GRAY WOLVES AND LIVESTOCK IN MONTANA: A RECENT HISTORY OF DAMAGE MANAGEMENT

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Abstract: The Montana gray wolf (*Canis lupus*) population grew from 2 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 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. Cattle and sheep were killed most often from March to October, although losses were confirmed each month. From 1987 to 2006, wolves killed 230 cattle and 436 sheep. However, confirmed losses probably represent a fraction of actual wolf losses. Few other types of livestock classes were killed. Conflicts are addressed on a case-by-case basis, striving to connect the agency response to the damage in space and time and to decrease the potential for future losses. Lethal control is implemented incrementally after predation was verified, and 254 wolves were killed from 1987 to 2006. Only complete removal of either wolves or livestock eliminates the potential for wolf depredation. The continued presence of a viable wolf population requires that a wide variety of non-lethal and lethal tools be investigated and implemented. That combination will also be required to maintain local public tolerance of wolves where the two overlap and to foster broad public acceptance of techniques used to minimize conflicts. Resolving wolf and livestock conflicts at a local scale is but one component of a larger state wolf conservation and management program. When wolves are delisted, regulated public harvest will allow us to more proactively manage the population.

Key words: *Canis lupus,* cattle, damage, domestic sheep, gray wolf, lethal control, livestock, management, Montana, non-lethal control

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INTRODUCTION

Gray wolf *(Canis lupus)* recovery in Montana began during the late 1970s. Gray wolves increased in number and expanded their distribution in Montana because of natural emigration from Canada and a successful federal effort that reintroduced wolves into Yellowstone National Park and the wilderness areas of central Idaho. The Montana population grew from 2 documented wolves in 1979 to a minimum of 316 wolves at the end of 2006.

United States Fish and Wildlife Service (USFWS) wolf recovery efforts emphasized legal protection under the Endangered Species Act (ESA), building local tolerance, and minimizing conflicts with livestock through adoption and implementation of special regulations allowing greater management flexibility than is ordinarily available for federally protected species (USFWS 1987, 1988, 1994a, 1994b, 1999, 2005).

USFWS enlisted the expertise of United States Department of Agriculture, Animal Plant Health Inspection Service, Wildlife Services (WS) to investigate injured or dead livestock or domestic dogs reportedly killed by wolves. When WS confirmed wolf caused damage, USFWS and WS implemented non-lethal and lethal tools believed to most likely foster wolf recovery and reduce the potential for further livestock damage. Resolving conflicts, both perceived and real, between wolves and livestock was a dominant social issue for the recovery program (Bangs et al. 2005) and remains so in Montana today.

The northern Rockies' gray wolf population attained the biological recovery goals in 2002, but remains listed under Endangered Species Act (ESA). Montana Fish, Wildlife & Parks (MFWP) completed its management plan in 2003, and USFWS approved it in 2004. When federal funding became available beginning in 2004, MFWP increased its role in day-to-day wolf conservation and management under an interim interagency cooperative agreement with USFWS. During 2005, MFWP expanded its responsibilities statewide, and the USFWS role was reduced to providing funding to the states, ESA-related law enforcement issues, coordination between various federal, state, and tribal agencies, and federal regulatory actions such rule changes and delisting proposals.

The cooperative agreement designates MFWP as the lead agency for wolf conservation and management and allows MFWP to implement its approved state plan to the extent possible and within the scope of special federal regulations.

Montana assumed full responsibility for population monitoring, wolf-livestock conflict resolution, outreach, and research. The agreement also authorizes MFWP to direct problem wolf control using a combination of the USFWS approved state management plan and the applicable federal regulations.

In 2006, MFWP expanded an existing Memorandum of Understanding with WS to include assistance with investigations of reported wolf damage. WS continues to be the lead agency investigating the causes of injured or dead livestock and domestic dogs in Montana. If WS determines wolves are responsible for depredation, they notify MFWP. MFWP and WS field staff share information, confer with the affected producer, and coordinate on the appropriate response. MFWP has the primary responsibility for the decision on what actions are to be taken and to convey that decision and its rationale to the affected producer.

In addition, WS continues to operate as a subpermittee under a USFWS permit to conduct various activities in Montana to

enhance recovery, survival, propagation, and scientific research. WS is authorized to pursue, capture, harass, drug, hold, mark, radio tag, transport, relocate, and kill gray wolves as specifically authorized by USFWS or MFWP which is the designated agent of USFWS for wolf conservation and management in Montana.

Montana's wolf conservation and management program is based on the work of a diverse stakeholder group. The plan outlines an adaptive management approach that ensures the long-term success of wolf recovery in a landscape where people live, work, and recreate. The plan recognizes wolves as a native species and part of Montana's wildlife heritage, allows wolves to find their place on the landscape similar to other wildlife, and addresses and resolves conflicts.

The Montana plan outlines an adaptive management framework in which the status of the wolf population guides agency decision making in a hierarchical way. If there are 15 or more Breeding Pairs (BP) by the USFWS recovery definition (an adult male and an adult female and at least two pups on December 31), then more aggressive management tools (e.g. lethal removal of problem wolves) can be selected and applied commensurate with the number of BPs above 15. If the number of BPs is below 15, management decisions become more conservative, with an increasing sensitivity towards preventing the total number of BPs statewide from dropping below the 10 minimum BP required by USFWS to maintain Montana's share of the northern Rockies wolf population.

After BP numbers, the second factor considered is whether the incident took place in remote backcountry areas and areas near national parks or in areas of mixed public/private landownership. In remote backcountry areas where there is lower potential for conflict, management could be more conservative compared to areas where there is a matrix of public and private lands having a greater potential for conflict. In areas of mixed landownership and when the number of BPs is 15 or greater, more aggressive management tools may be selected and applied more aggressively commensurate with the number of BPs above 15.

The adaptive framework is paired with population monitoring efforts that result in an annual snapshot of the minimum number of wolves, the number of packs of 2 or more wolves, and the number of BPs statewide on December 31 of each calendar year. Monitoring efforts also provide an annual snapshot of wolf pack distribution in Montana. The December 31 statewide BP count sets the stage for the following 12-month period as to whether selected management tools will be more conservative or more aggressive. Ongoing monitoring efforts year long allow MFWP to determine whether a pack territory is situated in an area of primarily remote public lands with a lower potential for conflict or a mixed landownership area where the potential for conflict is higher. Telemetry-based monitoring efforts are also conducted with an eye towards areas of higher livestock density at both course and fine scales to gauge the potential for conflicts and to identify individual livestock operations within a pack's territory.

