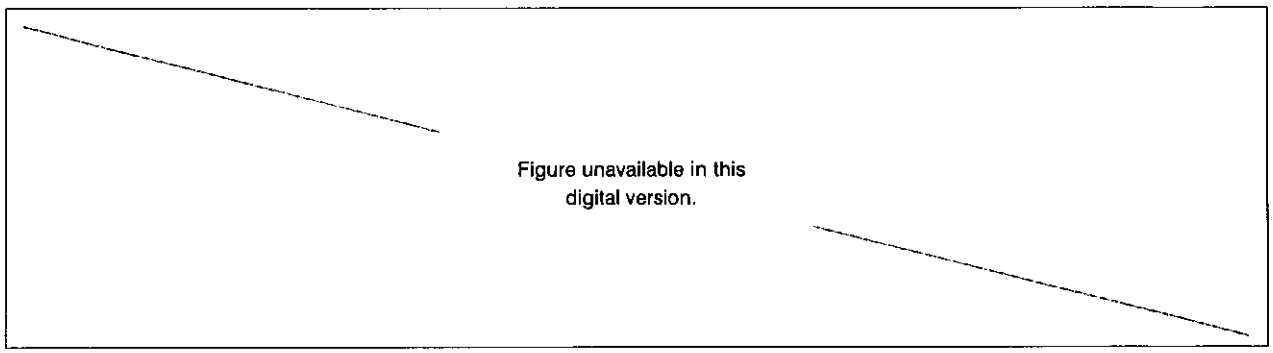

Figure 46. *Cat tracks.*

Feeding is characterized by heavy gorging with two or three days between feeds or kills. Smaller or young prey may be completely consumed during the first feeding. Cougars generally begin to feed on internal organs through an opening behind the ribs. Blood, heart, lungs, liver and kidneys are usually eaten first. The stomach and intestines are often removed from a kill but are not eaten.

Cougars readily feed on meat. As with all cats, cougars will chew off pieces of meat and leave clean-cut edges where they feed. These clean-cut edges are in contrast to the ragged edges left by the pull-and-tear feeding of other carnivores. Cougars will not eat carrion except when live prey is scarce.

Attempts are usually made to cover remains of a kill with vegetation, soil or snow. Cougars do not have as great a reach as bears when scratching debris over a kill; cougars reach out about 1 m (3 ft).

Cougar paw prints show no claw marks unless the animal runs or slips. The front foot print of adults average 9 cm (3 1/2 in.) in length and 9 cm (3 1/2 in.) in width (Figure 46). The hind and front foot prints are similar, but the hind print is slightly narrower, with the heel imprint not as pronounced. The hind foot is placed in the imprint made from the forepaw when cats are walking. Cats walk around puddles rather than through them. Cougars generally travel on paths unless food is scarce. Scratchhills made by cougars to cover their urine or dung are often found along travelways or near kill sites. Scrapes of debris, sometimes including scat and urine, are also used by males as territorial markers.

Lynx and Bobcat

The ranges of lynx (*Lynx canadenis*) and bobcat (*Lynx rufus*) in Alberta are shown in Figures 47 and 48. The predatory and feeding behaviour of these animals are similar. Poultry is their most common prey. Lynx predation on sheep, goats, calves, colts and pigs has been reported on rare occasions in Alberta.

Lynx and bobcats stalk and attack prey from cover in a manner similar to cougars. They normally leap on the back and bite at the neck and throat of larger prey. Claw marks are often found on the neck and shoulders. Deer, caribou calves and lambs have been attacked in this manner.

Predation of large prey by lynx or bobcat is poorly documented in Alberta. However, the neck of large prey seems to be the focal point of a lynx attack. Lynx or bobcat will commonly be seen around a farmstead before poultry predation occurs. Lynx and bobcat carry poultry away and return night after night, and they will frequently kill more animals than they can eat or carry away.

Feeding patterns of lynx and bobcat are similar to those of the cougar. Generally, the abdomen of prey is entered behind the ribs and the internal organs are eaten first. Meat from the thighs and shoulders is usually consumed last. Bobcat and lynx leave

clean-cut edges where they feed. Bobcat and lynx do not normally feed on carrion except when prey is scarce. Kills are often covered with debris or snow. You can distinguish bobcat and lynx kills from cougar kills by the way in which they are covered. Bobcat and lynx reach out to scratch for debris a little over 0.3 m (1 ft), while cougars reach out about 1 m (3 ft).

Bobcat tracks are much smaller than those of lynx or cougar (Figure 46). Lynx and cougar tracks tend to be greater than 9 cm (3 1/2 in.) long, while bobcat tracks are usually less than 6 cm (2 1/2 in.) long. Bobcat and cougar tracks are more distinct than the imprint of a furred lynx paw. The paw size of lynx and cougar are similar, but the heavier cougar makes deeper track impressions in snow or soft ground and the stride length is much greater than that of the smaller lynx.

Family Mustelidae

Weasel, Mink, Skunk and Badger

Weasels and mink (*Mustela* spp.), badgers (*Taxidea taxus*) and skunks (*Mephitus mephitus*) occasionally kill poultry and domestic rabbits. Weasels, skunks and mink are distributed throughout Alberta. Badgers occur throughout the prairie and parkland areas of Alberta (Figure 49). Weasels and mink usually kill prey with bites to the skull, neck or throat. Multiple kills of confined poultry are common, with feeding only on one or two birds. Poultry chicks may be carried away or piled in a corner of the pen; larger prey are fed on at the kill site. The head is often eaten. They may also feed on the breast. Mink prefer habitat near streams, lakes or other water bodies. Mink predation usually occurs on farms close to water. Weasels

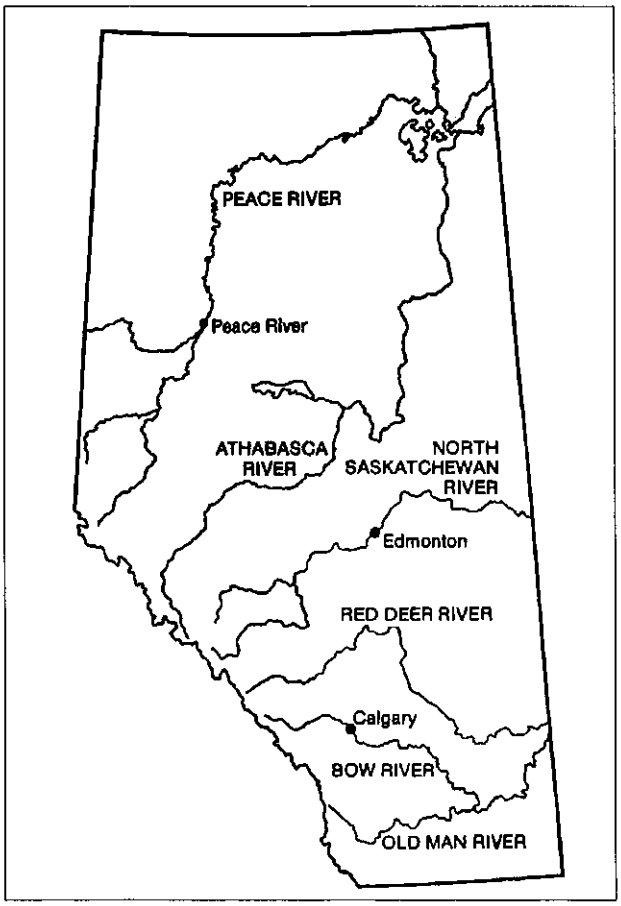

Figure 47. *Lynx distribution in Alberta.*

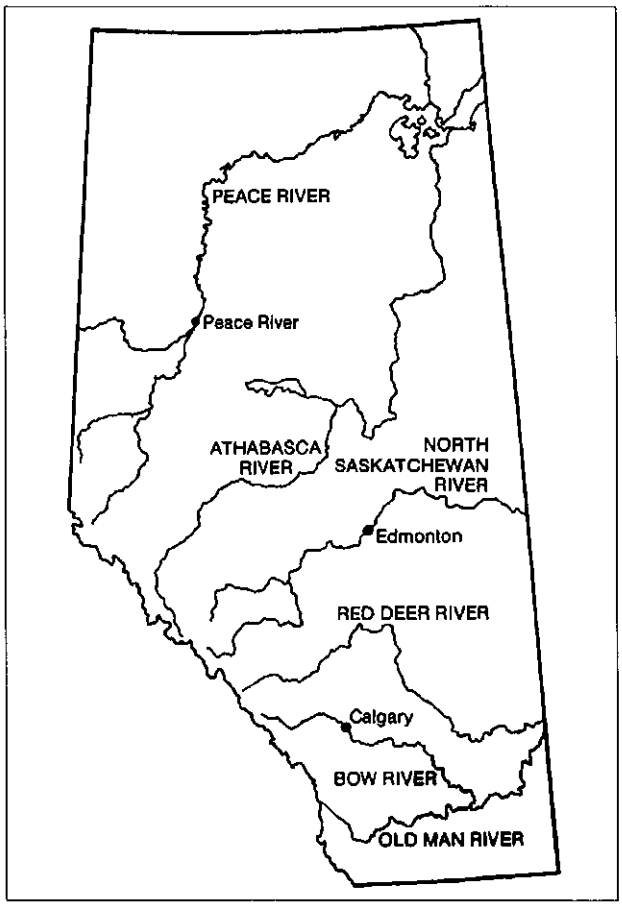

Figure 48. *Bobcat distribution in Alberta.*

occur in a variety of habitats. Consequently, weasel predation may occur anywhere. Mink and weasels climb and enter buildings or fenced areas through openings too small for most other predators. Mink are larger than weasels, so predation by these animals may be differentiated by the distance between canine tooth punctures on prey. The canines of mink are just over 1.3 cm (1/2 in.) apart while those of weasels are less than 1.3 cm (1/2 in.) apart.

Badgers commonly gain access to confined poultry, rabbits or other small farm animals by burrowing under fences or walls. Multiple kills are common. Extensive digging, large dig holes and badger tracks are usually present where badger predation occurs. Prey is often cached in holes dug at the predation site.

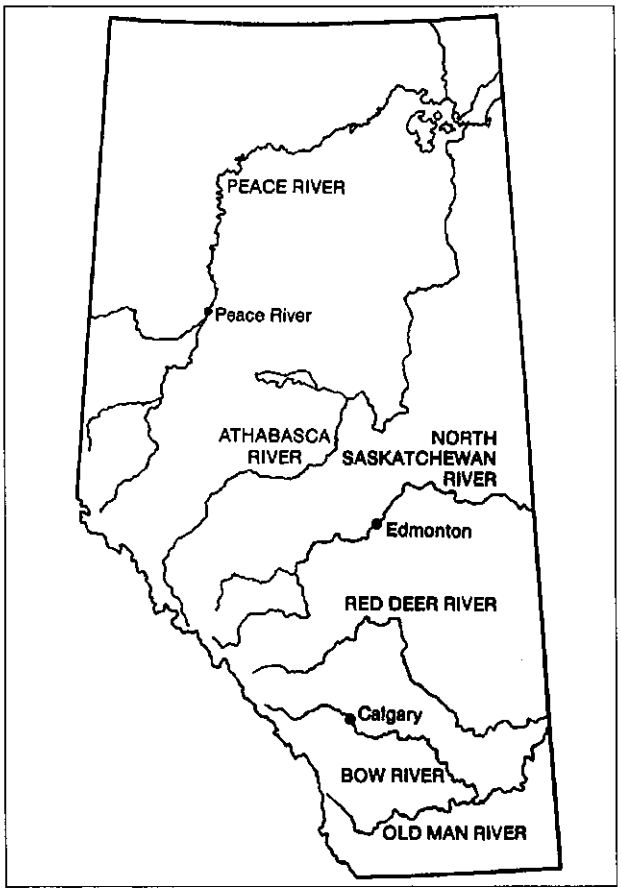

Figure 49. *Badger distribution in Alberta.*

Skunks generally kill one or two birds during each visit. Birds are typically mauled and bitten on the lower neck and breast. Confined poultry are most vulnerable, especially those that roost on the ground. Skunks normally dig or crawl into pens or buildings through holes in wire or walls. Do not confuse scavenging of poultry carcasses with actual skunk predation.

The presence of a predator can cause large numbers of poultry to be lost from suffocation as they crowd into a corner in panic. Mustelids (members of the weasel family) are often observed near predation sites and will return to feed on kills or kill additional prey.

Badgers and skunks have large claws on their front feet that usually show in paw prints (Figure 50). Badger tracks measure 5 to 6.5 cm (2 - 2 1/2 in.) long and approximately 5 cm (2 in.) wide. Skunk tracks are about 4 to 5 cm (1 1/2 - 2 in.) long and 3 cm (1 1/4 in.) wide.

Mink and weasel tracks are generally absent at predation sites unless snow is present. Mink and weasels leave a characteristic bounding track pattern with two feet together at approximate equal distances (Figure 50). Mink tracks are larger than weasel tracks. Weasel tracks average 1.5 cm (2/3 in.) in length while mink tracks average about 4.4 cm (1 3/4 in.).

Family Procyonidae

Raccoon

Raccoons (Procyon lotor) are common in southern Alberta, especially south of the Bow and South Saskatchewan rivers (Figure 51). They will occasionally prey on poultry. Raccoons prefer habitat near water. Farms near streams, lakes or other water bodies are most susceptible to raccoon problems. Raccoons are excellent climbers and can manipulate objects with their front feet. This helps them to enter uncovered or poorly constructed poultry pens easily. They can climb over fences, and pull off or open loose boards and weak wire mesh.

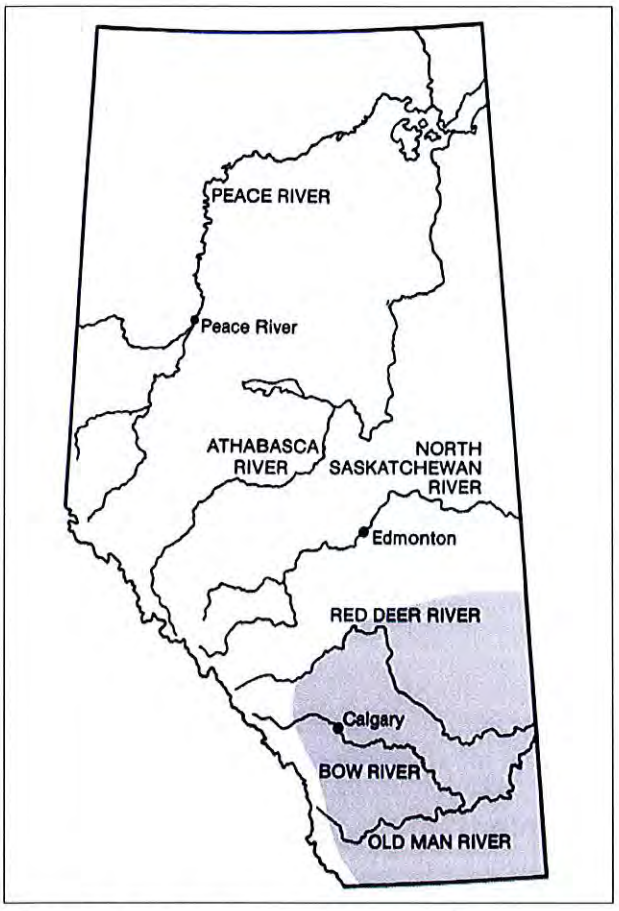

Figure 51. *Racoon distribution in Alberta.*

Signs of raccoon predation may include carcasses with missing heads, bites on the back, torn necks and breasts, and feeding on the breast or entrails (Figure 52). Raccoons usually attempt to drag or carry prey to cover before they feed. They may kill several birds in one night. Often a family group is involved in predation. Eggs are also removed from nests or eaten on the spot.

Tracks of raccoon are longer than they are wide and resemble miniature human hands or footprints (Figure 53). Five toes are evident. The toes are bulbous on the tips. Claw marks usually show in the tracks. Front paws measure approximately 6.5 cm (2 1/2 in.) long and 6.5 cm (2 1/2 in.) wide; hind feet measure about 10 cm (4 in.) long and 6 cm (2 1/4 in.) wide.

Figure 52. *These ducks were bitten on the neck and back, and the entrails were eaten by a racoon.*

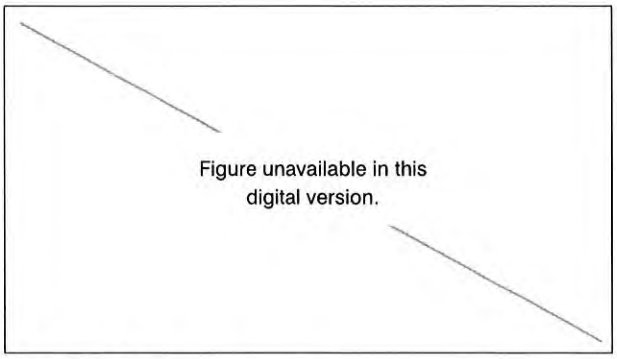

Figure 53. *Racoon tracks.*

Raptors – Birds of Prey

Eagles, Hawks and Owls

Raptors occasionally kill poultry, domestic rabbits and other small domestic animals. Hawks and eagles normally attack unconfined domestic prey during the day. Small animals are simply picked up and taken away. Occasionally owls will enter a poultry house and make multiple kills or cause severe losses when poultry pile and suffocate. The great horned owl (*Bubo virginianus*) is usually the owl species responsible for predation on poultry and other domestic animals. Prey are killed by talon punctures into vital organs. The head of dead poultry is characteristically bitten off close to the body. When multiple killing takes place, not all birds will be decapitated.

Figure 54. *The skinned shoulder of this day-old calf reveals talon puncture wounds from a golden eagle. The eagle has fed on the rear quarters of this calf.*

Figure 55. *This stillborn calf was scavenged by a bald eagle. The ealge picked flesh from between the ribs.*

Newborn lambs and calves have been attacked by eagles on rare occasions in Alberta. However, eagle predation of lambs and kid goats is common in the United States. Adults are also occasionally attacked. Golden eagles (*Aquila chrysaetos*) are usually involved. Prey is grasped with the talons anywhere on the head, neck or body. Multiple talon punctures in the skull or along the spine damage organs and tissue (Figure 54). Death usually occurs from shock and blood loss. Eagles strip all soft tissue including cartilage, tendons and soft bones from a carcass. They leave most of the skeleton intact and the hide turned inside out. Tissue and hemorrhage may be cleanly removed from the hide. The rumen of larger prey is usually not eaten. Eagles will readily feed on carrion, especially when prey is scarce (Figure 55).

Birds may defecate on or around a carcass leaving characteristic white streaks of feces.

Scavenging Birds

Magpies, Ravens and Crows

Healthy livestock are rarely preyed upon by scavenging birds. Most attacks occur on livestock that are in difficulty and unable to escape or defend themselves (Figure 56). Most situations would therefore be classified as pseudo-predation. Typically, these birds attack and feed on the eyes, nose, neck and rectal area or at wounds. Scavenging birds are often associated with remains of animals preyed upon by carnivores. Birds may defecate on or around a carcass leaving characteristic white streaks of feces.

True predation of young poultry, piglets, newborn lambs and calves by ravens (*Corvus corax*) and magpies (*Pica pica*) has occurred in Alberta and British Columbia. High densities of birds, lack of food and feeding of nestlings contribute to predation by scavenging birds. Changes in management usually alleviate this kind of predation.

Figure 56. *Magpies fed on this goat after its horns became entangled in a fence.*

CHARACTERISTICS OF MAJOR PREDATORS

	Wolf	Coyote	Dog	Bear	Cougar
Area of conflict	Fringe of settlement, grazing leases, pastures and farmland along the forest-agricultural transition fringe.	Throughout Alberta.	Throughout agricultural areas; often near urban centres or residential subdivisions.	Grazing leases, pastures and farmland along the forest – agricultural transition fringe.	Mountains and foothills near agricultural area.
Domestic prey	Cattle, sheep, horses, dogs.	Sheep, calves, goats, poultry.	Sheep, poultry, calves, goats.	Cattle, sheep, swine.	Horses, swine cattle, sheep.
Attack behaviour	Cattle, horses: long chase, trails of blood and hair, bites on hindquarters, vulva and tail. May attack shoulders, flank, nose or head. Sheep: Severe bites on neck, hindquarters, head or flank. Disembowelment common.	Sheep: usually throat, top of neck or head. Occasionally attack hindquarters or flank. Calves: Newborn – flank bites on back. Older calves – hindquarters, tail, flank and back. Poultry: multiple kills when confined. Carry off individual unconfined poultry.	Prolonged harassment and mutilation ears, nose and shoulders, flank, hindquarters and tail.	Bite on top of neck, back or head. Shallow claw marks on face and shoulders. Wounded prey common.	Bites on top of neck damaging spine, teeth marks on upper neck, deep claw marks on neck and shoulders.
Feeding behaviour	Prefer viscera and hind limbs, preferential feeding not obvious in packs.	Feed on prey through upper flank, consume viscera and upper thigh first, leave hide in more or less one piece.	Feed lightly or not at all.	Drag prey to cover; prefer flesh over viscera. Skin and bones remain more or less intact. Grizzlies generally cover prey, black bears usually do not.	Drag prey to cover. Heart, lungs, liver, and kidneys eaten first, then meat. Cover remains of prey.

SUMMARY

Locate the attack and kill site.
Record:
Vegetation – Woods, brush, open pasture
Topography – Ravine, hilltop, stream bottom
Distance from buildings

Note the position of the carcass.

Look for signs of a struggle.
Record:
Broken vegetation
Trampling
Blood trails
Tufts of hair

Note predator sign.
Record:
Tracks
Scat
Hair

Examine the carcass for wounds.
Record and photograph:
Signs of hemorrhage
Blood on ground
Stage of decomposition
Location and description of external wounds (i.e., bites, claw marks, tooth punctures)
Parts consumed

Skin normal attack sites or areas of carcass where wounds are evident (that is, throat, hind legs, neck).
Record:
Size and description of subcutaneous bruises and wounds

Open the chest and abdomen.
Record:
Damaged organs and massive blood clots

Cut along neck and back bone.
Record:
Broken vertebrae
Hemorrhage

Note and record the age of the animal.
Examine footpads of newborn.
Did the newborn breathe and nurse?
Was it cleaned by the mother?

Check the carcass for general health.
Record abnormalities of:
Coat condition
Body fat
Amount and kind of food in rumen
Lungs
Circulation
General appearance
Age

Note the condition of pasture.
Record:
Overgrazing
Poisonous plants

Note any irregularities in the rest of the herd.

Check for sources of poison.

Determine the cause of death.
Predation
Pseudo-predation
Other causes

In case of predation, determine species responsible from:
Predator ranges
Habitat preference
Domestic prey involved
Attack behaviour
Feeding behaviour
Tracks, scat, hair

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Rancher's Guide To Predator Attacks on Livestock

Government of Alberta

Before or after?

Bears, wolves, cougars and coyotes can be scavengers as well as predators.

Evidence of Scavenging	Evidence of an Attack
• There may be no blood on the ground around the carcass, or blood may have drained onto the ground from body cavities such as the nose. • Lacerations and puncture wounds found on the hide's exterior do not show corresponding signs of hemorrhaging on the interior of the hide or in adjacent tissue. • The body may be curled up with the legs tucked in, indicating the animal died of disease or other condition not related to predation.	• There may be blood on the ground indicating the animal bled when attacked. Blood stains may be spread widely around the dead animal. There may be a blood trail. • Lacerations and puncture wounds on the hide's exterior will show corresponding signs of hemorrhaging on the interior of the hide and tissue. Blood may also drain from puncture wounds. • The body may be stretched out in an unnatural position.

Common Attack Zones on Adult Livestock

Indications: hemorrhaging/bruising/lacerations/tears/bite marks/crushed bones

	Wolf	Grizzly Bear	Black Bear	Cougar	Coyote
Tail	X				X
Hindquarter/Groin	X				X
Flank	X				X
Behind and under front leg	X				X
Withers		X	X		
Spine		X	X		
Neck		X	X	X	X
Throat				X	X
Skull		X	X	X	
Spacing between canine teeth	1½-2"	2-3"	1½-2½"	1½-2¼"	1-1 3/8"
Diameter of canine tooth punctures	¼"	¼"	¼"	¼"	1/8"

Animal Attack

4

Characteristics of a wolf attack

Wolves chase their prey.
During the attack, prey are weakened through pursuit and blood loss.

Wolves normally attack their prey from behind.
Bite marks and lacerations are often found on the animal's hindquarters, and the tail may also be missing or stripped of its hide.

Wolves may attack other parts of the body.
Bite marks can also be found on the nose, under and behind the front legs and on the ears.

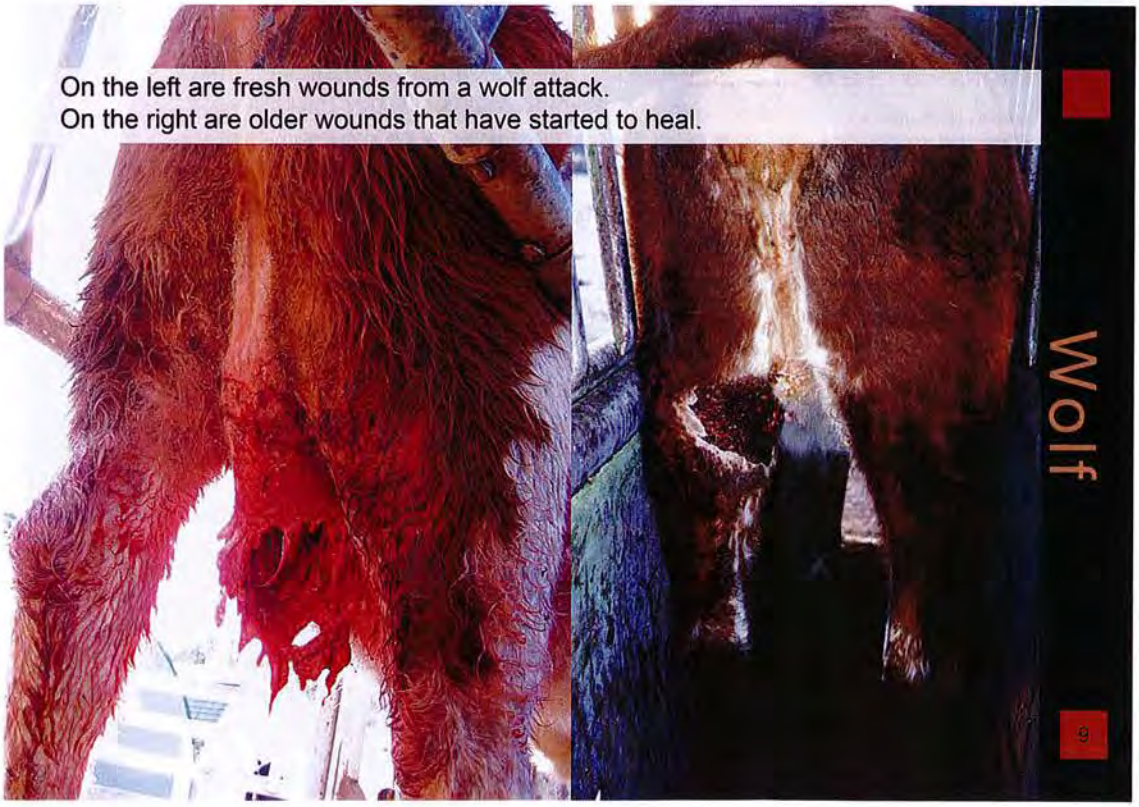
When wolves prey on younger or smaller animals, they may centre their attack on the animal's back.

Wolves use their teeth in an attack.
The biting causes hemorrhaging, which is most evident on the inside of the hide and in the adjacent tissue.

Wolf

5


Black/purple stains on an older, inverted hide shows hemorrhaging caused in an attack. Evidence of bite marks will be visible on the exterior of the hide.
Wolf
8


On the left are fresh wounds from a wolf attack.
On the right are older wounds that have started to heal.
Wolf
9


Bear Attacks
Bear
The bear attack to the withers of this spring calf resulted in extensive tissue damage.
12


103
Bear
The bear attack on this calf resulted in crushed nasal bones.
13

The bear attack on this sheep resulted in puncture marks to the skull and wounds to the back.

Bear

16

Characteristics of a cougar attack

Cougars stalk their prey.

When hunting, cougars sneak up on prey and then rush it from a short distance away.

They will not pursue their prey over long distances. However, once the animal is dead, they may drag it some distance to feed under the protection of cover.

Cougars are efficient hunters.

Cougars normally kill their prey in one of two ways: by biting at the head and neck to crush the skull and neck bones, or by biting at the throat to crush the windpipe.

Cougars use their strength and sharp claws to grip their prey.

In a struggle, cougars are normally strong enough to maintain their hold on their prey with minimal re-adjustment. Lacerations may not show marks from all five of the cougar's claws. The claw marks are knife-like, with very clean edges.

Cougars prey on a variety of livestock.

Cougars typically attack sheep, goats, horses and exotic animals, such as llamas and alpacas.

Cougars feed on organ meat first.

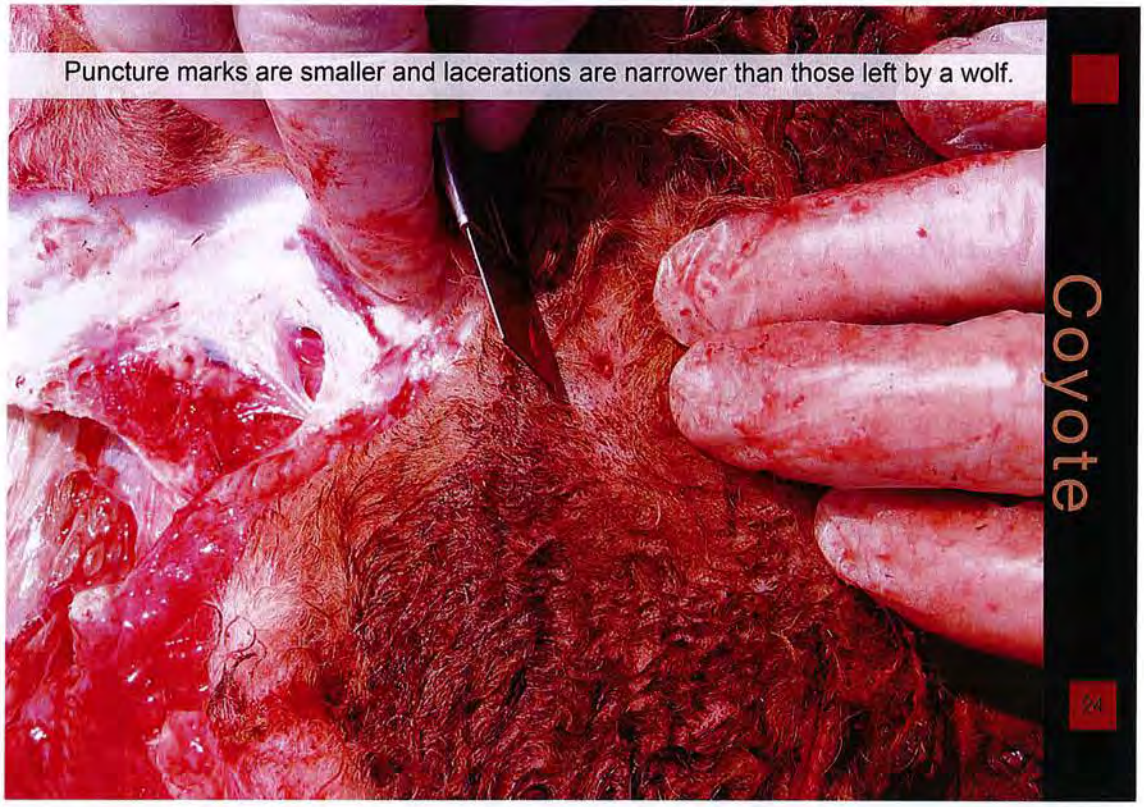
Cougars feed on the heart, lungs and liver first. They use their teeth to chew out a clean entryway rather than tearing at the tissue. Before feeding, cougars pluck out the wool or hair from the hide. Unlike bears, cougars do not normally eat the stomach, intestines or their contents.

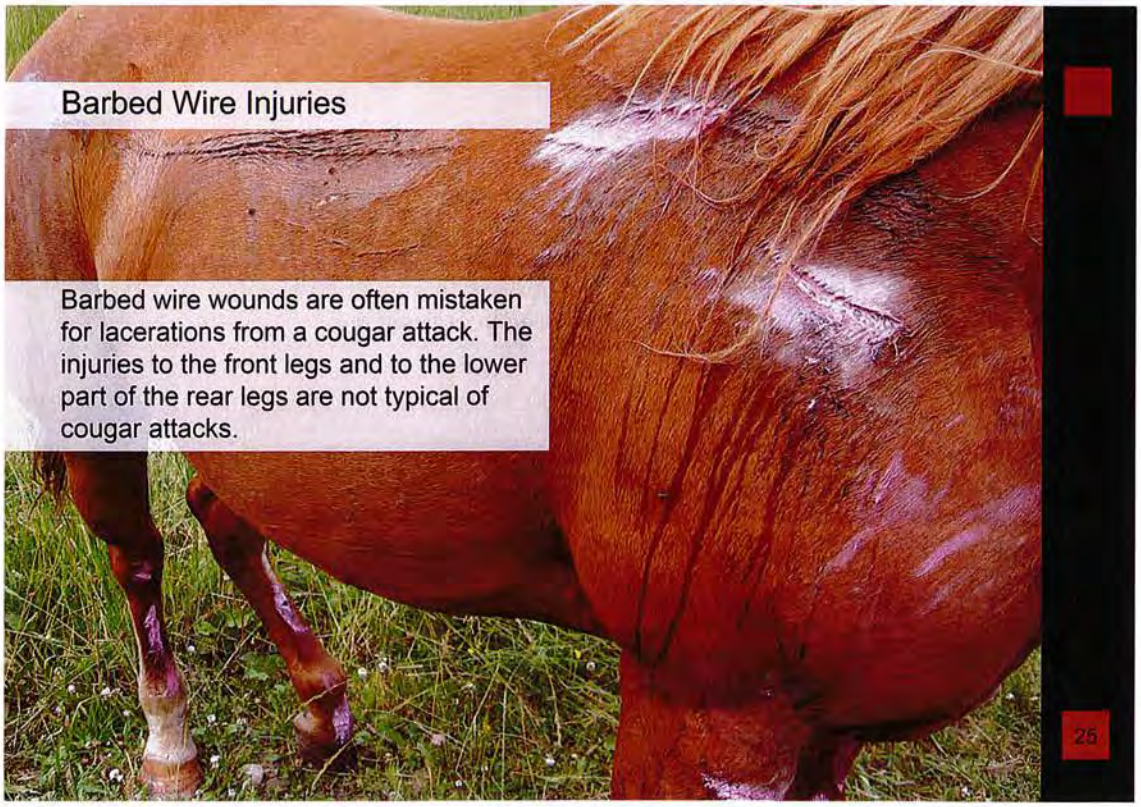
Cougar

17


The cougar attack on the foal left canine tooth puncture wounds in the throat area.
Cougar
20


Wounds made by cougar claws:
• Top images: lacerations
• Right: punctures
Cougar
21

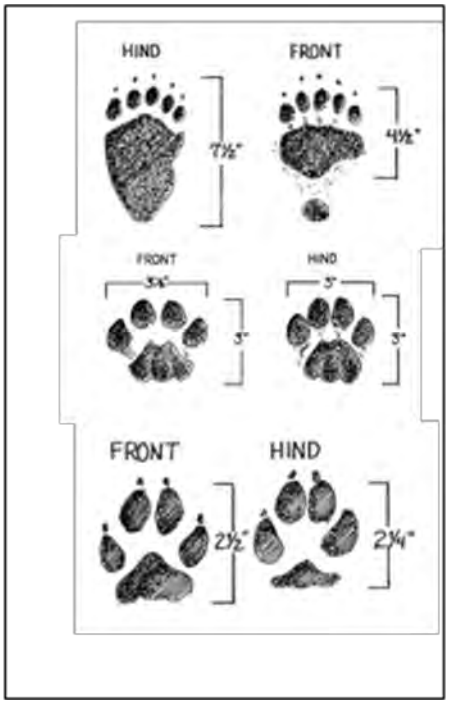

Puncture marks are smaller and lacerations are narrower than those left by a wolf.
Coyote
24

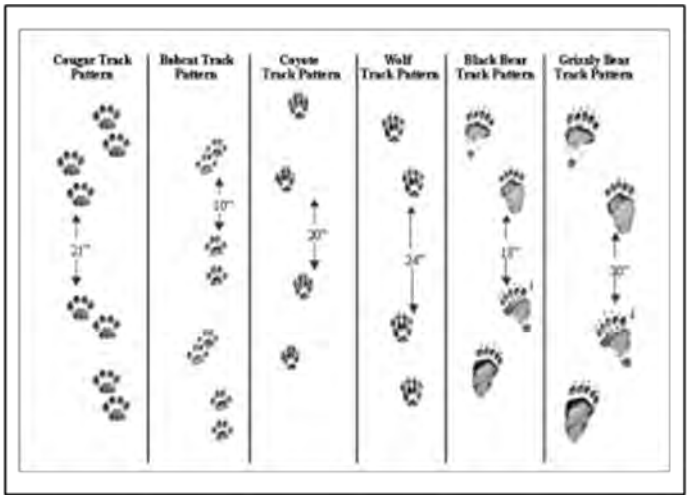

Barbed Wire Injuries
Barbed wire wounds are often mistaken for lacerations from a cougar attack. The injuries to the front legs and to the lower part of the rear legs are not typical of cougar attacks.
25

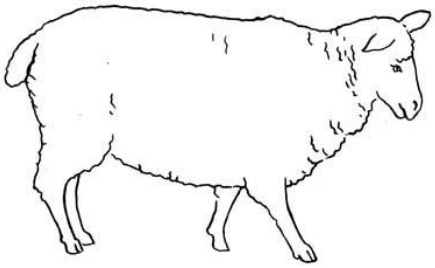
Washington Department of FISH and WILDLIFE

LIVESTOCK INJURY AND MORTALITY INVESTIGATIONS

A REFERENCE GUIDE FOR WDFW FIELD PERSONNEL







LIVESTOCK INJURY AND MORTALITY INVESTIGATIONS

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LIVESTOCK INJURY AND MORTALITY INVESTIGATIONS

INTRODUCTION

This guide is intended to be used for general reference only. In no way does it attempt to describe every possible piece of evidence, every situation, the condition of every carcass, the amount of carcass that remains to examine, or the variability of injuries that an investigator may encounter during a livestock injury or mortality investigation.

The reference guide does not provide step by step instructions on how to perform an investigation because it is expected that, over time, each investigator will develop techniques that work best for them. However, this guide follows the same general layout of the livestock injury and mortality investigation form. The investigation form was designed in sections that pertain to the order an investigation should progress, from general to more specific. These sections include the initial report, the incident location, the type of animals affected, site description and physical evidence present, description and location of injuries, source of injuries, and the injury/mortality classifications. If the form is completed in order, no steps will be missed during a livestock injury and mortality investigation.

This guide has many pictures of injured and dead livestock. These photos were selected because they primarily represent the "classic" characteristics of a predator attack and, in some cases, the associated damage they caused. Please remember that every livestock injury and mortality investigation is unique due to a whole host of variables, and what you may observe during an actual investigation may be very different than what is illustrated in the photos.

LIVESTOCK INJURY AND MORTALITY INVESTIGATIONS
INITIAL REPORT

Sample questions to ask reporting party (RP) once initial report is received. Feel free to ask more questions based on the information you are receiving.

1) Is the animal injured or dead?

2) When and where was the animal found?

3) When was the animal last observed uninjured or alive?

4) Are there any witness accounts to the incident? *Use caution here, oftentimes the RP will already "know" what happened even if no witnesses observed the incident. Please remember to keep an open-mind and let the investigation lead you to your conclusion.*

5) Are injuries visible and, if so, describe the location of the injuries?

