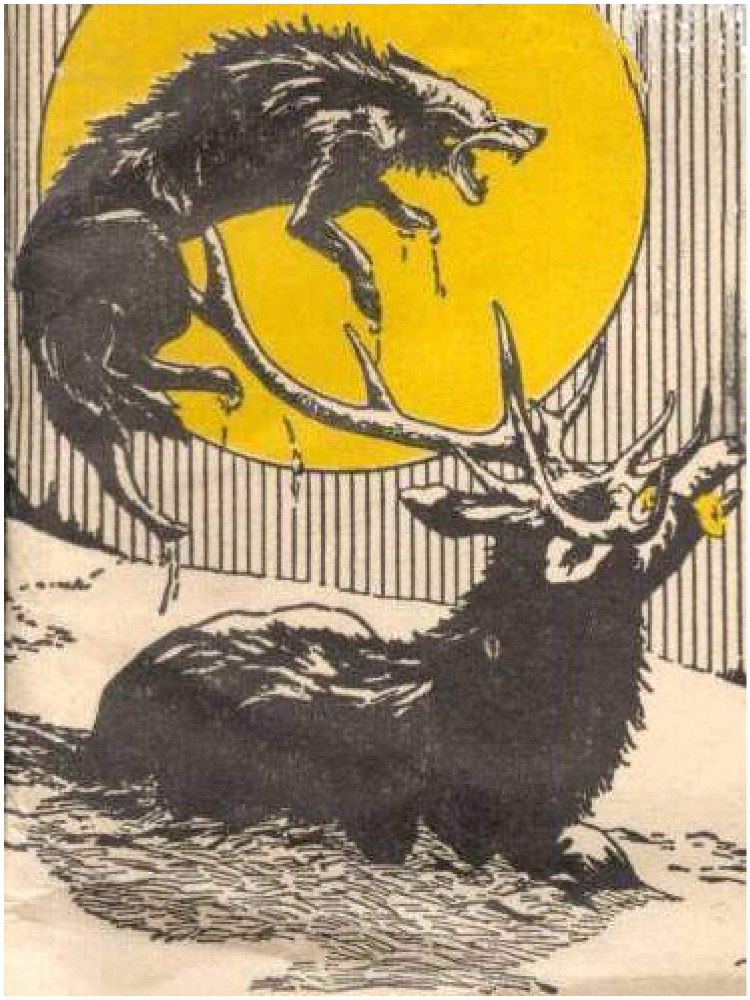
# Monitoring and Assessment of Wolf-Ungulate Interactions and Population Trends within the Greater Yellowstone Area, Southwestern Montana, and Montana Statewide



Graphic from 1927 fur buyer's ad represents fate of alpha male wolf in Chief Joseph pack in 2001

2005

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# INTRODUCTION

Montana Fish, Wildlife, and Parks (FWP) and the Ecology Department of Montana State University – Bozeman (MSU) initiated a cooperative investigation focusing on wolf-ungulate population interactions in the Greater Yellowstone Area of southwestern Montana. Private landowners, the National Park Service (NPS), and the U. S. Fish and Wildlife Service (USFWS) are important partners in this effort. Here, I summarize objectives and preliminary results of these investigations. Other summaries of this cooperative project are available at the following website location: http://www.montana.edu/ecology/staff/garrott/wolf%20ungulate/index.htm and http://www.montana.edu/wwwbi/staff/creel/creel.html#Creel's%20Homepage

I will also discuss FWPs more extensive, but less intensive monitoring of wolf and ungulate population characteristics throughout Montana in relation to GYA studies.