Montana wolves routinely encounter livestock on both public grazing allotments and private land. Wolves are opportunistic predators, most often seeking wild prey. While some wolves learn to prey on livestock and can teach this behavior to other wolves, management intervention prevents chronic livestock depredation by the majority of wolves. Wolf depredation on livestock is difficult to predict in space and time and is a relatively rare cause of livestock death compared to all causes of

death (Bangs et al. 2005). However, direct and indirect losses due to wolves can and do accrue disproportionately to individual livestock producers. Death losses can be easier to quantify than other types of loss such as the number of "missing" livestock, potential disruption of livestock foraging behavior if wolves move through or actually chase livestock, or even adjustments to husbandry practices to decrease risk of loss. Furthermore, risk of loss is probably higher for producers whose annual cycle of livestock operations place livestock closer to den or rendezvous sites when they are occupied by wolves because of the potential for closer physical proximity and more frequent encounters. Risk is also probably higher for livestock grazed in more remote, rugged terrain where there is less human presence and wolf activity near livestock is more difficult to detect proactively before a problem develops.

In theory, higher livestock densities at a local scale and year-round presence of livestock where wolves frequent should increase risk of loss. Fenced pastures where depredations occurred were more likely to have elk (*Cervus elaphus*) present, were larger in size, had more cattle, and grazed cattle further from residences than pastures without depredations. Greater vegetation cover, closer proximity to wolf dens, and physical vulnerability of cattle were also likely important factors (Bradley and Pletscher 2005).

An integrated program of proactive and reactive non-lethal and lethal control tools was instrumental in achieving recovery goals while reducing the risk of livestock damage and improving tolerance of wolves (Bangs et al. 2005). MFWP and WS now work together to address conflicts using a similar combination of non-lethal and lethal tools to ensure recovery success long-term. Federal regulations and the approved state plan guide MFWP's decision-making. Conflicts are addressed on a case-by-case, incremental basis, striving to connect the agency response to the damage in space and time. This is similar to the approach taken when other wildlife species damage private property in Montana.

This paper summarizes wolf-livestock interactions in Montana and combined state and federal agency efforts to resolve conflicts 1987 to 2006, and the status of the Montana wolf population. Our data analyses are Montana-specific and our interpretations signal another step in the transition from a northern Rockies federal recovery program to a state led resident wildlife program.

STUDY AREA

Montana's diverse landscape can be described as 6 ecosystems based on topography, climate, and vegetation (montane forest, intermountain grassland, riparian, shrub grassland, plains grassland, and plains forest [MFWP 2003]). Being a habitat generalist, wolves historically occurred across all vegetation types in Montana where there was adequate prey. Wolves as a self-sustaining breeding population were probably extinct in Montana by the 1930s. The northern Rockies wolf recovery plan designated three separate recovery areas: northwest Montana (NWMT) which already had a recolonizing population of endangered wolves, Central Idaho experimental area (CID) and Greater Yellowstone experimental area (GYA) which were the areas selected for reintroduction. Montana contains portions of all three. Because Montana has an USFWS-approved wolf plan, similar regulations apply in the Montana portion of CID and GYA, hereafter referred to as the southern Montana experimental area (Figure 1).