6) If the animal is dead, how much of the carcass is left?

7) If the animal is dead, did you notice sign of any other animals near the carcass?

8) If the animal is dead, did you cover the remains with a tarp to preserve evidence? *If not, there is no need to go back and do this unless you are unable to respond in a reasonable amount of time.*

Before hanging up the phone, remind the RP to minimize disturbance to the area to preserve any possible evidence at the incident site prior to your arrival.

Most important items to include in your necropsy kit *(an equipment list put together by District 1 can be found in Appendix 3 of this guide)*

- Livestock injury/mortality investigation form*
- Knife*
- Blade sharpener*
- Digital camera*
- GPS unit*
- Measuring tape*
- Thick skin*

References used for this manual:

(1) AgriLife Communications. 2010. Procedures for evaluating predation on livestock and wildlife. Texas A&M University, Texas, USA.
(2) Government of Alberta. 2010. A rancher's guide to predatory attacks on livestock. ISBN: 978-0-77895-9053-8.
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LIVESTOCK INJURY AND MORTALITY INVESTIGATIONS

SITE DESCRIPTION AND PHYSICAL EVIDENCE PRESENT

IF POSSIBLE, CONDUCT A COMPLETE SITE INVESTIGATION PRIOR TO EXAMINING THE INJURED ANIMAL OR PERFORMING A NECROPSY

Things to document and take note of might include:


Grizzly bear bed site near depredation

- Tracks
- Hair
- Scat
- Blood
- Bed sites
- Sign of struggle
  - trampled vegetation
  - broken branches on nearby trees or shrubs
  - spilled or sprayed blood on ground or nearby vegetation
- Was animal moved from site of incident?
  - by humans (likely if animal was injured)
  - evidence animal was moved or carried from site of incident
- Evidence of caching behavior
  - scrape marks
  - covered with debris

At times, there may be no or very little site evidence to assist the investigator in determining what happened, but it remains a very important step during the investigation process whether any additional evidence is found or not.

Understanding the behaviors and habits of large predators as well as knowledge of any recently confirmed sightings and/or other information that may indicate a large predator might have been in the area may also assist the investigator during a livestock injury/mortality investigation even when site evidence is lacking.

PHOTOGRAPHS: If evidence is found, photographs should be taken for documentation. If possible, take photos of the entire scene and where any evidence may be located in relation to the carcass. If close-ups are necessary, take a wide angle view for reference before taking that close-up photograph. When photographing tracks, remember to place something of known size next to the track so a lay person can have some reference to size.

LIVESTOCK INJURY AND MORTALITY INVESTIGATIONS
SITE DESCRIPTION AND PHYSICAL EVIDENCE PRESENT

TRACKS, HAIR, AND SCAT

During the initial site investigation, search the area surrounding the incident location for evidence of predator presence. Creek banks, puddles, muddy ground, cow pies, fences, and nearby trees and/or shrubs are a few good places to search for tracks and hair. Please remember, even if predator sign is found, this does not necessarily mean that predators were responsible for the injury or mortality.

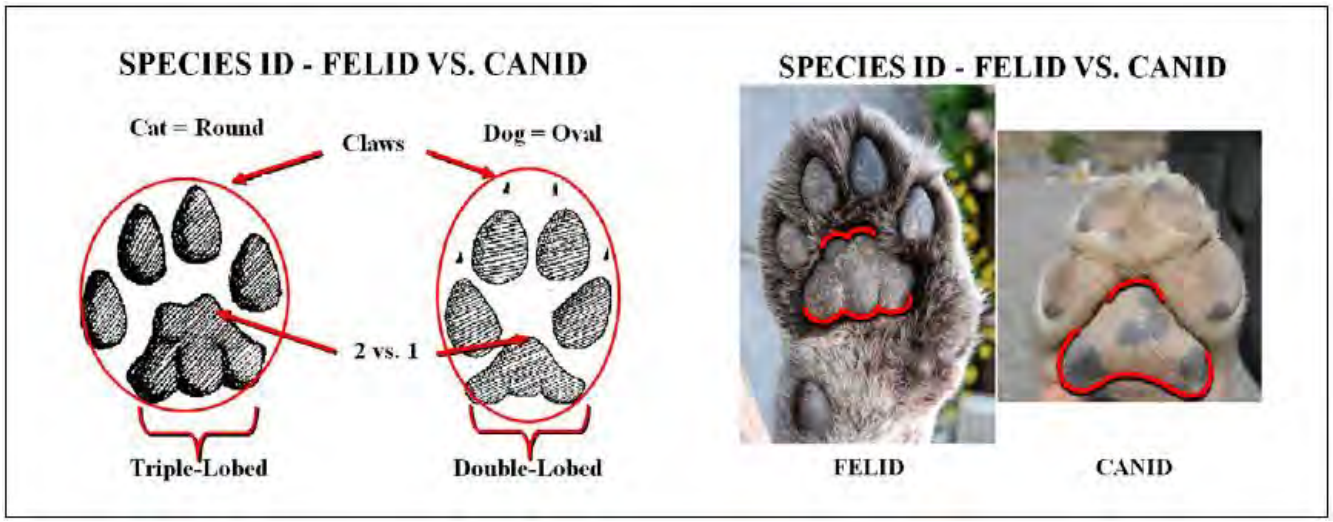
Scat may also be present, but unless additional sign is found in the area, it may be difficult to determine which predator species the scat came from. Below are general scat characteristics of predator species (color and size were not included due to the amount of variation both within and among species). **NOTE:** *If the predator recently consumed meat (from scavenging or something it may have killed), the scat will appear very dark brown or black and will most likely have no or very little form.*

Bears: Scats are highly variable and often contain partially undigested parts of a single food source. Scats may be large and tubular in shape with relatively blunt ends or they may be relatively small and round/oval or any variation in between. Bears often deposit scats in large piles and seldom, if ever, cover them with debris.

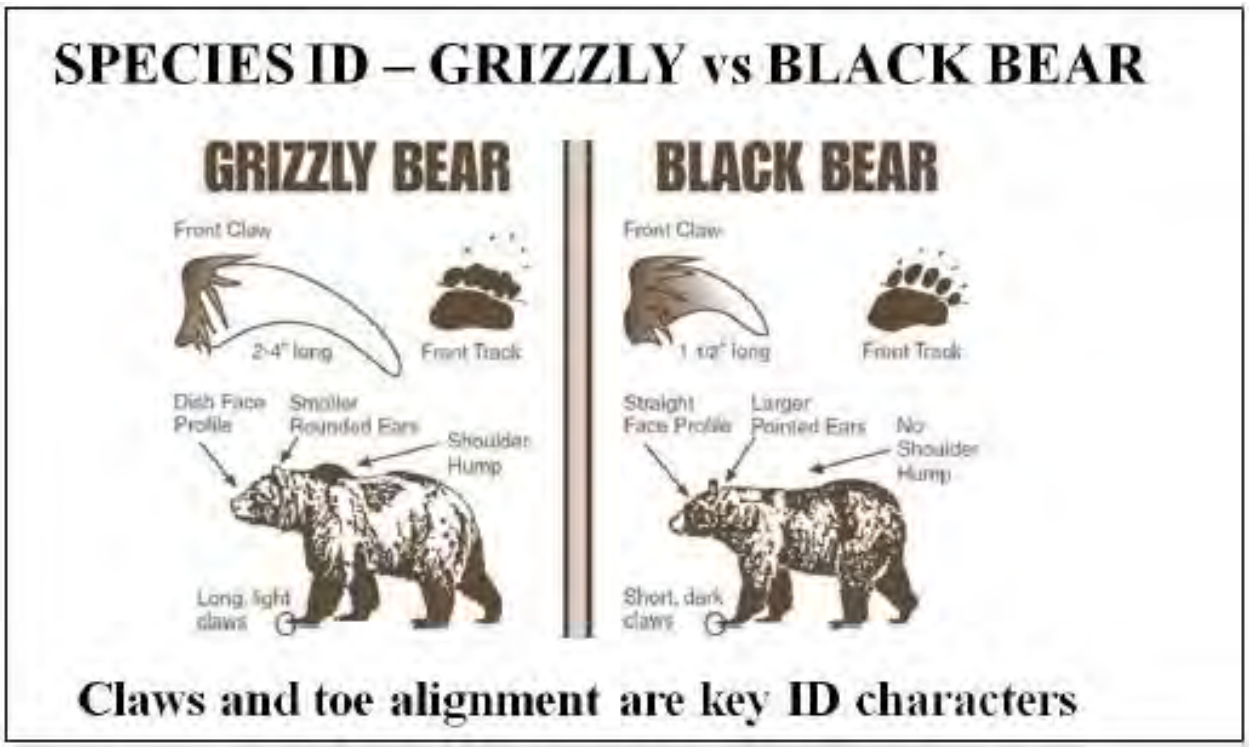
Cats: Highly variable, but scats often appear segmented with blunt ends. Cats often scratch out areas and deposit scat in this spot then they may or may not cover scats with ground debris. Scats may contain large amounts of hair and/or bone. Cougar scats will often be larger than bobcat.

Dogs: Highly variable, but scats often have a tapered end. May or may not appear segmented or twisted like rope. Scats may contain large amounts of hair and/or bone. Scrapes may be evident, but these are generally due to vigorous, random movements of the hind legs after defecation. Scats will seldom, if ever, be covered with debris.

TRACK IDENTIFICATION



Another identifying characteristic, seen in the set of images on the left (above), is that the two middle toe pads on cat tracks are slightly offset (one slightly in front of the other) while the two middle toe pads on dog tracks are nearly straight.



WOLF OR DOG TRACKS?

Determining whether a dog or a wolf left a set of tracks can be a very challenging task. Dogs can overlap wolf tracks in size and, because they are closely related, there are no morphological features one can use to separate the two. Gaits and track patterns around kills and carcasses are often confusing and not diagnostic.

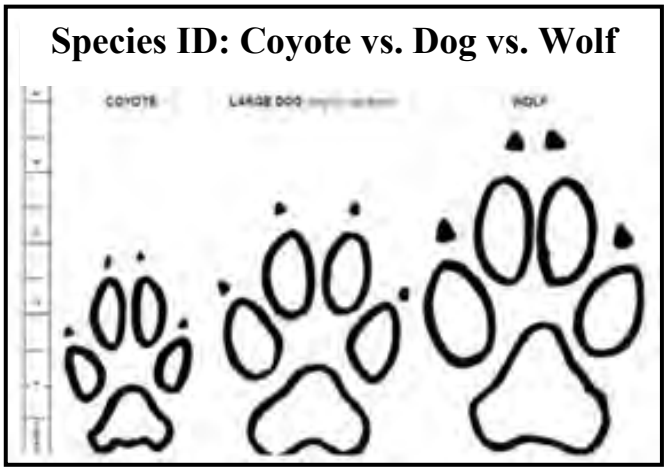
That said, accurate measurements are extremely helpful in separating out these two closely related canids. Tracks were likely made by wolves if either of the following is true (82% of dogs have feet smaller than this):

- Hind foot length 3 ½“ or longer without claws
- Front foot length 4” or longer without claws

Some dog breeds that commonly have tracks in the wolf size range: Irish Wolfhounds, Akitas, Saint Bernards, Newfoundlands, Great Danes, and Mastiffs.

Tips on Measuring Tracks

- Try to identify front and hind prints. The dog and cat families both have front feet that are slightly larger than the rear.
- Try to measure from the floor (bottom) of the track, not the top edge (minimum outline).
- Measure several footprints and average the size if possible.
- It is best not to measure claws, as they sometimes register well, other times not at all, and every variation in between. Measuring claws introduces more variation into a process that is oftentimes difficult to begin with.



- *Length*: Measure from the tip of the furthest forward toe pad to the back of the heel pad (interdigital pad). Measure parallel to foot axis.
- *Width*: Measure from the farthest point on the outside toe pad to the farthest point on the inner toe pad. Measure perpendicular to the foot axis.

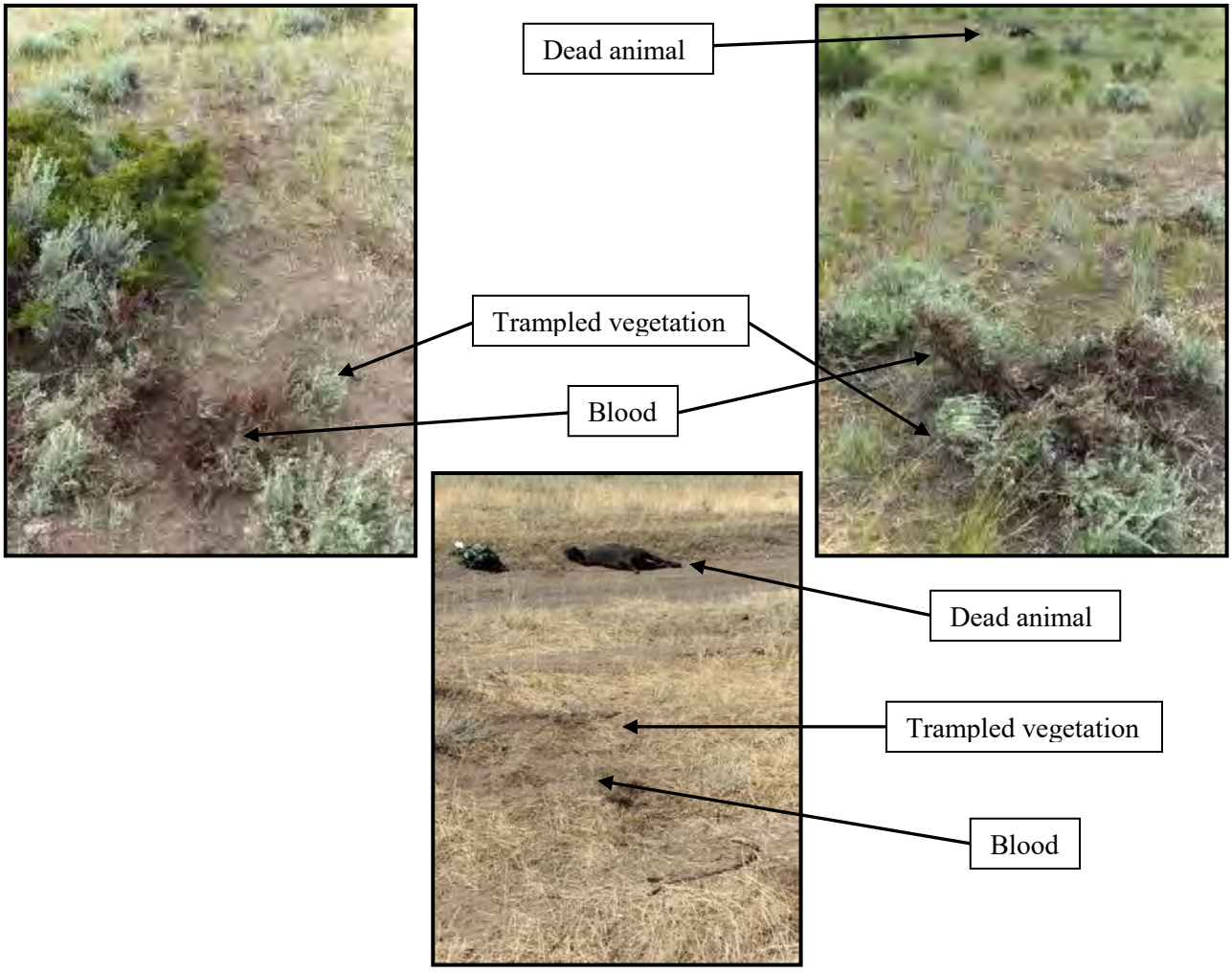
Reference used for this page:

1) Halfpenny, J., and T. Furman. 2010. Tracking wolves, the basics. CreateSpace Independent Publishing Platform. Gardiner, Montana, USA.

BLOOD AND SIGN OF STRUGGLE

Due to differences in how predators attack, there may or may not be evidence that a struggle occurred near the location of the incident. Cougars tend to use stealth when attacking prey thus attacks are over relatively quickly so there may be little evidence to indicate a struggle occurred. Bears may chase prey for short distances then use size and strength to their advantage which may result in a struggle of relatively short duration. Wolves tend to chase and bite prey to slow it down and bring it to the ground so there may be some indication at the scene that an extended attack and/or struggle occurred, but not always.

Below are some examples which indicate that a struggle occurred. The top two photos show evidence of a struggle found during a wolf depredation investigation and the bottom photo shows evidence of a struggle found during a grizzly bear depredation investigation.



EVIDENCE ANIMAL WAS MOVED FROM INCIDENT SITE AND CACHING BEHAVIOR

Cats: Usually carry or drag prey item away from kill site, often to an area of dense cover. May then cache prey by carefully scraping the surrounding area and covering the prey item with ground debris.

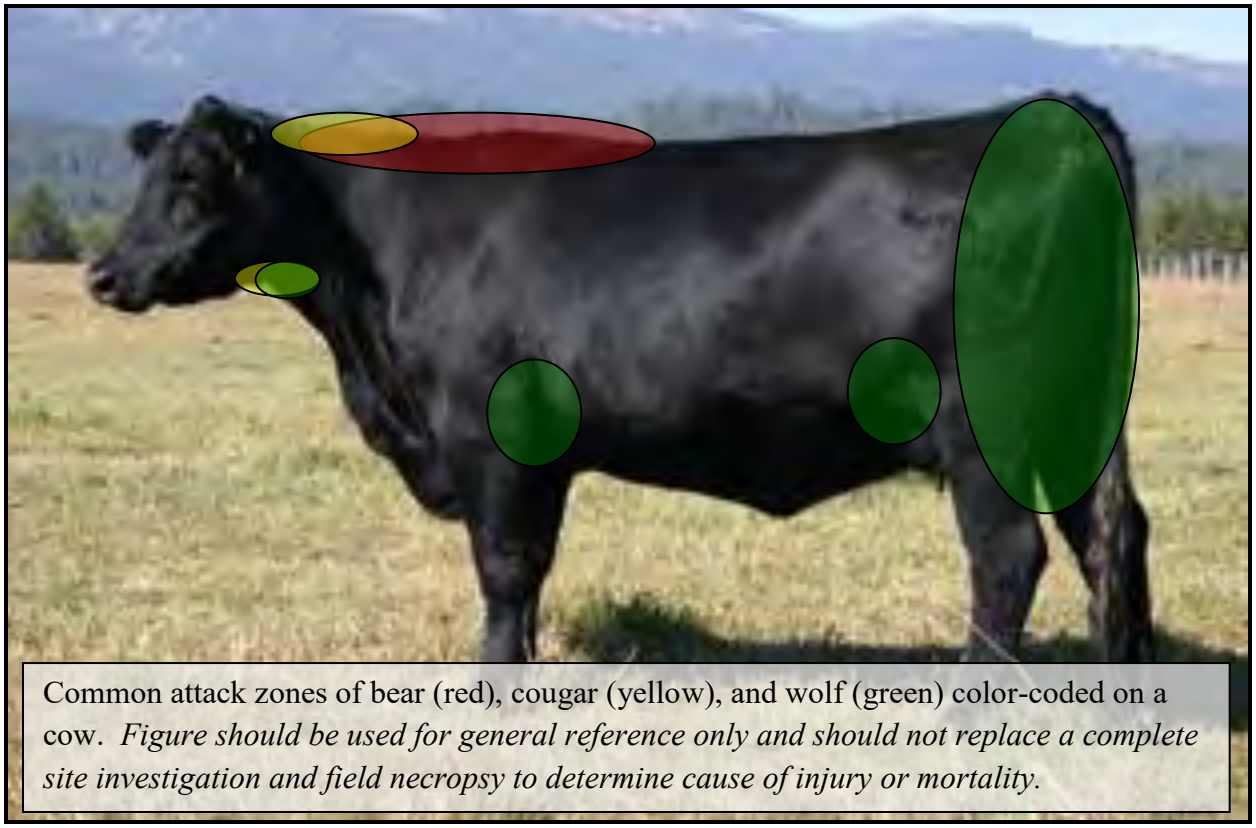
Bears: More variable than cougars with this behavior. May or may not carry or drag prey item away from kill site. May or may not cache prey. If prey is cached, bears will use ground debris as well as dirt and ground may appear as if it was "roto-tilled" around the prey item.

Dogs: Seldom, if ever, will carry or drag prey item away from location of kill or cache prey.

In the photo to the left, the prey item was killed relatively quickly (blood in single location), then dragged away to heavier cover; characteristics of a cougar kill. Photos below represent caching behavior of cougars.

CHARACTERISTICS OF PREDATOR ATTACKS

Large predator species have a unique method of attacking and securing prey throughout their range. Some variation and overlap among species is likely, but the general characteristics of each predator are common no matter the species or age of species attacked.



Common attack zones of bear (red), cougar (yellow), and wolf (green) color-coded on a cow. *Figure should be used for general reference only and should not replace a complete site investigation and field necropsy to determine cause of injury or mortality.*

The investigator should also have an understanding of the behaviors and general habits of large predators as well as knowledge of any recent, confirmed sightings and/or other information that may indicate a large predator might have been in the area (especially if it is in an area not typical for that particular species). This information may be used in combination with a site investigation and examination of the injured or dead animal to determine, to the best of their ability, the cause of the injury or mortality.

Note: Although predators can and do injure and/or kill large animals (i.e., adult cows, horses, etc.), the majority of livestock injured and/or killed by predators are smaller in size (i.e., calves, sheep, foals, etc.).

LIVESTOCK INJURY AND MORTALITY INVESTIGATIONS
DESCRIPTION AND LOCATION OF INJURIES

EXTERNAL EXAMINATION

When combined with a site investigation, the external examination can provide further evidence as to which predator, if any, was responsible for the observed injuries or mortality. Prior to performing a necropsy, complete an external examination of the animal and take note of the location of any:

- Puncture marks
- Lacerations
- Scrapes on hide
- Feeding patterns

In the above photos, external examinations suggested: (1) feeding pattern characteristic of wolves, but site investigation and necropsy suggested no predator involvement in mortality; (2) scrape marks and puncture marks by wolves in left armpit; (3) scrape marks and puncture marks by wolves in groin area; (4) puncture marks to skull by grizzly bear; and (5) puncture marks to back of neck by cougar.

LIVESTOCK INJURY AND MORTALITY INVESTIGATIONS
DESCRIPTION AND LOCATION OF INJURIES

NECROPSY

The purpose of the necropsy is to examine the hide and underlying tissues of a carcass for damage that may or may not have been inflicted when the animal was still alive. Large predators can bite with a tremendous amount of force so damage and trauma associated with each bite can be quite severe. If the animal was still alive when an attack occurred, there will most likely be evidence on the hide itself, hemorrhaging (or bruising) underneath the hide, and damage to underlying muscle and tissue.

When conducting a necropsy, **please remember to skin the entire carcass** rather than those specific areas where predators are most likely to have attacked the animal. Although large predator species have similar methods of attack, there can be, and often is, considerable variation in the location of injuries. Also, it is possible that damage may be missed if the entire carcass is not skinned because injuries are not always apparent on the outside of the hide, but become very apparent once the hide is peeled back.




PHOTOGRAPHING TIP: When photographing injuries/damage to livestock, close-up images are not necessarily the best since they give little reference as to where the injury/damage was located on the animal. Photos should be taken far enough away where a lay person could have some idea of where the injuries occurred. If close-ups are necessary, take a wide angle view for reference before taking that close-up photograph.

LIVESTOCK INJURY AND MORTALITY INVESTIGATIONS
DESCRIPTION AND LOCATION OF INJURIES

SCAVENGING VERSUS PREDATION

Did the feeding occur before or after? Wolves, coyotes, dogs, cougars, bobcats, and bears all take advantage of scavenging opportunities	
Evidence of Scavenging	**Evidence of Predation**
There may be no blood on the ground around the carcass or blood may have drained onto the ground from body openings such as the mouth, nose, anus, or areas where feeding has already occurred. After skinning the carcass, no hemorrhaging or corresponding tissue damage was apparent.	There may be blood on the ground around the carcass or in the area surrounding the incident site suggesting the animal bled and was alive when attacked. A blood trail and/or sign of a struggle may also be present. After skinning the carcass, hemorrhaging and tissue damage was apparent.
Lacerations and puncture marks found on the exterior of the hide do not show corresponding hemorrhaging and/or tissue damage when the hide was peeled back.	Lacerations and puncture marks found on the exterior of the hide show corresponding hemorrhaging and/or tissue damage when the hide was peeled back.
Evidence of predators may be found around the carcass (i.e., tracks, scat, hair), but these alone cannot be used to make a determination.	Evidence of predators may be found around the carcass (i.e., tracks, scat, hair), but these alone cannot be used to make a determination.

BEWARE OF LIVIDITY!

What is lividity? Lividity is the process by which the body's blood supply stops circulating once the heart stops beating. As a result of gravity, blood will settle to a low point depending on how the carcass is situated.

How to tell the difference between lividity and hemorrhaging? Note which side is down, complete an external examination on both sides of the carcass, then perform a necropsy by skinning the entire carcass. If you notice an area that looks similar to a hemorrhage, examine the corresponding portion of hide once again and make several cuts into the underlying muscle. If it is lividity, there may be no marks on the hide and the underlying muscle may not be damaged. If it is hemorrhaging, you may notice bite marks or scrapes that you missed previously and the underlying muscle may also show corresponding damage.

In these photos, the carcass was lying on the left side. No puncture marks or scrapes were evident on the hide. After the necropsy, a dark red spot was evident in a location typical of a wolf attack. After re-examining the hide and cutting into the muscle, there were no marks on the hide and the muscle was undamaged. Although evidence suggested wolves visited this carcass, it was determined they were not responsible for its death and the red spot was most likely caused by lividity.

LIVESTOCK INJURY AND MORTALITY INVESTIGATIONS

DESCRIPTION AND LOCATION OF INJURIES

WHAT TO DO IF YOU INVESTIGATE SOMETHING LIKE THIS?

Although most livestock producers keep a watchful eye on their livestock, some injuries and mortalities may not be found for quite some time. In these situations, there often may not be much an investigator can do because of the condition of the carcass. However, because attack patterns and feeding characteristics oftentimes differ, there may be a few things an investigator can do if the hide appears to be relatively intact.

- Complete a full site investigation
- If the hide is pliable, stretch it out and examine it for puncture marks and/or lacerations in locations typical of a predator attack
- If the hide is dried out, the investigator might consider soaking the hide in water overnight and examining it the following day

Sometimes, even after a thorough investigation, there may not be enough evidence present to make a determination. In these cases, the term “I don’t know” is a perfectly acceptable response.

LIVESTOCK INJURY AND MORTALITY INVESTIGATIONS
DESCRIPTION AND LOCATION OF INJURIES

OTHER INJURY CONSIDERATIONS

In any given year, livestock die for a variety of reasons unrelated to predation. Nationwide, cattle and calf losses from predators represented 5.5% of the total deaths from all causes in 2010 (U.S. Department of Agriculture [USDA] 2011a). When the states of Idaho, Montana, Oregon, Washington, and Wyoming were examined separately, predation accounted for approximately 6.7% of total cattle and calf losses in 2010 (USDA 2011a). Although certain producers can experience significant losses due to predators, these results underscore the importance of taking into consideration a multitude of other possible factors that may have contributed to the injury or mortality when conducting a livestock depredation investigation.

Use caution: generally predators do not inflict injuries in an area like this on a horse because the risk of injury is high; this was a structural injury from an enclosure.

Although these injuries appear to have been made by a predator, birds fed on this lamb after it died.

Use caution: this lamb died as a result of being trampled in an enclosure.

Please remember, as the investigator, we are called to a site to investigate a possible livestock injury or mortality because the reporting party suspected that a large predator may have been involved. If it was determined that no large predators were involved, **use extreme caution** when drawing inferences about what happened beyond predator involvement unless the full investigation leads you to an obvious conclusion.

References used for this page and suggested references for further information on this topic:

1) U.S. Department of Agriculture. 2011a. Cattle death loss. U.S. Department of Agriculture, Animal Plant Health Inspection Service, Veterinary Services. Fort Collins, Colorado, USA. http://usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do?documentID=1625.
2) U.S. Department of Agriculture. 2011b. Cattle and calves nonpredator death loss in the United States, 2010. USDA–APHIS–VS–CEAH. Fort Collins, Colorado, USA. #631.1111.
3) U.S. Fish and Wildlife Service, Idaho Department of Fish and Game, Montana Fish, Wildlife & Parks, Nez Perce Tribe, National Park Service, Blackfeet Nation, Confederated Salish and Kootenai Tribes, Wind River Tribes, Washington Department of Fish and Wildlife, Oregon Department of Fish and Wildlife, Utah Department of Natural Resources, and USDA Wildlife Services. 2012. Northern Rocky Mountain Wolf Recovery Program 2011 Interagency Annual Report. M.D. Jimenez and S.A. Becker, eds. USFWS, Ecological Services, Helena, Montana, USA. http://westerngraywolf.fws.gov.

Washington Department of FISH and WILDLIFE

LIVESTOCK INJURY AND MORTALITY INVESTIGATIONS

SOURCE OF INJURIES

WOUNDS PRIMARILY ON UPPER FRONT HALF OF CARCASS

- Little to no evidence of chase
- Evidence carcass may have been dragged or carried some distance from kill site
- Carcass may be covered with debris
- Carcass remains concentrated in single location or very small area

BEARS

- Bites along spine between shoulder blades and/or to the head or neck
- Possible lacerations from claws to chest and shoulders
- Hide inverted and may be pulled over skull (older carcass)

GRIZZLY BEAR

- Generally more open habitats
- Tracks and hair found in area

BLACK BEAR

- Generally denser habitats
- Tracks and hair found in area

CATS

- Bite to the head, neck, throat, or skull
- Knife-like lacerations to sides, back, and/or shoulders
- Hair removed by sheering or plucking
- "Clean-cut" edges where feeding
- Rumen removed intact

COUGAR

- Long scrape marks (≥ 24")
- Tracks and other sign in area

BOBCAT

- Short scrape marks (≤ 16")
- Tracks and other sign in area

WOUNDS PRIMARILY ON BACK HALF OF CARCASS

- Most obvious severe wounds may be concentrated around the hindquarters
- Wounds may also be observed on front half of carcass (i.e., armpit, throat)
- Evidence of chase and struggle
- Ragged or frayed wounds and lacerations
- Consumption of carcass at or very near kill site; rumen often busted open
- Carcass remains scattered around kill site (older carcass)

WOLF

- Damaged or missing tail
- Large bones cracked open and marrow consumed (older)
- Calves and sheep more than larger livestock
- Tracks and other sign in area

COYOTE

- Often reposition bite to throat (multiple bites)
- Smaller bones broken and chewed (older)
- Small prey and calves shortly after birth
- Tracks and other sign in area

DOG

- Relatively indiscriminate in attack location
- Bites may be repositioned multiple times (inefficient killers)
- Seldom feed on carcass
- Tracks and other sign in area

Predation chart to assist investigators in the assessment of possible predator involvement during a livestock depredation investigation. *This figure should be used for general reference only and should not replace a complete site investigation and field necropsy to determine cause of injury or mortality.*

LIVESTOCK INJURY AND MORTALITY INVESTIGATIONS

INJURY/MORTALITY CLASSIFICATION

WDFW Criteria for Classification of Reported Wolf Depredation Incidents

1) **Confirmed Wolf Depredation:** There is reasonable physical evidence that the dead or injured animal was actually attacked or killed by a wolf. Primary confirmation would ordinarily be the presence of bite marks and associated subcutaneous hemorrhaging and tissue damage, indicating that the attack occurred while the victim was alive, as opposed to simply feeding on an already dead animal. Spacing between canine tooth punctures, feeding pattern on the carcass, fresh tracks, scat, hairs rubbed off on fences or brush, and/or eyewitness accounts of the attack may help identify the specific species or individual responsible for the depredation. Predation might also be confirmed in the absence of bite marks and associated hemorrhaging (i.e., if much of the carcass has already been consumed by the predator or scavengers) if there is other physical evidence to confirm predation on the live animal. This might include evidence of an attack or struggle. There may also be nearby remains of other victims for which there is still sufficient evidence to confirm predation, allowing reasonable inference of confirmed predation on an animal that has been largely consumed.

2) **Probable Wolf Depredation:** There is sufficient evidence to suggest that the cause of death was depredation, but not enough to clearly confirm that the depredation was caused by a wolf. A number of other factors will help in reaching a conclusion, such as (1) any recently confirmed predation by wolves in the same or nearby area, and (2) any evidence (e.g., telemetry monitoring data, sightings, howling, fresh tracks, etc.) to suggest that wolves may have been in the area when the depredation occurred. All of these factors and possibly others would be considered in the investigator's best professional judgment.

3) **Confirmed Non-Wild Wolf Depredation:** There is clear evidence that the depredation was caused by another species (coyote, black bear, cougar, bobcat, domestic dog), a wolf-dog hybrid, or a pet wolf.

4) **Unconfirmed Depredation:** Any depredation where the predator responsible cannot be determined.

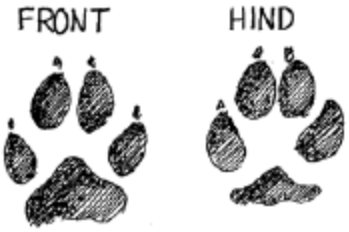
5) **Non-Depredation:** There is clear evidence that the animal died from or was injured by something other than a predator (e.g., disease, inclement weather, or poisonous plants). This determination may be made even in instances where the carcass was subsequently scavenged by wolves.

6) **Unconfirmed Cause of Death:** There is no clear evidence as to what caused the death of the animal.

LIVESTOCK INJURY AND MORTALITY INVESTIGATIONS

PREDATOR "SIGNATURES"

WOLF



Track Dimensions
Approx. 4" wide by 4.5" long
(length = toe to heel pad)

Most common domestic prey

- Cattle (primarily calves and yearlings)
- Sheep
- Domestic dogs

Hunting strategy – coursing predator

- Individual or group hunter
- Hunts across a wide variety of habitats
- Potential for prolonged chase and attack
- Kills rarely moved from attack location

Common attack zones

- Hindquarters
- Groin region
- Tail
- Front armpits
- Throat

Severe hemorrhaging and damage with associated punctures and scrape marks to throat.

Notice the stripped tail, hemorrhaging in the hind quarters, and the damage under and behind the front legs

Attack characteristics – maiming

- May be extensive biting and trauma
- Most severe damage may be concentrated around the hindquarters
- Bites and damage may also be found in the armpits and throat
- May be damaged or missing tail
- Ragged or frayed wounds and lacerations

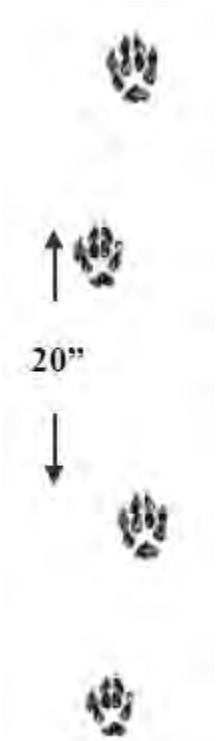
Feeding characteristics – messy

- Internal organs consumed first, then generally progresses from rear to head
- Rumen often busted open
- Consume carcass at or very near kill site
- Large bones cracked open and marrow consumed (older carcass)
- Prey remains spread across site (older carcass)

LIVESTOCK INJURY AND MORTALITY INVESTIGATIONS

PREDATOR "SIGNATURES"

COYOTE



Track Dimensions
Approx. 2.5" wide by 2.5" long
(length = toe to heel pad)

Most common domestic prey

- Sheep
- Goats
- Fowl
- Domestic pets
- Newborn calves

Hunting strategy – coursing predator

- Individual or group hunter
- Hunts across a wide variety of habitats
- Potential for prolonged chase and attack
- Kills rarely moved from attack location

Common attack zones

- Throat/neck
- Hindquarter/groin
- Flank
- Tail

Typical puncture wound caused by coyote. Inter-canine distances are highly variable among species so use caution.

Coyote canine punctures may be smaller in diameter than a wolf, but may be similar to dogs. Very difficult to obtain accurate measurements, so use caution.

Attack characteristics – maiming

- Typically attack at or near the throat
- May also be extensive biting and trauma to other parts of body including hindquarters and groin
- Crushed windpipe may be present
- Ragged or frayed wounds and lacerations

Feeding characteristics – messy

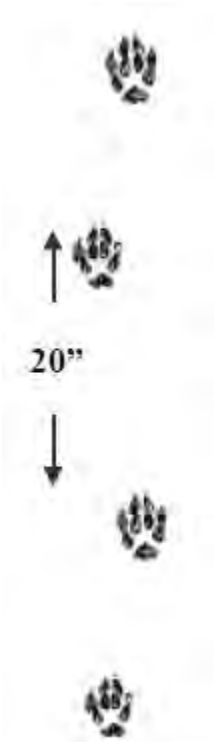
- Internal organs consumed first
- Rumen often busted open
- Consume carcass at or very near kill site
- Smaller bones broken and chewed
- Prey remains spread across site (older carcass)

LIVESTOCK INJURY AND MORTALITY INVESTIGATIONS

PREDATOR "SIGNATURES"

FERAL OR DOMESTIC CANINE

Track Dimensions (variable)
Approx. 3" wide by 3" long
(length = toe to heel pad)



Most common domestic prey

- Sheep
- Goats
- Fowl
- Domestic pets
- Newborn calves

Hunting strategy – coursing predator

- Individual or group hunter
- Hunts across a wide variety of habitats
- Potential for prolonged chase and attack
- Kills rarely moved from attack location

Common attack zones

- Face/nose
- Hindquarter/groin
- Throat/neck
- Flank
- Tail

Typical dog attack showing multiple injuries, but little feeding.

Dogs are rarely experienced enough to kill efficiently.

Attack characteristics – maiming

- Relatively indiscriminate in attack location
- Bites may be repositioned multiple times (inefficient killers)
- Widespread trauma due to multiple bites
- Ragged or frayed wounds and lacerations

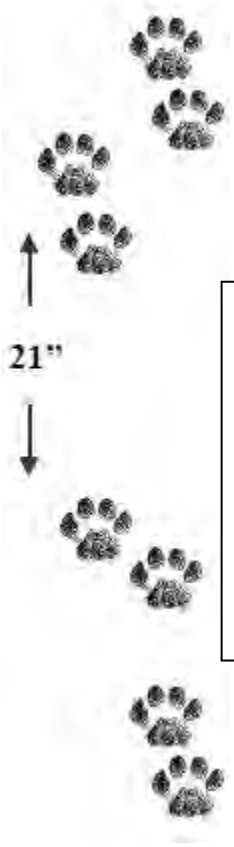
Feeding characteristics – messy

- Seldom feed on carcass
- If feeding occurred, carcass may be at or very near kill site
- Feeding on carcass may leave ragged tissue or splintered bone

LIVESTOCK INJURY AND MORTALITY INVESTIGATIONS

PREDATOR "SIGNATURES"

COUGAR



FRONT HIND

Track Dimensions
Approx. 3.5" wide by 3.5" long
(length = toe pad to heel pad)

Most common domestic prey

- Goats
- Sheep
- Llamas and alpacas
- Fowl
- Domestic pets

Hunting strategy – stalking predator

- Individual hunter (except a female with yearlings)
- Requires cover (e.g., understory vegetation, topography, trees)
- Attacks occur over limited distance with little or no chase
- Kills may be drug or carried considerable distance to an area of cover

Common attack zones

- Neck
- Throat
- Head
- Shoulder


Canine punctures on throat (may not be this obvious)


Typical felid "cache" where remains are neatly covered up with debris.


Cougars feed in a predictable pattern. The organs are part of the first feeding.