The elk herds of the Yellowstone, Gallatin, Madison and the Gravelly-Snowcrest complex represent a highly valued resource. The re-introduced and expanding wolf populations in the same Greater Yellowstone Area (GYA), likewise, command national and statewide attention. The potential impact of wolf predation on ungulate populations is a highly controversial issue, both within the general public and the scientific community. Our investigations will monitor trends in population parameters for these elk herds and newly established wolf packs across a range of geographic sites and different environmental conditions. The best estimate as of December 2004 is that there were 835 wolves in at least 66 breeding packs in Montana, Idaho and Wyoming (U.S. Fish and Wildlife Service et al. 2005). This is the 5th consecutive year with more than 30 breeding pairs for this area. The total included an estimated 324 wolves in the Greater Yellowstone Recovery area and an estimated minimum of 153 wolves and 15 breeding pairs within the State boundaries of Montana (U.S. Fish and Wildlife Service et al. 2005). Wolves have reached the numerical and distributional goals for recovery. As Montana, in conjunction with Wyoming, Idaho, and the USFWS, prepares for the de-listing effort of the Gray Wolf, it is imperative that we gain a better understanding of how these two important resources interact. This information will be especially pertinent to decisions affecting potential adjustments in hunter harvest prescriptions for ungulate populations in Montana.

Wolves are well established within Yellowstone National Park (YNP) and have been dispersing from the Park and establishing new packs in adjacent areas. Elk populations are a highly valued resource in this area and FWP has collected data on these elk populations going back in some cases to the 1920s. FWP administrative Region 3, surrounding YNP, provides approximately 50% of Montana elk harvest and hunter days of recreation. Land ownership, land use, vegetation communities and environmental conditions vary across this area. Elk harvest management strategies also vary and reflect different migratory patterns, harvest availability, and habitat of these elk herds. Our study approach allows comparisons to be made among the demographics of elk herds subjected to wolf predation, but no hunting, herds affected by both wolf predation and hunting, and elk herds affected by hunting, but little or no wolf predation.

Expansion of study outside the GYA is necessary to find areas with no impact by wolf predation. It is also important to document ungulate population size, trend, and characteristics for areas without wolves prior to wolves becoming established. By working in areas with differing ecological characteristics, we can make comparisons to identify factors that most impact wolf-elk dynamics. For comparative purposes, it is also important that wolves have been present in northwestern Montana, near Glacier National Park since 1979 and breeding pairs have been present there since about 1985-86. Because FWP has historical data on elk and other ungulates, we can make pre- and post-wolf comparisons among sites.

The objectives of this report are to: 1) Summarize findings of research to date on wolf-ungulate interactions in the GYA funded and conducted by this project; 2) incorporate more extensive findings of research in the GYA by other projects for comparative purposes and; 3) incorporate extensive data throughout Montana on wolves, other predators, and ungulates for comparative purposes and to help determine data needs for further research.

## STUDY SITES

### Intensive Winter Studies by MSU Students

Intensive studies by MSU of the effect of wolves on ungulates during winter occur at three sites (Figure 1). These sites are the Gallatin Canyon (Dr. Scott Creel and John Winnie, Jr. - finished), (Dr. Scott Creel and Dave Christianson – starting); Lower Madison (Dr. Robert Garrott and Justin Gude - finished), Dr. Robert Garrott and Jamin Grigg –starting and; Madison-Firehole (Dr. Garrott and students). The Madison-Firehole site is a separately funded study, but because Dr. Garrott is a cooperator on our studies, its results can be used for comparisons. This is especially important because the non-migratory elk herd associated with this area remains in YNP yearlong and is not hunted by humans.

### Extensive Studies by FWP

FWP collects population data on elk and other ungulates in the Gallatin Canyon and Lower Madison sites during winter as well as at other times of the year. This data also includes information on numbers and composition of hunter kill. As part of the comparative nature of the study, FWP collects information on ungulate populations in the adjacent Northern Yellowstone area near and north of Gardiner, Montana and in the Gravelly-Snowcrest Mountain complex in the Ennis and Dillon areas (Figure 2). FWP has long-term, pre-wolf data for these areas also. For help with interpretation, FWP will also use ungulate population data from other widely scattered areas in Montana to include areas with little or no influence by wolves at this time.