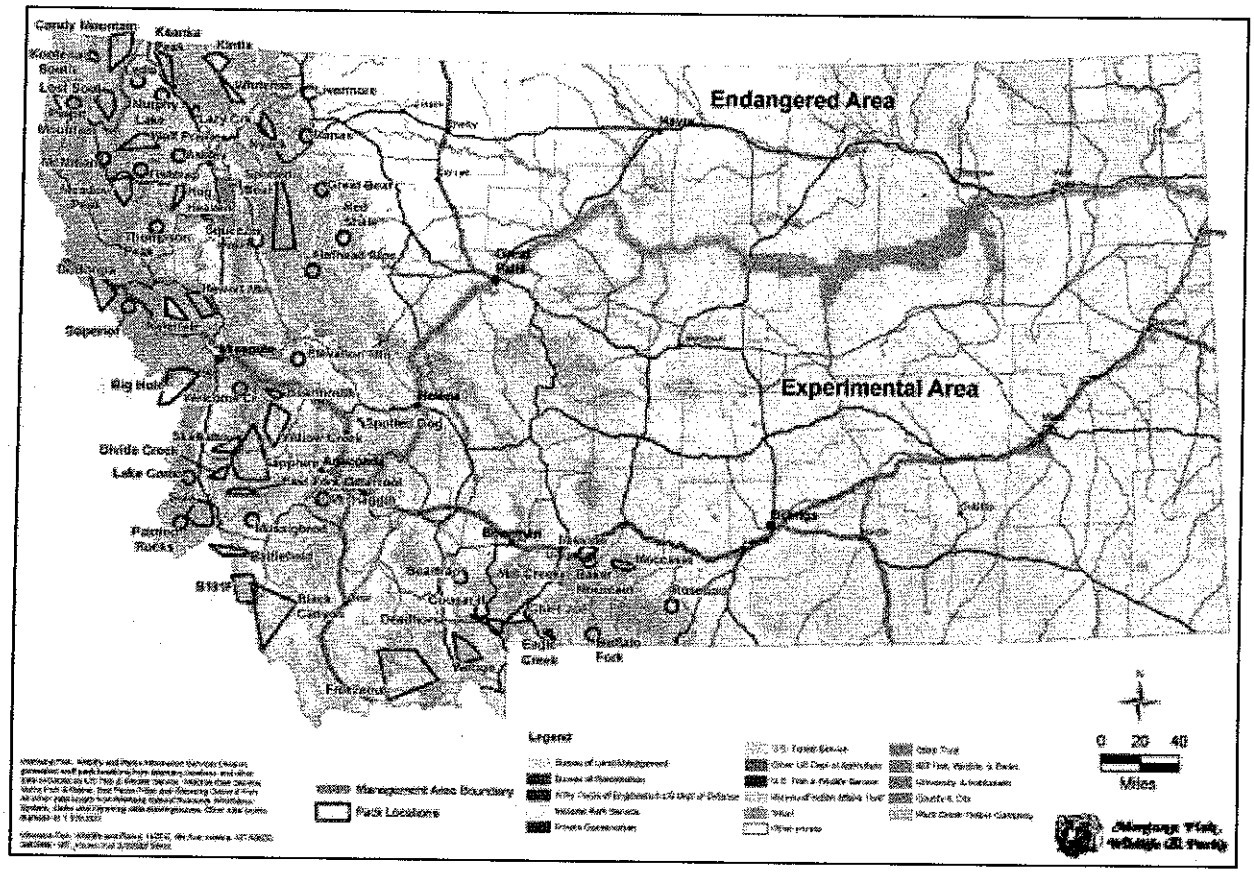

Figure 1. Distribution of gray wolf packs in Montana, December 2006, and the line delineating the Montana portion of the northwest Montana endangered area and the combined area of the Montana portion of the central Idaho and Greater Yellowstone experimental areas. Upon delisting, this line dissolves to the Montana state boundary, within which wolves will be classified under Montana statute as a "species in need of management."

Wolves recolonized NWMT in 1979 and were generally confined to the mountainous portions in the northwest corner of the state (Pletscher et al. 1997, Bangs et al. 1998). Wolf population growth was lower in NWMT than in the experimental areas after reintroduction. Trends in later years indicated intermittent phases of relative stability and moderate growth (USFWS et al. 2007). Lands in NWMT were primarily public or corporate-owned and managed for timber production with limited seasonal grazing by cattle. Valley bottomlands were generally privately owned with smaller scale commercial livestock operations or hobby livestock.

In the southern reaches of NWMT, the predominant vegetation pattern transitions from nearly continuous montane forests to intermountain grasslands with increasing larger blocks of private property with larger scale livestock operations. Wolves in NWMT were managed as an endangered population; human-caused mortality due to poaching and vehicle or train collisions were the primary causes of mortality and exceeded legal removals by agency personnel. The 1988 and the revised 1999 USFWS Interim Control plans historically guided USFWS decisions about lethal control to address livestock depredations. The 1999 control plan still

guides responses by MFWP and private citizens because of the continued listed status of the species. In the endangered NWMT area, private citizens could not legally haze, harass, or kill wolves caught in the act of attacking livestock. Agency application of lethal control was guided by the number of BPs to assure that lethal control would not disproportionately and negatively affect a small, recovering wolf population in NWMT.

Wolf reintroduction into Yellowstone National Park and the central Idaho wilderness areas in the mid-1990s created a source of dispersing wolves to immigrate to Montana and pioneer vacant habitat. The first established pack in the southern Montana experimental area resulting from dispersal was verified in 1999, although individual wolves most certainly traveled into Montana from the reintroduction sites prior to that time. Wolf numbers have gradually increased (USFWS et al. 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007). The increase in the Montana portion of the GYA has stabilized in more recent years while wolf numbers continued to increase in the Montana portion of CID.

In the southern Montana experimental area, landownership was a mixture of public and private, and livestock production was prevalent. The southwest Montana counties surrounding Yellowstone National Park have some of the highest densities of cattle and sheep of all Montana counties. Wolves were managed as an experimental, non-essential population under special 10j regulations (USFWS 1994b, 2005). The primary source of wolf mortality in the experimental areas was human-related, the majority of which was agency-directed removal in response to wolf-livestock conflicts.

Special federal regulations in the southern Montana experimental area were first adopted in 1994 (FR 59:60252). The 1994 regulations allowed hazing and lethal take by private citizens under certain conditions. In 2005, those regulations were liberalized and additional flexibility for private citizens to kill wolves caught in the act of threatening or attacking livestock became available to Montana citizens because Montana's wolf management plan was approved (FR 70:1286). These regulations are patterned after the Montana "defense of property" statute (Montana Code Annotated MCA 87-3-130) that will take effect statewide upon delisting. Statewide, private citizens will be legally permitted to haze or harass a wolf or kill a wolf seen actively killing or threatening to kill livestock. Citizens will be required to report the incident, and an investigation will be conducted.

Under certain conditions (i.e., after confirmed depredations and WS lethal control work had been authorized), USFWS or MFWP allowed lethal take by private citizens by special permit (i.e., shoot-on-sight). This permit was limited to a specific time period and a defined area, but it did not require that the wolves be actively chasing or harassing the livestock.

The generalized husbandry model for many commercial livestock producers within Montana wolf distribution requires a combination of private land and public land grazing leases to remain economically viable given short growing seasons and lower vegetation productivity typical of drought-prone northern latitudes. Typically, livestock were fed throughout the winter on private land, where calving and lambing also usually occurred in late winter and early spring. During summer, livestock were grazed in more remote settings such as public land grazing allotments having more rugged topography and more complex vegetation patterns. In the fall, livestock were gathered and young shipped to market. Breeding stock were returned to private land

to winter. Wild ungulates also followed a similar seasonal pattern of habitat use, summering at higher elevations on public land and wintering along the public-private land interface within and along the margins of lower elevation intermountain valleys.

Other animal husbandry models also occur in Montana. Some livestock producers have operations wholly supported by private lands and do not rely on remote public grazing allotments. Other producers have specialized in specific genetic lines of more highly valued animals and may or may not utilize public allotments. Other livestock are kept as a hobby interest rather than commercial production, including goats, sheep, and llamas. Horses, mules, donkeys and guarding/herding dogs are also commonly associated with livestock operations.

The Montana gray wolf population is secure but very dynamic. A minimum of 316 wolves in 60 packs of two or more wolves were verified in Montana by the end of 2006 (Sime et al. 2007). From 1995-2006, the statewide population averaged about 14% growth per year. Wolf distribution consists primarily of the western one third of the state (Figure 1).