Attack characteristics – clean, efficient

- Crushed neck, windpipe, skull (occasionally the rostrum)
- Punctures and lacerations to neck and head
- Knife-like wounds and lacerations with very clean edges (all claws may not register)
- Limited repositioning during attack
- Caching of kill

Feeding characteristics – efficient, tidy

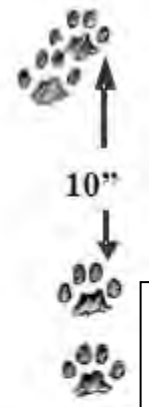
- Hair removed by sheering or plucking
- Entry behind shoulder or just behind ribs
- Internal organs consumed first (heart, liver, lungs)
- Muscle tissue consumed secondarily
- Feeding activity and prey remains concentrated at a single location

LIVESTOCK INJURY AND MORTALITY INVESTIGATIONS

PREDATOR "SIGNATURES"

BOBCAT

Track Dimensions
Approx. 2" wide by 2" long
(length = toe pad to heel pad)



Most common domestic prey

- Goats
- Sheep
- Fowl
- Domestic pets

Hunting strategy – stalking predator

- Individual hunter (except female with yearlings)
- Requires cover (e.g., understory vegetation, topography, trees)
- Attacks occur over limited distance with little or no chase
- Small prey may be drug or carried away from attack location

Common attack zones

- Neck
- Throat
- Head
- Shoulder

The scratching below to cover up a carcass (cache behavior) is typical of bobcats and cougars. Size will dictate which feline it is.

Bobcat (and cougar) feeding pattern; chest is opened cleanly, hair is plucked clean from hide, and organs are exposed and eaten first.

Attack characteristics – clean, efficient

- Crushed neck, windpipe, skull, or rostrum with associated trauma
- Knife-like wounds and lacerations with very clean edges (all claws may not register)
- Limited repositioning during attack
- Caching of kill

Feeding characteristics – efficient, tidy

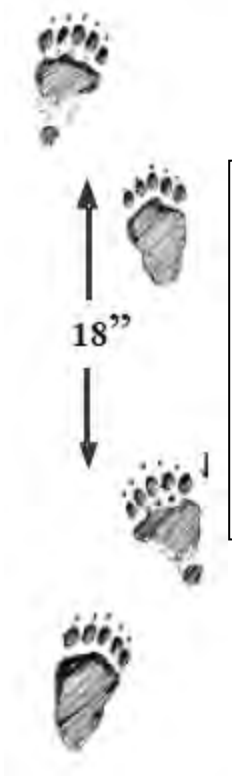
- Hair removed by sheering or plucking
- Entry behind shoulder or just behind ribs
- Internal organs consumed first (heart, liver, lungs)
- Muscle tissue consumed secondarily
- Feeding activity and prey remains concentrated at a single location

LIVESTOCK INJURY AND MORTALITY INVESTIGATIONS

PREDATOR "SIGNATURES"

BLACK BEAR

Track Dimensions (variable)
Front: 4" wide by 4.5" long
Hind: 3.5" wide by 7" long



Most common domestic prey

- Goats
- Sheep
- Calves

Hunting strategy – ambush predator

- Individual hunter
- Hunts across a variety of habitats, but generally prefers habitats with greater cover
- Chases typically occur over short distances
- Kills may be moved or carried away from attack location (especially if kill was made in open, it may be carried to area with more cover)

Common attack zones

- Back/spine
- Neck
- Skull

Severe hemorrhaging and tissue damage along spine.

Severe hemorrhaging and tissue damage along spine.

Attack characteristics – blunt force

- Bites to top of prey along spine
- Possible lacerations from claws to the chest and shoulder
- Skull or rostrum may have punctures or may be crushed
- Ragged or frayed wounds and lacerations

Feeding characteristics – messy

- Internal organs and soft tissues generally consumed first
- Rumen often busted open
- Hide inverted and may be pulled over skull (older carcass)
- Carcass may be covered with debris

LIVESTOCK INJURY AND MORTALITY INVESTIGATIONS

PREDATOR "SIGNATURES"

GRIZZLY BEAR

Track Dimensions (variable)
Front: 5" wide by 5.5" long
Hind: 6" wide by 10" long

Most common domestic prey

- Goats
- Sheep
- Calves

Hunting strategy – ambush predator

- Individual hunter
- Hunts across a variety of habitats, but generally prefers more open habitats
- Chases typically occur over short distances
- Kills may or may not be moved or carried away from attack location

Common attack zones

- Back/spine
- Neck
- Skull

Severe hemorrhaging and tissue damage along spine.

Punctures and skull fractures caused by bite to head.

Attack characteristics – blunt force

- Bites to top of prey along spine
- Possible lacerations from claws to the chest and shoulder
- Skull or rostrum may have punctures or may be crushed
- Ragged or frayed wounds and lacerations

Feeding characteristics – messy

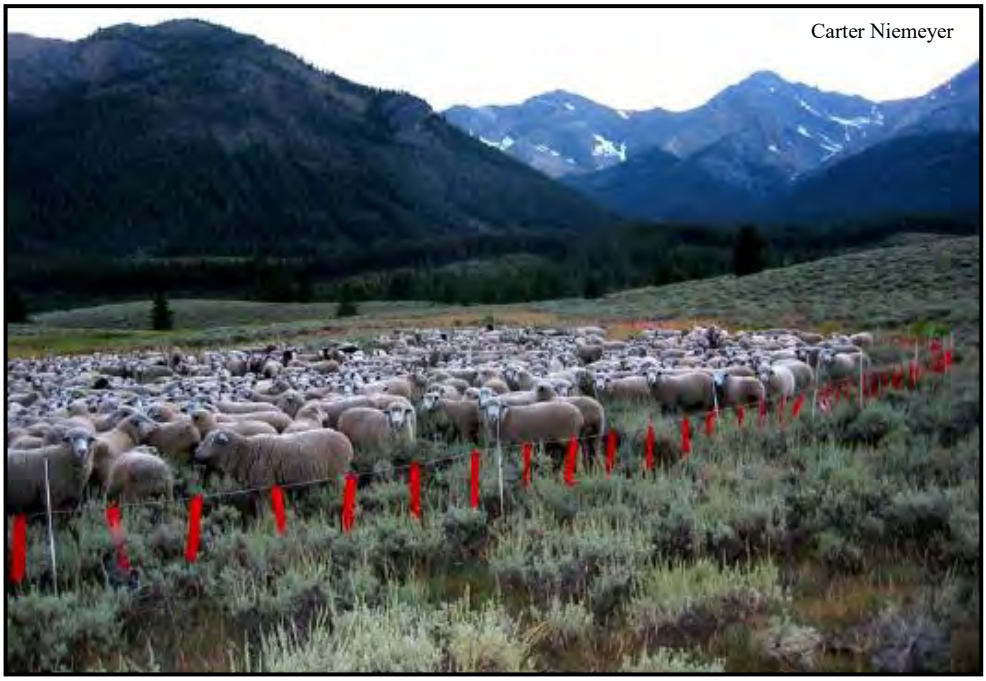
- Internal organs and soft tissues generally consumed first
- Rumen often busted open
- Hide inverted and may be pulled over skull (older carcass)
- Carcass may be covered with debris

Tethering goats and sheep and/or not boarding them at night may make them more vulnerable to predation.

Cleaning up bone piles and removing dead livestock is an easy technique to reduce possible predator attractants on the landscape.

Intentionally or unintentionally feeding ungulates has the potential to draw in large predators closer to developed areas and humans.

Human presence, in the form of range riders or a general increased monitoring of livestock, may deter predators from frequently using an area.



Fladry (above) and turbo-fladry (electrified fladry; below) may reduce the probability of livestock being attacked by predators. These techniques tend to work best during calving season and for night penning range livestock; however, they are not very useful in open range situations. A single person can carry and install ½ mile of fencing in less than 2 hours.

APPENDIX 1
WDFW LIVESTOCK INJURY/MORTALITY INVESTIGATION FORM

Database record #: _____

CODY reference #: _____ Date report received: _____ Date investigated: _____

WDFW personnel (include detachment/unit #): _____

Witnesses present (other agency personnel, public): _____

_____

Livestock owner/Ranch name: _____

Contact information (address, phone #): _____

Summarize initial report (witness accounts, when livestock was found, when livestock last seen uninjured/alive, etc.): _____

_____

_____

Location of incident (physical land description, drainage, nearby features, etc.): _____

_____

Incident GPS coordinates (Circle one: Lat/Long or UTM with zone): _____

Datum: _____ GPS coordinates are (check one): ☐ Actual ☐ Approximate

Land status (check one): ☐ USFS ☐ BLM ☐ State ☐ Private ☐ Other _____

Type of pasture/enclosure incident occurred in (i.e., est. size, fence type used, etc.) and estimated distance to nearest occupied structure (i.e., house, barn, other)? Please describe: _____

_____

_____

General cover classification: ☐ Open/Rangeland ☐ Brush ☐ Lightly forested ☐ Heavily forested

Are attractants present near location of incident (i.e., bones, other carcasses, trash, fruit trees, grain/feed, etc.)? Please describe: __

_____

_____

Affected animals: _____ Adult sheep _____ Cattle & yrlgs _____ Horse _____ Dog
(# and sex) _____ Lambs _____ Calves _____ Foal/Pony _____ Other (_____)

Status of animal (# and sex): _____ Injured _____ Dead

Site description/physical evidence present (i.e., describe scene, tracks, scat, hair, blood, sign of struggle, scrapes, moved from incident site, etc.): _____

_____

_____

_____

_____

WDFW LIVESTOCK INJURY/MORTALITY INVESTIGATION FORM

Description and location of injuries (i.e., puncture marks, lacerations, feeding patterns, evidence of hemorrhaging, tissue damage, estimated age of injuries, etc.): _____

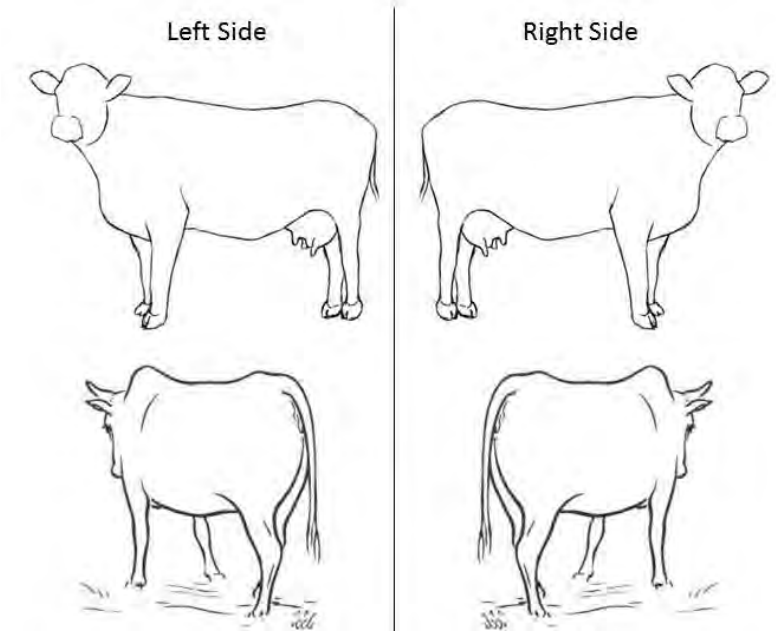
_____

_____

_____

_____

_____



On the above figure, please note the general location of observed injuries described in the "Description and location of injuries" section above. Detailed sketches are not necessary.

Source of injuries: ☐ Black bear ☐ Cougar ☐ Wolf ☐ Dom canine ☐ Structural ☐ Unknown
(check one) ☐ Grizzly bear ☐ Bobcat ☐ Coyote ☐ Unk predator ☐ Other _____

Injury/mortality classification (circle one; refer to manual for description of each): 1 2 3 4 5 6

Classification justification: _____

_____

_____

_____

Additional comments or notes (other information to support determination, telemetry, confirmed sightings, previous history, etc.): _____

_____

_____

_____

If this is a potential wolf depredation then complete and attach the Livestock-Wolf Preventative Measures Checklist

APPENDIX 2
SAMPLE WDFW LIVESTOCK INJURY/MORTALITY INVESTIGATION FORM

Database record #: _(will be filled out later)_____

CODY reference #: _WA-13-123456__ Date report received: _6/13/13___ Date investigated: 6/13/13 _____

WDFW personnel (include detachment/unit #): Officer John Doe (W123), Biologist Jane Doe (W456) _____

Witnesses present (other agency personnel, public): Cty Sheriff Billy Bob; Jim and Jane Dow _____

_____

Livestock owner/Ranch name: Jim and Jane Dow / Spotted X Ranch _____

Contact information (address, phone #): 123 Pine Street, Moses Lake, WA 99988; 509-123-4567 _____

Summarize initial report (witness accounts, when livestock was found, when livestock last seen uninjured/alive, etc.): RP reported they found 4 dead calves and 2 injured calves this morning (6/13/13). Animals last observed 2 days ago and were in good health. Could not discern injuries, but animals were partially consumed. RP reported he observed wolf and bear tracks near remains. _____

Location of incident (physical land description, drainage, nearby features, etc.): Big Creek, Wenatchee National Forest _____

_____

Incident GPS coordinates (Circle one: Lat/Long or UTM with zone): 123456 x 1234567 z11 _____

Datum: NAD83 GPS coordinates are (check one): ☐ Actual ☐ Approximate

Land status (check one): ☐ USFS ☐ BLM ☐ State ☐ Private ☐ Other _____

Type of pasture/enclosure incident occurred in (i.e., est. size, fence type used, etc.) and estimated distance to nearest occupied structure (i.e., house, barn, other)? Please describe: grazing allotment; no nearby structures _____

_____

General cover classification: ☐ Open/Rangeland ☐ Brush ☐ Lightly forested ☐ Heavily forested

Are attractants present near location of incident (i.e., bones, other carcasses, trash, fruit trees, grain/feed, etc.)? Please describe: __

Uncovered bone pile approx 2 miles north of incident site; apple trees very common throughout allotment _____

_____

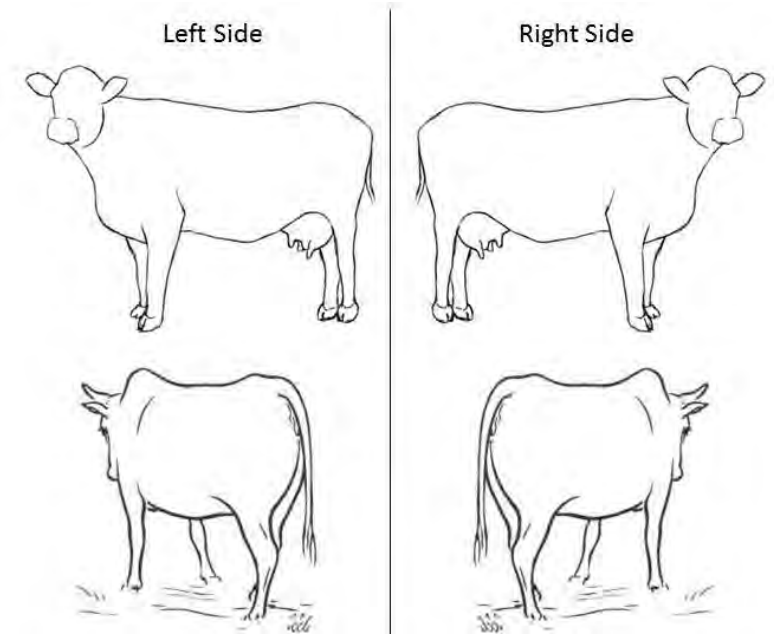
Affected animals: _____ Adult sheep _____ Cattle & yrlgs _____ Horse _____ Dog
(# and sex) _____ Lambs _2f/4m_ Calves _____ Foal/Pony _____ Other (_____)

Status of animal (# and sex): _2m____ Injured _2f/2m____ Dead

Site description/physical evidence present (i.e., describe scene, tracks, scat, hair, blood, sign of struggle, scrapes, moved from incident site, etc.): a clear struggle was evident with spilled blood on ground and sprayed blood on nearby trees, some tree branches were broken and the ground was torn up; carcasses appear to have been drug under a tree approx 150 yds south of where blood was found and were partially covered with ground debris, wolf tracks and black bear tracks were observed; numerous large hominid tracks measuring approximately 18" in length also located near remains; black bear hair found on trees; numerous scats located, but few have any form _____

SAMPLE WDFW LIVESTOCK INJURY/MORTALITY INVESTIGATION FORM

Description and location of injuries (i.e., puncture marks, lacerations, feeding patterns, evidence of hemorrhaging, tissue damage, estimated age of injuries, etc.): Estimated time of death was approx 6/12/13; all remains exhibited similar injuries; internal organs and some muscle tissue on hind legs consumed; puncture marks along spine between shoulder blades with associated hemorrhaging and severe tissue damage; some scrapes marks and associated minor hemorrhaging on left shoulder_



On the above figure, please note the general location of observed injuries described in the "Description and location of injuries" section above. Detailed sketches are not necessary.

Source of injuries: ☐ Black bear ☐ Cougar ☐ Wolf ☐ Dom canine ☐ Structural ☐ Unknown
(check one) ☐ Grizzly bear ☐ Bobcat ☐ Coyote ☐ Unk predator ☐ Other _____

Injury/mortality classification (circle one; refer to manual for description of each): 1 2 **3** 4 5 6

Classification justification: Physical evidence present on carcasses and surrounding area are consistent with predation by a black bear _____

Additional comments or notes (other information to support determination, telemetry, confirmed sightings, previous history, etc.): RP stated he observed a large black bear chasing cattle on the allotment on 6/9/13; black bears are observed in area nearly every day, most feed on the numerous apple trees in area; RP stated he has lost calves to black bears on several occasions in the past _____

If this is a potential wolf depredation then complete and attach the Livestock-Wolf Preventative Measures Checklist

APPENDIX 3

DISTRICT 1 NECROPSY EQUIPMENT LIST

Inside a sealed 5 gallon bucket and/or tool bag:

- Procedures for Investigation of Livestock Injuries and Depredation Form in zip lock
- Wyoming skinning knife w/ extra blade
- Ruler/tape measurer
- Electric clippers
- Rite in Rain note pad/pencils
- Fladry: either commercial or wire/flagging to encircle carcasses
- 6 by 8 ft. grommeted tarp
- Twine or -p-cord with lead weights to hold tarp down, make fladry
- Smaller bucket for covering tracks, scat in bad weather
- Disposable exam gloves and anti-bacterial wipes/liquid hand sanitizer
- LE evidence envelopes
- Coin envelopes for DNA (hair)
- 1 gallon zip locks for bones, scat, etc…
- Plastic tubes such as used for lymph nodes for other evidence
- Small plastic tubes with alcohol for tissue samples (such as used for cougar DNA)
- Flagging
- Rope
- Extra mechanical pencils/clipboard

Other equipment to bring that may not stay in kits:

- Digital camera (w/batteries)
- GPS (w/batteries)
- Flashlight and/or headlamp (w/batteries)

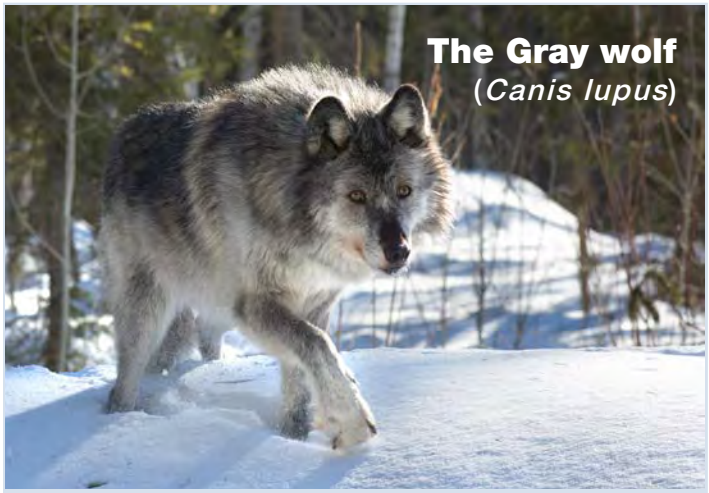
Wolves and People

Myths and stories have been told throughout history about wolves. While some have been positive, such as early societies admiring wolves, other stories have encouraged people to be fearful of these animals. Livestock depredation is one such example, which has led to negative relationships between wolves and people across Canada, the United States, Mexico, and most of Europe. Normally, wolves are wary of people and will generally keep their distance and stay hidden. This situation is healthy for both the wolves and people. However, wolves that are fed by people (i.e. improperly stored garbage, carcasses, etc.) may become food conditioned, and a serious safety problem whether at your home, campsite or workplace.

Be WolfSmart to avoid conflicts when hiking, camping, hunting or fishing, etc.

Reducing and preventing conflicts between wolves and people can be achieved by being WolfSmart. This includes:

- Removing and properly storing attractants such as deer, elk, and fish carcasses when hunting or fishing, other food sources and garbage.
- Never feed wolves. These are wild animals and not pets.
- Never toss food from a vehicle toward wildlife alongside roads. You are placing other drivers at risk and nearby workers at camps. Conditioning wildlife to look for food near homes, campsites or worksites is dangerous.



The Gray wolf
(*Canis lupus*)

The Gray wolf (*Canis lupus*) is an intelligent and resourceful predator found throughout Alberta's foot-hills, mountains and boreal forest regions. It is the largest member of the wild dog species (*Canis*) and can weigh up to 60+ kgs. Typical prey includes moose, elk, deer, bison and smaller animals like beaver or hare. Gray wolves typically hunt at night as a pack, which can range from 2 to 20 or more wolves. Mating takes place between February and March and the birth of pups (usually 4 to 7 in a litter) occurs by June. Populations in Alberta are considered stable.

- Always watch for signs of possible wolf activity on your property and on trails: such as dead animals, scat and tracks.

If a wolf approches within100 meters, growls or snarls...

- Show the wolf you are not easy prey—make yourself look bigger by waving your arms over your head.
- Gather children and others close to form one large body.
- Always leave the wolf an escape route—never try to corner it.
- Back away slowly, looking for a safe place (e.g. vehicle, cabin, etc.).
- Never turn your back to a wolf. Carry and use bear spray if wolves are frequently seen in an area. This is also advantageous for other wildlife species (i.e. bears, cougars).
- Make lots of noise and throw rocks, sticks or other objects if the wolf approaches.

Wolves can be hunted or trapped in Alberta, subject to provincial regulations. Further information is available at **MyWildAlberta.com**

Report wolf encounters by calling local Fish and Wildlife at 310-000.

If after regular business hours, use the Report A Poacher line at 1-800-642-3800.

The Gray wolf (*Canis lupus*)

The **Gray wolf** (*Canis lupus*) is an intelligent and resourceful predator found throughout Alberta's foothills, mountains and boreal forest. It is the largest member of the wild dog species (*Canis*) and can weigh up to **60+ kgs**. Typical prey includes moose, elk, deer, bison and smaller animals. They typically hunt at night as a pack, which can range from 2 - 20+ wolves. Populations in Alberta are considered stable.

Wolves and People

Myths and stories have been told throughout history about wolves. While some have been positive many have negatively portrayed wolves, often as a result of conflict with people. Livestock depredation is one such example. Normally, wolves are wary of people and will generally keep their distance and stay hidden. However, wolves that have been directly or indirectly fed by people (i.e. garbage, carcasses, etc.) and become food conditioned, or have learned to hunt livestock, are more likely to become problematic and pose livelihood and safety risks.

Be WolfSmart and adopt best management practices on your farm!

Reducing and preventing conflict between wolves, people and livestock can be achieved by being ***WolfSmart.*** Best management practices include:

- Removing and properly storing attractants such as dead carcasses, other food sources and garbage.
- Plan your breeding season, as the scent of birthing mothers and new born calves are strong attractants for wolves. Also remove afterbirth or still borns, and time castration and branding so calves can heal, thereby reducing smells, before they are released into pastures.
- Use defined storage areas at least 200m from calving or feeding areas to reduce hiding cover. Also, plan your pasture sites, avoiding areas of thick vegetation, creek beds, etc.
- Using pens, electric fencing, or guard dogs (e.g. Anatolians or Great Pyrenees) for livestock. Also increase the routine presence of people checking on livestock, at various hours.
- Using hazing or scaring devices, such as fladry, strobe lights, or sirens to scare wolves away or alert people. Fladry combined with electric fencing has been particularly effective—use a series of bright cloth flags (red or orange) tied at 18-inch intervals on fencing to deter wolves.

Some resources that may be helpful include:

http://www.watertonbiosphere.com/projects/carnivores-communities/

http://www.ablamb.ca/images/documents/management-modules/Predation-Management.pdf

https://www.bcac.bc.ca/sites/bcac.localhost/files/WPLP%20Best%20Management%20Practices%20for%20Cattle.pdf

http://www.albertatrappers.com/

Wolves can also be hunted or trapped in Alberta, subject to provincial regulations.

Further information is available at MyWildAlberta.com

If a wolf approaches, growls or snarls:

- Show the wolf you are not easy prey—make yourself look bigger by waving your arms, and gather children or others close to form one large body.
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- Carry and use **bear spray**. This is also advantageous for other species (i.e. bears, cougars).
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Report wolf encounters by calling local Fish and Wildlife at 310-000. After regular business hours use the Report A Poacher line at 1-800-642-3800.

Alberta Environment and Parks

Fact Sheet 1:

Introduction to Washington's Wolves, Wolf Behavior, and Non-lethal Wolf Deterrent Methods

Gray wolves are returning naturally to Washington State. Washington's wolves have dispersed from neighboring Canada and Idaho where wolf populations are established, and are beginning to reproduce here in Washington as well. Currently, wolves are protected throughout Washington as an endangered species under Washington State law. In the western 2/3rds of the State, wolves are also protected under the Federal Endangered Species Act. For these reasons, lethal control of gray wolves is seldom allowed and only under very narrow circumstances. This requires approval and investigation by Washington Department of Fish and Wildlife, (WDFW) the agency charged with managing and protecting wolves in Washington. Where wolves are still federally protected, US Fish and Wildlife Service is the responsible agency. Nonlethal methods that can help to avoid conflict with wolves are required to be in place before livestock producers are eligible for compensation from WDFW for verified livestock depredation by wolves.

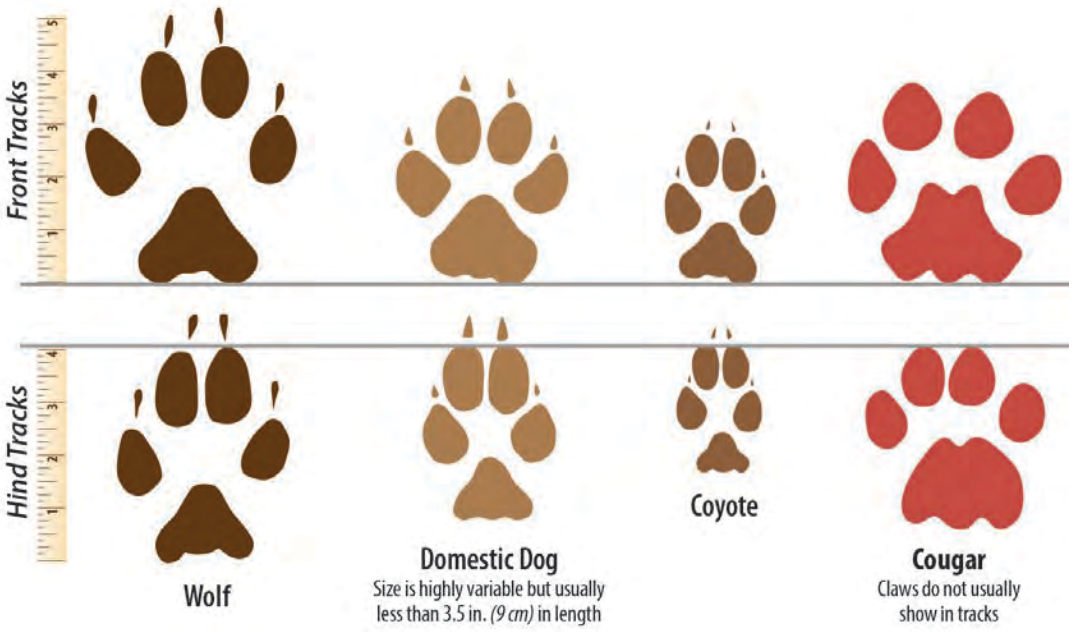
Livestock producers living and working in areas where wolves may be present can utilize a variety of nonlethal wolf deterrence tools. Not all methods work in all circumstances, and many of these tools have a temporary effect on deterring wolves from approaching livestock. This series of fact sheets has been prepared to help with the evaluation and selection of the best solutions, along with frequently changing the approach, to provide the most long-lasting effects. First, a basic understanding of wolf behavior will help determine the best methods for a given situation.

Basic Wolf Ecology and Behavior

Wolves are highly intelligent, naturally cooperative hunters. Wolves have an inborn sensitivity that helps them detect and target the most vulnerable prey: the young, weak, injured, old or unwary. Wolves know that every hunt involves a risk of injury or death for themselves or pack mates. They need to target prey that provides the most calories for the least amount of risk and energy expended. Wolves prey primarily on deer, elk and smaller mammals and birds. Occasionally livestock become prey, particularly if wolves don't detect the presence of humans, and where pastures are shared with native ungulates. Wolves are also scavengers that readily feed on dead animals. The smell of a decomposing carcass can attract wolves and other carnivores to the area from some distance.

Curious by nature and wary of humans, wolves are intelligent and learn quickly to adapt to changed or new situations. Although they may be seen in the open, they rarely approach humans, but will observe humans and even follow them, particularly if humans are near a den or rendezvous site. The rendezvous site is a protected, partially open area, where pups are taken when they are old enough to leave the den, and where they may begin to practice hunting behaviors. There is almost always at least one adult present at the rendezvous site keeping watch over the pups until they are old enough to travel and hunt with the pack. Wolves may be particularly aggressive to herding or guardian dogs, viewed as canine competitors, near these areas.

Identifying Wolf Sign:



Wolf Tracks:

— Long, rather than wide, (4-5" long by 3–4.5" wide).

— 4-toed, with a triangular main pad, and claw marks.. 18–25" in stride, the distance between tracks of the same foot.

— Coyote tracks are similar, but much smaller and more rounded.

— Cougar tracks are 4-toed, round rather than oval, and lack claw marks in most cases.

Wolf Scat:

— Wolves produce scats composed of hair, bone fragments, and other signs of their carnivorous diet.
— Coyote scats are often smaller than wolf scats and typically contain small mammal remains, berries, or insects. There can be some overlap in contents and appearance.
— Dog scats are generally more uniform in texture and shape without noticeable hair or bone fragments.
— Cougar scats (roughly large dog-sized) are dense and segmented, and usually covered with loose soil.

Wolf Howls:

— Wolves howl in long and low tones, deep and mournful, with sustained pitch, long and low tones without yipping (except pups). Pups minus adults can sound similar to coyotes.

— Wolves seldom bark, but they do practice "bark howling" when they become alarmed.

Fact Sheet 2:

Assessing Livestock Operations and Choosing Best Methods for Avoiding Conflicts with Wolves

With the recent re-establishment of gray wolf populations in Washington State, many livestock producers are looking for additional tools they can use to avoid conflicts between livestock and wolves. In order to choose the best tools, first assess the livestock operation and the terrain and find out what is known about the presence of wolf packs and their habits in the area. WDFW or local Tribal governments will have information on the presence of wolves and wolf packs. Research has shown that developing a site-specific management plan is the single most important action a producer can take to avoid conflicts with wolves.

Location and Terrain

Large herds of livestock turned out on sizeable grazing allotments that include many acres of rugged terrain are the most difficult to protect from all types of predators. Carcass management alone can be a dilemma on remote grazing sites. It is more difficult for herders, range riders, and livestock managers to spot potential conflicts before they occur. Depending on where livestock are located, range-riders or herders may need to make more frequent livestock checks in areas known to be used by wolves. More herding and/or livestock guardian dogs may be needed. On the other hand, livestock kept behind fences near people or buildings derive protection from the proximity of human activity, especially during critical calving and lambing times, and are far less likely to fall prey to wolves and other predators.

Type, Age and Number of Livestock

Research has shown that when wolves attack livestock, they focus on the animals that are easiest to kill, like sheep, goats and calves, or yearlings as well as injured or sick animals. Wolves are far less likely to attack healthy adult cattle and horses. Some cattle breeds are more capable of fending off predators. Breeds like Texas Longhorn, Brahmans crossed with Angus and Herefords producing the breeds of Brangus and Brafords *(top)* and Scottish Highland cattle *(bottom)* all exhibit a strong blend of mothering skills and aggression to predators. Some Washington State producers operating in wolf country have made the decision to switch livestock breeds for these reasons.

Human Presence and Vigilance

Loss of livestock to wolves can occur when a rancher is unaware of a nearby wolf pack and allows his animals to be moved near to or adjoining areas frequently used by wolves. WDFW or Tribal governments may have location information from radio-collared wolves that

can help avoid wolf and livestock conflict. Wolves tend to be more active at dawn and dusk, so that is the most important time for range rider presence. Responding quickly by hazing wolves that approach or chase livestock will cause them to feel threatened and will help curtail further activity. Increased human vigilance will also allow ranchers and range riders to find sick, injured, or dead animals more readily and remove them as a potential predator attractant. Determinations of the cause of depredations are easier to make when carcasses or injuries are fresh. Contact WDFW for specific wolf pack locations and the possibility of entering into a voluntary agreement for the sharing of wolf collar location information.

Timing and Seasonality

Timing of livestock turnout is an important consideration in avoiding conflicts with wolves. Keeping cow/calf pairs off the range until the wolves' natural deer and elk prey have given birth can prevent the temptation for hungry wolves to pick off small calves. Check with WDFW biologists to determine local ungulate calving times. Waiting to turn out cow/calf pairs has the additional advantage of letting the calves gain strength, size and weight before turnout. Stronger, larger animals are more difficult to pursue and may represent more risk of injury or death to the wolf.

When livestock guardian dogs are being used for herd protection it is essential to avoid placing them near wolf den sites in spring when wolves are breeding and pupping. Wolves will aggressively defend their young from other canines including dogs, coyotes, or other wolves that are not members of their pack. Using livestock guardian dogs in these areas during this critical time of year could actually increase the likelihood of conflicts with wolves, and put the guardian dogs at risk. Some studies have shown that using guardian dogs at other times of the year in combination with sheepherders or range riders may greatly reduce livestock depredation. However, livestock guardian dogs need appropriate training and handling. **See Fact Sheet #__ Livestock Guardian Animals.**

Keeping Records

For any conflict avoidance plan to work over time, good record keeping is helpful. Such a tracking system could record:

- Date, time and location of nonlethal control measures
- Weather, terrain and vegetation cover
- The effectiveness of nonlethal control measures used
- Records of wolf sightings and behavior
- Wolf and livestock response to avoidance strategies
- Related observations of livestock and wolf behavior.

  (One Washington range rider noted that his horse usually detects when wolves are in the vicinity of the cattle herd before the humans.)

Tracking and analyzing the effectiveness of specific nonlethal control measures will help improve the effectiveness of preventative measures the following season.

Fact Sheet 3:

Range Riders, Herders and Increased Human Presence

The use of range riders or herders to provide watch over herds of livestock, and to watch for signs of wolves and other predators, is one of the most effective methods for avoiding predator conflicts, particularly with wolves. Wolves are naturally wary of humans and will usually avoid livestock when humans are nearby. Herders or range-riders can also use noise, lights and motion to haze away any wolves that do approach livestock. Unlike cowboys of days gone by, range riders of today may perform their jobs using a variety of transportation methods: horseback, truck, ATV, or dirt bike/motorcycle. Tools they rely on include cell phones, computers, and radio-collar location information to keep cattle or sheep from venturing into areas where wolves are known to be present. Increased human activity provides an opportunity for better monitoring of livestock. Closer observation of the herd means that dead livestock can be more quickly located and removed, and sick or injured animals can be isolated and treated before becoming an attractant for wolves.

Choose an Experienced Range Rider or Herder

The most effective human presence is a seasoned range-rider who is constantly aware of his/her surroundings, is extremely familiar with the local terrain, and knows the characteristics of the livestock breed and behaviors. A good range-rider or herder has learned how to distinguish wolf signs from those of other predators and can assess conditions that may make livestock more vulnerable to wolves, avoiding these areas when possible.

Key Factors for Increasing Range Rider and Herder Effectiveness:

- Monitor the ranch or allotment regularly when wolves are most active, particularly at dawn and dusk.
- Pay particular attention to the behavior of horses and dogs. They are usually aware of wolf presence before humans can detect them.
- Record locations and wolf sign on a GPS device to help decide future grazing locations.
- Keep dogs close at hand in wolf country. Wolves may view dogs as rivals especially near a den or rendezvous site. Also, cattle may behave more aggressive towards dogs in wolf country.
- Be aware of the livestock's behavior. If they are unsettled, agitated, or seem alert and worried, wolves or other predators may be around. Watch for wolf tracks, scats, and hair by examining the ground.
- Consider modifying grazing practices. Bunch the cattle together and move them frequently. Livestock may need to "learn" this behavior through practice. It is more difficult for predators to isolate an animal from a tightly bunched herd than to pursue individual animals dispersed across the landscape.

Other Points to Consider:

— Range-riding alone may not be sufficient to prevent wolf and livestock conflict. It is hard for a range rider to be everywhere at once. Dogs and range-riders make good teams.

— Cattle and sheep require the most protecting at vulnerable times such as calving, lambing and early turnout.

— Temporary fencing with fladry or turbo as a second line of protection as well as noise deterrents could prove useful during these times.

Observing and Learning from Wolves

Range riders and herders have the unique opportunity to observe wolves first-hand and record their behavior and movements. Like humans, wolves prefer easy travel routes and will make use of paths, roadways, trails, lakeshores, ridges, and mountain passes to move through their territory. These are places a range rider is likely to find tracks and other sign, especially in soft ground or snow.

— Wolf tracks resemble those of a large dog, although tracks from the largest dogs, such as those used as livestock guard animals may actually be bigger than wolf tracks. *(See Fact Sheet 1)*

— Wolves must conserve their energy so they generally travel in straight lines leaving precise tracks. Domestic dog trails often exhibit back and forth movement and imprecise foot placement. Wolves howl to communicate among pack members.

Wolf Den and Rendezvous Site Characteristics:

— Wolves begin denning in March, and usually bear young in April. Until mid-June, sometimes into July, packs usually stay close to the den and hunt nearby. However, pack members may travel for miles to bring food to the den for pups. Range-riders need to be tuned-in to these seasonal considerations.

— Range-riders should be able to identify den and rendezvous sites, and avoid these areas when grazing livestock. A rendezvous site is a partial clearing where adults move the pups when they are old enough to leave the den but still need supervision. The rendezvous site is typically littered with chewed-on bones and sticks, and wolf hair is evident as well as disturbed patches of ground. The pups may use one area as the communal "toilet" where their scat can be found. It appears like adult scat, only smaller.

— Dens are often found on south-facing slopes, which are less snow-covered in late winter. They are usually located near a water source.

— Dens are usually excavated in the ground, sometimes by enlarging the den of another animal. Den openings are approximately 1' to 2' in diameter, with depth ranging from 5' to 20'. Wolves may also den in hollow logs, root masses, or rock caves.

— Numerous tracks and trails are usually visible around den sites, due to the traffic of pack members coming and going.

Fact Sheet 4:

Reducing Attractants, Carcass Management, and Composting

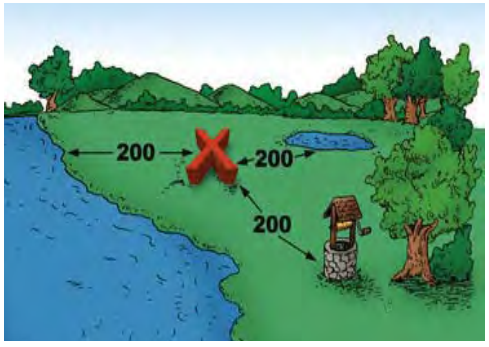
Ailing and injured livestock, afterbirth, blood from the birthing process, and livestock carcasses left on the range or near habitations can attract predators, including bears, coyotes, or wolves. Some research indicates that wolves that depredate livestock may have been attracted into the proximity of livestock in the first place by these attractants. By quickly removing them to a composting site, it may increase the likelihood that wolves and other predators will bypass livestock altogether. Traditional carcass disposal methods such as burial, rendering, and incineration, are becoming increasingly expensive. Composting is a solution to keeping carcasses and other organic matter from becoming nuisance attractants. It can also be a cost-saving measure. Some other advantages to composting are the ease of maintenance, using equipment already present on most farms, and the production of a useful, cost-free source of organic fertilizer. Most on-farm composting does not require a special permit.