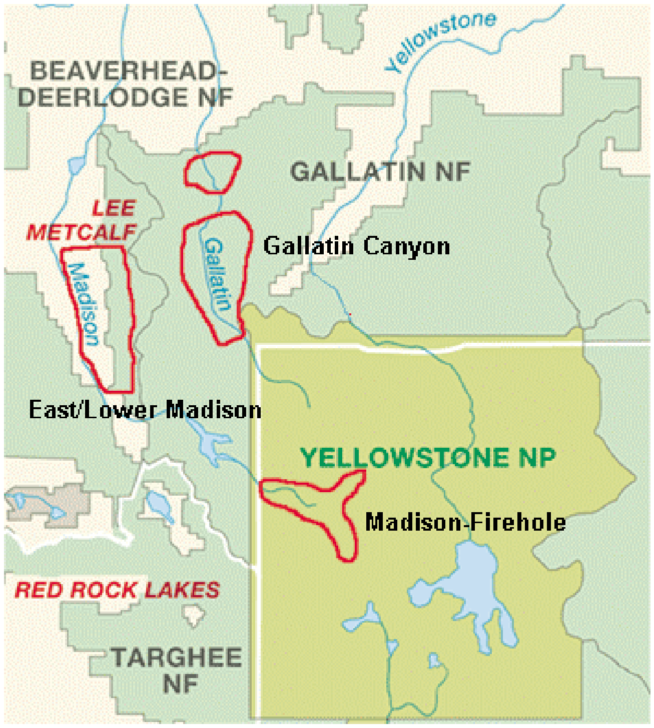



Figure 1. Location of Gallatin Canyon, Lower Madison, and Madison-Firehole student Study areas.

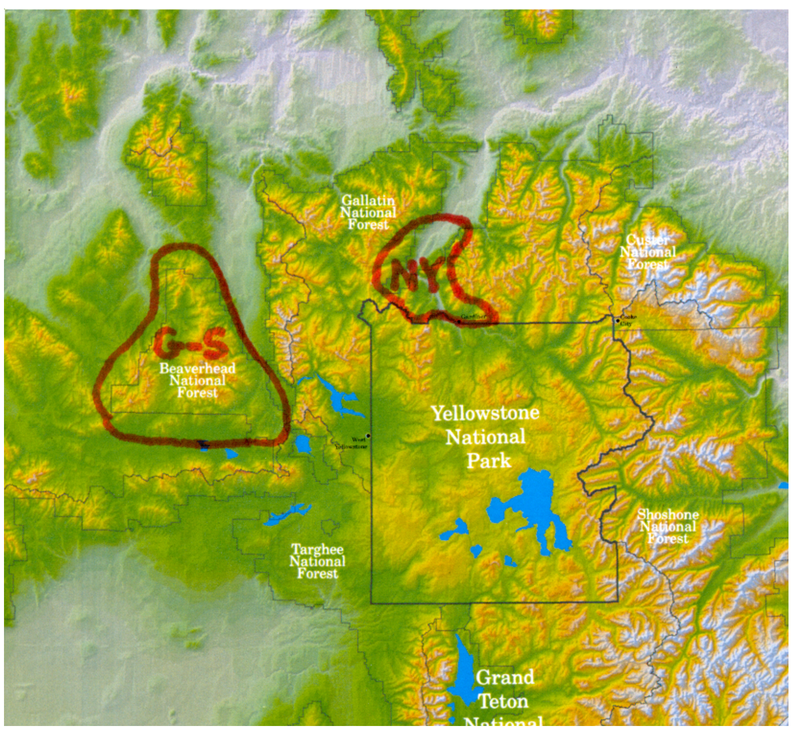



Figure 2. Location of Gravelly-Snowcrest (G-S) and Northern Yellowstone (NY) study areas.

## OBJECTIVES

### Intensive Winter Studies by MSU Students

Gallatin Canyon

1.) Determine kill rate by wolves on ungulates and sex and age composition of that kill, especially for elk.
2.) Determine the effects of this kill on elk population structure and numbers in comparison to hunter kill.
3.) Determine habitat factors that make elk vulnerable to predation by wolves.
4.) Determine if wolf predation adds to or compensates for other kinds of elk mortality.
5.) Determine the behavioral and geographical responses of elk to wolf predation.
6.) Determine the physiological costs to elk of these responses to predation risk.