METHODS

Montana livestock producers reported any suspected wolf damage to WS directly. If MFWP was contacted first, the call was referred to WS. WS investigative procedures followed Paul and Gipson (1994) and Roy and Dorrance (1976). Most incidents were investigated within 24 hours. WS investigators first had to determine if a predation event had occurred and if so, the predator species responsible. Non-predator causes included disease, lightening, poisonous plants, and accidents. The main predatory species in Montana known to kill livestock include golden eagle (*Aquila chrysaetos*), black bear (*Ursus americanus*), grizzly bear (*U. arctos*), mountain lion (*Puma concolor*), bobcat (*Felis rufus*), coyote (*Canis latrans*), domestic dog, gray wolf. A field investigation report form was completed, identifying the cause of the damage. Additional data were recorded such as: date of investigation, class, age, and number of livestock injured or killed, whether the damage occurred on public or private land, field evidence, and management recommendations.

If wolves were confirmed to have caused the damage, USFWS (historically) or MFWP (currently) would determine the management response based on recommendations of the WS investigator, federal regulations for as long as wolves remain listed, and, now in conjunction with Montana's wolf plan. Depending on the situation and decision, WS implements the decision, particularly if lethal removal is involved as a cooperating agency partner with MFWP.

Since 1987, wolf-livestock conflicts have been addressed with a variety of tools, including non-lethal deterrents, wolf relocation (Bradley et al. 2005), and lethal control (Bangs et al. 2005). Non-lethal management responses are either directed at wolves (e.g., relocation, collar and release wolves captured at a depredation sight, or intentional harassment) or are intended to decrease the risk of wolf damage proactively (e.g., fladry, electric night pens, increased human presence, opportunistic non-injurious harassment, light and siren scare devices, and guarding dogs).

Lethal control was intended to remove problem wolves from the population. Lethal control could only be implemented after damage was confirmed by WS, where confirmed is defined as follows: Cases where there is reasonable physical evidence that an animal was actually attacked and/or killed by a wolf. The 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 eye witness accounts of the attack may help identify the specific species or individual responsible for the depredation.

We summarized Montana data on confirmed wolf damage from 1987 to 2006. Because confirmed losses were recorded the most consistently through time, we only report information about confirmed injured and dead livestock. We acknowledge that additional losses occurred (e.g., classified and recorded as probable or missing livestock which were never found) and that confirmed depredations under report the full extent of wolf-related damage to livestock.

RESULTS

Between October 1, 1996 and September 30 2006, WS received approximately 679 complaints of suspected wolf damage. The total number of complaints received on a federal fiscal year basis gradually increased over the last 10 years, but leveled out at around 96 in the last 3 years. On average, about 50% of the complaints received were confirmed as wolf damage (Figure 2).

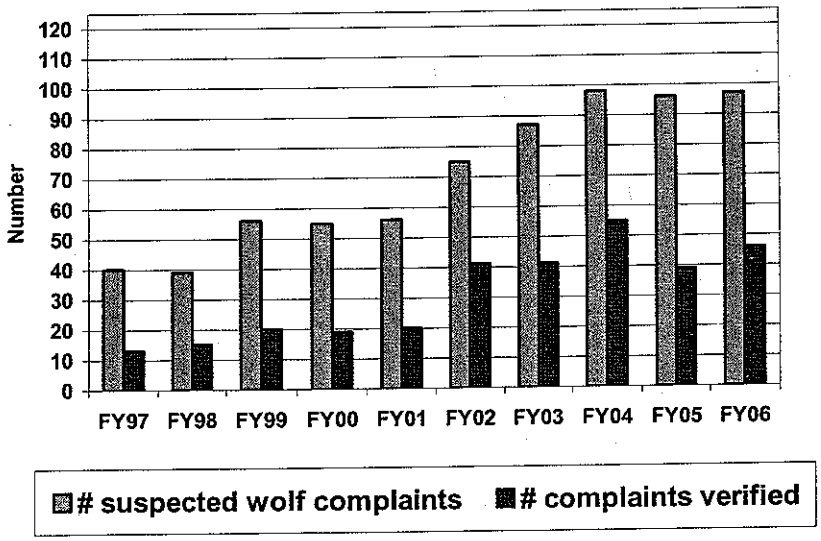

Figure 2. Number of complaints received by USDA Wildlife Services of suspected wolf damage in Montana and number confirmed as injured or dead livestock in federal fiscal years 1997-2006.

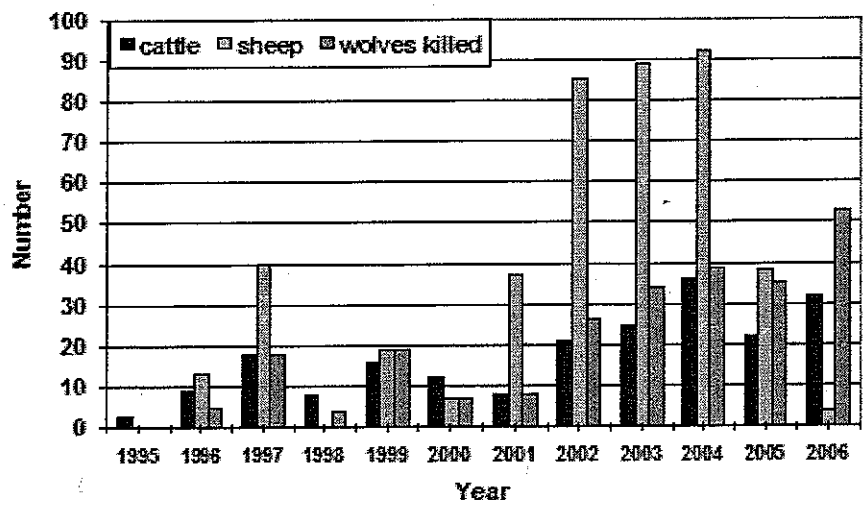

Figure 3. Death loss of cattle and sheep confirmed by USDA Wildlife Services and the total number of wolves killed by calendar year, 1995-2006.

From 1987 to 2006, a total of 230 cattle, 436 sheep, 12 llamas, 1 adult horse, 2 goats, and 2 young horses were confirmed killed by wolves in Montana. The number of confirmed death losses of cattle and sheep gradually increased through that period, particularly after 1995 as wolves started dispersing into Montana after reintroduction to CID and GYA. In the last 6 calendar years, an average of 25 cattle and 58 sheep were killed per year and 33 wolves per year were removed (Figure 3).