Composting is the breakdown of organic matter by which naturally occurring microbes reduce the matter into byproducts that can useful on the farm or pasture. The most efficient microbes are the ones that work best with heat. The optimal compost temperature is just above 130˚F, and a proper "carbon to nitrogen" ratio of 30 parts carbon to 1 part nitrogen (30:1) is required. A rule of thumb is: if the temperature is in this range, and there are no odors, the correct ratio is being maintained.

Thermophilic (heat-loving) microbes generate their own heat, but insulation is necessary to keep the compost pile warm enough. A compost pile should have 3 to 5 feet of porous compost materials — adding leaves, straw, sawdust, or cardboard to the mix may help maintain an appropriate balance and serve as insulation. It may also be necessary to occasionally add water to keep the pile from drying out and slowing down the decay process. Some producers choose to turn their compost piles once a week to speed up the breakdown process. At the completion of the composting process, a useful, humus-like material is produced that doubles as slow-release fertilizer, organic soil amendment, or water-saving mulch.

To compost smaller animals, such as poultry, pigs, and sheep, a properly constructed covered structure is recommended. For larger animals, such as cattle and horses, a freestanding pile on a well-drained or improved surface is adequate.

Selecting the Site



When selecting a location for carcass composting, the following are important considerations:

- Compost activity should be set back at least 300' from surface water and drinking water wells or well catchment areas.
- Composting activities may not adversely impact groundwater resources and should not occur in areas with seasonally high groundwater unless conducted on an impervious surface with leachate collection and means to prevent storm water run-off.

— Local regulations should be checked for specific constraints regarding distance to property lines, residences, schools, and other public areas, as well as for potential odor control.

— Sufficient infrastructure should be present such as paved pads, and year-round vehicle access, providing the ability to properly manage the compost as well as leachate to prevent storm water run-off.

An example of how to create a compost site:

— Lay a 24-inch bed of bulky, absorbent organic material. Wood chips about 4-6 inches long work well. Ensure the base is large enough to allow for 2-foot clearance around the carcass. You can make the bed as long as space permits for multiple carcasses.

— Lay the animal in the center of the bed. Lance the rumen to avoid bloating and possible explosion. Explosive release of gases can result in odor problems and it will blow the cover material off the composting carcass!

— Turning helps to expedite the composting process by adding air, but the pile can also sit undisturbed for 4-6 months. Check to see if the offal is degraded.

— Long-stemmed thermometers are the most flexible devices for measuring temperatures in several different locations in a pile or in several different piles. A properly built pile should reach thermophilic conditions (130 to 150˚F) within 2 or 3 days and remain there for at least 2 weeks.

— Remove large bones before spreading the compost on your land. Use the bones as part of the base for the next compost pile.

— Site cleanliness is the most important aspect of composting. Fencing the pile adds additional assurance that other animals will not scavenge the location. A clean compost site deters scavengers, helps control odors, and keeps good neighbor relations. A properly installed electrified high tensile fence will provide excellent protection from wolves and other predators. **For guidelines on fencing to deter wolves and other predators refer to Fact Sheet #5.**

In addition to any local regulations, Washington State requirements for permitting and reporting on-farm mortality composting vary depending on the size of operation and use of the compost material. Most on-farm composting operations will be exempt from permitting. Contact the Washington State Department of Ecology or the Department of Agriculture for more information on regulations. For a more complete handbook on carcass composting, the WSU publication ***On Farm Composting of Large Animal Mortalities*** can be found online http://cru.cahe.wsu.edu/CEPublications/eb2031e/eb2031e.pdf

ELECTRIFIED FLADRY for
DETERRENCE OF GRAY WOLVES (Canis Lupus)
An Evolving Manual of Best Practices

By
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&
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People & Carnivores Program
Northern Rockies Conservation Cooperative
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Introduction

There are many tools for reducing wolf predation on livestock (Shivik 2004). Among these, fladry shows great promise in excluding wolves from pastures. Fladry consists of a line of cordage, from which flags are suspended. Field experiments demonstrate that properly-deployed fladry can be effective for as long as 60 days (Musiani et al. 2003). Fladry combined with sufficient electrical current, however, is far more effective when properly deployed. Rigorous research indicates that electrified fladry (aka "Turbo Fladry") has a far longer duration of effectiveness (Lance 2009).

While electrified fladry can potentially be highly effective in excluding wolves from pastures, adoption of this tool remains limited. There are several reasons for this: high capital costs (approximately $2,900 per mile, excluding labor), limited availability of fladry, and skepticism about effectiveness.

Perhaps most challenging, fladry is difficult to deploy. In large quantities, coils of fladry can become unworkable tangles. Further, because the flags create voltage leaks when they touch other objects, it can be difficult to keep sufficient voltage flowing through electrified fladry. Further, the flags themselves can become tangled in vegetation and fences, making them ineffective deterrents.

The learning curve for people who are new to fladry can be prohibitively steep, leading some first-time users to abandon this promising tool. Ironically, some highly-progressive ranchers – those who employ short-duration grazing systems to maintain healthy rangelands – may be reluctant to use fladry because their frequent pasture changes would mean that fladry would have to be moved frequently, too.

II. Deployment issues

Fladry deployment can be extremely labor intensive. Lance (2009) documented labor inputs of roughly 32 person-hours per kilometer of fladry, or approximately 50 person-hours per mile. To put this in perspective, it takes one mile of fladry to surround and protect a square 40 acre pasture. Once fladry has been erected, it is often difficult to keep it effectively deployed. Wind, precipitation, and ungulates can cause fladry to sag, collapse, or become dismantled. It is challenging to build a secure, tight line of fladry, even for experienced electric fence users. While there are many similarities between a conventional polywire fence and electrified fladry, the weight and wind resistance of the flags themselves add a new dimension.

Also, a fladry enclosure typically surrounds an existing fenced pasture. For user convenience, the fladry line must duplicate every gate in the per-

manent pasture fence. Also, there will likely be places where the electrified fladry line will cross existing fence lines, creating opportunities for voltage shorts if they are not properly insulated.

III. Key improvements

Through five years of deploying stretches of fladry up over four miles in length, we have harvested many important lessons. We are certain that other fladry practitioners have already made similar discoveries, and may have developed useful techniques we have not thought of. Nonetheless, we think it would benefit future fladry users to have a concise summary of helpful techniques.

A. Spooling fladry

Figure 1: Hand-Coiled Fladry is extremely inefficient

After multiple deployments, we have taken a hard look at what makes fladry deployment so inefficient. With numerous experienced workers, we found repeatedly the biggest time sink was in dealing with hand-coiled fladry. Even when neatly coiled, it is unwieldy and prone to tangling. Also, ¼ mile coil of fladry (1320 feet) is fairly long, somewhat heavy, and a handful even for people with large hands. Thus, workers inevitably set the coils down or try to hang them on fences when carrying them in the field – another opportunity for tangling.

Most professional graziers insist on using spools or reels for handling temporary electric fence wire in the pasture. Why? Tangles waste time, and make fence construction unpredictable and inefficient. Adding flags to the polywire makes the tangling problem exponentially worse.

Thus, we cannot stress enough that fladry needs to be spooled up. Fladry on a spool has greatly improved our efficiency, as well as making fladry easier to store.

Figure 2: Fladry spooler 2.0 in action on Sun Ranch.

Other users have noted the potential efficiency gains of spooling fladry, and have developed their own methods and equipment. For example, Val Asher of Montana Fish, Wildlife and Parks developed a way of spooling ¼ mile lengths of fladry onto garden hose reels; the user carries the reel on a chest-mounted harness.

Our fladry spooler is a simple machine with minimal moving parts, and can be constructed from readily available parts with no custom machining required. Complete details and a parts list are available in Appendix A. Our larger spools will hold over 1.5 miles of fladry, depending on how tightly it is wound up. We have found that 1.5 miles of fladry makes a very heavy spool, and mostly limit our quantities to one mile per spool. Note that, because of the bulk of the flags, fladry requires a far larger

spool than bare polywire.

Thus, in considering a spooling device, think big: six inches minimum bare spool diameter, and 11" minimum spool width. While there are many excellent electric fence reels available, these are generally too small to hold more than a trivial amount of fladry.

Figure 3: 1.5 miles of fladry on one spool

B. Golf Bags

Our second major efficiency gain came to us from a professional grazier in Wyoming. As with fladry, temporary electric fence needs to be attached to something to keep it at the correct height. The most popular and economical choice is 3/8 inch x 4 foot fiberglass rod posts. Handling dozens of these posts in the field, while also wielding a hammer to drive them in the ground, can be challenging. The solution: get an old golf bag. The fiberglass posts slide into the golf club slots.

Figure 4: golf bag filled with fladry posts; bag pockets can be used to store small parts

The worker can sling the bag across her torso, allowing her to carry roughly 40-50 posts hands-free. Having both hands free allows the worker to pull a post from the bag with one hand, position it, and then tap it into place with a hammer in the other hand. This dramatically shortens deployment time over carrying the posts in one's hands.

Figure 5: Using a golf bag for posts leaves hands free for positioning and hammering posts

C. Attaching Fladry to the Posts: the Harp Clip

Fiberglass posts – spaced roughly 32' apart, or substantially closer than for bare polywire – need some sort of clip or attachment point for joining fladry to post. After much trial and error, we have found only one product that is suitable: Premier Fence's Harp Clip. The Harp Clip is durable, stays where you want it, and allows the fladry flags to slide through rather than snagging when tightening up the line. Clips made of wire springs

snag the flags. Clips that look similar to the Premier Harp Clip have not performed well and tended to come off the posts.

Figure 6: Premier Fence Harp Clip

The Harp Clip is also well-suited to the golf bag technique, because the clips can be left on the posts with no risk of entangling with each other. This makes storage of large quantities of posts easier as well. The only difficulty with the Harp Clips is that they can be difficult to install, since they are made of very strong plastic. Premier Fence has responded by making an inexpensive tool for snapping the clips onto the post. See http://www.premier-1supplies.com/detail.php?prod_id=21478&cat_id=46.

D. Anchor posts for applying tension or making corners

The 3/8 inch fiberglass post are the mainstay of a fladry line; however, they are also very flexible and smooth. Thus, when trying to add tension to a segment of fladry so the line does not sag, we cannot rely on the 3/8 posts by themselves. These smaller posts will bend and will eventually pull out of the ground as we add tension to the fladry.

Thus, it is necessary to install heavier posts at regular intervals for adding tension to the line. We experimented with numerous ways of doing this, and with different spacings. We found that, in rolling terrain, it was necessary to have a heavier, less flexible post approximately every 250 feet.

Steel "T" posts are one option for heavy anchoring posts. They are durable and reliable. They have drawbacks, though: they weigh a lot, they require a post-pounding device, as well as a device for removing from the ground at the end of the deployment. Furthermore, since they are steel they require careful attention to insulation, because if the electrified fladry line contacts the steel, it creates a "dead short," or a complete loss of voltage.

Figure 7: Steel t-post as an anchor for tensioning the fladry line. This was a fladry + polywire setup for dividing a cattle pasture.

While we still use T-posts in some situations, we have found better alternatives for tension anchors. In situations where the fladry line is paralleling an existing permanent fence, we found that we could periodically tie the fladry line to the permanent posts using plastic insulator clips and twine. These anchors proved to be reliable, and the hardware was far more portable than steel T-posts and a pounder.

Our preferred method involved Dare-brand corner insulator clips and a length of twine, with fence staples if connecting to a wooden post. The Dare (Part # BW-CP-10) clip proved to be very durable, and very affordable at less than ten cents each.

Figure 8: Tensioning anchor, using a Dare-brand insulated clip and twine to connect the fladry line to a permanent post.

We have also begun using a variety of thicker/stronger fiberglass and composite posts for these purposes, as well. Unlike steel t-posts, these posts require no insulators as they do not conduct electricity. Composite posts like the Powerflex G2 have performed the best – they are fairly flexible, nearly indestructible, and have enough roughness on their surface to help them stay in the ground. Smooth fiberglass posts may pull out of the ground under great strain; however, this makes them easier to remove at the end of a deployment as well. These posts range from ¾" diameter to 1.6 inches in diameter.

Figure 9: Powerflex composite post used to provide mid-line tension for fladry. Wire clip inserted through post keeps fladry at proper height; multiple half-hitches around the post vary the tension on the line.

Half-inch diameter fiberglass posts are substantially stronger and stiffer than 3/8 inch diameter, and can be used to make a fladry segment more robust in challenging conditions. These posts require special clips; we have found two varieties that work well.

Figure 10: Galvanized clip for half-inch fladry posts; this clip is very strong.

For creating a 90 degree corner in a fladry line, however, it is still hard to beat a steel t-post. Again, it is imperative that the electrified fladry line not make any contact with the post. We have found that the Dare clip anchored to a T-post makes a strong, reliable, insulated connection. There are other insulators for T-posts, but we have found it preferable to have some space between the line and the steel.

E. Maintaining consistent line height over rough terrain.

On many pastures, the fladry line will have to contour over rough terrain, crossing ditches, ravines, and other features. Keeping the fladry line at a fairly consistent height in such places can be challenging. It is possible to use posts to keep the line at the desired height, but in extremely rough terrain the tension on the line may be enough to uproot most any posts besides T-posts. Compounding matters, many ravines and draws are extremely rocky, making it difficult to manually drive T-posts or composite posts into the ground.

The Dare corner insulator clip once again proved very useful in such situations (see Figure 11). Using the Dare clip, a length of nylon cord (such as parachute cord), and a good-sized rock, we improvise a "dead-man" for holding the line parallel to the terrain. Again, this has the advantage of being highly portable and with no risk of shorts, relative to steel posts.

Figure 11: Dare clip deadman

F. Fladry gates

Gates are a necessary part of any fladry deployment. Livestock and people will need to get into or out of the pasture at some point. Gates are fairly simple to construct; they just require a pair of fixed anchor posts, as described above, so that adequate tension can be maintained across the gate. It is possible for one end of the gate to be anchored to a permanent fence post near the gate, but it is inadvisable to put the gate or any other segment of the electrified fladry line within fladry-flag's length of the permanent fence due to flag entanglement or electrical short risk.

The gateway should be wider than the permanent gate it parallels (see Figure 11). This will allow plenty of room for moving vehicles and livestock through the gate. The free end of the fladry gate should be on the same end as the permanent gate to facilitate easy use.

Figure 12: Fladry gate parallel to permanent gate. Both gates open from the right.

Electric fence gate handles are required hardware for making a gate. Good quality handles cost about $4.00 and are far superior to the $2.00 ones. Cut the fladry line where a gate is required, and tie the end to the eye on the end of the gate handle. To ensure a good electrical connection, wrap the polywire two or three turns on the gate handle eye, then tie it off with a bowline or other suitable knot.

The gate handle's hook end (the free end) will then need to be connected to an anchor post that can withstand tension.

Figure 13: Gate handle connected to eye-bolt, attached to a Powerflex composite post.

We suggest a minimum of 7/8" diameter fiberglass or composite post. We prefer the Powerflex 1.6" composite post, with a hole drilled through to accept an eye bolt (see Figure 13). The gate handle's hook end then clips into the eye bolt. The fladry line continuing from the gate can then be tied into the eye bolt; again, make multiple turns around the metal to ensure good conductivity.

A gate connector called a wood-post activator is another good solution. This can be screwed into a permanent wood post (see Figure 14). If using this method, the fladry gate must not be closely parallel to the permanent gate, but should intersect the fixed post at an angle that keeps most of the fladry line a good distance from the permanent fence. Otherwise, the flags will tangle in the permanent fence and/or the electrified fladry will short on the permanent fence, rendering it ineffective.

T-posts also work for gates, but require reliable insulation. We have used several insulator/connector devices that worked well on T-posts. It is

also possible to use insulated fence wire wrapped around the T-post as a makeshift device for connecting gates.

Figure 14: Gate handle connected to a wood post activator/insulator.

IV. Electrifying

Once the various posts and gateways have been installed, and the electrified fladry line has been attached to the posts and adequately tensioned to prevent sagging, it is time to add the electricity itself. This is fairly straightforward, and any good fence energizer will include an illustrated manual for proper installation.

It is important to select a good quality fence energizer for electrifying fladry. The flags themselves create significant voltage leaks, especially if they are in contact with vegetation or the ground. Thus, electrified fladry requires a significantly stronger energizer than an equivalent length of bare polywire.

The baseline strength of electric fence energizers is measured in **joules**. Some manufacturers report stored joules, while others report output or released joules. The most important number to focus on is **output joules** as a parameter of the energizer's ability to supply voltage over a wide range of situations.

Based on our monitoring of fladry voltages in a variety of settings, we believe that a good general guideline is that an energizer should have at least one **(1) joule of output per mile of fladry**. We found that an energizer with 3 output joules (Horizont Hotshock A50), with a fully charged 12 volt battery, delivered consistent voltages of 4-5 kilovolts on over three miles of electrified fladry. This was under challenging conditions, with the fladry in contact with tall sagebrush and other vegetation.

In addition to the 1 output joule/mile of fladry guideline, we also recommend adding more ground rods to the energizer than the manufacturer specifies. In the case of the Hotshock A50, Horizont recommends six feet of ground rod; we used three ground rods of three feet each for a total of nine feet. High quality rods of either copper or galvanized steel are also important.

The Horizont Hotshock A50, as well as a few other energizers from Horizont and other manufacturers (available through Premier Fence), are termed "wide impedance" energizers. Wide impedance energizers may not have as high a peak voltage as other energizers, but deliver far better average voltage under adverse conditions. Such conditions are fairly common in the Intermountain West when dealing with wolves:

1. Dry, high mineral content soils that do not conduct electricity well.
2. Dry snow in cold temperatures serving as insulation from electrical shock.
3. Long fur insulating the animal against electric shock (particularly an issue in winter with wolves, especially when they may be standing on dry snow).

Since these factors are fairly routine when dealing with wolves, we suggest that fladry practitioners seriously consider using only wide impedance energizers.

Figure 15: Horizont wide-impedance energizers with solar panels. The Hotshock B4 (left), with 0.35 output joules, is a compact unit that is suited for smaller runs of fladry around corrals or small pastures. The Hotshock A50 is a heavy duty unit that can adequately power over 3 miles of electrified fladry; its 40 watt solar panel insures a well-charged battery.

Other points to keep in mind regarding electricity:

- The fladry flags should be kept slightly above the ground when possible, without raising the line itself higher than about 28", to minimize voltage leaks from the flags. Higher than 28" and it may become too easy for wolves to walk under the line without getting shocked. During spring and summer growing seasons, it may be impossible to keep the flags from touching vegetation because the grass is growing so fast.

- When surrounding pastures with permanent fences, the fladry line is likely to cross over or through existing fence lines. Each of these is a potential short that must be insulated. Short runs of insulating tube can be made from rubber garden hose (the black heavy duty hose), which can be slit lengthwise then taped on with electrical tape.

- A good voltmeter is absolutely imperative for monitoring energizer performance and locating problems. Accurate voltmeters are available for less than $50; more sophisticated models that help find shorts are roughly $120.

Electrified fladry for Livestock Containment

We found that standard electrified fladry was only marginally effective as a livestock fence. This was because flag lengths of 19" dictated a top wire height of no greater than 23" above grade (Davidson-Nelson and Gehring 2010). In our projects, we found that cattle would often step over the fence, which often resulted in brief entanglements that resulted in long stretches of fladry being torn down and rendered ineffective.

Thus, we sought to experiment with longer flags that would allow the top electrified wire to be closer to the recommended cattle containment height of 30"-32". After discussion with experts and extensive research, we could find no compelling rationale for flags 19" long. We think, however, that there is an upper limit on effective height for fladry: too high, and wolves would find it too easy to cross under the electrified wire without ever making contact.

Therefore, we believe that the optimal top wire height should correspond to wolf anatomical parameters – that is, that the wire height should be slightly below average shoulder height for a wolf, or about 30". We base this on the idea that wolves that begin to lose their fear of fladry will first explore the novel object with their nose and mouth. Canids in a curious attitude often hold their head slightly below shoulder height as they explore novel objects.

Thus, we chose 27" as a hypothetical optimum flag length; this would allow deployment of the top wire at approximately 29-30" above grade

without the flags making excessive ground contact (a significant voltage drain). Preliminary trials with cattle have shown that 29" is an effective wire height for containing adult cattle.

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Fact Sheet 6:

Alarm or Scare Devices and Hazing to Deter Wolf Presence

Alarms or scare devices for deterring wolves include any kind of sound and/or light system that emits signals that frighten wolves away from areas where livestock are present. They are where livestock are kept in close proximity to each other or confined by some type of permanent or temporary fencing. Hazing devices may include the use of non-lethal munitions – including cracker shells, rubber bullets, paintballs and beanbags – to haze wolves near livestock. The use of these tools must be done in coordination with WDFW and/or appropriate federal authorities. In some cases, training and permits may be required. In order to achieve maximum effectiveness, work with WDFW personnel to determine which hazing and scare tactics may work best in your circumstances.

The following are the main type of alarm/scare devices for wolf deterrence:

- **Alarms – Radio Activated Guard system (RAG) and Motion-sensor devices**
- **Strobe Lighting and Fox Lights**
- **Hazing and "Less than lethal Ammunition"**
- **Biofence**

Alarms – Radio Activated Guard Systems (RAG)

Although there are a number of designs being tested, Radio Activated Guard, or "RAG" boxes consist of a receiver, a bright strobe light, two loudspeakers and is usually linked to an internal computer that collects and stores information received from transmitters on wolves' radio collars. The boxes are calibrated to be triggered when a wolf wearing a radio-activating collar approaches to within a certain distance of the box. The combination of loud, unfamiliar sounds frighten off the wolf wearing the collar and any others that may be present at the time. The noises may include sirens, gunshots, loud car noises, human voices shouting and singing and any combination that will alarm and frighten the wolf for maximum effect. The obvious drawback to this system is that only a collared wolf will trip the device. Other motion detector devices have been used with some success as well. If you are interested in discovering whether or not a RAG box might work for you and your particular operation. coordinate with WDFW. WDFW may have boxes that they can make available.

Whether you choose to use RAG boxes or motion-sensor devices, it's recommended that the placement, timing and cadence of the devices be varied frequently. Wolves may habituate to noises and lights that are predictable.

Strobe Lighting and "Fox Light"-type Lighting

Effective wolf deterrent lights need to have the following characteristics: weather resistant; built from sturdy materials; powered by long-life batteries; turn on at sunset and shut off automatically with daylight; intermittent and capable of being seen from a long distance. It is believed that the random nature of this type of lighting is responsible for frightening wolves away from livestock. It is likely that wolves associate the lights with the presence of humans and keep their distance. However, like many deterrents, unless the pattern and placement are changed up frequently, wolves may "catch on" and approach the lights and the livestock.

Hazing and "Less than Lethal" Ammunition

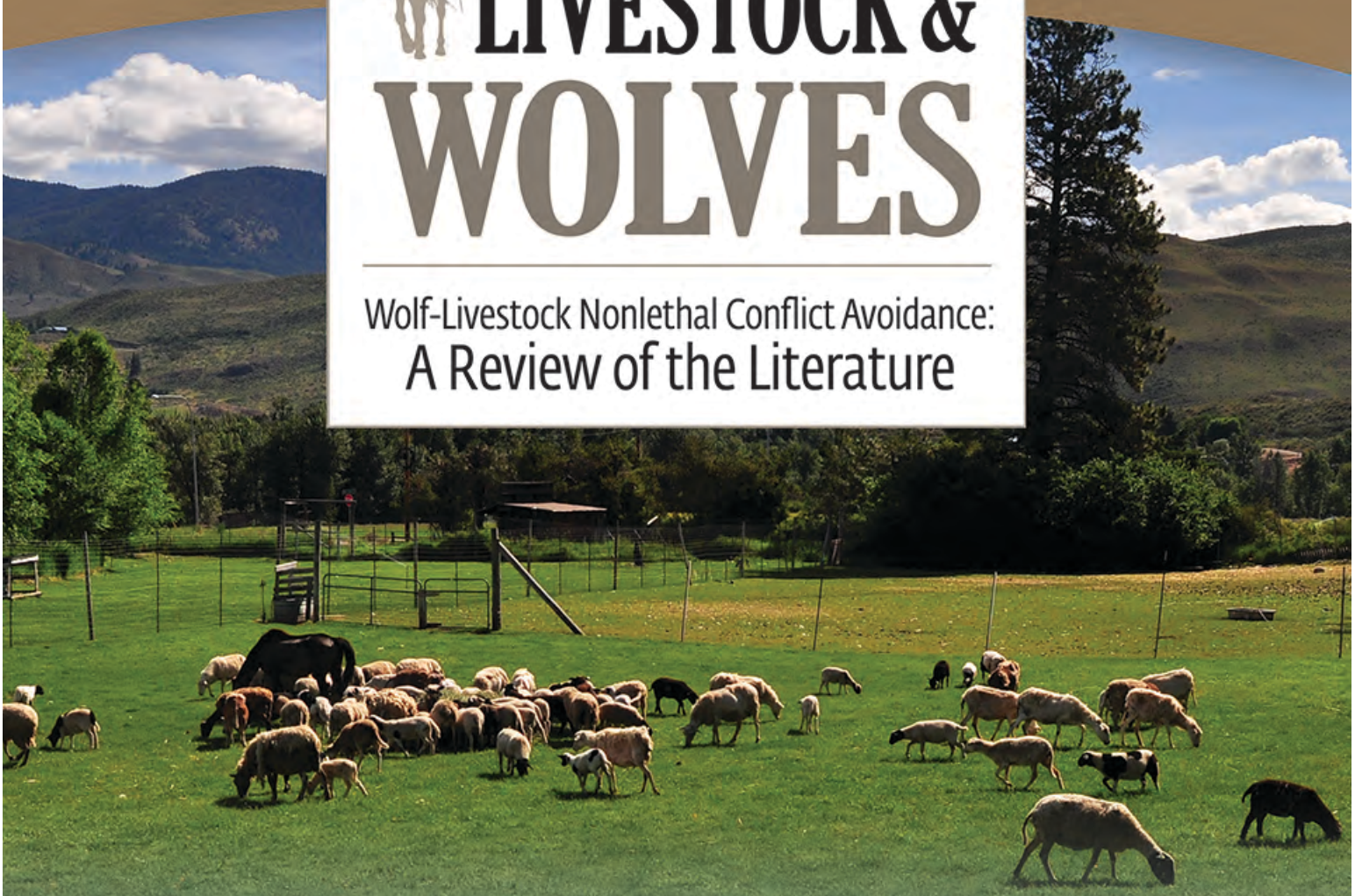
It is important to note that the use of these hazing tools is regulated and must be done in coordination with WDFW and federal authorities. The combination of the noise and temporary pain associated with the use of cracker shells, beanbags, paintballs or rubber bullets fired at wolves has been proven to stop them from approaching livestock. However, as with many of the other conflict deterrent methods, wolves may learn to avoid the shooter, but not the livestock or pasture. This depredation deterrence method requires the constant present of humans and absolute diligence in application. There are other drawbacks as well. Nonlethal ammunition is not reliable and can occasionally cause injury to the shooter if it jams in the firearm. It can also cause serious injury to the target animal by hitting an eye or other vulnerable body part. It goes without saying that in fire season, extreme caution must be taken, and cracker shells, which make noise like fireworks, should not be used as the high likelihood of sparks may cause fires to ignite.

Biofencing

Some research has been done on the effectiveness of creating a "biofence" to keep wolves from approaching livestock. This is a method that shows promise and merits further research. The way it works is to utilize the strong odors in wolf urine (gathered from captive wolves) to make a spray that can used to create a "biofence" around the area where livestock are present. The urine of wolves from an unknown pack creates a biological barrier that keeps other wolves from entering a specific area. Obvious drawbacks are the difficulty of production and availability, but it is a method that may hold promise for the future.

Living with LIVESTOCK & WOLVES

Wolf-Livestock Nonlethal Conflict Avoidance: A Review of the Literature



Livestock producers, their animals, and wolves can coexist by implementing some straightforward measures.

Western Wildlife OUTREACH

WOLF-LIVESTOCK NONLETHAL CONFLICT AVOIDANCE: A REVIEW OF THE LITERATURE

With Recommendations for Application to Livestock Producers in Washington State

A Project of Western Wildlife Outreach

With funding provided by

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It is the intent of the authors of this report that frequent updates shall be made as more research in this field is specifically targeted to Washington State. For copies of this report and/or further information regarding the studies reviewed, please contact:

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"Effective management of predator damage is also a conservation issue, and the edges – that is the intersections of carnivores, people, and livestock – are where efforts need to be focused."

John A Shivik, Utah State University
USDA/APHIS/WS National Wildlife Research Center Predator Research Center

INTRODUCTION

Gray Wolf on the Landscape

In 2008 the first breeding pack of Gray Wolves (*Canis lupus*) in Washington was documented near Twisp in the Methow Valley following an absence of nearly 70 years. In response to the wolves' reappearance in Washington, the Fish and Wildlife Commission adopted the ***Wolf Conservation and Management Plan for Washington (Plan)*** in December 2011, following a lengthy scientific and public involvement process. The Plan provides the framework for how wolf conservation and management will be addressed during the gray wolf population recovery phase and beyond. The *Plan* states:

> *"No wolves have ever been or will be reintroduced into Washington from areas outside the state as part of this plan. This is a state plan. There is no requirement for federal approval of the plan because the U.S. Fish and Wildlife Service (USFWS) has not established federal recovery criteria for wolves in Washington…The purpose of the plan is to ensure the reestablishment of a self-sustaining population of gray wolves in Washington and to encourage social tolerance for the species by addressing and reducing conflicts (Wiles et al 2011)."*

Since 2008 wolves have continued to re-establish themselves in Washington on their own through immigration, most likely from the neighboring states and provinces of Idaho, Montana, Oregon, and British Columbia, and through reproductive success of established breeding packs. By the end of 2013, Washington Department of Fish and Wildlife (WDFW) had documented thirteen packs comprised of fifty-two individual wolves, including five successful breeding pairs, residing in eastern Washington and the eastern Cascade foothills (Becker et al 2014). Gray wolves are currently protected as an endangered species by both federal and state law in the western two-thirds of the state. The wolf population in the eastern one-third of the state, where a number of packs have become established, are only protected under state law.

During the recovery period for Washington's wolves, lethal control options are limited in order to give the maximum protection to the recovering population. Although there have been few documented conflicts between wolves and livestock to date in Washington, as wolf numbers continue to grow it is anticipated that conflicts will also increase (Becker et al 2014). Nonlethal conflict avoidance methods are the preferred option recommended by WDFW to ensure livestock and human safety as well as gray wolf recovery.

Fortunately, Washington State livestock producers and wildlife managers can benefit from the extensive research that has already been conducted throughout North America, where wolves have re-established a foothold, and in places like Europe, where wolves have always been present but whose numbers have been increasing in recent years. This report should prove beneficial to biologists, wildlife managers, livestock producers and conservationists as these groups continue to work together to identify and utilize the most practical and cost effective nonlethal wolf-livestock conflict avoidance practices.

Organization and Research Methods

In 2013 Western Wildlife Outreach (WWO), a nonprofit organization dedicated to disseminating science in order to advance human and carnivore coexistence, was contracted by WDFW to conduct a review of published research on the effectiveness of **nonlethal carnivore and livestock conflict avoidance methods.** University of Washington student intern, Jane Hutchinson, headed up this research effort under the direction of WWO's Executive Director, Lorna Smith. Unless otherwise noted, the research studies focus on the following canid species: Gray Wolf (*Canis lupus*), Coyote (*Canis latrans*), and Domestic Dog (*Canis lupus familiaris*). The primary research tool was the University of Washington Library's online "**Articles & Researches Databases**" website with the majority of the studies located through the ***Web of Science,*** a Thomson Reuters research platform containing multidisciplinary scholarly and scientific research articles. Search terms were generated from relevant combinations of the following key words: "**wolf, gray, canid, canine, livestock, conflict, predation, depredation, cattle, lethal, nonlethal, control, method**, **wildlife, mitigation, husbandry, ranch, range, farm, management, stockmanship, planning, guardian, fencing, and conservation**." These references were cross-compared with those provided by wildlife biologists with WDFW and other stakeholder groups, faculty and research staff from various educational institutions, and those cited in the Plan. All research was reviewed for relevancy regarding what might confront wildlife managers, livestock producers, biologists and conservationists working towards identifying the most practical, cost effective nonlethal conflict avoidance practices, protecting livestock as well as Washington's still-recovering population of gray wolves.

In total 103 research studies dating from 1979 to 2014 were selected for review. Of these, fifty-four of the studies are summarized and their findings reported on. A list of these cited studies is in Appendix A. The other forty-nine studies are located in Appendix B, suggested as further reading to provide more in-depth information on a particular topic. WWO and WDFW intend to make these studies available through an online library operating in the public domain. The sections of this report are organized in the following manner:

- "Research Studies" provides a summary of the study location, purpose and methods, organized chronologically and then assigned a number for easy citation and identification throughout the paper.

- "Summaries of Study Findings" highlights pertinent findings from these studies categorized into three focus areas– Husbandry Practices, Nonlethal Predator Control Methods, and Wildlife Management Strategies.

- "Conclusion: Applicability to Washington" provides an overall summary of the findings, with recommendations and ratings for those management strategies considered most applicable to livestock producers operating in the state of Washington.

Abbreviations Used Throughout this Document

CAN-Canada
CFA-Conditioned Food Aversion
CI-Central Idaho Gray Wolf Recovery Zone
CTA-Conditioned Taste Aversion
ESA-Endangered Species Act
EU-Europe
GIS-Geographic Information System
GYA-Greater Yellowstone Area Gray Wolf Recovery Zone
LGA-Livestock Guardian/Guarding Animal
LGD-Livestock Guardian/Guarding Dog
LiCl-Lithium Choride
LPD-Livestock Protection Dog
MAG-Motion Activated Guard
NRM-Northern Rocky Mountain Gray Wolf Recovery Zone
NWMT-Northwest Montana Gray Wolf Recovery Zone
NWRC- National Wildlife Research Center
RAG-Radio Activated Guard
RTVF-Real Time Virtual Fencing
USA-United States of America
USFWS-United States Fish & Wildlife Service
USDA-United States Department of Agriculture
WDFW-Washington Department of Fish & Wildlife
WS-USDA Wildlife Services
WWO-Western Wildlife Outreach

RESEARCH STUDIES

This section provides a brief descriptive paragraph for each of the fifty-four research studies selected for analysis. Included in the summary is the study's location, purpose and methods. The research is organized chronologically and assigned a number for easy identification throughout the rest of the paper. Complete citations for each study are provided in Appendix A.

RESEARCH STUDIES

1. ROBEL ET AL 1981 (USA-KS). This study evaluated the efficacy of several husbandry methods in reducing sheep losses to coyotes and domestic dogs. Sheep losses of 109 producers were monitored monthly in a nine-county area of south central Kansas to assess the effects of husbandry practices. At the time of the study, Kansas had the third highest index of predator abundance of the seventeen western states with the study area equal to or exceeding the statewide average. Principal information collected included method of sheep-carcass disposal, season and location of lambing, presence of large dogs in the farmyard, method and success of predator control, season of shearing, breed of sheep, poultry (if any), management practices, types of pasture used, use of bells, time of day sheep were turned out to pasture and returned to corrals, and general confinement practices. Flock sizes ranged from 4-913 (mean=154). No large-scale commercial operations (>1000 head) were included in the study. Findings are considered applicable to most sheep operations managed under farm-flock conditions.

2. GUSTAVSON ET AL 1982 (CAN-SASKATCHEWAN). Taste aversion programs using lithium chloride (LiCl) in sheep baits and carcasses have been applied in Washington to one sheep herd for two years; applications have been made in California and in Saskatchewan on forty-six herds over three years. Ten of these forty-six herds were available for statistical analysis, indicating a significant reduction in the percent of sheep lost to coyotes. All applications have suggested reduced sheep losses to coyotes. This method of predation control may cost less than traditional techniques, save sheep, and should allow coyotes to carry out positive functions in the ecosystem.

3. BOURNE & DORRANCE 1982 (CAN-ALBERTA). Researchers in the 1970's concluded that baits treated with LiCl were effective in reducing coyote predation on domestic sheep (Gustavson et al 1974, 1976, 1977). In order to test this assertion, and the research methods used to support it, predation rates and lethal control actions were studied at seventeen farms located in four areas of Alberta – Grande Prairie, Barrhead, Rocky Mountain House, and Cardston. The study area was located in the Boreal Mixedwood Forest Region, the Boreal Aspen Grove Forest Region, and the Boreal Lower Foothills Forest Region. Cardston, located in SW Alberta, had the greatest native habitat, which consisted of grassland and quaking aspen groves, with only one-half of the land in cultivation at the time of the study. In this region sheep grazed on native grass pastures where they still remained. The farms ranged in size from 64-1036 ha (mean distance between farms=24 km). In 1978 baits and placebos were placed around the farms beginning 3-6 weeks before sheep went to pasture in April and continued being maintained until the following September. Six radio-collared coyotes with home ranges of 2-8 km were present in the area from April-September in 1977 and 1978. Flock size and number of sheep lost to predation were obtained from farmers for 1976 & 1977 and confirmed by government compensation records. Predation losses in 1978 were reported directly to researchers by the farmers and then confirmed by predator specialists. When predation was confirmed lethal control activities were initiated.

4. BLACK & GREEN 1984 (USA-NAVAJO). The 70,000-km^2 Navajo Reservation is located on the Colorado Plateau situated across the southwestern United States of Arizona, Utah, and

New Mexico. Seventy-two Navajo ranchers were questioned about their mixed-breed guarding dogs and their role in general livestock operations, the extent of dog care and training, and what kinds of dog-coyote-sheep interactions occurred. Fifty eight flocks were studied, ranging in size from 17-300 individuals. On the homesteads visited, 230 mixed-breed dogs were used as livestock protection dogs (LPD). Navajo dogs function primarily as guardians of sheep and goats to whom they have developed social bonds. Mixed breed dogs of the Navajo appear to exhibit all behavioral traits believed to be important in protecting flocks from predators, especially coyotes: they are attentive, defensive and trustworthy. Navajo dogs could be quickly deployed in a variety of ranching situations to help reduce predation on livestock.

5. COPPINGER & COPPINGER 1988 (USA). This paper presents data from a ten-year study on livestock guarding dogs (LGD) conducted by researchers at Hampshire College known as the Livestock Dog Project. The project began in 1976 after consultations with livestock industry leaders about staggering losses of sheep to coyotes (*Canis latrans*) and the associated costs to producers, as well as the renewing effort on the part of the industry, the federal government and environmental groups to find an effective, nonlethal method of predator control. Initially, guarding dogs were observed during a 1–month tour of a dozen ranches in the United States where producers were reportedly working with guarding dogs, and a 3-month tour of sheep-producing regions in Europe and Turkey where the best dogs available were purchased. Dogs from working stock were obtained in Italy (*Maremma*), Turkey (*Anatolian Shepherd*), and Yugoslavia (*Shar Planinetz*). These three main breeds were used as breeding stock to produce pups for the various programs. Hampshire College mitigated financial impacts of dog ownership and kept ownership of dogs at the college so placement and breeding could be regulated. Producers volunteered for the program but were required to have at least two dozen sheep or goats for commercial production and a history or threat of predation. They were sent an annual form to complete with 32 database fields. The Livestock Dog Project permitted researchers to see the variety of habitats and management schemes used by the growers. Over the decade, project staff members logged a half-million miles and placed 1,091 pups with producers across thirty-seven states.