Lower Madison

1.) Determine kill rate by wolves on ungulates and sex and age composition of that kill, especially for elk.
2.) Determine the effects of this kill on elk population structure and numbers in comparison to hunter kill.
3.) Determine the factors that influence wolf predation on elk.
4.) Determine how wolf activity influences elk behavior, distribution and grouping behavior.
5.) Determine if any behavioral changes result in nutritional changes for elk and subsequent changes in elk calf production and survival.

Extensive Studies by FWP

1.) FWP will provide estimates of elk population trend by continuing aerial counts of elk populations in the Gallatin Canyon and Lower Madison study areas. FWP will add an early winter helicopter flight in the Gallatin Canyon to the one previously conducted in late winter.
2.) Additionally FWP will continue cooperative aerial trend counts of the Northern Yellowstone elk population and trend counts for the Gravelly-Snowcrest populations. FWP will also use aerial elk and other ungulate trend counts from other areas in Montana for comparison with the intensive study areas.
3.) FWP will add mid-summer flights to the Gallatin, Madison and Gravelly-Snowcrest elk study areas and other areas of Montana to aid in determining timing of elk calf mortality.
4.) FWP will conduct mid-summer, early winter and late winter classifications of elk sex and age composition to aid in determining timing of elk calf mortality and the population composition from which wolves and hunters select their prey.
5.) FWP will run hunter check stations and use the statewide hunter harvest questionnaire to determine number and composition of hunter kills.

6.) FWP will capture and mark elk with VHF and GPS radio transmitter collars in the various study areas to help determine yearlong elk distribution, causes of mortality of adults and distribution of elk as affected by wolves and hunters.
7.) FWP will collect various data on the Gallatin Canyon, Lower Madison and Gravelly-Snowcrest study areas to help determine elk pregnancy rates, nutritional status, and stress levels.
8.) FWP proposes to further examine elk calf mortality during summer in the Gallatin Canyon to aid in determining causes and timing of mortality and potential nutritional impacts of wolf predation. We will also cooperative where possible with a study of summer elk calf mortality on the Northern Range of YNP.

## PRELIMINARY FINDINGS

### Gallatin Canyon Study

Project personnel have 1 manuscript accepted and 2 submitted for review to professional Journals. These manuscripts provide more detailed findings than the summaries provided here and are listed below.

Scott Creel and John A. Winnie, Jr. (*in press*, 2005). Responses of Elk Herd Size to Fine-Scale Spatial and Temporal Variation in the Risk of Predation by Wolves (*Animal Behavior* 69:).

John Winnie, Jr. and Scott Creel. (*submitted*, 2004). Behavioral Responses of Elk to the Threat of Wolf Predation (*Animal Behavior*).

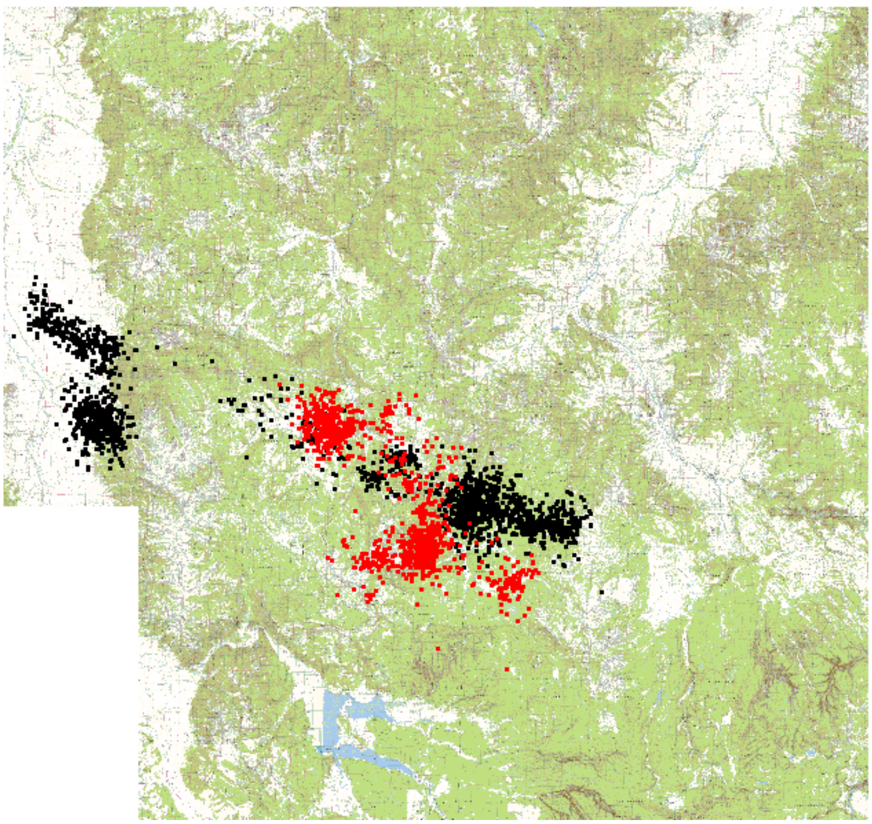
Scott Creel, John Winnie, Jr., Bruce Maxwell, Ken Hamlin and Michael Creel. (*submitted*, 2005). Elk Alter Habitat Selection as an Antipredator Response to Wolves (*Ecology*).