In a 2005 survey conducted by the National Agricultural Statistics Service, Montana cattle producers reported they lost a total of 66,000 cattle and calves to all causes, 3,000 of which were due to predators (4.5% of total losses). Coyotes were responsible for 54% of calves lost to predation in 2005 (1,300 of 2,400 total). The remaining 1,100 calves were killed by all other Montana predator species combined, including an unknown number by wolves.

In a 2006 survey, Montana sheep producers reported losing a total of 51,000 sheep (ewes and lambs combined) to all causes, of which 14,100 sheep were killed by predators (28% of total sheep losses). In 2005, coyote predation accounted for 72% of all predator losses (n = 10,100) and 20% of all death losses. Wolf predation accounted for 1.4% of total reported predator losses (n = 200) (National Agricultural Statistics Service 2007).

A total of 254 wolves were killed to help resolve conflicts with livestock from 1987-2006 (Figure 3). Despite this level of lethal removal, particularly in the early years, the Montana population still increased in number and distribution, in part due to immigration from Yellowstone National Park and central Idaho. From 2001-2006, an average of 13% of the wolf population per year was killed due to conflicts with livestock (Figure 4). Under the more flexible special federal regulations in the southern Montana experimental area, a total of 10 wolves were legally killed by private citizens when discovered in the act of chasing or attacking livestock and 13 wolves were killed under shoot-on-sight permits from 2001-2006. WS and MFWP received numerous other reports of non-injurious hazing and harassing, but records are not complete enough to report accurately.

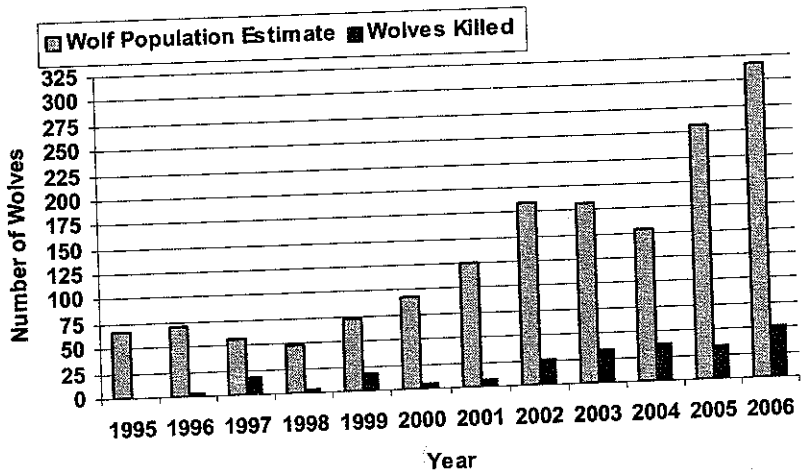

Figure 4. Minimum number of estimated wolves in the Montana population on December 31 of each calendar year and the number killed to address livestock conflicts, 1995-2006.

The number of wolves removed in each incremental control event or from a single pack in a calendar year varied with each conflict situation and through the years. The total number of wolves killed had been relatively stable for the last several years (n = 34-40), despite an increasing wolf population. The number of wolves killed increased from 35 in 2005 to 53 in 2006. Over half of the total lethal wolf control in 2006 was attributed to 2 packs that repeatedly killed livestock within a few weeks on private lands.

About 75% of confirmed injured or dead cattle involved calves (n = 213). Of all confirmed injured or dead sheep, ewes comprised about 34% (n = 147), lambs accounted for 26% (n = 114), and 8% (n = 35) were bucks. The remainder was of unknown classification. A seasonal pattern of wolf-livestock depredations was evident based on all incidents investigated 1987-2006 (Figure 5). Most confirmed cattle depredation events in Montana occurred in spring (March, April, and May) when calves were small and most vulnerable and were likely in calving pastures where detection of injured and dead calves is more likely compared to remote grazing allotments. A smaller spike occurred in the fall (September and October), presumably as food demands of the pack increased and pups began traveling with the pack and learning to hunt. In addition, wild ungulates were still well dispersed on summer range and young-of-the-year ungulates were more mobile.

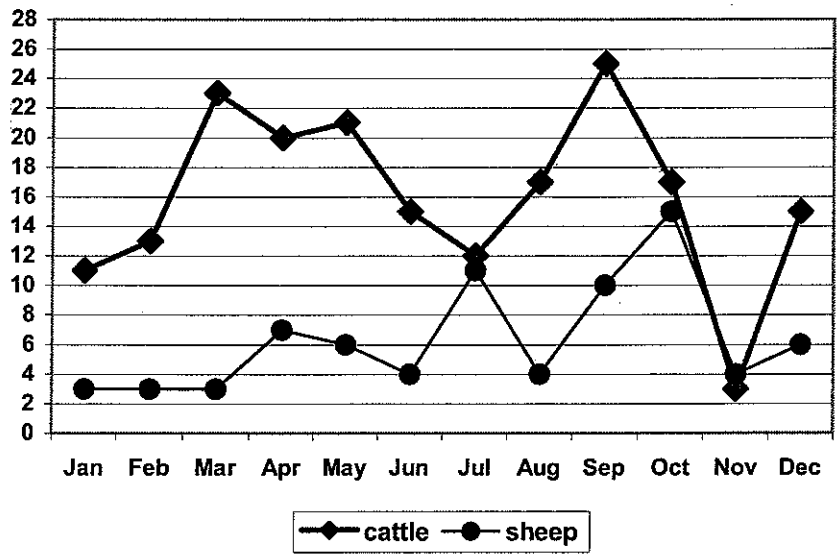

Figure 5. Number of confirmed cattle and sheep depredation events confirmed by USDA Wildlife Services in Montana by month, 1987-2006 (n = 192 cattle events; n = 76 sheep events).

Most confirmed sheep depredation events in Montana occurred in July, September, and October. Because of their smaller size relative to cattle or other classes of livestock, sheep are more vulnerable to wolf predation year round, and multiple sheep are usually killed per incident. Sheep are more available during summer and fall months when greater numbers of sheep (adults and young of the year) are widely dispersed on the landscape.