6. GREEN & WOODRUFF 1988 (USA & CAN). A survey of LGD users in the USA and Canada in order to determine effectiveness of particular guarding dog breeds and how successfully they are being used by livestock producers. Comparisons were made on effectiveness of breed and sex of guarding dog, how guarding dogs were utilized and how effective they were in general and economically. Sheep and goats were livestock protected in herds of variable size managed in both pasture and open rangeland situations. Small pasture operations ran 4-50 head (median=25), large pasture operations had 56-8,000 head (median=200) and range operations had from 12-16,000 head (median=1,000). Of these operations, 4 range operators and 11 pasture operators ran mixed herds of goat and sheep. The study was conducted from January to August 1986.

7. NASS & THEADE 1988 (USA-OR, WA, CA). The use of anti-predator electric fences for reducing predation on sheep was investigated by interviewing 101 sheep producers in the Pacific Northwest region of the United States. Significant reductions in sheep losses to predators were reported after installation of electric fences compared to pre-fence losses. Low sheep losses to predation were also reported by those producers that acquired sheep after

installation of electric fences. The expenses of construction and maintenance were important considerations in management plans; however, most producers were satisfied with electric fences for sheep containment and predator exclusion.

8. FRITTS ET AL 1992 (USA-MN). The nature and extent of wolf-livestock conflicts in Minnesota during 1975-86 was studied as part of a wolf depredation control program. The level of gray wolf depredation on livestock in Minnesota, as determined from the total number of complaints verified annually during 1975-86, showed a slight upward trend but did not increase significantly. A significant portion of the annual variation in verified complaints, perhaps the best index on severity of the depredation problem, was explained by variation in severity of the winter before the depredation season (inverse relation). The addition of a time variable did not account for a significant portion of the remaining variation. Verified complaints of depredations averaged 30 per year, affecting an average of 21 farms (0.33% of producers) annually. Conflicts were highly seasonal and involved primarily cattle (mainly calves), sheep, and domestic turkeys. Annual variation in losses of sheep and turkeys was higher than for cattle. In recent years, sheep and turkey losses in two northwestern counties have increased; preventive control may be warranted in those areas. Site-specific trapping and removal of wolves in response to depredations was the primary control method, resulting in captures of 437 wolves in 12 depredation seasons. This experience with active depredations in the state may lend insight into problems and solutions that may occur where wolves become established naturally or by reintroduction, and can provide background for developing effective control programs in those areas.

9. CONOVER & KESSLER 1994 (CAN-SASKATCHEWAN). In 1990, researchers surveyed 49 Saskatchewan sheep producers who participated in a large- scale conditioned food aversion (CFA) program administered by the Saskatchewan Agriculture Department beginning in 1976 and a random sample of 81 Saskatchewan sheep producers to determine how many were still using CFA to protect their sheep from coyote predation and if use of the method had spread to other producers in the area. With CFA, sheep carcasses or sheep bait packages are treated with the emetic agent, lithium chloride (LiCl), and distributed in areas where coyotes may prey on sheep. In theory, coyotes become ill after ingesting the bait, develop an aversion to the taste of mutton, and subsequently avoid killing sheep. This theory prompted an abundance of research, but results have been inconsistent, and therefore, the concept has been controversial. In this study, we examined producer perceptions of the Saskatchewan Program (SP) after >10 years. Researchers for this study assumed that if CFA effectively reduced coyote predation, producers who had participated in the SP would still be using the technique. Hence, producers were contacted who had participated in the SP to determine how many were still using CFA and to assess their experiences and attitudes about this method.

10. FRANKLIN & POWELL 1994 (USA-IA). In 1990 Iowa State University initiated research on guard llamas (*Lama glama*) in order to determine how North American sheep producers were using them, if they significantly reduced sheep losses to predation and what management practices gave the best results. The average flock size of those ranchers interviewed was 250-300 sheep maintained in a pasture of 100-125 hectares. Producers had used guard llamas an average of 3 years, but some for as long as 12 years. Nearly all llamas in this study had no experience with sheep before being introduced into the flock they were to

protect. Llamas averaged 2 years of age at introduction with the average age being 6-11 months. Before producers obtained their guard llamas they had been losing about 11 percent of their flocks. Intensive field studies revealed that 41 percent of all sheep losses were from canid predators (coyotes and dogs).

11. CAVALCANTI & KNOWLTON 1998 (USA-UT). Llamas are frequently used as guard animals by sheep producers as part of their predation management programs. However, few data are available concerning physical and behavioral attributes that distinguish between effective and ineffective guardian llamas. This study was conducted at the Predator Research Facility of the National Wildlife Research Center (NWRC) near Millville, UT. Twenty llamas were randomly assigned to one of four groups. Focal group sampling techniques were used to rank individual llamas according to frequencies with which they displayed alertness, leadership, dominant, aggressive, and threatening behaviors as well as postures indicating dominance or subordination. Researchers then examined the behavior of individual llamas with sheep. Finally, interactions among llamas, sheep, and a surrogate predator border collie were documented.

12. ANDELT ET AL 1999 (USA-UT). This study tested the effectiveness of an electronic dog-training collar to deter captive coyotes from killing domestic lambs by shocking coyotes whenever they attempted to attack lambs during a 22-week period.

13. ANDELT & HOPPER 2000 (USA-CO). Research compares sheep mortalities to predators for producers in Colorado who did and did not have guard dogs, presenting the effects of herd size, sheep/dog, dogs/herd, and number of years dogs were used on predation rates. Data include changes in proportion of sheep mortalities from 1986-1993 for producers with and without dogs in both years, and producers who obtained dogs between those years. Sheep occurred in varying densities across differing operation types (fenced pasture, feedlot, open range). Coyote, black bear, mountain lion and domestic dog were predators reported by producers.

14. MECH ET AL 2000 (USA-MN). Gray wolf depredations on livestock cause considerable conflict and expense in Minnesota. Furthermore, claims are made that such depredations are fostered by the type of animal husbandry practiced. Thus, researchers tried to detect factors that might predispose farms in Minnesota to wolf depredations. This study compared results of interviews with 41 cattle farmers experiencing chronic cattle losses to wolves (chronic farms) with results from 41 nearby "matched" farms with no wolf losses to determine farm characteristics or husbandry practices that differed and that therefore might have affected wolf depredations. Geographic Information System (GIS) was used to detect any habitat differences between the 2 types of farms.

15. SMITH ET AL 2000a (EU & USA). The use of domestic animals to protect livestock was reviewed through visits to actual users, discussions with experts and a thorough literature search.

16. SMITH ET AL 2000b (EU & USA). The use of aversive conditioning, repellents and deterrents in the management of predator–livestock problems is evaluated based on a comprehensive literature review, contact with leading authorities and visits to areas with

similar predation problems. The status of these management tools is reported and their applicability under Scandinavian conditions evaluated.

17. BROMLEY & GESE 2001 (USA-UT). Researchers examined whether surgical sterilization of coyote packs would modify their predatory behavior and reduce predation rates on domestic sheep as compared to coyote packs with pups. The study area was located on Deseret Land and Livestock Ranch, comprising 400-km^2 in northeastern Utah. While sheep grazing was a historical use of the area, sheep had not grazed the study area recently while cattle were grazed intermittently. Coyotes were distributed throughout the study area and were relatively unexploited. Winter carrion in the form of cattle and elk carcasses was plentiful. Mule deer and pronghorn antelope were common in the area. The most abundant small prey were white-tailed jackrabbits, cottontail rabbits, Uinta ground squirrels, deer mice, and least chipmunks. The study area is primarily sagebrush steppe, with an understory of western wheatgrass, needle-and-thread grass, Indian rice grass, and planted crested wheatgrass.

18. APPROPRIATE TECHNOLOGY TRANSFER FOR RURAL AREAS (ATTRA) 2002 (USA). It is virtually impossible to eliminate all predators and the damage they cause to livestock, but good management can reduce this damage and still be consistent with sustainable or organic livestock production. Because every farm is different, there is no single practice or single combination of practices that will be right for every situation. Therefore, when predators strike, it is important to be aware of all options available for their control and to act at once. Many species of animals can be classified as predators, but coyotes and dogs account for more than three-quarters of all livestock lost to predators. Highlighted predators include coyotes and wolves with goats and sheep as the primary livestock for protection efforts with discussion on how to identify predator attacks from other types of death. Presented are various sustainable management practices, such as fencing, proper carcass disposal and the use of livestock guardian animals (LGA).

19. BRECK ET AL 2002 (USA-ID). In response to the need to manage wolf predation in a non-lethal manner, wildlife managers developed and are currently testing a Radio Activated Guard (RAG) scare device that is behaviorally contingent and designed to disrupt predation events in small areas (<15-25 hectares). Preliminary results of ongoing testing of RAG boxes is reported. The two questions addressed are 1) do RAG boxes effectively deter wolves from depredating cattle, and 2) how long does it take wolves to habituate to RAG boxes? The study describes the equipment, reports three case histories from central Idaho in which RAG boxes were used to protect cattle, and discusses limitations of the method. Conclusions describe plans for more rigorous testing of the device.

20. MUSIANI ET AL 2003 (CAN-ALBERTA, USA-GYA). Trends in wolf depredation on livestock in Alberta, Canada, during the 1980s and 1990s are compared with trends in Idaho, Montana, and Wyoming in the United States during 1987–2001. Researchers report on experiments to evaluate the effectiveness of fladry for deterring wolves from accessing food in captivity and in the wild and for separating social groups of wolves in captivity. Finally, the study documents the use of fladry barriers in field situations in Alberta and Idaho for protecting livestock from depredation by wild wolves.

21. OAKLEAF ET AL 2003 (USA-ID). Researchers examined interactions between wolves and domestic calves within a grazing allotment in central Idaho, USA, to evaluate the role of wolves on calf survival and movements. During the 1999 and 2000 grazing seasons, 231 calves/year-representing 33% of the calf population were radio marked-on the Diamond Moose Association grazing allotment and their survival and movements relative to wolf distribution monitored.

22. SHIVIK ET AL 2003 (USA–MN). Aversive and disruptive stimulus approaches for managing predation were evaluated with captive wolves at the NWRC in Minnesota. Because experimental evaluations of depredation control technologies are difficult to implement in actual management situations, researchers tested two repellents for their efficacy in reducing consumption only. They then tested the effectiveness of a Motion Activated Guarding (MAG) device with two other disruptive stimulus approaches (fladry with wild wolves, shock collar with penned wolves), and using deer carcasses as the attracting resource.

23. TREVES & KARANTH 2003 (WORLD WIDE). Carnivore conservation depends on the sociopolitical landscape as much as the biological landscape. Changing political attitudes and views of nature have shifted the goals of carnivore management from those based on fear and narrow economic interests to those based on a better understanding of ecosystem function and adaptive management. In parallel, aesthetic and scientific arguments against lethal control techniques are encouraging the development of nonlethal approaches to carnivore management. Researchers for this study anticipate greater success in modifying the manner and frequency with which the activities of humans and domestic animals intersect with those of carnivores. Success should permit carnivore populations to persist for decades despite human population growth and modification of habitat.

24. TREVES ET AL 2004 (USA-MN, WI). Many carnivore populations escaped extinction during the twentieth century as a result of legal protections, habitat restoration, and changes in public attitudes. However, encounters between carnivores, livestock, and humans are increasing in some areas, raising concerns about the costs of carnivore conservation. This study presents a regional model that predicts future sites of human-carnivore conflict in relation to landscape features such as human land use and vegetation types. The model is based on the sites of past wolf attacks on livestock in Wisconsin and Minnesota (U.S.A.). Researchers used a matched-pair analysis of 17 landscape variables in a GIS to discriminate affected areas from unaffected areas at two spatial scales (townships and farms). They believe this approach can be applied wherever spatial data are available on sites of conflict between wildlife and humans.

25. BRECK & MEIER 2004 (USA). With the successful recolonization and reintroduction of wolves in parts of the western United States and the natural expansion of wolves in the upper Midwest, managing conflicts between wolves and livestock is a growing issue for livestock producers, resource professionals, and the general public. Unlike the coyote, where a great deal is known regarding the biology and ecology of depredation and methods for managing it, very little is known regarding patterns and processes of wolves preying on livestock and effective ways to mitigate this conflict. Understanding the ramifications of growing wolf populations for livestock production and successfully managing these problems will require knowledge of depredation patterns, wolf ecology, livestock husbandry, and the

effectiveness of different tools and techniques to manage wolves. As wolf populations expand into more agricultural areas such knowledge will become increasingly important. Here historic records were compared to current data on wolf depredation rates and wolf management techniques relative to the wolf's status on the endangered species list. The objectives were to synthesize the history of wolf depredation and management, present current data of wolf impacts on livestock, and speculate on the future management of wolves so that producers can consider the ramifications of a growing wolf population and possible mechanisms for decreasing the threat.

26. BANGS ET AL 2005 (USA-NRM). Wolf restoration in the western U.S. began in 1986 when a 'Canadian' pack denned in Glacier National Park, Montana. Management in northwestern Montana emphasized legal protection and building local public tolerance of non-depredating wolves. Wolves from Canada were reintroduced to central Idaho and Yellowstone National Park in 1995 and 1996 to accelerate restoration. The wolf population grew to an estimated 800–850 wolves in the Northern Rocky Mountains (NRM) of Montana, Idaho, and Wyoming by late 2004. Since 1987, wolves have killed a minimum of 410 cattle, 1,044 sheep, 70 dogs [18 of which were being used to guard livestock], 12 goats, 9 llamas, and 3 horses. To minimize conflicts, we moved wolves 117 times and killed over 275. Researchers for this study encourage sheep producers to use livestock guarding dogs (LGDs) and other methods to reduce the risk of wolf depredation. LGDs are working well against a diverse carnivore guild but this paper is intended to show some novel aspects of their use against wolves. This report discuss some interactions that have been observed between LGDs and wolves and speculations are made about increasing the effectiveness of LGDs to protect livestock from wolf depredation.

27. BRADLEY ET AL 2005 (USA-MT & ID). Successful nonlethal management of livestock predation is important for conserving rare or endangered carnivores. In the northwestern United States, gray wolves have been translocated away from livestock to mitigate conflicts while promoting wolf restoration. We assessed predation on livestock, pack establishment, survival, and homing behavior of 88 translocated wolves with radio telemetry to determine the effectiveness of translocation in our region and consider how it may be improved.

28. BRECK ET AL 2005 (USA-CA). Wildlife managers developed and tested a system that alerts personnel when a radio collared animal enters an area designated as off-limits. The remote alarm combines the monitoring capabilities of data loggers with a message transmitter that sends a voice message via two-way radios when an animal enters a monitored area. The remote alarm system was tested with food-conditioned American black bears *(Ursus americanus*) in Yosemite National Park by setting up six remote alarms in areas designated off-limits to bears (i.e., campgrounds and parking lots). Researchers recorded the number of times a radio tagged bear entered an off-limits area, the number of times bear management detected a bear in areas off-limits, and the number of hazing events.

29. MUSIANI ET AL 2005 (CAN & USA). Due primarily to gray wolf predation on livestock (depredation), some livestock producers and other interest groups oppose wolf conservation, which is an important objective for large sectors of the public. Predicting depredation occurrence is difficult, yet necessary to prevent it. Better prediction of wolf depredation also would facilitate application of sound depredation management actions. In this paper

researchers analyze temporal trends in wolf depredation occurrence and wolf control, which is employed as a depredation management action. Data were gathered from wolf depredation investigations for Alberta, Canada, from 1982-1996 and for Idaho, Montana, and Wyoming, USA, from 1987-2003.

30. BRADLEY & PLETSCHER 2005 (USA-ID, MT). Managing wolf depredation on livestock is expensive and controversial; therefore, managers seek to improve and develop new methods to mitigate conflicts. Determining which factors put ranches at higher risk to wolf depredation may provide ideas for ways to reduce livestock and wolf losses. Researchers sampled cattle pastures in Montana and Idaho that experienced confirmed wolf depredations from 1994–2002 and compared landscape and selected animal husbandry factors with cattle pastures on nearby ranches where depredations did not occur.

31. SCHULTZ ET AL 2005 (USA-WI). Researchers evaluated the use of a dog-training shock collar fitted to wild, free-ranging gray wolves to prevent livestock depredation. The study was conducted on 536/ha farm that included mixtures of oak-pine-aspen forest, brushy grasslands, and open pastures dominated by cool-season grasses. Lowlands adjacent to a small (5m-wide) stream comprised about 10% of the farm. County forest lands, used extensively by wolves since the early 1990s, surrounded much of the farm to the west, north, and south. Approximately 300-560 calves were born on the farm each year during April-May in outside pastures. Calves were rotated among 2-3 fenced pastures during the course of the summer. Cattle were contained with a four-strand 1.4m tall barbed wire fence with an additional one strand of electric wire in the center. A pair of wolves established a territory (Chase Brook Pack) near the farm during the winter of 1994-1995. During the study period, the pack occupied a 156-km^2 territory encompassing the farm. It was assumed this pack was responsible for the majority of wolf depredation on the farm from 1998-2001...Black bears and coyotes occurred frequently on the farm, but neither was determined to be responsible for any livestock losses. White-tailed deer densities in the area ranged from 12-16 per km^2 (Wisconsin Department of Natural Resources, unpublished data). Other wolf prey species included snowshoe hare, beaver, and cottontail rabbit.

32. BANGS ET AL 2006 (USA-NRM). Gray wolf populations were eliminated from the NRM of the western United States by 1930, largely because of conflicts with livestock. The wolf population is now biologically recovered and over 1,020 wolves are being managed in Montana, Idaho, and Wyoming under the federal Endangered Species Act (ESA). From 1987 to December 2005, 528 cattle, 1,318 sheep, 83 dogs, 12 goats, 9 llamas, and 6 horses were confirmed killed by wolves, and over $550,000 was paid from a private damage compensation fund. To help restore the wolf population, managers employed 22 variations of nonlethal control tools, relocated wolves 117 times, and killed 396 wolves to reduce conflict between wolves and livestock. A variety of tools, including regulations that empower the local public to protect their private property, reduced the probability of wolf-caused damage. This wolf population was restored, the risk of livestock damage reduced, and public tolerance of wolves improved through an integrated program of proactive and reactive nonlethal and lethal control tools. Reduced conflict increases the potential to restore wolf populations.

33. SHIVIK 2006 (USA). The loss of large carnivores at the edges of parks, preserves, and human habitations threatens the conservation of many species. Thus, effective predation management is a conservation issue, and tools to mitigate conflicts between humans and predators are required. Both disruptive-stimulus (e.g., fladry, Electronic Guards, radio-activated guards) and aversive-stimulus (e.g., electronic training collars, less-than-lethal ammunition) approaches are useful, and technological advances have led to many new, commercially available methods. Evaluating the biological and economic efficiency of these methods is important. However, social and psychological effects should also be considered. The management of animal damage to human property is necessary, and methods that allow the coexistence of livestock and large predators must be employed. With further research and development that includes interdisciplinary approaches to management methods, biologists may be better able to conserve large carnivore species by ameliorating human conflicts with them.

34. TREVES ET AL 2006 (WORLD WIDE). Conservationists recognize the need to work beyond protected areas if they are to sustain viable populations of wildlife. But ambitious plans to extend wildlife corridors beyond protected areas must consider the economic and political implications when wildlife forage on crops, attack livestock, or otherwise threaten human security. Traditionally, humans respond by killing “problem” wildlife and transforming wild habitats to prevent further losses. This traditional response, however, is now illegal or socially unacceptable in many areas, changing a simple competitive relationship between people and wildlife into a political conflict. As a result of experiences in Bolivia, Uganda, and Wisconsin researchers outline a strategy for mitigating human–wildlife conflict based on participatory methods and co-management with twin objectives of wildlife conservation and safeguarding human security. Incorporating local stakeholders as partners in planning and implementation can help to win space for wildlife beyond protected area boundaries. We also show why systematic study of local people’s perceptions of risk and participant planning of interventions are irreplaceable components of such projects.

35. SIME ET AL 2007 (USA-MT). The Montana gray wolf population grew from two wolves in 1979 to a minimum of 316 by late 2006. Resolving conflicts, both perceived and real, between wolves and livestock became a dominant social issue for the federal recovery program, and it remains so today. The United States Fish and Wildlife Service and now Montana Fish, Wildlife & Parks work with United States Department of Agriculture, Animal Plant Health Inspection Service, Wildlife Services (WS) to reduce depredation risks and address wolf-related conflicts through a combination of non-lethal and lethal management tools. The number of wolf complaints investigated from 1987-2006 increased as the population increased and expanded its distribution into Montana after reintroduction into Yellowstone National Park and central Idaho during 1995 and 1996. Montana wolf packs routinely encountered livestock, though wolf depredation was a relatively rare cause of livestock death and difficult to predict or prevent. Conflicts are addressed on a case by case basis and lethal control is implemented incrementally after predation is verified. Resolving wolf and livestock conflicts at a local scale is but one component of a larger state wolf conservation and management program.

36. STONE ET AL 2008 (USA-GYA). In 1999, Defenders of Wildlife and The Bailey Wildlife Foundation worked together to create The Bailey Wildlife Foundation Proactive Carnivore

Conservation Fund. One of the main purposes of this fund is to support research and on-the-ground use of tools, methods and strategies to reduce livestock deaths and therefore reduce lethal control of wolves. Five years later, Defenders established the Livestock Producer Advisory Council to provide advice from a producer's viewpoint. In 2006, Defenders brought together wildlife conservationists, university researchers, agency staff who work on wolf-livestock conflicts, biologists and members of the Livestock Producer Advisory Council for a Yellowstone-area workshop to evaluate proactive livestock protection tools and nonlethal methods and strategies that are helping to reduce livestock losses to wolves. This manual incorporates the experiences, insights and recommendations of the workshop participants and from ongoing discussions and interactions with livestock producers and researchers.

37. HARPER ET AL 2008 (USA-MN). Gray wolf depredations on livestock in Minnesota, USA, are an economic problem for many livestock producers, and depredating wolves are lethally controlled. Researchers sought to determine the effectiveness of lethal control through the analysis of data from 923 government-verified wolf depredations from 1979 to 1998. Data was analyzed by 1) assessing the correlations between the number of wolves killed in response to depredations with number of depredations the following year at state and local levels, and 2) the time to the next depredation.

38. TREVES 2009 (WORLD WIDE). A literature review was combined with researcher's experiences of working with affected communities in order to list and describe distinct types of methods used to mitigate human–wildlife conflicts (interventions). These methods were then classified as *direct interventions* that aim to reduce the severity or frequency of encounters between wildlife and property or people or *indirect interventions* that aim to raise people's tolerances for such encounters. The study summarizes the recommendations about the interventions with three complementary criteria: cost effective design, selectivity and specificity for the problematic wildlife, and sociopolitical acceptability. These three criteria are not prescriptions. Rather they capture experiences of strengths and weaknesses of each method under different conditions, so users can assess whether the interventions are feasible in their particular sociopolitical and biophysical situations. Finally this framework dovetails with recent standards for conservation planning.

39. RUID ET AL 2009 (USA-MN, WI, MI). Recovery of gray wolves in the Great Lakes region has been accompanied by an increase in wolf—human conflicts. The interface between owners of domestic animals and wolf recovery presents unique challenges for wildlife management. Investigating wolf complaints, explaining wolf ecology, conservation goals, and litigation that has impacted wolf management to people who have had domestic animals killed by wolves are challenges faced by those involved with managing wolf—human conflicts. In this chapter, wolf—human conflicts and management are described, focusing on the period 1974-2006, when wolves were protected under the ESA.

40. HAWLEY ET AL 2009 (USA-WI). Lethal control alone has not proven entirely effective in reducing gray wolf depredation in chronic problem areas. Opponents of lethal control argue that more emphasis should be placed on integrating nonlethal strategies into current management. However, few evaluations have tested the effectiveness of nonlethal options. Researchers compared behavior patterns in terms of frequency and duration of bait station

visits for five wolves fitted with shock collars to five control animals inhabiting wolf pack territories in Northern Wisconsin during the summers of 2003 and 2004. Prior to this research, shock collars had not been tested on free-ranging wolves in a controlled experiment. The study's objective was to determine if current shock collar technology could effectively deter free ranging wolf movements from using a desirable site. The study area comprised 9,000-km^2 of beef and dairy cattle operations at 1280 head per 100-km^2 in Northern Wisconsin, bordering the Upper Peninsula of Michigan. The topography was 64-percent forested encompassing federal, state, county, timber company, and private land with a wolf population of around 140 individuals comprising 40 packs and averaging 3.5 individuals per pack, or 1.5 wolves per 100 square kilometers. White-tailed deer were present at 1800 per 100-square kilometers. To avoid variation in wolf behavior and movement patterns, all research was conducted during the rendezvous season, when adult wolves leave pups in a designated area between hunting and territorial excursions.

41. MUHLY & MUSIANI 2009 (USA-MT, WY). Due primarily to wolf predation on livestock (depredation), some groups oppose gray wolf conservation in the Northwestern U.S., which is an objective for large sectors of the public. Livestock depredation by wolves is a cost of wolf conservation borne by livestock producers, which creates conflict between producers, wolves and organizations involved in wolf conservation and management. Compensation is the main tool used to mitigate the costs of depredation, but this tool may be limited at improving tolerance for wolves. Furthermore, livestock production may in fact provide indirectly an important benefit for wolf conservation – i.e. a positive externality, by maintaining relatively intact habitat on private lands. Researchers analyzed some of the costs of livestock depredation by wolves to livestock producers relative to recent economic trends in the livestock production industry, specifically income generated from livestock production and trends in land and livestock value. Data were gathered from depredation investigations, from the livestock compensation program and on land and livestock prices in Idaho, Montana and Wyoming, U.S.A. from 1987 to 2003 – a period during which wolves had endangered species status.

42. GEHRING ET AL 2010 (EU & USA). Europe and North America share a similar history in the extirpation and subsequent recovery of large carnivore and ungulate species. Both continents face challenges and opportunities for managing human-wildlife conflict at the junction of livestock production and wildlife conservation. Predation of livestock and disease transmission between wildlife and livestock is an ongoing and escalating worldwide issue. In order to manage this conflict, producers need effective tools, and they have used livestock protection dogs LPDs for reducing predation for well over 2000 years. This study reviews the history of the use of LPDs, including the loss of information on their use and the paucity of scientific research on their effectiveness. Researchers then discuss the potential for LPDs to be integral components in modern-day livestock husbandry and outline future directions to pursue.

43. LANCE ET AL 2010 (USA). Wolf predation on livestock can cause economic hardship for livestock producers as well as reduce tolerance for wolves. Lethal control of wolves is often controversial thus development of effective non-lethal methods for reducing wolf–livestock conflict is important. Electrified fladry is a new tool that is similar to fladry (i.e. a barrier system that scares wolves), but electrified fladry also incorporates an electric shock designed to

decrease the potential for wolves to habituate to the barriers. Evaluation of electrified fladry requires understanding of its effectiveness relative to fladry and the costs and benefits of applying it in the field. By using captive wolves, researchers compared the effectiveness of electrified fladry v. fladry for protecting a food resource during two-week trials. They then performed a field trial with electrified fladry for managing wolves in Montana, USA. Researchers measured livestock depredation and wolf activity on six treatment and six control pastures, calculated the cost of installation and maintenance, and surveyed all study participants about application of electrified fladry.

44. DAVIDSON-NELSON & GEHRING 2010 (USA-MI). Several forms of nonlethal management exist, but field testing is problematic, and few such techniques have been tested on free-ranging gray wolves or other predators. Researchers tested fladry in the eastern Upper Peninsula of Michigan during the summers of 2004 and 2005 on treatment farms and control farms.

45. RIGG ET AL 2011 (EU-SLOVAKIA). Conflicts with human interests have reappeared following recovery of large carnivores in Europe. Public acceptance is higher than historically but there is a need to identify effective, acceptable techniques to facilitate coexistence. We present a case study of predation on livestock in Slovakia. Livestock and large carnivores are largely confined to ranges in the Carpathian Mountains which are interspersed with lower-lying areas of higher human use and permanent settlement. Commercial forestry, game management, gathering of forest fruits and recreation (hiking and skiing) are common. The area studied was 793 km^2 and contained 95-97 percent of Slovakia's large carnivores, including Gray Wolves, Brown Bear & Eurasian Lynx. Native red deer, roe deer, and wild boar occurred at medium to high densities. Livestock comprised 164 flocks at 147 farms totaling around 79,000 sheep, primarily grazed in unfenced pastures and attended by one to five shepherds and a herding dog. In 2004 reported losses averaged 3.1 sheep per flock to wolves and 0.7 to bears, representing 0.8 and 0.2 percent of sheep losses respectively. Damage, mitigation measures and public opinion were assessed using compensation records, analysis of farm conditions, questionnaire surveys, semi-structured interviews, diet analysis and on-farm trials of LGDs. The study was conducted spring to autumn during the lambing season.

46. DIETSCH ET AL 2011 (USA-WA): This report documents the results of a study assessing the attitudes and beliefs of residents living in the state of Washington toward the following: the place where they live and wildlife, including the wildlife near their homes; lethal control of coyotes and black bears; management actions addressing problem deer/elk and the recolonization of Washington by wolves; salmon recovery; and the importance of and willingness to pay for wildlife-related services. Levels of participation in outdoor and wildlife-related recreation as well as beliefs about access to land areas for recreational opportunities were also explored. Findings are part of the larger research program entitled *Understanding People in Places*, a multi-state study designed to demonstrate the utility of geographically-tied human dimensions information for fish and wildlife management and to introduce and test a spatially-explicit approach to depicting such data.

47. FONTURBEL & SIMONETTI 2011 (WORLD WIDE). Translocation is a nonlethal practice used to manage carnivore-livestock conflicts. Nevertheless, its use has been

questioned due to its low success rate and high cost. Researchers performed a literature review to assess the effectiveness of translocation, human-related mortality and cost.

48. JACKSON ET AL 2012 (AFRICA-BOTSWANA). Researchers studied the effectiveness of targeted scent-mark deployments around the boundaries of the Northern Tuli Game Reserve to keep the ranging behavior of the endangered African wild dog (*Lycaon pictus*) within the safety of the protected area.

49. VERCAUTEREN ET AL 2012 (USA & EU). Dogs have been employed to protect an array of resources from various species of offending wildlife. Historically, LPDs protected domestic sheep and goats from predators based on development of a strong bond between protected and protector. Within reason, developing that bond between a LPD and other species of livestock should be achievable. Researchers conducted several studies in which they raised and bonded LPDs with bovine calves and evaluated them for protecting cattle in a variety of settings. Though successful strategies in developing LPDs to protect cattle were similar to those established for sheep, this study found differences that were important for optimizing the process. Strategies are outlined for developing LPDs for maintaining separation between cattle and wild ungulates that are reservoirs of disease that cattle are susceptible to, as well as wild carnivores that are predators of cattle.

50. AUSBUND ET AL 2013 (USA-ID). Conserving large carnivores can be challenging due to conflicts with human land use and competition with humans for resources. Predation on domestic stock can have negative economic impacts, particularly for owners of small herds, and tools for minimizing carnivore depredation of livestock are needed. Canids use scent-marking to establish territories and avoid intraspecific conflict. Researchers for this study hypothesized that human-deployed scent-marks (i.e., 'biofence') could be used to manipulate the movements of gray wolves in Idaho, USA. They deployed 65 km of biofence within three wolf pack territories during summer 2010 and 2011 and used location data from satellite collared wolves and sign surveys to assess the effectiveness of biofencing.

51. FOX 2013 (USA-CA). The Marin County Board of Supervisors approved a community-based program to assist ranchers with livestock-predator conflicts known as the Marin County Livestock and Wildlife Protection Program (hereafter MCLWPP). The MCLWPP is a collaborative effort involving multiple stakeholders from local wildlife protection organizations to ranchers, scientists, and county government officials. Five years after implementation of the MCLWPP, a research assessment was conducted (Fox 2008) that compared the former Wildlife Services program to the MCLWPP, with regard to rancher satisfaction and preferences, lethality to predators, livestock losses, use of nonlethal predator deterrent techniques, and costs.

52. VAN LIERE ET AL 2013 (EU–SLOVENIA). Researchers aimed to characterize differences between sheep farms in wolf habitat in Slovenia that either suffered from wolf attacks or not during the main pasture seasons of 2008–2010. Sustainable animal production is mainly limited to sheep and goat breeding in mountainous and hilly perennial grasslands with shallow soils of poor quality. This Natura2000 area is an EU protected natural corridor with high biodiversity maintained by grazing small ruminants. It links the Alps in the northwest with mountainous Gorski Kotar in the southeast border with Croatia. It is also the main Slovene

habitat for wolves. The total area of Slovene wolf territories is around 4700 km^2, implying a density of 1 wolf/100 sq km. The estimated total biomass of ungulates in these wolf territories is 245 kg/sq km. Sheep density was 23.3 per ha with goat mixed into the flocks on nine farms.

53. BECKER ET AL 2014 (USA-WA). In 1973, gray wolves were classified as an endangered species in Washington under the provisions of the ESA. In December 2011, the Washington Fish and Wildlife Commission formally adopted the Wolf Conservation and Management Plan to guide recovery and management of gray wolves as they naturally recolonize the State of Washington. At present, wolves are classified as an endangered species under state law (WAC 232-12-014) throughout Washington regardless of federal status. Washington is composed of three recovery areas which include Eastern Washington, the Northern Cascades, and the Southern Cascades and Northwest Coast. The WDFW is the primary agency responsible for managing wolves in the Eastern Washington recovery area while WDFW works as an agent of the USFWS in the remaining areas of the state. Wolves that inhabit tribal lands in the Eastern Washington recovery area are managed by those specific tribal entities.

54. JACHOWSKI ET AL 2014 (WORLD WIDE). Fences can both enhance and detract from the conservation of wildlife, and many detrimental impacts are associated with creating physical barriers. By contrast, virtual fences can restrict, control or minimize animal movement without the creation of physical barriers, and present key benefits over traditional fences, including: (1) no need for construction, maintenance or removal of traditional fences; (2) rapid modification of boundaries both temporally and spatially based on specific conservation concerns; (3) application of novel conservation approaches for wildlife that integrate monitoring, research and management; and (4) social-psychological benefits that may increase support for conservation. Researchers review the various types of sensory, biological and mechanical virtual fences, and the potential benefits and costs associated with fully integrating virtual fences into protected area management and wildlife conservation. The recent development of real-time virtual fences represents the potential for a new ‘virtual management’ era in wildlife conservation, where it is possible to initiate management actions promptly in response to real-time data. Wide-scale application of virtual fences faces considerable technological and logistical constraints; however, virtual fences are increasingly popular and soon will offer realistic management strategies for both terrestrial and avian wildlife conservation.

SUMMARIES OF STUDY FINDINGS

The findings from these studies are categorized into three focus areas: Husbandry Practices, Nonlethal Predator Control Methods, and Wildlife Management Strategies. Studies are referenced according to their numbering in the “Research Studies” section. Due to the complexities inherent in addressing multi-dimensional conflicts between livestock and predators, human applied strategies will also be multi-faceted. Therefore, certain studies will have findings reported across multiple categories. Additional context to the topics contained in these studies can be found in Appendix B.

SUMMARIES OF STUDY FINDINGS

I. HUSBANDRY PRACTICES

General Practices

STUDY 1. It is highly unlikely that any single factor is completely independent of other factors. Attempts to measure the data for the interaction of management practices was not possible. *Correlations between pasture characteristics and losses of sheep to predators do not necessarily imply cause-and-effect relationships.*

STUDY 8. On the basis of data and observations from 1975 to 80, the development and perpetuation of depredation problems in Minnesota was found to be related to three animal husbandry or farm management practices: 1) *Leaving livestock carcasses near farmyards or in pastures during winter and spring centered wolf activity there at calving time*. 2) *Allowing calving on pastureland also drew wolves to easy prey; and, 3) allowing livestock access to large wooded areas prevented them from being easily monitored.*

STUDY 29. Researchers for this study see *the greatest promise for reducing wolf depredation by improving animal husbandry, especially in high-risk seasons.*

STUDY 25. *Producers experienced less predation loss when they hauled away sheep carcasses, lambed during particular seasons, confined flocks of sheep to corrals, and maintained large flock sizes.*

STUDY 30. Depredation problems represent unique situations requiring consideration on a case-by-case basis to determine the best course of action. *Ranches should be individually assessed to determine which methods are most applicable given the time of year and sites where depredations are occurring.*

STUDY 32. Some people mistakenly believe that changes in livestock husbandry will prevent wolf depredation and that wolf depredations are often the producer's "fault." *Some conditions (sick cattle, carcass removal) are difficult to detect and resolve in remote areas.* Most wolf depredations occur on private land (70% of cattle and 48% of sheep).

STUDY 39. Wolf depredations occur in all habitat types including edges of densely populated urban areas. Population growth and range expansion of wolves has resulted in wolves occupying agricultural areas and increasing wolf-livestock conflicts. During expansion of wolf range in the Great Lakes Region, wolves have proven adaptable at occupying or colonizing human-disturbed areas.

STUDY 52. Within a year, repeated attacks by wolves usually occurred within 5 days of each other.

Facility Design & Location

STUDY 1. *Slightly more than 80% of all predator-caused losses were on 22% of the farms in the study. Sheep losses to coyotes were less on farms <1.6km from a town or human settlement than those located >8km.* On the other hand, sheep losses to dogs on farms <1.6km from a town or settlement were greater, likely being a reflection of predator density (more dogs than coyotes in human settlements). *As pasture size increased, rate of sheep loss to coyotes increased*. Rate of loss of sheep to dogs relative to pasture size was not as clear as for coyotes. Distance from a residence to the center of a pasture was not related to rates of losses of sheep to coyotes. Woven wire was the fencing material most commonly used. Fencing was designed to confine sheep, not exclude predators. Construction and maintenance of fences capable of deterring predators is expensive and the benefit would have to outweigh the cost. *Only a small portion of the sheep and lamb losses were in corrals. Losses of sheep to coyotes were higher in corrals without lights than with lights* but the reverse was true for dogs.

STUDY 4. Only *2% of 41 ranchers had experienced predation while flocks were corralled.* The average distance between corrals and hogan (homestead) was less than 200m.

STUDY 8. Aside from totally wooded pastures, areas with *a mosaic of fields and forests seemed to present the greatest opportunity for depredations*. *Wolves were reluctant to cross large open spaces. In areas with a sharp transition between expanses of forest and expanses of open pastureland, wolves generally remained in the forest.* The same finding was reported in the vicinity of Riding Mountain National Park, Manitoba.

STUDY 24. *Wolves preyed on livestock in townships sharing a consistent set of landscape features* across both states (Wisconsin & Minnesota) despite dramatic differences in the two states' wolf population sizes, wolf control policies and farm sizes. Pasture area and townships with high deer density was strongly and positively correlated with risk to livestock. Perhaps wolves select areas with many head of livestock. Alternately, deer prefer a mixture of forests and pastures so that wolves following the deer encounter cattle incidentally. *The roles of pasture and deer in wolf predation deserve further scrutiny.*

STUDY 29. Researchers detected a 3-season pattern to wolf depredations in Alberta, Canada and a 2-season pattern in depredation occurrence in the United States. *However, the greatest number of depredations occurred in August for both locations.* In Alberta and in the northwestern United States, there was a clear relationship between number of depredation occurrences in a particular season and occurrences during the same season in following years. *These findings indicated annual reoccurrence of depredation events.* [TABLE 1, p 880: Quantitative data tying control methods to depredations in western US and Canada.]

STUDY 30. The data from this study demonstrates that in the GYA, NWMT, and ID recovery regions that pastures with depredations compared to pastures without depredations were larger, had more cattle and were located further from human residences. These three ranch-size related factors were correlated. The data from this study found no differences between pastures with depredations and without depredations in regard to distance from forest edge, percent vegetation cover, cattle breed, cattle type and carcass disposal method.