Capture and Marking

During February 2004, we captured 18 adult female and 5 adult male elk on the Gallatin Canyon study area by helicopter darting via chemical immobilization. Ten of these (7 female and 3 male) were fitted with GPS collars and the others with VHF collars. Total elk with working radio-transmitter collars at the end of marking was 44. During this capture operation, project personnel also darted and radio-collared 2 members of the Chief Joseph wolf pack. One of these wolves died shortly after marking.

A total of 76 elk (62 adult females and 14 adult males) were captured and marked during 2002-2004. Twenty-six of these (18 females and 8 males) were fitted with GPS transmitters and “blow-off” collars. Ages of the captured sample were generally older than other Montana elk populations (Hamlin and Ross 2002). One yearling, six 2-year-old, 29 3-8 year-old, 16 (26.7%) 9-12 year-old, and 8 (13.3%) 13-18 year-old females were captured. Three each 1- and 2- year-old males and 8 males 3-9 years old were captured.

Elk and Wolf Capture and Marking in the Gallatin Canyon Study Area.



Examples of 2,146 successful GPS locations (6.2/day) for female elk 071 (black) between 16 February 2002 and 28 January 2003 and 1,367 successful GPS locations (4.1/day) for female elk 140 (red) between 19 February 2002 and 15 January 2003. Both females were captured in the Taylor Fork drainage of the Gallatin Canyon study area.

Pregnancy Rate

Seventeen (0.944) of 18 adult females captured in 2004 were pregnant as determined by level of Pregnancy Specific Protein B in blood samples. The non-pregnant female was estimated to be 18½-years-old. Combined for 2002-2004, 56 (0.918) of 61 adult females were pregnant as determined by Pregnancy Specific Protein B in blood samples. Excluding a non-pregnant yearling and 18 ½-year-old, 56 (0.949) of 59 adult females were pregnant.

Pregnancy rate estimates based on progesterone concentrations in fecal samples collected after mid-March have not been finalized. These estimates are also complicated by the necessity to estimate, based on classifications, percent of the sample from adult females. Preliminary results indicate lower pregnancy rates than determined by blood samples of captured adult females.

Survival/Mortality of Radio-collared Adult Elk

Fifty-seven adult female and 14 adult male elk provided information for determination of survival/mortality from 16 February 2002 through 31 May 2004. Elk that died within a week of capture or those for which the transmitter did not function were excluded. Because 26 elk were equipped with GPS collars with programmed "drop-off" dates, annual samples by year were problematic. Average monthly mortality rates, which are multiplied to estimate average annual rates over the period are reported here (Table 1). The months of February-May are based on 3 years and the other months are based on 2 years of data. Annualized rates of mortality for adults were relatively low compared to the adjacent Gravelly-Snowcrest elk population (Hamlin and Ross 2002). Wolf predation was the cause of 2 of 9 mortalities (Table 2). These relatively small samples indicated 1.7% and 6.1% annualized mortality due to wolf predation for adult females and adult males, respectively.