Statewide, most confirmed death losses for all livestock occurred on private land. Cattle and sheep were killed on private land in 85% and 89% of incidents, respectively (Figures 6 and 7). The likelihood of detecting injured or dead livestock is higher on private lands where there was greater human presence than on remote public land grazing allotments and in rugged terrain. The magnitude of under-detection of loss on public allotments in Montana was not known. In an Idaho study on a densely forested and remote public land grazing allotment, overall, survival of a marked sample of calves was high (n = 231 calves; survival ≥95%) [Oakleaf et al. 2003]). Five of the 13 total dead calves were killed by predators, 4 of which were killed by wolves. The other 8 documented calf mortalities were unrelated to predators (e.g., disease, unknown natural causes). But confirmed wolf losses were a fraction of actual wolf-caused losses (1 confirmed out of 8 wolf kills), representing a possible worst-case scenario to detect wolf depredations (Oakleaf et al. 2003).

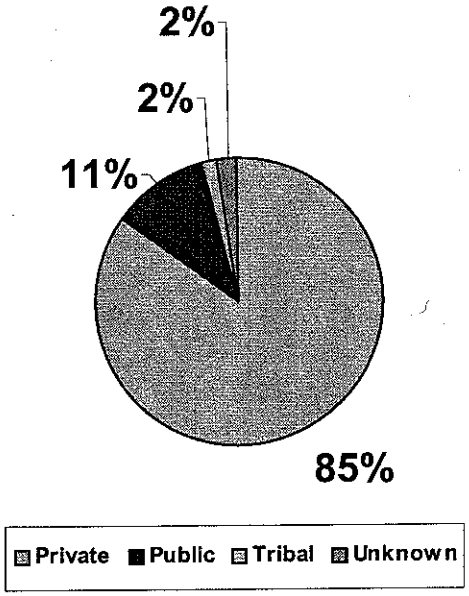

Figure 6. Cattle depredation events (incidents of injured or dead cattle or calves) confirmed by USDA Wildlife Services by landownership, 1987-2006.

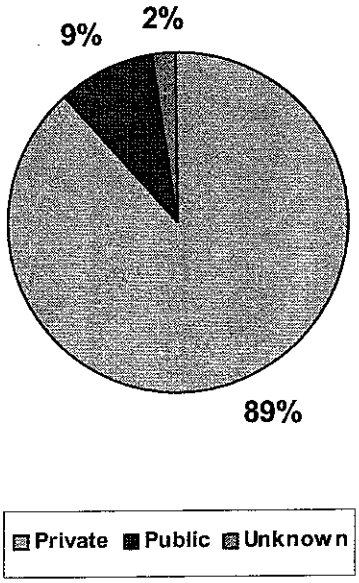

Figure 7. Sheep depredation events (incidents of injured or dead sheep) confirmed by USDA Wildlife Services by landownership, 1987-2006.

Most wolves in Montana routinely encounter livestock, but do not kill livestock at each encounter. On average through the last 10 years, 10-25% of Montana wolf packs were confirmed to have predated on livestock in any given year. One pack has been on the landscape for 18 years and was confirmed to have killed livestock a total of 3 times even though livestock occurred within its territory and within 2 miles of the den site. Other packs depredate once or twice a year, every other year, or at more widely spaced intervals. Still others depredate more frequently, some demonstrating an escalating behavior pattern of actively hunting livestock in the span of a few weeks or months. Packs that have killed livestock repeatedly and within short periods of time, particularly adult-sized livestock, eventually became sources of chronic conflict. In these situations, lethal control occurred more regularly within and across years. In some cases, incremental removal in a stepwise fashion after repeated losses resulted in full pack removal.

WS confirmed a total of 314 incidents of injured or dead livestock due to wolves, affecting 162 different livestock owners from 1987-2006. Most confirmed incidents of injured or dead livestock in Montana (n = 213; 68%) involved livestock producers who experienced wolf damage 2 or more times. The greatest number of incidents experienced by a single livestock owner in Montana was 16. Two owners experienced 11 incidents, and two experienced 7. However, of all the affected livestock owners, more experienced a single incident of confirmed wolf damage (n = 101 of 162; 62%) than experienced multiple incidents (n = 61 of 162; 38%) (Figure 8).

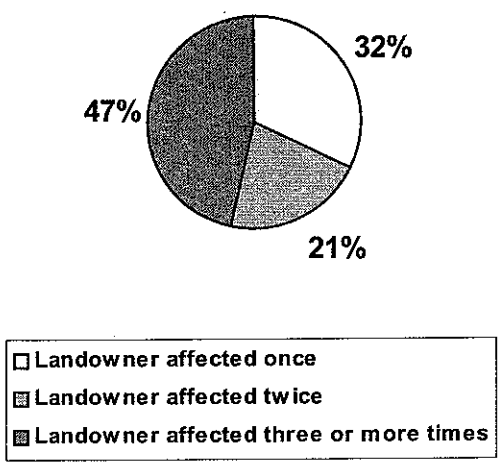

Figure 8. Number of wolf depredation events (incidents of injured or dead livestock) confirmed by USDA Wildlife Services affecting different landowners.

Occasionally, livestock were confirmed killed by lone dispersing wolves or a pair of wolves passing through, as evidenced by the lack of a resident pack or subsequent instances of injured or dead livestock or wolf sign in the area. In these situations, the wolf usually does not return to the original depredation site. In other instances, livestock are killed by remnants of packs that became fragmented due to

lethal control, dispersal or disease-related mortality.

DISCUSSION

Agriculture is important to Montana, both economically and culturally. It also secures open space and wildlife habitat. However, wolves do kill livestock and can have varying degrees of impact on individual livestock producers. Key characteristics of livestock grazing in Montana were its seasonality, varying degrees of livestock vulnerability to wolf predation (size and location of livestock), and livestock class. The Montana wolf program seeks to decrease the risk of livestock losses and to manage wolves similar to other wildlife species, where biology and social tolerance are balanced using a wide array of lethal and non-lethal management tools when resolving conflicts.