The data from this study found no differences between pastures with depredations and without depredations for calving locations, calving duration and the date calving begins. Data from this study found that 5 of 7 pastures where depredations occurred during the wolf denning season were closer to wolf dens than grazed pastures on ranches without depredations. *Based on the above data, pastures predicted to experience depredations had elk present, had >310 head of cattle, and were far (>1,487.5,) from human residences. Elk presence was the variable most related to pastures with depredations and was the best predictive variable in classification tree analysis of pastures with depredations in combination with other variables.* Distance from human residence variable is still in question as this and other studies have experienced wolf depredations near residences.

STUDY 35. At a course spatial scale, the data suggest that most wolf-livestock conflicts in Montana occurred on private land and that some areas are more prone to conflict than others. *However, this could simply reflect that depredations are easier to discover on smaller, private pastures compared to losses on remote, rugged grazing allotments.*

STUDY 36. What type of livestock is being protected and where they are grazing are important considerations for creating a predation management strategy. *Permanent fencing has proven to be a very effective deterrent for smaller operations where livestock use night corrals or small pastures. For open range conditions, portable fencing and pens are more easily used and affordable*, but stress to livestock and native plants, and the conditions and restrictions of grazing permits must be considered.

STUDY 39. *The reoccurrence rate for wolf depredations on all species of livestock was estimated to be 23% at the farm level, 29% within 4 km of the farm, and 37% within 8 km of the farm. I*n Minnesota, the re-depredation rates were higher for sheep and turkey than for cattle. Wolves may live near livestock without causing depredations and proportionally few wolf packs cause depredations. *Generally, wolves kill livestock opportunistically when they find livestock in close association with wild prey.*

STUDY 52. There was no statistical difference between farmers with or without problems with wolves in the size of fenced area, herd size or density. *Number of sheep killed per attack tended to correlate positively with herd size and density. Farms with wolf attacks more often used open night barns or no night enclosure at all than farmers without attacks.*

Herd Management

STUDY 1. Kansas' primary lambing season is October-December during a time when predator demand for food is low. *Rate of sheep loss to coyotes and dogs was greater in flocks that lambed during January-March than in flocks that lambed in October-December or year-round. The highest monthly rate of sheep loss to coyotes and dogs occurred in flocks pastured day and night with no access to a corral, and the lowest rate of loss was in flocks confined to corrals day and night. Most predator losses occur at night so a pasturing-confinement scheme that takes this into account is a major option to reduce losses.* Lambing in confinement, although less convenient for large range operations, may be an economically feasible alternative if large losses of lambs are being incurred by individual producers in certain

geographic areas. The data for this study indicate that sheep confined near human residences suffered less loss to predators than those far from residences, but the evidence was not strong.

STUDY 4. Eighty-eight percent of 51 ranchers herded mixed sheep-goat flocks for several hours in the morning and night. Twelve percent said they herded flocks throughout the day. Flocks were returned to corrals or kept near the homestead between foraging periods, which took place on open rangeland with no fencing*. A combination of walking and riding horses were used. LPD's were present at all times. Few ranchers had lost LPD's to coyotes.*

STUDY 21. The data indicates that for each day older a calf is when turned out onto an allotment, the calf's risk for wolf predation drops by five percent (5*%). On average, the surviving cohort of calves from our study were 24 days older than that of the wolf-killed cohort*. *Maternal age and experience level, as well as birthdate of calves, should be evaluated more fully as potentially predisposing livestock to wolf predation. Core area overlap between wolves and cattle appear to result in a higher predation rate for that herd. Cattle likely constitute a secondary prey item, one killed opportunistically by wolves. On several occasions wolves were observed in close proximity to cattle (<500m) without resulting in either predatory attempts or clear avoidance behavior by either species.* Wolf predation risk did not influence cattle movement patterns or group size, suggesting *that wolf-caused mortalities were not frequent enough to influence cattle behavior*. *Managers may be able to minimize the spatial overlap of wolves and cattle by implementing a system to move cattle away from wolf core areas during periods of intensive activity.*

STUDY 29. Grazing practices and *seasonality of calving* might explain the 2-season pattern of wolf depredation documented for the United States, *with more attacks occurring March-October* than from November-February. Unlike wild ungulates, domestic prey species are not allowed to move to new areas or to select suboptimal habitat to reduce depredation risk. This further explains adherence of temporal patterns in wolf depredation to patterns in grazing and calving practices. The data on seasonality of wolf depredation and on reoccurrence of seasonal patterns across years suggest wolf attacks on livestock are predictable across time. Ranchers and managers can use this data for predicting wolf depredation risk and for planning in advance investment of resources to prevent depredation increases.

STUDY 25. *Wolves predate on sheep 2-30x more than cattle and the phenomenon of surplus killing is only associated with sheep*.

STUDY 36. *Keeping records of wolf-livestock interactions and related observations can help producers identify trends, problem areas and vulnerable times of year, which can help improve the effectiveness of targeted, preventative measures. Count livestock on a regular basis. This is especially true in large pastures or areas with dense vegetation and/or rugged terrain where livestock could go undetected for weeks or months. When options are limited, moving livestock to an alternative grazing location temporarily to avoid wolf conflicts can be a win-win situation.*

STUDY 41. Findings on food waste and on killing in excess of food requirements demonstrate that wolves conduct 'excessive killing' on sheep (1.07 cattle/per attack, 14.48

sheep per attack) demonstrating their vulnerability as a prey species. Researchers were unable to assess if wolves would return to carcasses to consume more meat if human disturbance of the carcass had not occurred. *The number of cattle and calf losses due to the category called "other predators" (including wolf, grizzly, black bear) was no more than 3% of all mortality In Idaho, Montana & Wyoming during 2005.*

STUDY 45. *Losses reported from 93 flocks kept in pastures at night averaged 3.6 sheep per flock compared to 0.4 for 47 flocks always or sometimes returned to a barn. Losses dropped to zero when flocks were confined to barns in winter.* This study found no correlations between predation and flock size, number of dogs or shepherds' experience.

STUDY 52. The start or ending month of the pasture season did not differ between farmers with attacks and those without.

Human Presence

STUDY 1. The personal contact with all cooperating producers coupled with a monthly reporting system, which reduced reliance on the producer's memory, greatly increased the accuracy and reliability of the livestock loss data gathered.

STUDY 4. All family members participated in herding duties. The herder did not devote constant attention to the animals but intervened as necessary to change direction of the herd toward a desired grazing location, a water hole, or toward the homestead.

STUDY 5. The essential difference between management of dogs in the U.S. (mainly farm operations) and in Europe (mainly range operations) tends to be *the amount of time owner-operators spend with their stock.*

STUDY 13. *Important additive factors to the LGD effectiveness were the attentiveness of the herder, disposing of carcasses (burned,) and regularly moving the herd.*

STUDY 20. Guard dogs are used effectively in Europe and northern Asia where shepherds and ranchers work direct with the dogs. North American ranchers use guard dogs less frequently. In addition, dogs are often left alone to guard livestock, and some evidence suggests that this makes guard dogs less effective.

STUDY 32. *It is uncertain if more human presence (range riders) among widely distributed livestock like cattle reduces the risk of wolf depredation.*

STUDY 36. *Range Riders can monitor cattle while looking for signs of wolves and other predators, scaring any away. Sheep herders can work in shifts, with the herder on night duty focusing on spotting and scaring away predators while sheep are on bedding grounds.*

Livestock Guardians

STUDY 1. *Lower losses of sheep to coyotes were incurred by those with dogs compared to those without*. However, higher losses of sheep to dogs were suffered in this category.

Additionally, farm dogs may attract free-running (feral) dogs and may be enticed into killing sheep. Three producers reported their dogs killed sheep while six producers reported catching neighbor's dogs killing sheep and lambs.

STUDY 4. *LPD's were associated with herds throughout the year and were not excluded from any husbandry practices such as shearing, dipping and lambing*. Most ranchers said their dogs could not catch coyotes but mostly kept them away by chasing and barking. Most believed depredations would increase without the protection of dogs. *Ranchers said the simplest method of training pups to guard sheep was to raise them with an experienced sheepdog, preferably their mother.*

STUDY 5. Prevailing beliefs that guarding dogs would be more successful in fenced pastures than on range operations were not sustained, either in the national data or in the Oregon Pilot Project. In the United States, the only places where dogs were judged not effective were those where sheep scattered widely over a great area and never flocked, or where producers did not spend more than a minimal amount of time with the flock. *Dogs that protect livestock have to display a set of behaviors appropriate to their work. The natural variation in guarding dogs can be capitalized on by matching its behavior with the type of livestock operation and/or the style of the producer. Problems arose on farms with mixed stock where experienced dogs that were socially bonded to one species displayed predatory or protective displays against other species.* Disadvantages arose when a few dogs, trustworthy with sheep or goats, drove deer from the range where a producer earned part of his income from hunting leases. Producers for the most part were willing to accept the "mistakes" of young dogs, or an occasional loss of new lambs or odd sheep, due to the overall reduction of predation on the flock. *Guarding dogs enter into social interactions with predators, rendering their predatory behavior contextually inappropriate at best and inefficient at least.* This means that the predator may totally avoid a dog-guarded flock, or else enter into greetings, scent-marking, dominance displays, play, exploratory behavior or ritualized aggression, any one of which diverts the predator from attacking the stock. Thus the mere presence of the dog has the effect of disrupting a predator's behavior and thereby reducing predation on farms and ranches by 60-70% or more. This management system has attracted increasing attention and use not only because of its effectiveness but because producers feel they can take charge of what happens on their farms or ranches.

STUDY 6. Ratings of dogs from small pasture operations (<50 head) were better than for dogs on large pasture or range operations (m=1000 head). However, range operators only made up 10% of the study sample (39 operators) and of those, 66% rated their dogs very effective, 19% somewhat effective, and 15% not effective. All but one range operator recommended use of LGDs. *The top two common breeds for guarding from this study were the Great Pyrenees and Komondor. Dogs were more successful when they were reared with livestock from the time they were ≤2 months old.* Despite the indication that mixed-breed dogs of non-typical guarding stock may be effective guardians, few were identified in this survey.

STUDY 8. Effectiveness of dogs seems to be reduced in wooded or brushy pastures where livestock are dispersed, and in situations close to neighboring residences or other farm operations.

STUDY 10. Before producers obtained their guard llamas, they had been losing an average of 26 head (11%) annually to predation. After obtaining llamas, producer's losses dropped to 8 head (1%) annually. All producers reported continuing to use other preventive and control methods in addition to the llamas. Llamas averaged 2 years of age when introduced to sheep, with the most common age being 6-11 months. For the 201 flock introductions reported, the initial adjustment period lasted anywhere from a few hours to a week. Introductions were most effectively made in a corral. Llamas are canid aggressive and can be aggressive towards herding dogs and family dogs. Predation was higher in flocks guarded by multiple llamas then flocks guarded with a single llama. There appeared to be no differences in losses on open rangeland versus rangeland with cover (forested, shrubby, gullies, etc) but this needs further study. It appears that llamas do not reach their full protective potential until 1 to 2 years old. 80% of producers said that daily care for the llama is the same as the sheep, and no special feeds are given. 25% of 61 intact males and 5% of 135 gelded llamas attempted to breed ewes. In one instance a single male killed 100 ewes before the problem was determined. Five percent of producers reported their llamas were overprotective, so much so that they couldn't work with the sheep. *How guard llamas respond to group hunting canids is unknown. One rancher reported a 7-month old llama was killed by a group of coyotes.* [TABLE 1, TABLE 3, p9: Comparison of characteristics of guard llamas and guard dogs]

STUDY 11. *Further experiments should document how llamas react to canid predators in larger, fenced pastures, in open-range situations, and with flocks of different sizes.* More research is needed to determine how guard llamas react to the approach of more than one predator, such as group hunting canids.

STUDY 13. This study demonstrated that the top three rated livestock guardian dogs were Akbash, Great Pyranees and Komondor. It also showed that lambs have a statistically greater survival rate with guard dog presence while ewe survival rate did not vary. Open range producers experience higher mortality rates overall when compared with fenced pasture and feedlot operations. Producers who did not have guard dogs lost 5.9 and 2.1 times greater proportions of lambs to predators than producers who had dogs in 1986 and 1993 respectively. *Producer ratings of guard dog effectiveness at deterring predators did not differ between fenced pasture and open range operations. The data for this study indicates that guard dogs are more effective against mountain lions and black bears as predators on open range systems. Ewe and lamb mortalities decreased with the number of years producers used dogs*. Mortalities in this study did not vary with the number ewes or lambs/guard dog nor with the number of dogs/herd. This relationship may reflect producers adjusting numbers of ewes or lambs/dog or numbers of dogs/herd for each operation until mortalities are reduced to a certain level. Producers estimated that their guard dogs saved $891,440 of sheep from predation during 1993. This savings has an economic "multiplier effect" of about 2.7 which suggests the use of guard dogs added about $2.4 million of value to Colorado's economy during 1993.

STUDY 15. LGD are different from herding dogs. Herding dogs behave more like a predator with livestock threatening flocks and herds to move with clear predatory mannerisms. Guarding dogs are genetically adapted to retain some adolescent traits into adulthood, thus encouraging behaviors that bond them to their flock or herd. *To be effective LGD are required to be more strongly bonded to livestock than to humans. It is critical to remember that the dog*

is a working dog and not a pet. Because LGD are often used in conjunction with other predator control methods, it is difficult to attribute such reductions to LGD alone; however, many ranchers have been able to reduce other control measures after incorporating LGD into their management system. *A crucial factor is early bonding to the flock, accomplished by placing 6-8 week old pups with the sheep. Pups older than ten weeks have passed the primary socialization stage where bonding is most successful, although some individuals have been bonded as late as twelve weeks (but with less positive results). It is recommended that LGDs be established with livestock in possible conflict zones before wolves arrival, giving the LGD time to establish a territory.* Data collected in the Absorka Mountains in Montana from 1990-1993 documented 40 bear-sheep encounters. Of these encounters, 29 sheep were killed in the 2 years before employing LGD's and 7 sheep were killed in the 2 years after employing dogs. *The use of donkeys and llamas as guardian animals isn't as promising as LGD's because most livestock are grazed on the open range and these animals need enclosed pastures to work best.* In addition European depredations are usually from large predators on open range systems where these guardian animals are likely to become prey themselves. 81% (91 total) of open range producers rate their dogs "effective" or "very effective" compared to 79% (671) of fenced pasture producers.

STUDY 20. *Guardian animals besides dogs remain largely untested against wolves, but a few anecdotes suggest little benefit.*

STUDY 26. *Wolves infrequently kill dogs and usually do not eat them. Only a few dogs killed in the NRM were fed upon and most conflicts appear territorial and competitive. At least 18 LGDs have been killed by wolves between 1995 and 2004 in the NWMT and GYA recovery zones.* The data from this study suggests that dogs are more likely to be killed by wolf packs. *Conflicts peak in summer when wolves are rearing pups and LGDs are in remote areas and most likely to encounter wolves.* Some conflicts occur in winter when wolf breeding behavior seems to make them more territorial and wolves seemed to seek out dogs. *All dog conflicts including LGDs suggest attacks by wolves are more likely when people are not present and the dogs are outnumbered or out-weighed.* Researchers of this study have never documented wild wolves and dogs breeding in the wild. LGDs have been an attractant to wolves and in some cases have befriended them, allowing the wolf to depredate on the livestock (sheep in the case cited) and in some cases joining them. Wildlife professionals speculate that multiple LGDs can repel lone wolves if the wolf does attempt to challenge them, and behaviorally, multiple LGDs might be less likely to 'accept' a strange wolf as a companion. *The case studies in this paper show a pattern where wolf packs with established territories and pups perceive dogs as trespassing 'wolves' and will, in some cases actively, seek out and attempt to attack and kill them. The authors speculate that defense of territory and pups is "considered a life and death matter by wolves."* Almost all of the dogs, including LGDs, were killed in areas within resident pack territories and were not being directly protected by people. LGDs can help reduce losses and are most likely to be successful when used in combination with other techniques to reduce the potential for depredations on livestock by wolves.

STUDY 32. Wolf packs search out, attack, and kill guard dogs so multiple dogs are often needed and herders must be nearby to protect dogs. Interest to try spiked collars to protect the guard dog was very limited, and they were rarely used in the field because the sharp spikes

were perceived as a nuisance to the guard dog, other dogs, equipment, and herders.

STUDY 33. Dogs and other guard animals can be thought of as behavior-contingent, multi-sensory disruptive stimulus producers, and continued understanding of their training and use may result in what amounts to the ultimate disruptive stimulus device.

STUDY 36. Breeds that make good LGDs are not the ones that make good livestock herders. The ability of LGDs to protect cows from wolves has been tested (MN, MI) and some dogs demonstrated that, if managed correctly, they could be effective. *LGDs defend livestock from wolves most effectively by alerting people to the presence of wolves, not by fighting off wolves. Once they sound the alert they need human support, such as a herder who can use other methods to deter wolves by scaring them away. Keep LGDs away from active wolf den sites to avoid increasing conflicts with wolves' protective of their pups. For LGDs to work successfully, a thorough understanding of guard dog training and management and how this approach will work into a producer's management system is vital.*

STUDY 39. Wolf attacks on dogs in Michigan usually occurred during hunting and training for hunting and generally occurred on lands open to public hunting while hunters were ≥200 m away. Wolves use rendezvous sites during July through early October and will aggressively defend these sites, especially from other canids.

STUDY 42. The integration of LPDs gives producers an opportunity to become active managers in protecting their livestock, helping them become integrated and active stakeholders in the wider management process. Preliminary studies suggest that LPDs are effective for excluding mesopredators (e.g. foxes, raccoons, skunks) from pastures, reducing predation on ground nesting birds. Consideration of diseases that LPDs might introduce or perpetuate must also be considered and preventive actions taken. The researchers for this study support the opinion that LPDs are excellent disruptive-stimulus tools, and would further suggest that LPDs may be an aversive-stimulus tool that can cause predators and ungulates to modify their behavior (e.g. shift spatial use or time spent in an area due to the presence of a perceived threat). Several interactions between wolves and LPDs (recorded using a thermal camera, France) strongly suggested that wolves were not frightened by the presence of LPDs. Researchers observed two wolves remaining on the same alpine pasture for 10 hours and interacting with LPDs a minimum of 15 times. This suggests one role of LPDs is to disrupt the predatory behavior of wolves. *Additional research is needed to gain a better understanding of why LPDs are sometimes killed by wolves, how the number of dogs in use might relate to this, and whether LPDs attract wolves.* More rigorous research is needed to definitively assess the effectiveness of LPDs in preventing livestock depredations from wolves or reducing the risk of livestock contracting zoonotic diseases. *Research is needed to develop guidelines for use of LPDs with livestock on open ranges or on small alpine pastures in cases when a shepherd is not present.* Additionally, direct study of the economics of using LPDs might include more refined cost-benefit modeling to assess producer risk as well as the conservation value of LPDs. Information exchanges between those producers who already use LPDs and those who do not in Europe and North America could lead to the development of a program for research, education, and outreach that would further address the modern conservation challenges of protecting livestock and conserving valued wildlife.

STUDY 45. Of 34 LGD pups that were placed at farms in Slovakia during 2000-2004, 17 were successfully integrated into flocks during their first full grazing season, five were partially integrated, ten were separated from livestock by shepherds and two died. *Total known mortality by two years of age was ≥7 of 68 dogs, none by predation activities. Three more disappeared.* The presence of LGDs was associated with lower levels of predation and an absence of surplus killing. The mean loss reported at 13 trial flocks in 2002 was 1.1 sheep compared to 3.3 for 45 control flocks in the same regions.

STUDY 49. This study provides a general strategic plan from which others can derive their own tactics for developing LPDs to protect cattle from a variety of wildlife-related risks, such as disease and predation. Too much interaction has potential to render LPDs less effective in protecting livestock due to lack of motivation to remain with cattle and desire to be with humans. It is important, however, that pups are familiarized enough with producers that they can be caught and handled for training, transport, and routine health care. On two occasions LPDs abandoned their herds and began to chase and kill livestock nearby and had to be euthanized. This situation emphasizes the importance of routine monitoring and maintenance of LPDs by producers to ensure success. *Breed selection and number of LPDs to employ should be based on likely adversaries and characteristics of the surrounding environment.* Researchers observed that cattle can respond aggressively to predators in response to particular dog vocalizations. This study suggests that it is easier and safer to introduce a LPD to calves or heifers than with adult cows, and especially cows with calves. The specific calves researchers started their pups with remained with them throughout the research (2-4 years) which was believed to help later transition into larger herds. Naive cattle were quick to accept the LPDs presence along with its associated calves. The larger a given fenced pasture or the higher the local density of deer the less likely LPDs could be expected to keep deer from entering areas occupied by cattle. Researcher observations and producer accounts noted occasional cases of LPD killed mesopredators in protected pastures. Researchers found most producers using LPDs deemed them an asset and cost-effective supplement to their management regime. In these studies, LPDs demonstrated the ability to effectively protect livestock when raised with attention to details such as building strong bonds with cattle, minimizing potential to roam, and providing a suitable level of protection for the level of threat. [TABLE 1, p. 130: Common problem behaviors encountered with employing livestock protection dogs and methods for correction (with references) as observed during research directed at protecting cattle from wildlife-related risks in USA and Europe.]

STUDY 52. There was no difference between wolf attacks for farms with or without guarding dogs. Of the 30 farmers with wolf attacks, there was no difference between those with and those without guarding dogs in the number of sheep killed per attack. Four farmers with wolf attacks and 3 farmers without had guarding donkeys. Guarding donkey presence did not affect the number of sheep killed per attack.

STUDY 53. During 2013 in Washington, two wolf packs were responsible for 3 confirmed dog injuries and 1 dog mortality.

Reducing Attractants

STUDY 1. *Producers who buried carcasses or had them hauled away had lower losses to coyotes than producers using other disposal methods.* [TABLE 3, p. 901: Variables within management practices with differences in losses of sheep to canine predators.]

STUDY 8. Losses near buildings were usually in early spring when wolves were visiting livestock carrion that had been disposed of outside the farmyard during winter.

STUDY 18. *One Canadian study found that on farms that promptly removed dead livestock, predator losses were lower than on farms where dead livestock were not removed.*

STUDY 30. This study found no evidence that carcass disposal method was related to depredation problems. Researchers believe that the question of carcass disposal would best be addressed with information on carcass presence or absence near the time of depredation, and, more specifically, whether wolves had fed on the carcasses.

STUDY 36. *Hauling away, burying or burning livestock carcasses rather than leaving them in the field to rot reduces the chances of attracting predators.*

STUDY 39. *Fritts et al (1992) reported improper disposal of livestock carcasses may condition wolves to prey on livestock. Bradley and Pletscher (2005) found no relationship between livestock carcasses and depredations in Montana and Idaho, and Mech et al (2000) reported this relationship was inconclusive.*

II. Nonlethal Predator Control Methods

General Practices

STUDY 8. During this study flashing highway lights were installed at farms in response to 36 depredation complaints, surveyor's flagging was placed on farms in at least 8 instances, and a combination strobe light-siren device was placed at the problem site in 6 instances. These devices were used along with trapping in 17 instances. *Whether these nonlethal devices were successful in frightening away wolves is not certain. The public must be educated to realize that nonlethal methods will work only in certain circumstances and have realistic expectations of them.*

STUDY 9. *Penning sheep at night or fencing them was the most commonly used technique by CFA respondents to reduce coyote predation. Some respondents also reported using guard animals (dogs and donkeys).*

STUDY 23. It is suggested that solutions to human-carnivore conflict can be classified as those that modify behavior (of human, livestock or carnivore) and those that prevent the activities of humans and carnivores from intersecting in space.

STUDY 32. *The effectiveness of nonlethal tools seemed to be enhanced when several types were used in combination.*

STUDY 33. There are two conceptual approaches to repelling carnivores. Disruptive stimulus approaches act by disrupting appetitive behaviors and frightening predators away from resources. Aversive-stimulus approaches seek to modify behavior through aversive conditioning of the predator.

STUDY 35. The effectiveness of nonlethal tools seemed to be enhanced when several types were used in combination with each other. Wolf specific nonlethal deterrents have all worked and they have all failed at one time or another. Circumstances are different for each livestock operation, and the key is to select nonlethal tools that are economically feasible and have the greatest potential to decrease conflict in each unique situation.

STUDY 53. In Washington state wildlife managers have employed the following nonlethal and preventative control measures to minimize wolf-livestock conflict: fladry, electrified fladry, RAG boxes, hazing, increased operator presence around range livestock, range riders, providing wolf location data to livestock producers and range riders, and removal of injured and/or dead livestock from grazing sites.

Disruptive Stimuli

STUDY 22. The effectiveness of disruptive stimuli can be prolonged by randomizing stimuli and location and by using behavior-contingent technologies that selectively activate dependent upon behavior of the predator being repelled. *Effectiveness of disruptive stimuli is possibly influenced by availability of alternative food resources and if unprotected food resources are not available, the effectiveness of any nonlethal technique is limited.*

STUDY 33. *Predators will rarely form a conditioned response to disruptive stimuli; rather, they normally habituate to the stimuli, which eventually renders the approach ineffective.*

Fladry / Electrified "Turbo" Fladry

STUDY 20. In captivity, wolves appear willing to risk crossing fladry only after an extended period of food deprivation (>28 hrs). Results with captive wolves suggest that wolf avoidance of fladry decreases when food attraction is coupled with the stress associated with social separation. *The limited duration of fladry's effectiveness in captivity suggests that it would also be only temporarily effective for the management of wolves in nature. Results with baited sites and cattle pastures in Alberta suggest that wild wolves can be effectively excluded for at least 60 days from food sources and smaller areas (≤25 ha) by fladry barriers. The presence of available prey outside the fladry boundary is critical for enhancing its effectiveness. Fladry increases time and energy invested in testing prey vulnerability. Therefore, theoretically, wild wolves should leave the area to seek alternative prey and not risk crossing fladry.* Field experiments should be conducted without researchers monitoring the structures on foot in order to distinguish between avoidance of people and avoidance of fladry.

STUDY 22. Fladry has limited effectiveness for wolves and it does not appear to be as effective for other predatory species.

STUDY 32. *Fladry is more portable and less expensive to purchase and install than wire fencing. Fladry does not appear to inhibit the movements of wildlife other than wolves. Turbo-fladry incorporates a shock and is much more effective. Fladry must be constantly maintained due to wind and livestock caused damage.* Wolves habituate to fladry barriers in a few weeks or may walk adjacent to the line until they can find a place to cross.

STUDY 33. Fladry's effectiveness on less wary species (e.g. ursid and avian predators) is limited and initial estimates indicate a 60-day period of effectiveness for wolves. "Turbofladry" incorporates electrically charged wires with a fladry barrier. Using electrified wires paired with novel signals may promote an aversion to a barrier such as fladry.

STUDY 36. *Fladry can be used alone or as an addition to permanent or portable fencing. It is relatively inexpensive, but must be properly installed and maintained.* Turbofladry, fladry hung on electrified fencing, can increase the length of time that fladry is an effective barrier against wolves.

STUDY 37. *Human activity may be at least partly responsible for the effectiveness of fladry. Waning of the aversive response to the fladry could have been caused by habituation to the fladry or to the human scent.*

STUDY 39. From 2004-2006, WS installed fladry on nine farms in Wisconsin after wolves depredated (four farms) or harassed livestock (five farms). After 60-180 days on each property, anecdotal evidence suggested that wolves only crossed this visual barrier once and never depredated livestock within an enclosed pasture.

STUDY 43. Electrified fladry is similar to fladry in that it consists of flagging, however the nylon tine that supports flagging is replaced with an electrified wire. Electrified fladry relies on this additional aversive conditioning technique to increase its effectiveness after habituation has begun. Fladry kept captive wolves from crossing to food resources for up to 7 days. Electrified Fladry kept them from crossing for up to 14 days, but this was limited by the observation time of the study and needs further research. Wolves are adapted to feast and famine cycles and can survive for up to 17 days between feedings. The data from this study suggests that the duration of habituation to fladry is less when coupled with an increase in food motivation. *Duration of success and rate of habituation is dependent on individual behavioral variations. Thus failure of non-lethal tools such as fladry may partly depend upon persistent and bold individuals within a population.* Maintenance and installation has the potential to be a limiting factor in the applicability of electrified fladry. A change in the design to an integrated approach with existing fencing would decrease the number of people, supplies, installation time, transportation and handling.

STUDY 44. Researchers observed two wolf visits inside fladry-protected pastures when the fladry barrier was not properly installed or maintained. The first fladry (+21 days in place) failure was due to calves pulling down a 200 m section as they escaped. The second failure (+26 days in place) occurred when the producer failed to re-attach a fladry gate to the fence line after leaving the pasture. *Wolf visitations inside pastures compared to those outside pastures were less on fladry-protected farms, whereas, we found no difference in wolf visitations both inside and outside pastures on control farms.* The study found no difference in coyote visitations inside and outside pastures on treatment and control farms. Coyotes first crossed the fladry an average of 47 days after fladry establishment. During the 2004 field season, there were no wolf or coyote depredations on either fladry or control farms. During the 2005 field season, there were no wolf depredations on either fladry or control farms, but we did document 8 verified coyote depredations on 1 sheep farm with fladry. *The total costs to establish and maintain fladry on a 150-ha farm would be $4,392 [2010 figures] per year. It takes 40.8 labor hours to install a fladry line on a 150-ha farm. Annual depredation losses would have to exceed 37 lambs or 11 calves to equal the approximate costs of using fladry on a 150-ha farm.* It is important for farmers to gauge the risk of depredation with the cost and time commitments of using fladry on their farms. This study suggests that fladry, if it is maintained, can exclude wolves from livestock pastures for up to 75 days. Additional research should focus on the relationship between the frequency of visitation to fladry-protected farms and the time it takes for wolves to become acclimated to it. There was no long term exclusion for coyotes from fladry protected pastures discovered in this study. Researchers speculate that the gap on the standard fladry used in this study may have been too great relative to the size of the coyote and did not prevent them from

accessing pastures. Future research should attempt to determine if modifications to standard fladry can effectively exclude coyotes from sites. *Researchers from this study suggest that it is important to install fladry independent and outside of existing livestock fencing.*

Visual & Acoustic Scare Devices

STUDY 8. *The combination strobe light-siren device reduced coyote depredations on pastured sheep when three to six devices were used, and thus may deserve systematic research trials with wolves in the future.*

STUDY 16. *No systematic research has been conducted to test the effect of frightening devices on livestock depredations by wolves.*

STUDY 19. *Visual and acoustic repellants act as disruptive stimuli to reduce a predator's desire to enter or stay in the area where livestock is located.* Rapid habituation can occur when the stimuli are not linked to any particular behavior of the predator. *Preliminary results indicate that RAG boxes are effective at deterring wolves from depredating cattle in small pastures.* An important limitation to the RAG device is that wolves or other predators need to be wearing a radio collar to activate it. Despite this limitation, RAG boxes may still prove cost effective in many management situations because of the high costs of other strategies (translocation, lethal removal). RAG boxes are not designed for open range situations but this drawback can be overcome by altering husbandry practices to incorporate night penning or pasturing of cattle or young calves. Continued monitoring in a variety of management situations and over a longer period of time will provide better understanding of RAG devices and their effectiveness for managing wolves.

STUDY 22. The MAG technology repelled all vertebrate consumers until the conclusion of the study. We did not evaluate the duration of effectiveness for the MAG device but such research is necessary, especially because different responses are likely from different predators.

STUDY 32. Wolves are afraid of novel stimuli and strange noises and light can temporarily displace them. *RAG can detect and record approaches of radioed wolves, allowing for more targeted control.* Wolves habituate to strange stimuli, especially when they go off regardless of wolf proximity. Scare devices can frighten and annoy livestock or people if close to dwellings [or on recreational lands]. *RAG devices require training and radio-collared wolves to work, and they are too bulky to use in remote areas. Individual devices cover a relatively small area and require livestock be confined.*

STUDY 33. The RAG is complicated because it requires radio-tagging predators, a significant effort. *The MAG uses passive infrared sensors to detect approaching predators. In a multi-predator system it has been determined that electronic devices (MAG) were more effective than passive disruptive stimuli (fladry) or electronic training collars.* More sophisticated sensor designs using radar and other technologies may result in sensors that are useful in a wide array of predation management situations. *Many aspects of electronic disruptive stimulus devices require more thorough research. The optimum area and duration of effective protection*

are not known.

STUDY 36. RAG boxes are most effective for small pastures (<25 hectares). With a range of up to 300 meters, the RAG device is not designed to protect cattle on large, open range operations except when cattle are bunched during calving time or corralled at night. *The RAG box's internal computer can record the number of times the box has been activated and which radio-collared wolf triggered the device, which can provide valuable information to managers on local wolf activity.*

Real Time Virtual Fence (RTVF) / Remote Alarm Aid

STUDY 28. The Remote Alarm Aid is a system designed to alert management personnel to the presence of individual radio-tagged black bears in off limits areas of Yosemite National Park. Bear managers were able to detect four times the number of bears entering off limits areas with the message transmitter active than when it was inactive. *The alarm system helped park personnel focus search efforts to areas known to contain bears. The alarm system increased awareness and alertness of personnel, increasing their detection rate and improving their bear-human conflict avoidance hazing program.* Inherent variation in radio-transmitter signal strength made a zone of uncertainty around each monitoring system where an animal could have been detected. Furthermore, as the radius of the detection distance increased the size of the uncertainty zone increased logarithmically.

STUDY 54. Elephants in south and central Africa are managed to stay within the boundaries of game preserves with cellular phone based transmission of real-time GPS location data from collars that trigger when the animal leaves an area. A task force is then dispatched to haze the animal back into game reserve boundaries. Alarm messages can be modified and restricted to certain animals, certain areas or certain times of the day or night. *The RTVF system allows for the management of risk across a wide geographic area without having to fence off areas physically, which causes impacts to a whole host of species other than the one being managed for.* Managers could establish virtual fence polygons surrounding key refuge and corridor areas that alert them to when human access to those areas should be limited. The organization "Save the Elephants" is developing an alert network that extends beyond wildlife managers to include private landowners outside of protected areas who can register their lands so as to be warned when elephants (in this case) have crossed or are approaching a virtual barrier near their land, (elephants raid agricultural crops). *There are at least 18 companies that produce satellite or cellular phone-based GPS collars for wildlife, at least four of which have the capacity to be integrated into a RTVF system.* Through RTVFs managers can gain detailed monitoring records of animal movement that are well suited to adaptive management programs, and that can enable improved protected area management. For RTVF systems, the availability of real-time locations can facilitate human-wildlife interactions, providing managed viewing opportunities as well as helping to mitigate potentially dangerous interactions

Aversive Stimuli

STUDY 12. This study suggests that prey-killing aversion can be most readily established by applying response-contingent aversive stimuli during the chase and attack phase of the predatory sequence.

STUDY 16. Aversive conditioning refers to the elimination of an established, undesired behavior, by associating that behavior with some negative conditioning stimulus. The retention time of the conditioned response and the number of treatments necessary to achieve it are important measures of the success and practicality of a particular conditioning stimulus.

Electric Fencing

STUDY 7. *Livestock management workloads decreased after electric fence installation for 32 of 51 (67%) producers. A reduction in the need for lethal control after installation of electric fences was reported by 38 of 51 (75%) producers. About 95% of producers in this study said that electrical malfunction was a chronic maintenance problem. Potential for electrical malfunctions, physical damage, additional gates, more washouts, and predator ingress increase as fenced areas increase in size.* Most producers were satisfied with their fences even though expenses of construction and maintenance were cited as important liabilities. Most producers agreed that electric fencing decreased the need for intense lethal control; however, they indicated that lethal control was still needed to prevent predators from entering fenced areas and to protect sheep that were grazing outside of protected pastures. Reported sheep losses to predators were significantly reduced after installation of electric fencing for 46 producers with 2 or more years of electric fence experience.

STUDY 18. Fencing is more effective if it is strung before the predator has established a pattern of movement. Snow and frozen ground can greatly reduce the effectiveness of an electric fence.

STUDY 30. *Protecting hay supplies with electric fences or other means, especially during spring when cattle are calving, may minimize attractiveness to elk and thus wolves.*

STUDY 32. *Livestock confined for long periods can have husbandry issues with diseases, birthing, cleanliness, and foraging.* Wolves can easily go through barbed wire fence or jump over short fences, while woven wire and taller fences can be barriers to other wildlife. Wolf depredation is so uncommon that if fences become burdens to producers they stop using them.

STUDY 52. Two farmers witnessed wolves jumping electric fences up to 145 cm in height. Farmers with wolf attacks strongly preferred wire-mesh fencing compared to farmers with wolf attacks who used single horizontal wires or no fencing at all. *This study did not find that electric fences provided a noteworthy physical barrier to wolves as they did not reduce attack rates when wolves were persistently depredating a particular farm.* Researchers for this study would like to see more detailed research into how wolves move under, over and around barriers like electric fences.

Bio-Boundary

STUDY 48. Scent mark trials with a reintroduced African wild dog pack habituated to human proximity consistently resulted in the pack moving in the direction of their familiar territory inside the protected area in the following 24 hours. The packs lengthy movements in the direction of the geometric center of their range are consistent with territorial avoidance of another wild dog pack. *The option to signal wild dogs to return to the relative familiarity of a protected area using translocated foreign scent marks represents a significant advance in management techniques.* Researchers for this study believe that the use of species-specific semiochemistry for management of free-ranging wildlife merits further investigation with other territorial species.

STUDY 50. *Biofencing effectively manipulated the movements of most radio-marked wolves in this study although some exceptions occurred that may have reflected behavioral differences among individuals. Trespass of the biofence occurred 1-14 days after refreshing, so researchers conclude that refreshing the line every 5-7 days may be desirable if total exclusion is the goal.* Given that trespass between adjacent wolf packs is expected and common researchers suggest placing biofences between 2 and 3 km from an attempted exclusion area based on the average trespass distances (163 m to 4 km) they observed. Wolves seldom overmarked the secondary line of fencing so one line may be enough to control movements, thereby greatly decreasing deployment and refreshment time. The study sample size (three packs, 8-14 individuals, over two seasons, 1 pack failed to breed & is disbanding) limits generalization and further evaluation to determine efficacy for wolves. A study sampling several animals per wolf pack and employing a treatment/control design would be beneficial, albeit expensive and logistically difficult. *Exploring the effectiveness of using more easily obtainable scats from captive wolves would be worthwhile. Use of automated howling devices might help fortify biofencing and increase its effectiveness.*

STUDY 54. By avoiding physical boundaries, virtual fencing provides a number of distinct benefits compared to traditional fencing such as few fence related edge effects, ease of use in multiple predator systems and low installation cost compared to traditional fencing. In contrast to traditional fences, all virtual fence techniques present key benefits associated with integrating monitoring, research and management action that could enhance wildlife population and protected area management. Future research is needed to identify optimal strategies for implementing virtual fencing for conservation programs that use either individual cues or multiple cues specific to a particular site or suite of species.

Electronic / Shock Collar

STUDY 12. Most shocks administered [to captive coyotes] during active pursuit resulted in an immediate interruption of the attack. Electronic training collars will have limited application for resolving conflicts with predators and the effectiveness of any application will need to be tested in the field. Primary applications will be where the extent of depredations or the conservation value of the predator can justify the costs of the method.

STUDY 22. *In this and other studies researchers reported that electronic training collars were difficult to use with wolves.*

STUDY 31. This study, using an adaptive management approach, found that the use of shock collars activated by a command center may have potential to help reduce wolf depredation on domestic animals in some situations. It appeared the shock collar by itself could drive wolves from farms, but unless wolves were able to relate the negative stimulus to some aversive signal, such as beepers associated with the shock, long-term avoidance was not possible. The command centers, which were located in the middle of calving pastures, were set up to emit a shock signal to the collar 2-3 seconds immediately before the shock command was sent. Researchers could hear the beeper from 200 m and because wolves can hear other wolves howl about 3 times as far as humans can, we assumed that wolves heard the beep >600m away. Repeated shocking of the wolves in our study did not affect the size or location of home range or den- and rendezvous-site attendance. *Nine calves were confirmed killed by wolves on the farm in 1998 but only 1 was killed after the shock collar was placed on wolf 724F (the lactating alpha female for the Chase Brook Pack.)* No calf kills were detected on the farm in 1999 and wolf 724F was not detected on the farm in 2000 when only 2 depredations occurred. In 2001 6 calves were killed and researchers captured wolf 367F who was lactating and appeared to have displaced wolf 724F as alpha female. Both collared wolves stayed off the farm while 5 command centers were operational. *It appears from this study that when an alpha female was caught prior to depredations that all depredations were prevented. When shock collars were placed on wolves after depredations had begun, it seemed less likely to affect other wolves.*

STUDY 32. The USFWS in the NRM region unsuccessfully attempted penned experiments with electric shock collars on 2 different groups of wolves that would have been killed for attacking cattle. These wolves were then released back into their territory where they depredated again. All were lethally removed. This experiment resulted in a large public outpouring of complaints for being inhumane.