We found that Montana landowners varied in their tolerance of wolf activity on or near their private property, and they varied in their reaction to wolf-caused livestock losses. Some were very tolerant of both activity and some wolf-caused losses, so long as a tolerance threshold was not exceeded. The threshold was difficult to quantify, but often included factors unrelated to actual damage losses such as wolf proximity, stress and uncertainty. Furthermore, the threshold varies from one landowner to another. Some landowners actively welcomed wolf presence, finding enjoyment and sometimes even an element of status in "hosting" wolves. Others stated that wolves would not be tolerated on or in close proximity to their property, and they preferred that all wolves be removed. In some cases, these individuals shared a common property boundary.

We also concluded that Montana landowners vary in their preferences and desires about how wolf-livestock conflicts are addressed. Permission is necessary prior to any agency fieldwork on private lands. Some landowners did not want any trapping or lethal control carried out on their property and others may only give permission for specific activities. We respect those differences and work closely with individual landowners to seek solutions amenable to them. In other situations, we had success working collaboratively with local watershed groups or other pre-existing community-level assemblies that provide a forum for a more comprehensive and strategic dialogue. Non-governmental organization representatives participated as well and frequently brought resources to the table in the form of grants or cost-share dollars. In many cases, the additional resources ultimately led to implementation of proactive, non-lethal tools intended to decrease risk or detect wolf-related problems sooner.

These differences (sometimes between adjacent landowners) create a challenging environment within which to address wolf-livestock conflicts. The operating environment was further complicated by the significant travel capability of wolves. Travel distances for Montana wolves could easily be 20 to 30 miles per day. Within those distances, a wolf would cross any number of different properties, both publicly and privately owned. These realities, in part, lead to development of the adaptive management framework in Montana's plan. The framework provides MFWP some discretion and flexibility to accommodate and balance the size of the statewide population, the unique attributes of each pack, the site-specific and local characteristics of its territory, and its conflict history.

MFWP makes decisions on a case-by-case basis, taking into account more specific factors such as pack size, status and distribution of natural prey, season, the pack's conflict history, age and class of

livestock, and the potential for future losses. A spectrum of management responses is typically considered. For example, MFWP may ask WS to attempt to collar and release a wolf after a confirmed or probable depredation event, particularly if the pack suspected of the damage does not have a radio-collared member.

If MFWP decides that lethal control is warranted, consistent with the state plan and within the federal regulations, MFWP takes an incremental approach to lethal control. Lethal removal is considered an option if the number of BPs is greater than 15 statewide, if non-lethal approaches alone are unlikely to be successful, livestock were confirmed killed, and depredations are likely to continue. The goal is to connect the management response, whether non-lethal or lethal, as closely in space and time to where the incident occurred as possible. This also helps MFWP and WS direct lethal control at the offending animals causing the damage.

For example, if a pack of 8 wolves is confirmed to have killed livestock, 1-2 wolves would be killed with efforts to remove the offending individuals. If more depredations occur, we remove a few more individuals to see if that prevents further losses. Incremental control is continued with each subsequent confirmed depredation until either the depredations stop or an entire pack is removed. This means that problem wolf removal is commensurate with the level of damage and implemented at a local scale, similar to the approach for other wildlife species such as black bear or mountain lion when individual bears or lions damage private property.

Stepwise incremental wolf control can result in the eventual elimination of an entire pack if wolves key into livestock as a food source repeatedly, despite the combination of non-lethal approaches and incremental removal. But in cases where entire packs were removed, 70% of vacant territories were recolonized, and most recolonizations (86%) occurred within a year of the previous pack's removal (Bradley 2004). 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.

In contrast, incremental control reduces the size of a pack, reduces local wolf density, reduces its overall protein demands, while still providing some measure of immediate relief when the offending animals are removed. It may also provide relief if it becomes more difficult for the fewer remaining wolves to kill livestock, livestock become less vulnerable or are moved out of the area, or when wolves move out of the area. Incremental control commensurate with damage in conjunction with social tolerance facilitates identification of suitable habitat in the absence of *a priori*, arbitrary, or administratively determined suitable habitat (e.g., management zones).

We documented 10 incidents in the last 10 years in which wolves caught in the act of chasing or attacking livestock were killed by private citizens. In addition, 13 wolves were killed by private citizens with shoot-on-sight permits issued after damage had occurred. We believed that local producers were more likely to successfully target the offending wolf than agency control efforts after the incident. We also believe that it empowers affected landowners to defend their own property, which is important to them and a net social benefit to the program and wolf conservation in general. It can also ease agency workloads and be more cost effective. We do not have a complete data set on the number of times wolves were opportunistically hazed or harassed, as many incidents go unreported. We believe it is

helpful and might possibly deter future attacks.

Our data demonstrated how variable wolf-livestock conflicts in Montana are within and among years. At a course spatial scale, our data suggested that most conflicts occurred on private land and that some areas are more prone to conflict than others, evidenced by the multiplicity of events experienced by some producers. Still, a majority of affected Montana producers experienced a single incident of confirmed wolf damage (62%). Thus it is difficult to predict exactly when and where wolves will attack livestock within an individual pack territory.

Only as a result of our monitoring efforts and experience gained through adaptive management can we improve our understanding of what puts one livestock producer at greater risk than another. Spatial patterns of conflict can and do become self evident in time if a producer experiences repeated losses. We suspect that physiographic landscape features, previous wolf occupancy, wolf behavior, pack size and dynamics, the seasonal distribution, density, and size of native ungulate populations, class and relative vulnerability of livestock, and time of year are relevant factors. An improved empirical understanding of these factors and the interrelationships between and among them will help managers and livestock producers decrease risk more effectively.

Our data also suggested that there is value in considering the feasibility of proactive wolf deterrents with those livestock producers who have experienced two or more confirmed wolf incidents. About 20% of affected Montana producers experienced two incidents and 17% experienced 3 or more. We examined such opportunities in many different situations over the years. In many of them, however, we found that implementation of proactive non-lethal deterrents was not feasible or economically cost effective to implement across an entire ranch or anywhere livestock will eventually be (e.g., install electric or tall predator proof fencing around large pastures) because of the combination of landscape features and the specific logistical or operational constraints unique to that producer and/or other producers in the area. There was also uncertainty whether "wolf-proofing" one ranch would re-direct wolves towards other nearby livestock which were not as well "protected." Furthermore, in some situations, we concluded that implementation of non-lethal deterrents alone will not adequately resolve conflicts and could in fact erode local tolerance for wolves if lethal control was not also available.