STUDY 36. *Shock collars have had limited experimental use but have demonstrated effectiveness in causing wolves to avoid specific sites in the few studies conducted so far.*

STUDY 40. *Results of this study demonstrated that shock collars altered free-ranging, wild wolf behavior in and around a specific site. Shock-collared wolves shifted 0.7 km further away from the center of the zone during and after treatment occurred.* Similar to Shivik et al (2003) this study found variability in wolf response to shock units during captive trials. The researchers for this study believe that much of the variability was attributable to technological variation within shock collars rather than behavioral differences of the wolves. If a shock collar with a higher degree of consistency is developed and tested, results could show a long term conditioning effect and a greater reduction in or complete elimination of both wolf visits and time spent in an area. The shock collar design used in this study could be further developed and tested to extend battery life, consistent shock probe contact with the neck, and audible shock warnings. *Future research should attempt to quantify effects shock-collared wolves may have on other pack members.*

STUDY 54. The use of electric shock raises significant animal welfare issues, and such collars are illegal in parts of the United Kingdom and Australia.

Less-Than-Lethal Ammunition

STUDY 16. Projectiles [rubber bullets, soft slugs] give a generally positive result for use with bears, but the scope of their use is rather limited as they will kill or injure smaller predators or even bears if improperly used. Only trained wildlife management personnel should be allowed to shoot an animal with these types of slugs. *Projectile repellants will be difficult to employ against livestock-killing wildlife as they must be used while in the act of killing livestock and are unlikely to provide much help against depredation.*

STUDY 32. USFWS developed a program of agency-issued permits and training, and provided 12-gauge shotgun cracker shells, bean bag shells, and rubber bullets to shoot at wolves. These munitions fire up to 100m and can hurt a wolf or explode near them. USFWS issued 200 permits and wolves were fired at numerous times. Only 3 wolves were reportedly hit and none were permanently injured. The permit, training and monitoring processes were time intensive although it allowed for a positive interaction between landowners and agency personnel prior to serious conflicts. *Munitions require a wolf be seen and at close range, and the landowner have a shotgun handy right at that time. Close encounters with wolves are relatively rare, and interest in obtaining the permits waned after a few years.*

STUDY 33. Nonlethal projectiles can be combined with harassing dogs as an aversive stimuli. Many predators are likely to develop a conditioned aversion to the person or vehicle applying the conditioning stimuli, rather than generalizing to an area or behavior. The duration of effectiveness for less than lethal ammunition strategies for black bears is about 1 month.

Conditioned Taste / Food Aversion

STUDY 2. One herd suffered very high identified domestic dog losses during 1978 before alternative elimination could be initiated, and finally, this manager and one other refused to maintain continued baiting or carcass lacing through each season, even though baits were placed yearly.

STUDY 3. The change in the numbers of lambs lost between 1978 and the preceding 2 years was not different between farms baited with LiCl and placebos. Thus, the LiCl treatment did not measurably reduce predation losses. Control was initiated when predation occurred, and was required on 5 of 8 farms baited with placebos and on all 9 farms baited with LiCl.

STUDY 8. An experiment with taste aversion on wolves was conducted in 1979 and 1980 (Gustavson 1982).

STUDY 9. *Sixteen percent of program participants rated CFA as very successful, 38% as somewhat successful, 36% as unsuccessful, and 10% indicated no opinion. However only 1 person in the program was still using CFA. Results of our study, when combined with the negative findings from a large-scale study in Alberta [Bourne & Dorrance 1982] and several*

studies on captive coyotes suggest that the proposed CFA technique may not be sufficiently effective to warrant its use. Other attempts to get animals to generalize an aversion from a treated to an untreated food source have succeeded. However in those cases the treated food closely mimicked the untreated food. The lack of close mimicry between a treated bait package and alive sheep or lamb may be a fundamental factor that diminishes the effectiveness of CFA as a predator control method.

STUDY 12. Various applications of aversive chemicals to the necks or bodies of sheep have been unsuccessful in establishing aversion to live prey in coyotes. *CTA has not led to rejection of live prey under practical field applications because coyotes apparently rely primarily on visual stimuli rather than taste and odor stimuli when capturing prey.*

STUDY 16. There continues to be controversy over this technique, with inconsistent results leading to questions as to whether an aversion to eating a particular animal will deter killing of that animal. Gustavson in 1982 reported no change in wolf predation in Minnesota with LiCl baiting. The concept of CTA/CFA still has merit, but perhaps further research should concentrate in another direction.

STUDY 33. *CTA may be useful in many situations and should continue to be examined, especially for limiting consumptive behaviors, if not predation behaviors.*

III. Wildlife Management Strategies

General Practices

STUDY 32. Intensive and intrusive management enforces unrealistic public perceptions about wolves and the resources needed to manage them, compared to other wildlife management and damage control programs in the western U.S. *USFWS loans radio telemetry systems to ranches that have had depredations so they can locate radio-collared wolves in their area. Although this provides ranchers with an increased sense of security, detection is limited to line of sight and a few miles on the ground and it does little to affect wolf-livestock hunting behavior.*

Contraception / Sterilization

STUDY 17. Among coyote packs that killed sheep intact coyote packs killed 6 times more sheep than sterile packs. The data for this study indicates that coyotes change their predatory tendencies when pups are present and that sterilization could be an effective method of reducing coyote predation on domestic sheep in the Intermountain West. For this technique to be successful, the breeding pair must be sterilized. In some areas where pups were present, no lambs were killed by some coyote packs even after 3 years of exposure to sheep. A more efficient method of fertility control would likely be needed for application as a viable management tool on a larger scale. Sterile coyotes maintained territories and pair bonds in a manner similar to non-sterile coyotes.

STUDY 31. It might be possible to use the shock-collar system in conjunction with sterilization to create “conditioned” wolf packs that do not produce pups but continue to occupy regular territories. Conditioned packs maintaining territories may prevent dispersing wolves from establishing territories and reduce local coyote abundance, which may further reduce depredation losses.

STUDY 33. *Contraception/sterilization may be counterproductive as a conservation tool but there is room for more investigation, because sterilization may help to stabilize local populations of predators and have longer-lasting effectiveness than lethal methods, at least for territorial predators.* Appropriate chemical contraceptives and delivery systems have not yet been developed and additional research is required.

STUDY 39. Surgical sterilization of wolves has been assessed for its feasibility for preventing wolf depredations. Breeding wolves die or can be displaced by other wolves and territories shift: this would require additional wolves be sterilized and if a wolf harvest was implemented it would require protection of sterilized individuals.

Translocation / Lethal Removal

STUDY 23. *In Wisconsin translocated adult and yearling wolves had significantly higher mortality than other radio-collared adults or yearlings.* Translocation can work if the individual is transported sufficiently far that it cannot return home and is placed in suitable habitat with

territorial vacancies. *A survey of systematic studies of lethal control suggests that 11-71% of the carnivores killed to prevent conflict showed no evidence of having been involved in recent conflicts.*

STUDY 27. This study examined 63 individuals and 9 cohesive groups of translocated wolves (moved because of livestock conflict) to determine whether they preyed on livestock or established or joined a pack after release. Overall most mortality of translocated wolves was caused by humans, with government control and illegal killing as the first and second leading cause of mortality respectively. Soft-released wolves were less likely to return to capture sites than hard-released wolves. Soft-released wolves travel shorter distances after release than hard-released wolves. *Translocated wolves showed a strong homing tendency. Most wolves, whether attempting to return home or not, moved away from the release site. Wolves that were translocated shorter distances were more likely to return home*. Wolf translocation was not always effective at reducing predation on livestock. *Translocations helped further wolf recovery by establishing eight new packs. However, most translocated wolves (67%) died or disappeared without ever establishing new territory. Release site selection is important and the extent of available habitat should be given the highest consideration when translocating wide-ranging animals such as wolves.*

STUDY 29. In Canada and the United States there was a strong relationship between wolf depredation and wolf removal, which was consistent with other studies that employed regression analysis. In either country, the absence of negative correlations indicated that wolf removal was corrective, not preventive. *This analysis, which was conducted on a regional scale, does not support the notion that removal of wolves at current intensity reduced depredation, immediately or in the following years.* Further research is needed to evaluate the cost-effectiveness and socio-economic benefits of wolf control. For example, it would be helpful to gather information on specific properties receiving lethal control and the fate of the livestock on the properties where wolves were lethally removed in future years.

STUDY 32. Just as removal is not a replacement for nonlethal tools, nonlethal tools are not replacements for targeted removal. Both appear useful and to enhance each other's effectiveness. *Removal addresses immediate conflicts but does not prevent conflicts from reoccurring in that area the following grazing season. Removal results in a cycle of wolf colonization, depredation, and wolf removal that repeats itself. Local producers supported wolf relocation, but producers where the wolves were released did not. Relocated wolves caused additional depredations.*

STUDY 33. Lethal removal may be an important long-term practice for selecting against depredation behaviors in predator populations and is ultimately useful for conserving predators.

STUDY 35. As an initial response to confirmed depredation, we believe full pack removal has limited utility, although it can provide immediate relief, albeit short-term until the "vacancy" is filled by the next pack. Researchers for this study believe the combination of proactive nonlethal deterrents combined with strategic incremental lethal control of problem wolves is the best way to resolve wolf-livestock conflicts.

STUDY 37. With the possible exception of removing an adult male, age and sex of wolves killed had no effect on re-depredation rates. Total number of animals removed did not appear to affect re-depredation rates. *None of the correlations from this study supported the hypothesis that killing a high number of wolves reduced the following year's depredations at state or local levels. Researcher's analyses of localized farm clusters showed that as more wolves were killed one year, the depredations increased the following year.* For all analyses, trapping but catching no wolves led to lower recurrence than not trapping at all, which suggests that the mere increase in human activity and the introduction of foreign odor and objects at a depredation site might have been enough to reduce further depredations. For depredations on sheep, killing wolves was more effective than unsuccessful trapping or not trapping similar to Fritts et al 1992. *Experimenting with a regimen of daily visits simulating trapping activities might show that such an approach is more cost-effective than trapping and killing wolves, especially at farms that require long travel by controllers.*

STUDY 39. Lethal removals are appropriate when wolves are actively harassing or hunting livestock and consideration for stakeholders who are negatively impacted by wolves must accompany wolf recovery. Removal of human-habituated wolves will become more important as wolves continue to colonize unsuitable areas.

STUDY 47. Except for the black bear and the brown bear, the number of lost livestock that could be compensated with the money spent on one translocation was greater than the number of individuals that a given carnivore could have killed in one year. Despite many possible mortality causes in translocated animals, human-related mortality accounted for 83% of the death causes. Homing behavior appears to be common in all carnivore groups and soft-release procedures may help to reduce it. Critical release distances to avoid homing on large carnivores usually range between 100 and 300 km, but could >500 km for some species. *From a conservation perspective, translocation appears equivalent to lethal removal for 6 out of 10 individuals.* The evidence presented in this study shows that in the vast majority of cases, a well implemented compensation scheme, associated with best herding practices, would be a more cost-effective alternative rather than translocating endangered carnivores.

STUDY 53. The WDFW has full management authority of wolves in the Eastern Washington recovery area and, under state law RCW 77.12.240, can implement lethal measures to control depredating wolves to detour chronic livestock depredations. However, in the western two-thirds of Washington, where wolves remain classified as an endangered species under the federal ESA, WDFW must consult with USFWS to ensure that any management actions being considered are consistent with federal law. Under state law (WAC 232-36-051), and the provisions of the Plan, WDFW may issue "Caught-in-the-Act" permits in the Eastern Washington recovery area to livestock producers and their authorized employees for wolves attacking livestock on private land and public grazing allotments they own or lease after a documented depredation. These permits are not available in the western two-thirds of Washington.

Planning, Conservation, Mitigation, Education

STUDY 8. Researchers believe that perception of the depredation problem in Minnesota exceeded the actual problem, because the term "wolf" was often used for both coyotes (*Canis latrans*) and wolves in Minnesota. Distinguishing wolf from coyote depredation was a common problem, stemming in part from the public's failure or inability to distinguish between the two canids. Thirty-nine percent of the 570 cattle claimed killed by wolves were missing cattle. Actual loss of cattle and other livestock to wolves lies between the verified and claimed loss figures. Often a few wolves have a disproportionate effect on the state's compensation program. We consider the Minnesota compensation program successful and well worth its cost, but suggest that payment be reduced or withheld when correctable husbandry practices seem responsible for depredations.

STUDY 20. *It has been suggested that compensation programs should be designed in combination with incentives to encourage preventative management.*

STUDY 21. The carcass detection data suggest that current compensation procedures in the western United States might be compensating for one-eighth the actual losses incurred by cattle producers from wolf predation.

STUDY 24. Policymakers can use data derived from this spatial model to more precisely define management zones regarding human-wildlife-livestock conflicts. Being able to anticipate sites and conflict can focus outreach, deterrence, and mitigation efforts where they are needed. Locally, wildlife managers, researchers and farmers could use this spatial model to tailor research and interventions according to local conditions.

STUDY 25. *Because large populations of native ungulates and abundant livestock have never been studied in relationship to wolves, there is little known about the impacts that wolves might have on these simultaneously present native game and livestock populations.* Often it is found that kills are relegated to a few ranches (i.e. hot spots) and that wolves can have a significant economic impact on these individual operations. *The data indicate that the size of the wolf population did not affect the rate at which they killed livestock.*

STUDY 30. Of 31 ranches with confirmed wolf depredations, 15 (48%) claimed to have additional unconfirmed depredations.

STUDY 32. Twice wolves were documented around livestock without conflict, but within days they attacked and injured livestock placed in the same pastures. Both instances involved young calves, one killed after being treated for severe cuts by a fence, and another after being treated for frostbite. Compensation programs have several challenges. First, they only mitigate for damage and do not provide an incentive to allow wolves to be present. Second, they do not reimburse producers for the full costs of wolf damage which may include unconfirmed or missing livestock losses. Still, compensation programs may help reduce negative attitudes towards wolves and attempts to illegally kill them. *Personally-conducted outreach by agency personnel reduces misinformation and rhetoric, and it lets wildlife professionals hear first-hand the concerns of livestock producers/landowners and wolf advocates.*

STUDY 33. There are three means to gauge the effectiveness and use of management tools. New tools should be applied in an adaptive management system during the limited periods of use indicated, and with a focus on understanding why they worked or failed to be effective. *While technological advances may well lead to further improvement in predator management, ultimately some of the tools that are most desperately needed are social ones.*

STUDY 34. Researchers present a step-by-step procedure for navigating the political, social, and strategic aspects of human-wildlife conflict management. When local stakeholders identify human-wildlife conflict as a priority, participatory planning may improve perceptions of projects, partners and outcomes. Joint objectives should include both protecting human welfare and abating threats to wildlife.

STUDY 36. *Agencies, Ranchers and NGO's may be able to pool resources to establish range-rider or herder programs.*

STUDY 38. The goals of participatory intervention planning (PIP) workshops were to help participants consider all possible types of interventions and weigh the relative merits of the alternatives with standard criteria. PIP workshop brainstorming was structured and preceded by a critical first step that defined the cause-and-effect relationships underlying a given human-wildlife conflict. This step exposed multiple possible focal points of intervention. Researchers identified eight distinct types of direct interventions to reduce the severity or frequency between wildlife and people or their property and five distinct types of indirect interventions intended to raise people's tolerance for wildlife encounters. Researchers for this study expect that additional methods will be added as researchers and practitioners around the world report on their observations and experiments. *Three common problems in planning in interventions are: 1) the assumption that only one or a few solutions exist for a given threat; 2) related to the first, the selection of the first solution that comes to mind to the exclusion of others; 3) the selection of interventions in any field should be based on feasibility, not just effectiveness, which includes cost-effective design, wildlife specificity, and sociopolitical acceptability.*

STUDY 39. From the years 2002-2006 WS verified 277 depredations of livestock animals by wolves, coyotes, bears, and domestic dogs. Of these, 69% were depredated by wolves, 28% by coyotes and 3% by dogs or bears. In Wisconsin, livestock producers have an incentive to report wolf and bear depredation because of compensation whereas coyote depredation is not compensated. *Conflict management needs to be flexible because depredation scenarios are multifaceted.*

STUDY 41. *Results suggest that difference in morphology, behavior and husbandry between sheep and cattle induce different predatory behaviors in wolves, represented as excessive killing of sheep in relation to wolf food needs.* Compensation providers should be aware of excessive killing of sheep by wolves. Compensation providers should identify and regularly communicate with sheep producers within wolf range to ensure that depredation events are identified and compensation is delivered promptly. *Managers from this study suggest that if wolf conservation is a recognized societal objective then public funds destined to wolves may be used to contribute to habitat conservation more directly. For example, wolf conservation programs could contribute funds to support ecologically-friendly livestock*

production on rangelands thus conserving habitat for large ranging wildlife species, such as wolves.

STUDY 46. In Washington, residents were less accepting of landowner compensation schemes for wolf-related livestock losses, but were slightly more accepting of these strategies if the funds for compensation came from the sale of hunting and fishing licenses rather than from state tax dollars.

STUDY 51. *The Marin County Livestock & Wildlife Protection Program (MCLWPP) initiated cost sharing to help ranchers install or upgrade fencing and other livestock protection infrastructure, install predator-deterrents and detectors, and purchase and sustain guarding animals, coupled with indemnification for any ensuing verified livestock losses to predators.* MCLWPP participants do not give up their rights to kill predators consistent with state and federal laws. MCLWPP provides a cost-effective, ecologically beneficial model to address carnivore-livestock conflicts and guide the development of other non-lethal programs across differing landscapes.

STUDY 53. In Washington, livestock producers can work actively to minimize conflict with wolves by receiving technical assistance from WDFW staff under a Damage Prevention Cooperative Agreement which enables producers to receive cost-sharing for deploying prescribed nonlethal conflict prevention measures. In cases of depredations considered "confirmed" or "probable" by WDFW personnel, producers can receive compensation from damage caused by wolves under RCW 77.36 and WAC 232-36.

STUDY 54. The implementation of RTVFs and remote monitoring of permeable barriers in particular, represents the potential for a new 'virtual management' era in wildlife conservation, where it is possible to initiate management actions promptly in response to real-time data.

CONCLUSION:
APPLICABILITY TO WASHINGTON

A summary of the findings contained in the review with recommendations and ratings for those management strategies considered most applicable to livestock producers operating in the state of Washington.

CONCLUSION: APPLICABILITY TO WASHINGTON STATE

IN SUMMARY

Gray wolves are a territorial species, therefore their use of space is routine and determined by their biological need for reproductive success (21, 29, 48, 50). Home ranges are variable in size with dynamic margins that fluctuate seasonally and across the years (Spotte 2012). The territories they establish within these ranges will depend on many environmental factors including elevation, weather patterns and wild prey migrations. Generally speaking, wolves limit their movements in order to mate, den and rear pups becoming nomadic when the pups are old enough to follow. Some packs will reside in the same location all year round.

While winter and spring are considered the highest risk seasons for wolf depredations in general, regional studies have demonstrated that the greatest number of depredations occur in August in western Canada and the northwestern United States (29). WDFW data from 2007 through 2013 show that in Washington most depredations occur during the summer months (53). Livestock likely constitute a secondary prey item, one killed opportunistically by wolves when they encounter them while hunting their wild prey sources (21, 24, 30). Researchers have demonstrated that wild prey density and livestock proximity to den location correlate with higher wolf depredations (24, 29, 30, 36). This growing body of research about a wolf's use of space can help develop management strategies that move livestock away from wolf core areas during periods of intense activity (1, 8, 21, 24, 30, 36, 39).

Improving husbandry practices around wolf territories during high risk seasons is one of the leading factors in reducing wolf depredations (1, 8, 29, 25). Because every operation has its own set of challenges, ranches should be individually assessed to determine which methods are most applicable to their livestock system given the time of year and sites where depredations are occurring or have occurred (30, 36). Personal contact with producers coupled with a monthly reporting system, which reduces reliance on memory, greatly increases the accuracy and reliability of the livestock loss data gathered (1, 21, 29, 30, 32, 36, 39, 52, 53). To aid with depredation management, there are a variety of nonlethal conflict avoidance strategies managers can employ.

When it comes to nonlethal methods for predator control there are two conceptual approaches: disruptive stimuli and aversive stimuli. Disruptive stimulus tools act by disrupting appetitive behaviors and frightening predators away from resources. Aversive stimulus approaches seek to modify behavior through aversive conditioning of the predator (33). The effectiveness of nonlethal tools seems to be enhanced when several types are used in combination with each other (32, 35). Circumstances are different for each livestock operation, and the key is to select nonlethal tools that are economically feasible and have the greatest potential to decrease conflict in each situation. The following table provides a 5-star rating of recommendations from the findings for applicability in the state of Washington.

RECOMMENDATIONS

NONLETHAL CONFLICT-AVOIDANCE MANAGEMENT STRATEGIES	RATING	STUDY #
HUSBANDRY PRACTICES		
Develop livestock management plan based on producer's site conditions	*****	1, 21, 24, 29, 30, 32, 34, 36, 35, 39, 52, 53
Graze livestock away from wolf activity, especially denning and rendezvous sites	*****	1, 8, 21, 24, 29, 30, 36, 39
Livestock maintained near human habitation when possible	*****	4, 30, 39, 52
Confine livestock during birthing activities	*****	1, 4, 21, 25
Delay turnout on open range for cow-calf pairs	*****	8, 21
Permanent, wire mesh fencing on smaller operations	*****	9, 36
Expeditious carcass removal and proper disposal	*****	1, 8, 13, 18, 25, 30, 36
Night corrals and night lighting in permanent corrals	****	1, 4, 9, 25, 45, 52
Maintain pastures away from native ungulates	****	21, 24, 25, 30, 39
Range Rider or Herder presence on open range system	****	4, 5, 32, 36
Manage herds/flocks away from wooded areas	****	4, 8
LGD/LPD's effective with right breed and operator commitment.	***	1, 4, 5, 6, 13, 15, 20, 26, 32, 36, 42, 49
NONLETHAL TOOLS		
Electric Fencing (wire mesh, higher than 145 cm)	****	7, 18, 32, 52
Fladry / Turbo Fladry (short term effectiveness)	****	20, 22, 32, 33, 36, 37, 39, 43, 44
Bio-Boundary (Needs more research)	***	48, 50, 54
MAG Devices (Needs more research, good for multiple predator system)	**	22, 33
RAG Devices (Needs more research on wolves, requires radio collars)	**	19, 32, 33, 36
Visual and Acoustic Scare Devices (largely untested on wolves)	*	8, 16

NONLETHAL CONFLICT-AVOIDANCE MANAGEMENT STRATEGIES	RATING	STUDY #
WILDLIFE MANAGEMENT		
Pool resources to establish range rider, herder programs	*****	36, 41, 51
Outreach/Education	*****	33, 34, 38, 51
Remote Alarm Aid / Real-Time Virtual Fence (Needs more research)	***	28, 54
Compensation to build public acceptance, tied to husbandry methods	**	8, 20, 21, 41, 46
Contraception/Sterilization (not recommended for wolves)	*	17, 31, 33, 39
Translocation /Lethal Control (ineffective at reducing depredation)	*	23, 27, 29, 32, 33, 35, 37, 39, 47
Aversion Chemicals (not proven effective with wolves)	*	2, 3, 8, 9, 12, 16, 33

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CANADA'S LARGEST CAT SPECIES

In Alberta, cougar sightings have been confirmed across the entire province, although they are most common in the mountain and foothill regions. In recent years, sightings in the prairie, parkland and boreal regions have become more frequent.

Cougars are adaptable and can survive in any location that provides them with cover and a food source, such as deer. They normally do not prefer open terrain, but cougars may use river valleys, ravines and other travel corridors that pass through open terrain.

They are generally shy and wary of humans, avoiding human activity and populations whenever they can. For this reason, calculating population numbers and mapping cougar range are difficult.

As Alberta experiences expansion in both cougar and human territories, human-cougar conflicts remain rare. Most problems involve juvenile cougars that are struggling to establish their own territories and find suitable prey.

Adult cougars weigh 40 to 90 kg and can be up to 2.5 m long, including a metre-long tail.

Tracks are asymmetrical, round and lack claw imprints (8-10 cm long)

HABITS AND BEHAVIOURS

Cougars are efficient hunters that prey on deer, elk, moose, sheep and other mammals. They may also occasionally feed on domestic pets and livestock. They can be active any time of day but most often hunt at dusk, night and dawn.

Cougars don't hunt by leaping from trees onto their prey. They stalk and then rush their prey from the ground. Cougars normally climb trees only when they are being chased or harassed.

Their dens are usually located on ledges, in tree hollows, on steep slopes, under fallen logs and in between rocks. Cougars can breed at any time of the year and usually have litters of two to four kittens. When her kittens are still young, a cougar mother will often stash them alone when she goes off to hunt.

Cougar Management

A healthy cougar population is an indication of a thriving local ecosystem.

In years when deer, elk and moose numbers are high, cougar numbers are also high.

Cougar populations in Alberta are managed with public hunting seasons to help maintain healthy populations, reduce conflicts with people, manage predation on wild ungulates and provide hunting opportunities.

Hunting seasons run between November and February. Throughout most of cougar range, hunting is regulated with a strict quota system - seasons are closed as soon as a designated number of cougars has been harvested. Consult the Alberta Guide to Hunting Regulations or MyWildAlberta.com for more information.

Any person who is the owner or occupant of privately owned land may at any time of the year, without the use of dogs, hunt (but not trap) cougar on such lands without a licence. Under this authority, registration is required within one week of the kill.

Cougars may be removed in situations when livestock or pets are killed or public safety is threatened. Cougars are never relocated as a wildlife management tool to control deer populations.

If a cougar or other wildlife is a public safety concern, call 310-0000 or, if after regular business hours, call 1-800-642-3800.

For more information on cougars and other wildlife in Alberta, scan in the QR code or visit **srd.alberta.ca**

PREVENTING CONFLICT WITH WILDLIFE

Cougars

also known as pumas or mountain lions

Government of Alberta ■

Taking a few simple steps can help you to prevent conflict with cougars and other wildlife species.

Track imprint in mud

Cougar kill, covered with leaves, grass and forest debris

Scat, with scrape marks

Preventing conflict with cougars

at home

Avoid attracting wildlife, especially deer, onto your property.

- Never feed wildlife or leave out salt licks for deer.
- Keep garbage in containers with tight-fitting lids and clean up spillage from bird feeders.
- Don't leave pet food outside.

Help keep your children safe.

- Children should play outside only during daylight hours, with adult supervision and away from heavily-wooded areas. Be sure they don't wander away from the group.
- Remind your children that if they see a cougar, they should not turn their backs, run away or show fear by screaming.
- Play areas should be set up in open spaces, away from trees and wooded areas.

Protect your pets.

- Ensure outdoor animal enclosures are secure and closed across the top.
- Don't let your cats or dogs roam free. Supervise pets when they're outside.
- Walk your dogs during the day and avoid off-trail areas with thick vegetation.

Don't provide cougars with shelter.

- Trim shrubs and low tree branches along driveways and walkways.
- Close off spaces under decks and buildings.
- Have good lighting in your yard, including motion detector lights.

in the wild

Stay alert for signs of wildlife.

- Watch for signs that cougars are in the area (tracks, scat, scrapes and covered kills).
- Don't wear headphones or anything else that interferes with your ability to detect wildlife.

Avoid recreating alone.

- Stay close together and keep children between the adults - don't let anyone run ahead or fall behind.

Be prepared.

- Carry bear spray, a noise maker and a walking stick - these can be used for protection in the event of an encounter.
- Cougars can be attracted to dogs, so it is best to leave your dog at home. If you do travel with a dog, keep it close and on a leash at all times.
- Carry a cell phone to call for help in the event of trouble.

Responding to an encounter

Merely seeing a cougar does not mean you are in imminent danger. Watch the cougar's behaviour and respond accordingly.

The cougar is at a distance and not focused on you.

- DON'T PROVOKE IT.
- Gather everyone in close, especially children and dogs.
- Back away slowly.
- Do not run.
- Keep your eye on the cougar.
- Prepare to use your bear spray.

The cougar is coming closer, and is hissing and snarling or staring intently and tracking your movements.

- SHOW THE COUGAR YOU ARE NOT A PREY ANIMAL AND WILL FIGHT BACK.
- Do not run and do not turn your back.
- If you can pick children up without crouching down, do so. Otherwise, keep them directly beside you.
- Shout at the cougar.
- Make yourself look larger by opening your jacket and waving your arms and walking stick.
- Use your noise maker and bear spray.
- Drop something (e.g. a back pack) that might distract the cougar long enough for you to get to safety.

The cougar makes contact.

- SHOW THE COUGAR YOU ARE NOT EASY PREY.
- Continue using your bear spray.
- Fight back, using anything you can find as a weapon. Aim at the cougar's eyes and face.
- If you're knocked down, get back up - don't give up.
- Never play dead with a cougar.
- After the cougar has left, continue to watch for it until you've reached a place of safety.

srd.alberta.ca

Living in Cougar Country

Cougars are efficient hunters that prey on deer, elk, moose, sheep and other mammals.
Cougars may also feed on domestic pets and livestock.

Avoid attracting wildlife onto your property.

- Use deer-resistant plants when landscaping and don't leave food or salt licks for deer.
- Keep garbage in containers with tight-fitting lids and clean up spillage from bird feeders.
- Don't leave pet food outside.

Teach your kids about cougars.

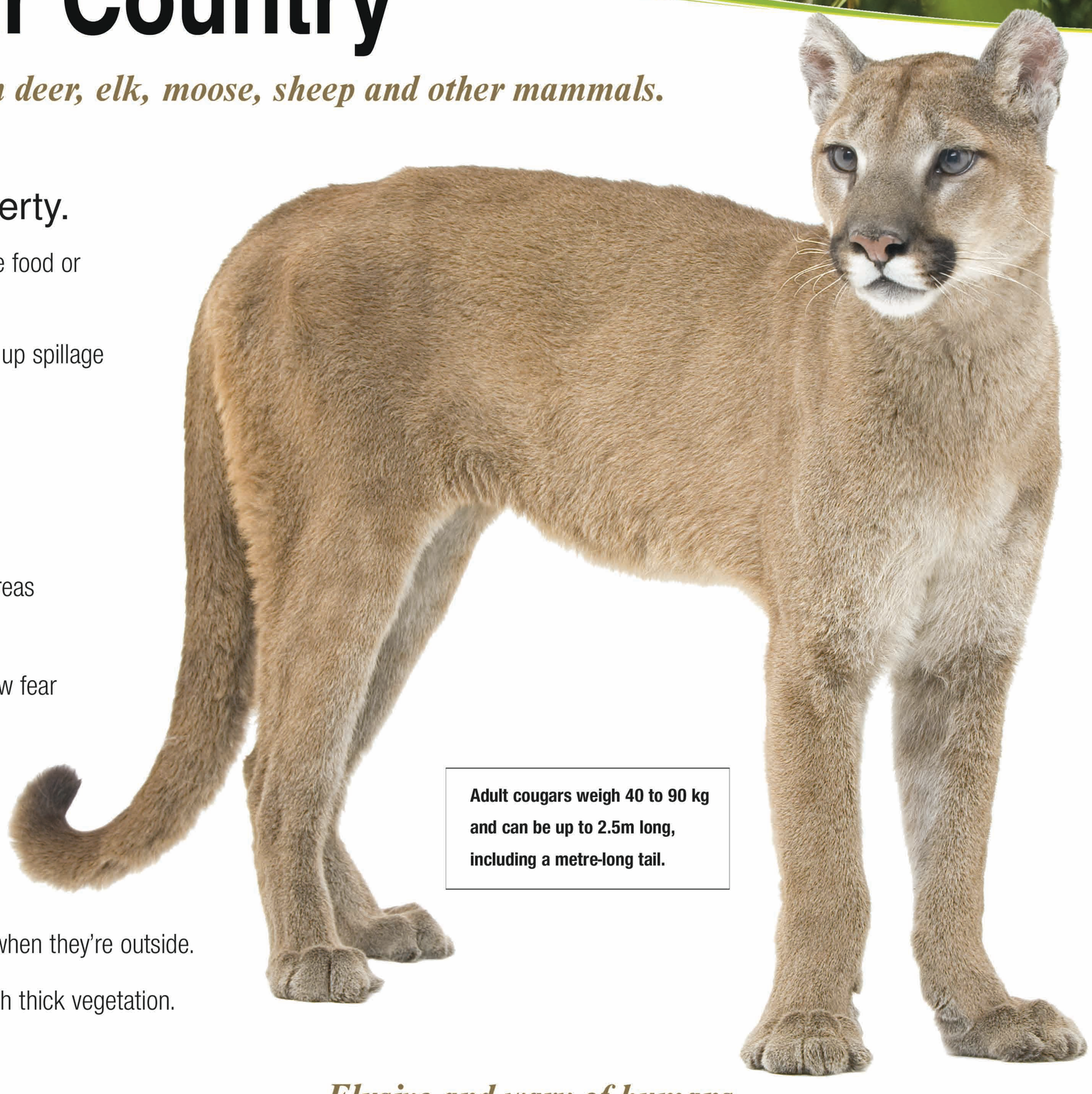
- Play outside during daylight hours, avoid heavily-wooded areas and stay in a group.
- If you see a cougar, never turn your back, run away or show fear by screaming.

Protect your pets.

- Ensure outdoor animal enclosures are secure and closed across the top.
- Don't let your cats or dogs roam and supervise your pets when they're outside.
- Walk your dogs during daylight and avoid off-trail areas with thick vegetation.

Don't provide cougars with shelter.

- Trim shrubs and the bottom of trees along driveways and walkways.
- Close off spaces under decks and buildings.
- Have good lighting in your yard, including motion detector lights.



Adult cougars weigh 40 to 90 kg and can be up to 2.5m long, including a metre-long tail.

Elusive and wary of humans,
cougars are most active at dawn, dusk and night.

Government of Alberta

Grizzly Bear Recovery Planning

Alberta

Alberta Government

Grizzly Bear Consultation

The draft of the *Grizzly Bear Recovery Plan* was developed in consultation with stakeholder groups, including members of Aboriginal groups, agricultural producers, municipalities, conservation groups, industry, the hunting community and recreational users.

This draft plan will now be posted online until July 15 with a stakeholder survey, to gather additional feedback and input. The *Grizzly Bear Recovery Plan* survey is open for comment and can be accessed at http://aep.alberta.ca/about-us/public-engagement/surveys.

Once the consultation process has been completed, results can be found at http://aep.alberta.ca/about-us/public-engagement/surveys/survey-results.aspx. A finalized copy of the plan, when ready, can be found at http://aep.alberta.ca/fish-wildlife/wildlife-management/grizzly-bear-recovery-plan.

Steps for Recovery Plan Approvals

- Consultation with stakeholders is done by the Ministry of Environment and Parks about the species of concern.
- A draft recovery plan is created based on data analysis and stakeholder input.
- The draft plan is posted online for public comment for 30-60 days.
- Alberta's Endangered Species Conservation Committee reviews draft plans and provides recommendations to the Minister of Environment and Parks.
- Once the plan has been accepted and approved for implementation by the Minister, it is published as a government recovery plan.

Funding Grizzly Recovery Work

The Alberta government has provided $475,000 in funding support to fRI Research to improve understanding of grizzly bear populations and an additional support of $150,000 to the Waterton Biosphere to reduce potential conflict between people and grizzly bears.

These funds support rearch, analysis, tools and actions related to grizzly bear recovery efforts and directly assists in achieving key elements of the grizzly bear recovery plan, such as education and awareness.

mistaken for black bear

human settlements

BSE Surveillance is Everyone's Responsibility: Do your Part

Test me for BSE

Help keep Alberta beef markets open by supporting BSE surveillance.

Contact your veterinarian to assess and collect samples from eligible cattle for BSE testing.

Alberta Beef Producers

Alberta Milk

Alberta Cattle Feeders' Association

AB.VMA Alberta Veterinary Medical Association

CCA Canadian Cattlemen's Association

Canadian Food Inspection Agency

Alberta Government

Call 310-FARM (3276) **www.agriculture.alberta.ca/bse**

Be ready before you call

Before calling your veterinarian, please remember:

- Only a registered veterinarian certified by the Government of Alberta can participate in the CABSESP.
- Make sure to call the veterinarian promptly, ideally when the animal is still alive. This will increase the chance of collecting a suitable sample and valuable clinical information.
- Cattle exhibiting clinical signs suggesting BSE, such as nervousness or aggressive behaviour, abnormal posture, difficulty rising from a lying position and lack of co-ordination, need to be promptly examined by a veterinarian.
- Producers will be required to provide the veterinarian with the animal history, records, tags and/or tattoos that confirm or estimate the animal's date of birth. In the absence of records, the veterinarian will estimate the age by dentition.
- Purchase documents are helpful in estimating the age of older animals.

It is really important that you as a cattle producer do your part by contacting your veterinarian to assess and collect samples from eligible cattle for BSE testing.

For more information please call
310-FARM (3276)
or visit: **www.agriculture.alberta.ca/bse**

BSE surveillance is a shared responsibility. Cattle producers, industry, veterinarians and governments all have a role to play.

Alberta Beef Producers
Alberta Milk
Alberta Cattle Feeders' Association
CCA Canadian Cattlemen's Association
AB.VMA Alberta Veterinary Medical Association
Canadian Food Inspection Agency
Alberta Government

BSE Surveillance

Is Everyone's Responsibility

Alberta

Why is ongoing BSE testing so important?

BSE testing (surveillance) is a tool used to measure the effectiveness of the actions put in place to control BSE. By doing ongoing BSE surveillance we can demonstrate the reduction of this disease in our province's cattle herd.

By participating in BSE surveillance you will help maintain continuous access to domestic and international markets for our cattle and beef products.

Which animals are eligible for testing under the CABSESP?

The Canada and Alberta BSE Surveillance Program (CABSESP) accepts animals *30 months of age and older that are legally possessed by Alberta's farmers* falling into any of the high risk categories.

Animals within the high BSE risk categories include those:

- Showing neurological signs
- Dead
- Dying
- Diseased
- Distressed (injured)

Protecting your investment is as easy as testing your eligible animals for BSE each year.

Reimbursement for Producers

Remember: BSE surveillance is voluntary. Producers are reimbursed $75 for each eligible animal. Reimbursement to producers under the CABSESP is paid to offset the costs to have an animal assessed for eligibility, sampled if eligible, and to retain control of the carcass until the BSE test result is available.

Sample Collection

Samples must be collected by your CABSESP-certified local veterinarian. You will benefit from the disease information that the veterinarian gathers while assessing your animal for the program. **Veterinarians visit your farm at no cost to you.**

Premises Identification (PID) Program

Do you have a PID Number? Call 310-FARM to confirm or Apply Online!

By registering your account online you will have direct access to your information and the ability to immediately make any changes to it.

Registration is easy; simply follow the prompts.

agriculture.alberta.ca/premises

Traceability in Alberta

PID, one of the three traceability pillars, links livestock and poultry to land locations or premises. Traceability information is used in planning for, controlling and preventing the spread of an animal disease. It is also used to notify animal owners of an impending emergency, such as a flood or fire, that could affect their animals.

Alberta PID Numbers have 9 characters & start with A _ _ _ _ _ _ _ _ _

Traceability Protects!

Your Animals - Your Livelihood - Our Future

Growing Forward 2 | Alberta | Canada

Traceability Protects!

Your Animals - Your Livelihood - Our Future

Hey, What's Your Number?

In Alberta, You Need a Premises Identification (PID) Number to

- Complete movement documents for livestock and poultry
- Buy medication for your animals
- Sell livestock at auction markets
- Apply for many agriculture grants, programs and services

Growing Forward 2 | Alberta | Canada

Premises Identification (PID) for Animal Owners/Operators of Commingling Sites

Animal owners must have a PID Account and at least one PID Number for the location where they keep their livestock or poultry.

If your animal(s) is only kept at a location controlled by someone else (e.g. stable) and the animal is never kept at a location you are in control of (e.g. farm/acreage), you do not need a PID Account. However, you will need to have the PID Number for the site that your animal(s) is located on.

Operators of Commingling Sites must have a PID Account and a PID Number for each commingling site they operate. They must also provide their PID Number(s) to the users of their site(s).

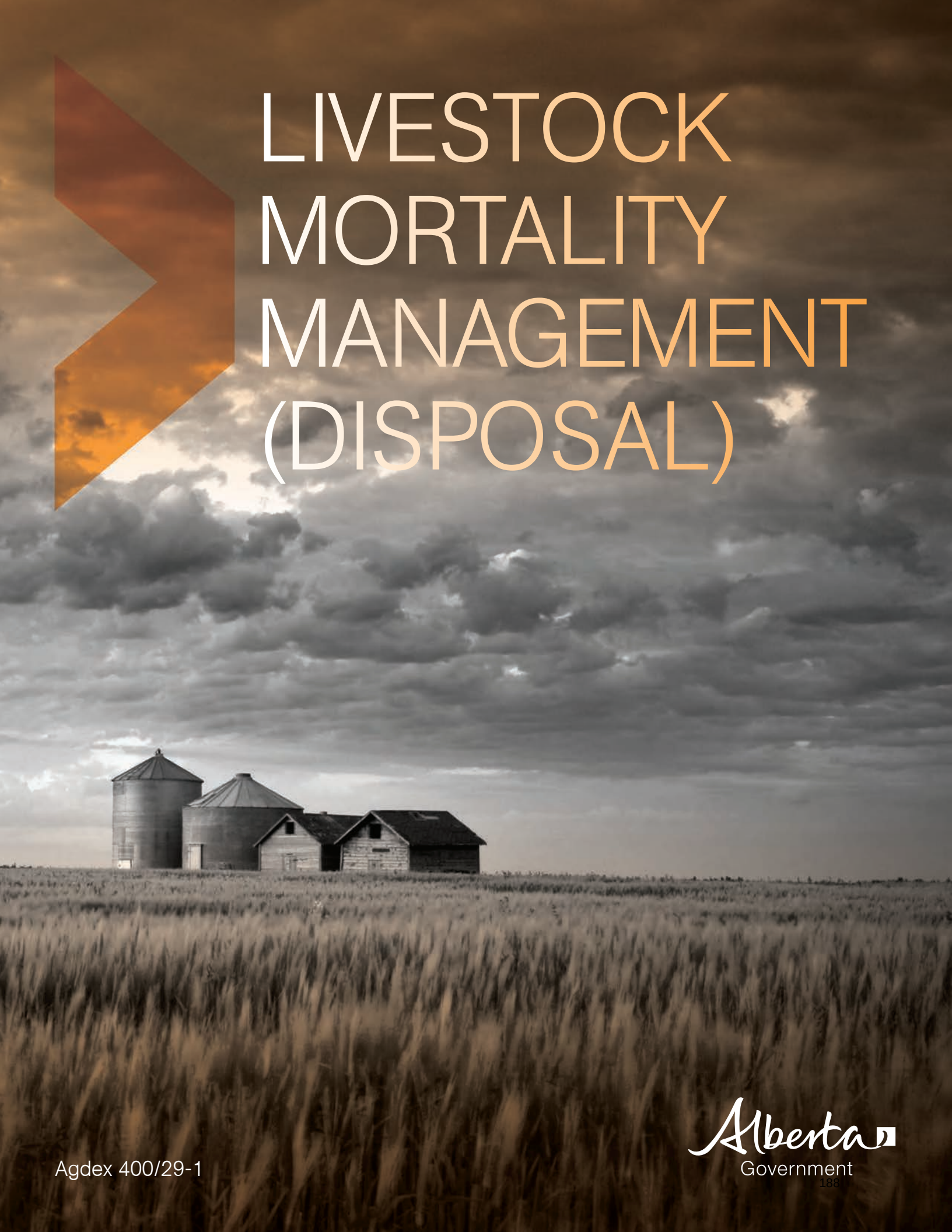
A commingling site is a location, other than a farm or a ranch, where animals owned by different owners are kept together either temporarily or permanently. It includes auction markets, feedlots, stables, fair grounds and community pastures.

Alberta's Premises Identification (PID) system is an integral part of Canada's traceability system. The system facilitates linking livestock, poultry and fish to geographic locations for planning and responding to animal health issues and emergency responses.

Livestock owners and operators of commingling sites are required to have a PID Number under Alberta's *Animal Health Act*, passed in 2009.

For more information on Traceability in Alberta call the Ag-Info Centre at 310-FARM(3276) or go online to www.agriculture.alberta.ca/traceability

LIVESTOCK MORTALITY MANAGEMENT (DISPOSAL)



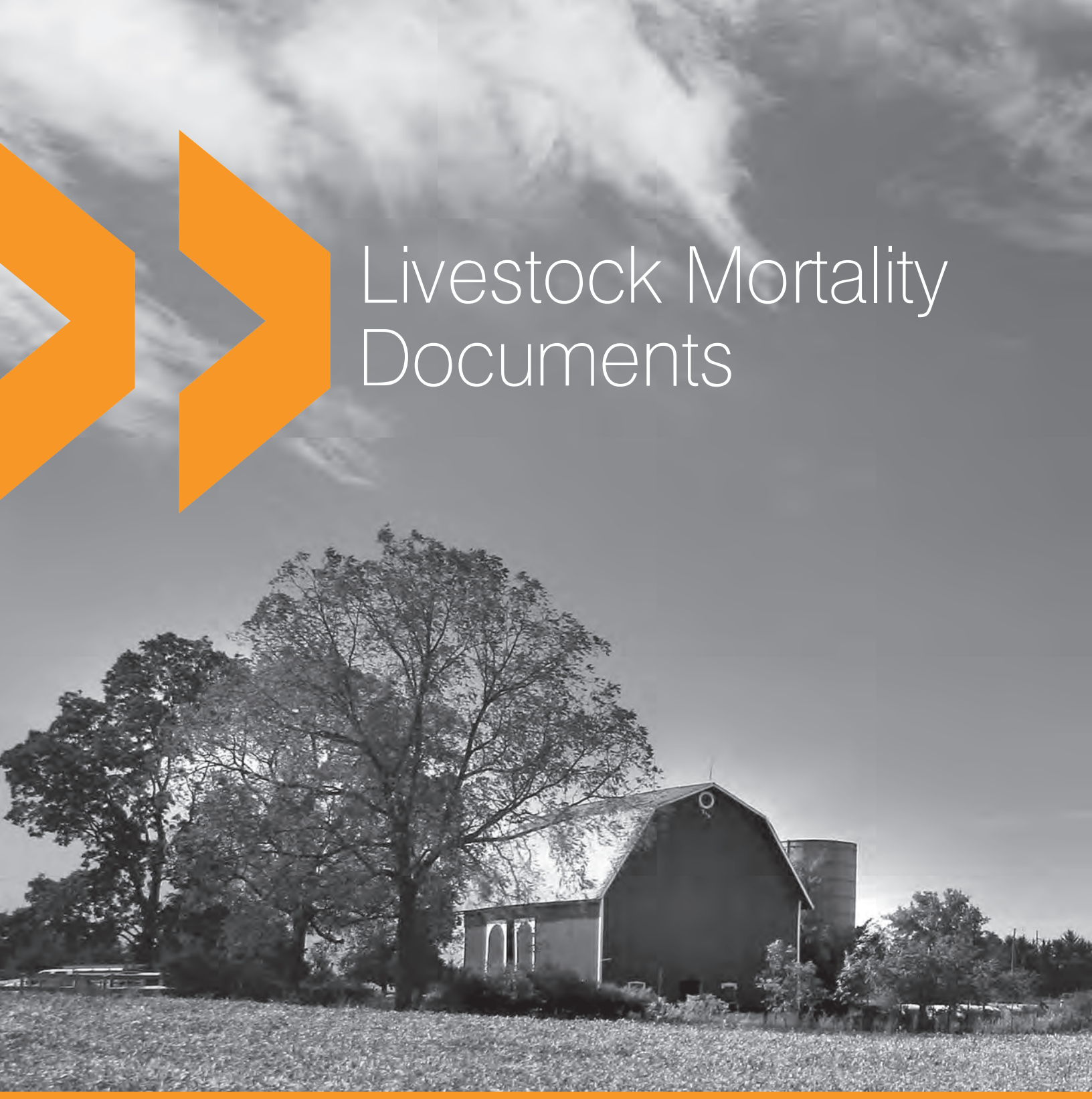
Agdex 400/29-1

Alberta Government

LIVESTOCK MORTALITY management (disposal)

contents

Livestock Mortality Documents



Poultry Mortality Composting Agdex 450/29-1

Swine Mortality Composting Agdex 440/29-1

Large Animal Mortality Composting Agdex 400/29-4

Livestock Mortality Burial Techniques Agdex 400/29-2

mortality disposal

Livestock producers are in the business of producing marketable meat products. However, every livestock producer must face the reality of carcass disposal, regulated by the Destruction and Disposal of Dead Animals Regulation of the *Animal Health Act*, Appendix A. Dead animals must be disposed of in an acceptable manner within 7 days of death. Mortalities can be composted, incinerated, buried, rendered or naturally disposed.

Proper disposal of carcasses is important for both the prevention of livestock disease transmission and the protection of air and water quality. Access to carcasses by scavengers is only permitted under the guidelines for natural disposal.

The environmental considerations for improper disposal include:

- Odour – decomposition of organic matter, particularly the anaerobic (lacking oxygen) breakdown of proteins by bacteria, will produce a foul odour.
- Scavengers – ravens, magpies, coyotes, etc. and insects can transmit disease and are a nuisance.
- Pathogens – disease-causing spores may still be viable.
- Excess Nutrients – concentrated source of nitrogen.
- Nuisance – visible carcasses and bones fuel social issues and can puncture tires.

potential environmental and biosecurity risk

POTENTIAL RISK

lowest risk

- Compost in a properly managed system or burn in an approved incinerator on the farm.
- Bury in appropriate soils or store frozen for spring burial or rendering plant pick-up (Refer to Livestock Mortality Burial Techniques, Agdex 400/29 – 2).
- Partially buried or carcass left outside for scavengers or to decay.

highest risk

disposal options

Incineration

Thorough and complete incineration of carcass (including all bones) is one option for livestock producers. While incineration can be convenient for those with access to the necessary equipment, producers need to realize that "complete incineration" will not result from a simple burn pile or barrel; furthermore, a simple burn pile or barrel cannot meet emissions standards for combustion. Double chambered incinerators reach temperatures greater than 850 °C (1560 °F) and provide oxygen to complete the burning process thus reducing particulate and gas emissions.

Incinerators must be loaded and operated according to manufacturer's recommendations to maximize equipment life and minimize emission problems. Ashes should be removed frequently to maximize combustion and prevent damage to equipment. Nuisance complaints generated by poor maintenance and operational efforts are common.

Fuel for incinerating carcasses is a significant expense. The cost of operation and discipline required to prevent complaints has reduced the popularity of incineration in recent years.

Producers choosing to install an on-farm incinerator must operate it in accordance with the *Environmental Protection and Enhancement Act* and the regulations or codes under the Act related to incineration.

incineration

Advantages:

- Complete reduction of volume.
- Rapid oxidation to carbon and water.
- Environmentally safe (may require an air permit).
- Can dispose of mortalities as they are generated, therefore no temporary storage required.
- Residue from properly incinerated carcasses will not attract insects or rodents.
- System can be mobile or a co-op could be formed to purchase an incinerator to be shared between farms.

Disadvantages:

- Major capital investment along with expensive fuel costs.
- Must be maintained (burners wear out and soot must be scrubbed out to prevent stack fires).
- Ash has no fertilizer potential and there may be a trace of heavy metals from micronutrients fed to the animals.
- Safety hazards associated with high temperature incinerators.

Livestock Burial

Burial is a suitable practice for summer yet difficult during winter due to frozen ground conditions. Dead animals can be placed in a pit which is then backfilled each time a carcass is added. Carcasses must be covered with either

- A minimum of 1 m (3.3 ft) of compacted soil.
- 0.15 m (6 in) of soil, 0.5 kg (1 lb) of quicklime for every 10 kg (22 lbs) of mortality, and a lid.

For more information see Livestock Mortality Burial Techniques, Agdex 400/29-2.

Burial requires great care in site selection because as carcasses decompose they release materials that pollute groundwater. Burial sites should be located in low permeable soils. Areas with a high groundwater level or shallow aquifer must be avoided. The weight of dead animals in the pit may not exceed 2500 kg (5500 lbs). Refer to Appendix A for site selection criteria.

Advantages:

- Inexpensive (if using your own equipment).
- Biosecure (no trucks coming from other farms to pick up carcasses).
- Convenient.

Disadvantages:

- Difficult to impossible in winter.
- Can cause groundwater pollution.
- No burial sites where the bottom of the pit is less than 1 m (3.3 ft) above the seasonal high water table.

Rendering

Another popular option is transporting carcasses to an approved disposal plant. Rendering is a convenient, clean and waste-free solution that ultimately recycles the remains into other products. The renderer generally provides on-farm pick up for a fee. However, some companies are selective about which species they accept and which geographic locations they serve. Since transportation is expensive, pick up will be scheduled when the renderer can make several stops in the same area.

Rendering processes dead animals into feed ingredients such as bone meal, meat meal, feather meal, and liquid animal fat. Animals that die during the winter can be frozen and delivered to the renderer at convenient intervals. Rendering companies will generally not accept carcasses that do not remain intact when handled. Depending upon the end product of the rendering process, there may be other restrictions on carcass quality and condition.
Refer to the Yellow Pages Directory under "Rendering Companies" for companies providing this service.

Timely pick up is the biggest challenge when using rendering as a mortality disposal method, specifically during the warm and hot seasons. Collection vehicles must employ proper biosecurity measures to prevent disease transmission between farms. Costs for rendering continue to increase and the expense and logistics of collecting small volumes of carcasses on a frequent basis prevents this disposal method from being widely accepted.

Some pick up fees have been instituted regardless of the volume of mortalities, therefore some producers have chosen to invest in on-site preservation methods such as refrigeration, acid preservation and fermentation. The costs of on-farm storage of carcasses should be determined as they may outweigh the benefit of less frequent pickups by the renderers.

Refrigeration:
Generally limited to poultry or young animals, refrigeration units are expensive to purchase and operate. As a preservation method, refrigeration works very well; however, the unit must have sufficient refrigeration capacity to rapidly remove heat from the carcass.

Acid Preservation:
Punctured carcasses are placed in an acid solution (e.g. 3% sulfuric acid) which preserves the nutrient content and inactivates pathogens and microorganisms. The renderer can process the acid – preserved organic matter – into a high nutrient feed ingredient. Acids and the associated equipment are expensive and safety is a primary issue.

Fermentation:
Lactic acid fermentation is a process that provides a way to store carcasses for at least 25 weeks. Carcasses are mixed with a carbohydrate source and a culture innoculant. When the pH is reduced to 4.5, the microorganisms are inactivated and the decomposition process ceases. This process is referred to as pickling.

Advantages:
- The carcass is completely removed from the farm.
- The rendering process destroys most diseases.

Disadvantages:
- Pathogenic transmission during pick up and transportation is possible (care must be taken to prevent the pathogens from moving through the system).
- Increasing cost due to reduced marketability of rendered products.

Composting

Composting is a controlled process. During the process, bacteria, fungi and other organisms break down organic materials to a stable mixture called compost, while consuming oxygen and releasing heat, water and carbon dioxide. The finished compost resembles humus and can be used as a soil amendment. Composting reduces the volume of the parent materials and most pathogens are destroyed if the process is controlled.

Composting of carcasses is gaining popularity. For more details on composting, see Poultry Mortality Composting, Agdex 450/29-1, Swine Mortality Composting, Agdex 440/29-1 and Large Animal Mortality Composting Agdex 400/29-4.

Proper management of the composting facility is required to ensure composting of the carcasses occurs. The basic requirements for successful composting are:

- Aerobic conditions (in the presence of oxygen).
- Proper temperature, moisture, pH and carbon to nitrogen ratio.
- Maintaining a temperature of 55 °C (131 °F) for at least three days.

Other factors that must be considered when composting are:

- Properly constructed facilities and the use of primary and secondary areas.
- Facility design must limit access of scavengers.
- Equipment needs including the use of a front-end loader.
- Management, monitoring and turning requirements of compost.
- Ensuring compost is applied to crop land without direct contact with livestock.
- Availability of necessary inputs of litter, straw and manure.
- The location of compost, Appendix A.
- Contaminated run-off must be collected and surface water directed away from the composting facility.

Advantages:

- Biosecure.
- Year-round use.
- Relatively inexpensive.
- Environmentally sound.
- Value-added product to sell or use (sales regulated by the *Fertilizer Act*).
- Best and recommended method to handle catastrophic losses.
- Heat of composting process kills most pathogens, weed seeds and insect larvae.
- Scavengers do not bother actively heating compost.

Disadvantages:

- May be labour intensive.
- Requires an impervious pad.
- Bin composting requires rot resistant walls and a cover to repel rain.
- Takes practice to develop the technique.
- Requires a carbon source.

Natural Disposal

Disposal of carcasses by scavengers is a permitted method in Alberta but because of the very high probability of disease spread and of creating a public nuisance, this method is not recommended. All regulations concerning natural disposal are outlined in Appendix A.

caution

If an animal is known or suspected to have died from an infectious or reportable disease, the owner must report this to authorities and dispose of the animal in the manner they recommend. For an animal that has been euthanized, owners need to prevent scavengers from gaining access to the dead animal. These animals cannot be disposed of by natural disposal.

Reportable Diseases are those which require action to control or eradicate because they are a threat to animal or human health, food safety or the economy.

Notifiable Diseases are those which simply require monitoring for trade purposes or to understand their presence in Alberta. No action will be taken.

Anyone who knows or ought to know that any of these diseases are or may be present in an animal MUST report that fact to the Office of the Chief Provincial Veterinarian within 24 hours by calling 1-800-524-0051.

SRM Alert – Cattle Carcass Disposal (Canadian Food Inspection Agency 2009)

In 2007, the Canadian Food Inspection Agency's (CFIA) enhanced feed ban was enacted to control the handling, transporting and disposal of specified risk material (SRM). SRM includes the skull, brain, trigeminal ganglia (nerves attached to the brain), eyes, tonsils, spinal cord and dorsal root ganglia (nerves attached to the spinal cord) of cattle aged 30 months or older and the distal ileum (portion of the small intestine) of all cattle. Under the regulations, a permit is required to receive, remove from any premises, use, convey (other than from one area to another on the same premises), treat, store, export, sell, distribute, confine or destroy SRM in any form, including bovine dead stock from which SRM has not been removed. The location receiving the SRM must have a separate permit.

The Health of Animals Regulations allows for cattle producers to dispose of SRM on the premises where the animal was found dead without the need for a CFIA permit. The CFIA has defined "site" as being contiguous properties whether or not there is a public access or right of way which traverses the properties. Therefore, a permit is needed to move SRM from one property to another if traveling on public land (roads) even if the sites are both owned by the same person.

A farmer may obtain an annual CFIA permit to transport SRM to this non-contiguous site. However, the receiving site requires an annual permit to receive the SRM and needs to meet defined minimal requirements as outlined on the permit.

The SRM permit application form is available online at www.inspection.gc.ca/bse. It should be completed and submitted to the nearest CFIA district office. If the situation is time-sensitive or occurs outside of normal business hours, call 1-800-442-2342 to request an emergency SRM permit. You will be directed to a CFIA inspector on-call who will request the following information:

- The transporter's name, address, phone number, e-mail address.
- A description of the conveyance used to transport the SRM (license plate of truck or description of tarp/bucket).
- The SRM permit number of the site that will be receiving the SRM (unless it is the farm of origin of an animal dying in transit).
- The number of carcasses and approximate weight of SRM being transported;
- CCIA or ATQ tag number(s).

The inspector will provide the permit number which will be valid for 48 hours or less. An actual copy of the SRM permit will be provided during an ensuing inspection.

CFIA's SRM permits to transport, accept and dispose of SRM are free. For more information, visit www.inspection.gc.ca/bse, call 1-800-442-2342 or visit your local CFIA office.

appendix A act and regulation

In this Regulation,

(a) "Act" means the *Animal Health Act*;

(b) "composting", in respect of a dead animal, means a managed process for aerobic decomposition of the dead animal;

(c) "dead animal" means

(i) all or part of an animal that has died from a cause other than having been slaughtered or killed for

(A) human or animal consumption, or

(B) an animal product or animal by-product,

(ii) inedible offal, condemned material or waste material from an animal that was slaughtered or killed for

(A) animal consumption, or

(B) an animal product or animal by-product,and

(iii) inedible offal, condemned material or waste material from an animal processed at a meat facility;

(d) "meat facility" means

(i) a meat facility within the meaning of the *Meat Inspection Act*, and

(ii) an establishment within the meaning of the *Meat Inspection Act* (Canada) in which animals are slaughtered;

(e) "rendering plant" means a rendering plant within the meaning of the *Health of Animals Act* (Canada).

Application

2 (1) This Regulation does not apply to wildlife as defined in the *Wildlife Act* or controlled animals as defined in the *Wildlife Act*, except

(a) wildlife or controlled animals possessed by a person who is or was the holder of a zoo permit under the *Wildlife Act* relating to the wildlife or controlled animals,

(b) wildlife possessed by a person who is or was the holder of a game bird farm permit under the *Wildlife Act* relating to the wildlife,

(c) wildlife possessed by a person who is or was the holder of a temporary shelter permit under the *Wildlife Act* relating to the wildlife,

(d) fur-bearing animals held by a person who is or was the holder of a licence under the *Fur Farms Act* relating to the fur-bearing animals,

(e) wildlife or controlled animals possessed by a non-resident or non-resident alien who is or was the holder of an import permit under the *Wildlife Act* relating to the wildlife or controlled animals, and

(f) wildlife processed at a meat facility.

(2) For greater certainty, nothing in this Regulation affects the operation of any other law, including, without limitation,

(a) any law that requires an approval, consent, permit, licence or other authorization or document to be obtained for an activity relating to the disposal of a dead animal, or

(b) any law that relates to a method of disposal, including without limitation, any law prohibiting or regulating the setting of fires.

DISPOSAL OF DEAD ANIMALS

Owner's duties

3(1) The owner of a dead animal shall dispose of the dead animal in accordance with this Regulation.

(2) In storing or disposing of a dead animal, the owner of the dead animal shall ensure that

(a) the odours generated by the dead animal are minimized,

(b) any run-on or run-off water at the site where the dead animal is located is minimized,

(c) the risk of the spread of disease is minimized, and

(d) the dead animal does not create a nuisance.

(3) The owner of a dead animal shall dispose of the dead animal within 7 days unless the owner stores the dead animal

(a) outside during winter months when the ambient temperature is low enough to keep the dead animal completely frozen,

(b) in a freezer unit, or

(c) in accordance with the directions of the chief provincial veterinarian, an inspector appointed under section 6(2) of the Act or a veterinary inspector appointed under the *Health of Animals Act* (Canada).

(4) The owner of a dead animal shall comply with any direction of an inspector directing the owner to dispose of the dead animal.

(5) The owner of an animal that is euthanized with drugs or other chemical substances shall take steps to prevent scavengers from gaining access to the animal beginning at the time the drugs or other chemical substances are administered until the final disposal of the dead animal.

Disposal by meat facility

4 Subject to section 6 and the terms of any order made under section 18, an owner or operator of a meat facility shall dispose of a dead animal by a method

(a) set out in section 7, 9(b), 10 or 13,

(b) referred to in section 15 that is approved for use by owners or operators of meat facilities under section 16, or

(c) authorized by the chief provincial veterinarian.

Conditions respecting use of disposal methods

5 An owner of a dead animal shall not dispose of a dead animal using a method referred to in section 8, 9(a), 11 or 14 unless

(a) the owner had custody or care and control of the animal immediately before the animal's death, and

(b) the owner is an owner of the land or premises

Diseased animals

6(1) If a dead animal is known or suspected to have had a disease that is reportable under the Act but is not reportable under the *Health of Animals Act* (Canada), the owner of the dead animal shall dispose of the dead animal by a method provided for in this Regulation as directed by the chief provincial veterinarian or an inspector appointed under section 6(2) of the Act.

(2) If a dead animal is known or suspected to have had a disease that is not reportable under the Act but is reportable under the *Health of Animals Act* (Canada), the owner of the dead animal shall dispose of the dead animal by a method provided for in this Regulation as directed by a veterinary inspector appointed under the *Health of Animals Act* (Canada).

(3) If a dead animal is known or suspected to have had a disease that is reportable under the Act and under the *Health of Animals Act* (Canada), the owner of the dead animal shall dispose of the dead animal by a method provided for in this Regulation as directed by

(a) the chief provincial veterinarian or an inspector appointed under section 6(2) of the Act, or

(b) a veterinary inspector appointed under the *Health of Animals Act* (Canada).

Disposal in landfill

7 Subject to section 6 and the terms of any order made under section 18, a dead animal may be disposed of in a Class I or Class II landfill as defined in the Waste Control Regulation (AR 192/96).

Burial

8(1) In this section, "provincial highway" means a provincial highway as defined in the Highways *Development and Protection Act*, but does not include a proposed highway.

(2) Subject to section 6 and the terms of any order made under section 18, a dead animal may be buried in a farm burial pit in accordance with subsections (3) to (6).

(3) A dead animal may be buried in a farm burial pit only if the bottom of the pit is at least one metre above the seasonal high-water table.

(4) One or more dead animals may be buried in a farm burial pit if

(a) the total weight of the dead animals buried in the pit doesnot exceed 2500 kg, and

(b) the pit

(i) is at least 100 m from any well or other domestic water intake, stream, creek, pond, spring, river, irrigation canal, dugout or other water source and the high-water mark of any lake,

(ii) is at least 25 m from the edge of any coulee or embankment,

(iii) is at least 10 m from any other farm burial pit,

(iv) is at least 100 m from any residence,

(v) is at least 100 m from the boundary of any land owned or leased by a person other than the owner of the dead animal, unless the owner or leaseholder of the land has consented in writing to the pit being located closer to the boundary,

(vi) is at least 300 m from any provincial highway, and

(vii) is covered with

(A) a minimum of one metre of compacted soil, if no additional dead animals are to be buried in the pit, or

(B) a wooden or metal lid that is designed to exclude scavengers and quicklime is applied to the dead animal or animals in sufficient quantities to control flies and odour, if the weight limit established by clause (a) has not been reached and the owner intends to bury additional dead animals in the farm burial pit.

(5) For the purposes of subsection (4)(a), the total weight of dead animals is determined by adding the weight at the time of burial of each dead animal buried in the pit to the weight at the time of burial of each dead animal previously buried in the pit.

(6) One or more dead animals may be buried in a farm burial pit if

(a) the total weight of the dead animals buried in the pit does not exceed 100 kg, and

(b) the pit

(i) is at least 50 m from any well or other domestic water intake, stream, creek, pond, spring, river, irrigation canal or other water source and the high-water mark of any lake,

(ii) is at least 25 m from the edge of any coulee or embankment,

(iii) is at least 100 m from any residence situated on land owned or leased by a person other than the owner of the dead animal,

(iv) is at least 3 m from any other farm burial pit,

(v) is covered with a minimum of one metre of compacted soil, and

(vi) has not been used for the burial of a dead animal during the previous 5-year period.

(7) If authorized in writing by the chief provincial veterinarian or an inspector appointed under section 6(2) of the Act, one or more dead animals exceeding 2500 kg in total weight may be buried in a farm burial pit in accordance with any directions provided in the authorization.

Burning

9 Subject to section 6 and the terms of any order made under section 18, a dead animal may be burned in accordance with the applicable provisions in the *Environmental Protection and Enhancement Act* and in the regulations or codes of practice under that Act relating to the burning

(a) in an open fire, or

(b) in an incinerator.

Composting in compost facility

10 Subject to section 6 and the terms of any order made under section 18, a dead animal may be disposed of by composting in a Class I compost facility as defined in the Waste Control Regulation (AR 192/96).

Farm composting

11(1) Subject to section 6, and the terms of any order made under section 18, a dead animal may be disposed of by composting

(a) in an outdoor farm open compost pile

(i) that is

(A) at least 100 m from any well or other domestic water intake, stream, creek, pond, spring, river,irrigation canal, dugout or other water source and the high-water mark of any lake,

(B) at least 25 m from the edge of any coulee orembankment, and

(C) at least 100 m from any residence,

(ii) that is designed in a manner that will exclude scavengers,

(iii) that is at least 100 m from the boundary of any land owned or leased by a person other than the owner of the dead animal, unless the owner or leaseholder of the land has consented in writing to the outdoor farm open compost pile being located closer to the boundary,

(iv) that is at least 300 m from any provincial highway, and

(v) in which the dead animal or animals are covered with at least 60 cm of composting material, or

(b) in an indoor farm open compost pile that is located in a building that has

(i) an impervious floor, and

(ii) adequate drainage control to prevent the contamination of surface water or groundwater from the compost effluent.

(2) Where one or more dead animals are composted in an outdoor or indoor farm open compost pile,

(a) the volume of the dead animal or animals in the compost pile must not exceed 25% of the total volume of the compost pile, and

(b) material may not be removed from the compost pile until the dead animal or animals are composted to the extent that

(i) the generation of odours by the compost is minimized,

(ii) the compost will not contaminate surface water or groundwater,

(iii) the compost will not attract vectors of disease, and

(iv) the use of the compost will not cause or contribute to the spread of disease, cause scavenging or create a nuisance.

Food for other animals

12(1) Subject to section 6 and the terms of any order made under section 18, the owner of a dead animal may dispose of the dead animal by feeding it or allowing another person to feed it to an animal if the owner of the dead animal

(a) knows that the dead animal

(i) did not have an infectious or contagious disease or a disease that is notifiable under the Act or reportable under the Act or the *Health of Animals Act* (Canada), and

(ii) was not euthanized with drugs or other chemical substances,and

(b) provides a written certificate to the owner of the animal to which the dead animal is being fed confirming that the dead animal did not have a disease referred to in clause (a) and was not euthanized as referred to in clause (a), where the dead animal is being fed to an animal that is not owned by the owner of the dead animal.

(2) No person shall feed a dead animal to a production animal as defined in the Authorized Medicine Sales Regulation if the feeding of the dead animal to the production animal would contravene the *Health of Animals Act* (Canada) or the regulations under that Act.

Rendering

13 Subject to section 6 and the terms of any order made under section 18, a dead animal may be disposed of by rendering at a rendering plant operated under a permit issued under the *Health of Animals Act* (Canada).

Natural disposal

14(1) In this section, "natural disposal", in respect of a dead animal, means disposing of the dead animal in a manner that allows for scavenging.

(2) Subject to section 6 and the terms of any order made under section 18, a dead animal, other than inedible offal or condemned material, may be disposed of by natural disposal if

(a) the animal is not known or suspected to have had an infectious or contagious disease or a disease that is notifiable under the Act or reportable under the Act or the *Health of Animals Act* (Canada),

(b) the dead animal was not euthanized with drugs or other chemical substances,

(c) the total weight of the animals being disposed of at one site does not exceed 1000 kg,

(d) there is a distance of at least 500 m between disposal sites, and

(e) the dead animal is disposed of at a disposal site that

(i) is on property that is owned or leased by the owner of the dead animal and at least 100 m from the boundary of land owned or leased by a person other than the owner of the dead animal, unless the owner or leaseholder of the land has consented in writing to the disposal site being located closer to the boundary,

(ii) is at least 500 m from any well or other domestic water intake, stream, creek, pond, spring, river irrigation canal, dugout or other water source and the high-water mark of any lake,

(iii) is at least 25 m from the edge of any coulee or embankment,

(iv) is at least 400 m from any livestock facility, including a pasture, situated on land owned or leased by a person other than the owner of the dead animal,

(v) is at least 400 m from any residence,

(vi) is at least 400 m from any road, and

(vii) is at least 400 m from any

(A) park or recreation area as those terms are defined in the *Provincial Parks Act*,

(B) wilderness area, ecological reserve, natural area or heritage rangeland as those terms are defined in the Wilderness Areas, Ecological Reserves, Natural Areas and *Heritage Rangelands Act*, or

(C) any other land intended for recreational use by the public.

Method approved by Minister

15 Subject to section 6 and the terms of any order made under section 18, a dead animal may be disposed of in a manner that has been approved by the Minister under section 16 if any terms or conditions imposed under that section are complied with.

Approval of disposal methods

16 The Minister may approve a method or methods for the disposal of dead animals in addition to the methods provided for under sections 7 to 14 and may, in the approval,

(a) specify whether the method or methods are approved for use by owners or operators of meat facilities, and

(b) impose any terms or conditions on the disposal of dead animals using the method or methods that the Minister considers appropriate.

Rendering plant

17 The owner or operator of a rendering plant shall ensure

(a) that a dead animal rendered at the plant is subjected to such temperature and pressure as is necessary to render every portion of the carcass free from all viable pathogenic organisms, and

(b) that microbiological quality assurance processes are in place to prevent the occurrence of viable pathogenic organisms.

Disaster or emergency

18(1) In the event of a disaster or emergency, including, without limitation, a flood, fire or outbreak of disease, the chief provincial veterinarian may, for the purposes of responding to and dealing with the effects of the disaster or emergency, make an order

(a) in respect of any person or class of persons that for the period set out in the order

(i) exempts the person or class of persons from the application of this Regulation or any provision of this Regulation, or

(ii) varies the rules applicable to a method for the disposal of dead animals set out in this Regulation in respect of dead animals disposed of or to be disposed of by the person or class of persons, or

(b) in respect of any owner or class of owner of a dead animal or type of dead animal specified in the order that directs the owner or class of owner to dispose of the dead animal or a dead animal of that type in a manner or by a method specified in the order.

(2) A person or owner who is the subject of an order or is a member of a class of persons or owners that is the subject of an order under subsection (1)(a)(ii) or (b) shall comply with the order.

GENERAL

Transport of non-rendered dead animal

19 A person who transports, or prepares for transport, a dead animal that has not been rendered shall ensure that the dead animal is transported or prepared for transport in such a manner so as to prevent

(a) any dissemination of pathogenic organisms into the environment from the leakage of blood or other body fluids of the dead animal, and

(b) the contamination of food intended for consumption by humans or animals.

Diagnosis of animal diseases

20 Nothing in this Regulation prohibits the collection, shipment or transport of a dead animal as may be required by a registered veterinarian or the owner of the dead animal for the diagnosis of animal disease.

Offences

21 A person who contravenes or fails to comply with this Regulation is guilty of an offence.

Penalties

22(1) A person who is guilty of an offence under section 21(a) for a first offence, to a fine of not more than $15 000 and, in the case of a continuing offence, to a further fine of not more than $1000 for each day or part of a day during which the offence continues after the first day, and

(b) for a 2nd or subsequent offence,

(i) to a fine of not more than $30 000 and, in the case of a continuing offence, to a further fine of not more than $2000 for each day or part of a day during which the offence continues after the first day, or

(ii) to imprisonment for a term not exceeding one year, or to both fines and imprisonment.

(2) A prosecution under subsection (1) may be commenced within 2 years of the commission of the alleged offence but not afterwards.

Repeal

23 The Destruction and Disposal of Dead Animals Regulation (AR 229/2000) is repealed.

Expiry

24 For the purpose of ensuring that this Regulation is reviewed for ongoing relevancy and necessity, with the option that it may be repassed in its present or an amended form following a review, this Regulation expires on September 30, 2023.

Coming into force

25 This Regulation comes into force on the coming into force of section 19 of the *Animal Health Amendment Act, 2009*.

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for more information

Emergency Carcass Disposal

Contact your local rural municipality for assistance.

Reportable Diseases

Office of the Chief Provincial Veterinarian
780-427-3448 or toll-free by first dialing 403-310-0000
http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/cpv4264

Alberta's Notifiable and Reportable Diseases Website

http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/afs12455

Canadian Food Inspection Agency

Visit www.inspection.gc.ca/bse, call 1-800-442-2342 or visit your local CFIA office listed on the following page.

Canadian Food Inspection Agency (CFIA) Offices

Canadian Food Inspection Agency (CFIA)
Alberta South Calgary
110 Country Hills Landing Northwest
Calgary, Alberta T3K 5P3
Telephone: 403-299-7660

Canadian Food Inspection Agency (CFIA)
Lethbridge Office – Animal Programs
3605-14th Avenue North
Lethbridge, Alberta T1H 6P7
Telephone: 403-382-3121

Canadian Food Inspection Agency (CFIA)
Coutts Office – Animal Programs
PO Box 130
Coutts, Alberta T0K 0N0
Telephone: 403-344-3808

Canadian Food Inspection Agency (CFIA)
Medicine Hat District Office
7 Strachan Bay Southeast, Suite 105
Medicine Hat, Alberta T1B 4Y2
Telephone: 403-528-6850

Canadian Food Inspection Agency (CFIA)
Animal Programs – Edmonton
7000-113th Street
Edmonton, Alberta T6H 5T6
Telephone: 780-495-3333

Canadian Food Inspection Agency (CFIA)
Edmonton Regional Office – Animal Health
7000-113th Street
Edmonton, Alberta T6H 5T6
Telephone: 780-495-3333

Canadian Food Inspection Agency (CFIA)
Grande Prairie District Office
10135-100th Avenue
Grande Prairie, Alberta T8V 0V4
Telephone: 780-831-0335

Canadian Food Inspection Agency (CFIA)
Vermilion District Office – Animal Health
5016-49th Avenue, Unit B
Vermilion, Alberta T9X 1B7
Telephone: 780-853-5637

Canadian Food Inspection Agency (CFIA)
Red Deer
6503-67th Street
Red Deer, Alberta T4P 1A3
Telephone: 403-340-4204

Canadian Food Inspection Agency (CFIA)
Wetaskiwin District Office
5729-40th Avenue
Wetaskiwin, Alberta T9A 2Z1
Telephone: 780-352-3955

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RR 1 Spirit River, AB T0H 3G0
www.saddlehills.ab.ca

VSI APPLICATION FORM

LEGAL NAME: _____ **CELL #** _____

MAILING ADDRESS: _____ **HOME #** _____

_____

E-MAIL ADDRESS:

LEGAL LAND DESCRIPTION: _____ Lease or Own? ☐

SOCIAL INSURANCE NUMBER: _____

TYPE OF LIVESTOCK:	CATTLE	SWINE	GOATS	SHEEP
NUMBER OF HEAD:				

I hereby agree to abide by the terms and conditions of the Veterinary Services Insurance Program as set out in the VSI Policy for Saddle Hills County. I also understand that this policy may be changed from time to time as deemed necessary. I agree to abide by any changes made.

_____ _____
DATE **APPLICANT**

_____ _____
DATE **SADDLE HILLS COUNTY**

This personal information is being collected and protected as per the *Freedom of Information and Protection of Privacy Act* and will be used in issuing an AGR-1 E (08), Statement of Farm Support Payments, Emergency Management and other requirements under the *Animal Health Act* .

Office Use Only

If lease, copy of lease agreement ☐ **yes or no** **VSI number:** **SHC-** ☐ **Update Database**_____ **date**

Notify VSI Manager ☐ date **Does Applicant have Livestock Protection Course?** ☐