Nonetheless, we have found non-lethal deterrents to be both feasible and effective at reducing risk and conflict potential quite successfully in some situations. Many Montana producers already use a variety of non-lethal deterrents. In 2005, survey respondents reported utilizing the following tools: frequent checks (31%), guarding animals (22%), predator exclusion fencing (21%), carcass removal (19%), night penning of cattle (10%), herding (10%), and other non-lethal methods (12%) (National Agricultural Statistics Service 2007). Wolf-specific non-lethal deterrents have all worked and they have all failed at one time or another, and each has its limitations. Circumstances are different for each livestock operation, and the key is to select non-lethal tools that are economically feasible and have the greatest potential to decrease conflict in each unique situation.

Within the narrow context of damage management, the combination of lethal and non-lethal tools along with "defense of property" flexibility operating at the individual or wolf pack level and at a local

scale has helped keep livestock losses lower than predicted by USFWS (1994a) and MFWP (2003) in their final environmental impact statements on wolf reintroduction and state-led conservation and management for a delisted population, respectively.

This suite of damage mitigation and resolution tools exists within an overall Montana wolf program that would transition from a model of wildlife protection under ESA to one of wildlife conservation implemented by MFWP. Upon delisting, wolves will be classified as a "species in need of management" under Montana statute. This classification provides the mechanism by which human-caused wolf mortality will be regulated by MFWP and the MFWP Commission (a policy oversight board appointed by the Montana governor). The administrative boundary dividing Montana into "endangered" and "experimental" areas dissolves to the Montana state boundary, and wolves become reclassified as a "species in need of management" statewide. The special federal regulations (i.e., Interim Control Plan for NWMT and the 2005 experimental regulations FR 70:1286) would no longer apply and the state's "defense of property" statute replaces them. Lastly, MFWP and the public can more forward with a program that is rooted in the concept that wolves fall within the public trust doctrine applied to all wildlife species in the U.S. system of wildlife conservation. The North American Wildlife Model holds that wildlife is a public resource and managed in trust by the respective states and/or federal government. Under that umbrella, resident wildlife populations can be more proactively managed through regulated public harvest across a broader landscape and at the species level.

Because the Montana gray wolf population still legally falls under ESA, public harvest as a proactive management tool to help adjust statewide wolf numbers and distribution at a scale and commensurate with how other wildlife are managed (e.g., deer (*Odocoileus spp.*), elk, mountain lion, or black bear) is precluded for now. Upon delisting, we envision that regulated public harvest would adjust wolf density and distribution at a scale fine enough to reduce wolf-livestock conflicts. We acknowledge that removal of individual wolves or entire packs by WS will be necessary to quickly resolve some wolf and livestock conflicts, even with regulated public harvest.

Interagency coordination and positive working relationships have also been critically important to successful conflict resolution and fostering public tolerance. USFWS, MFWP and WS staff worked closely to share information about wolves both programmatically and at the field level throughout the year and during specific conflict incidents. This collaboration allowed for timely and well thought out decisions with respect to the application of both non-lethal and lethal tools when conflicts occurred. The three agencies have also collaborated in a wide variety of research projects that have informed management.

CONCLUSIONS AND MANAGEMENT IMPLICATIONS

Evidence showed that most wolves and most packs did not attack livestock, especially adult horses and cattle, but wolf presence around livestock does result in some level of depredation (Bangs et al. 2005). Because most confirmed incidents of injured or dead livestock in Montana involve livestock producers who were affected 2 or more times and that most incidents occurred on private lands, we believe the combination of proactive non-lethal deterrents combined with strategic incremental lethal control of problem wolves is the best way to resolve wolf-livestock conflicts. However, public

harvest will become a valuable tool to proactively adjust wolf density and distribution once wolves are removed from the protections of the ESA and are managed as resident wildlife within a framework that is more familiar to Montanans. A framework that seeks to carefully balance environmental factors, economics, biology, and social tolerance. In a proactive sense, wolf harvest at the appropriate scale should disrupt the cycle of injured and dead livestock and reactive lethal wolf control.

The effectiveness of non-lethal tools seemed to be enhanced when several types were used in combination with each other and with lethal control at times. But just as lethal removal is not a replacement for non-lethal tools, non-lethal tools are not replacements for targeted removal (Brietenmoser et al. 2005, Treves and Naughton-Treves 2005). Both appear useful and to enhance the effectiveness of the other.

Lethal control will remain controversial because some segments of the public want fewer or no wolves killed while other segments want more or all wolves removed. Lethal removal addresses immediate conflicts but does not necessarily 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 (Bradley 2004, Musiani et al. 2005). Long-term solutions to wolf-livestock conflict can be achieved through a multi-pronged, problem-solving approach.

Wolf recovery and long term management of delisted populations by states both require a balance between social, economical, and biological opportunities and constraints. We believe the key to long-term wolf conservation on the Montana landscape is to combine localized damage management with more landscape-level proactive management in ways that: 1. recognize the diversity and broad spectrum of public interests in wolves and their management; 2. balance those diverse interests and fosters tolerance for wolves and their management (i.e., balance the secure presence of a restored wolf population with management tools that remove some wolves from the population); 3. maintain a secure, recovered population; 4. address and resolve wolf-livestock conflicts adequately using a combination of non-lethal deterrents and incremental lethal control; and 5. link agency decisions to wolf ecology and population status, the land and people through adaptive management principles. In short, full implementation of the Montana wolf plan, public participation in the management of "their" wolves, and close interagency cooperation.

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By now, literally hundreds of people have contributed to wolf recovery and management in Montana since the 1980s. Personnel from a wide variety of state and federal agencies, tribes, universities, and representatives from non-governmental organizations monitored wolves and participated in efforts to address and resolve wolf-livestock conflicts. The countless private landowners and livestock producers in Montana whose property is used by wolves, sometimes at great cost, deserve our respect, understanding, and attention to the new challenges posed by a restored wolf population.

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