Table 1. Annualized monthly survival/mortality rates for adult elk, Gallatin Canyon study, 2002-2004.

| **Month** | **Ad. Female Mean S/M(E. M.)[a]** | **Ad. Male Mean S/M(E. M.)[a]** |
|---|---|---|
| June | 1.00 / 0.00 (53) | 1.00 / 0.00 (8) |
| July | 1.00 / 0.00 (53) | 1.00 / 0.00 (8) |
| August | 1.00 / 0.00 (52) | 1.00 / 0.00 (8) |
| September | 1.00 / 0.00 (52) | 0.875 / 0.125 (8) |
| October | 1.00 / 0.00 (52) | 1.00 / 0.00 (7) |
| November | 0.976 / 0.024 (51) | 0.875 / 0.125 (7) |
| December | 1.00 / 0.00 (50) | 1.00 / 0.00 (6) |
| January | 0.974 / 0.026 (40) | 1.00 / 0.00 (5) |
| February | 1.00 / 0.00 (64) | 1.00 / 0.00 (14) |
| March | 1.00 / 0.00 (96) | 1.00 / 0.00 (19) |
| April | 0.989 / 0.011 (94) | 1.00 / 0.00 (19) |
| May | 0.956 / 0.044 (93) | 0.933 / 0.067 (19) |
| **Mean Annual Survival / Mortality** | **0.899 / 0.101** | **0.817 / 0.183** |

[a] Mean Survival/Mortality (Elk Months)

Table 2. Causes of mortality of radio-collared adult elk on the Gallatin Canyon study area, 2002-2004.

| Cause of Mortality | Adult Females | Adult Males | Total |
|---|---|---|---|
| Hunter-kill archery | | 1 | 1 |
| Hunter-kill general season | 1 | 1 | 2 |
| Hunter-kill late season | 1 | | 1 |
| Wolf-kill | 1 | 1 | 2 |
| Grizzly bear-kill | 1 | | 1 |
| Unk. spp. Bear-kill | 1 | | 1 |
| Natural/Broken leg | 1 | | 1 |
| **Hunting** | **2** | **2** | **4 (44.4%)** |
| **Predation** | **3** | **1** | **4 (44.4%)** |
| **Other Natural** | **1** | | **1(11.1%)** |

Wolf Kill Rates and Selection of Prey

Over a 3-month period during winter 2000-2001, when number of wolf-days on the study area could be determined, 24 wolf-killed elk were found by radio-tracking over 283 wolf-days. This was a kill rate of 8.48 kills/100 wolf-days or 0.085 elk kills per wolf-day (http://homepage.montana.edu/~rgarrott/wolfungulate/gallatin_canyon.htm).

During 2001-2003, 42 definite and 9 probable wolf-killed elk and 2 possible wolf-killed moose were found during winter. Of those elk for which sex and age could be determined, 24 (50%) were adult males, 15 (31.3%) were calves, and 9 (18.8%) were adult females. These proportions were biased toward adult males and calves compared to expected proportions (Creel and Winnie 2005).The home range of the Chief Joseph pack almost entirely overlapped the major bull wintering area in the Daly-Tepee-Lodgepole drainages of the Gallatin Canyon, which likely contributed to the observed sex/age ratio of the kill.

Photo by John Winnie, Jr.

Impacts of Wolves on Elk Behavior, Habitat Use, and Other Indirect Impacts

Creel and Winnie (2005) reported significant indirect impacts of wolves on elk in the Gallatin Canyon study, including group size, habitat use, and possibly proportion males in groups. They found that elk group sizes were smaller and elk were closer to (or in) cover when wolves were present in a drainage than when they were not detected (Fig. 3). These responses suggested that elk foraging and forage composition of their diet might be affected as well.

Further studies have begun to determine if foraging changes occur, and if so, is nutrition and possibly calf production and survival affected? Also, data collected thus far indicate that the presence of wolves could impact success by hunters as elk change behavior, location and habitat use from the traditional patterns that hunters have learned. Behavioral changes also have implications to commercial outfitters on USFS lands. Because outfitters cannot move their licensed area of use to other drainages, they may be significantly impacted depending upon the location where wolves establish territories.

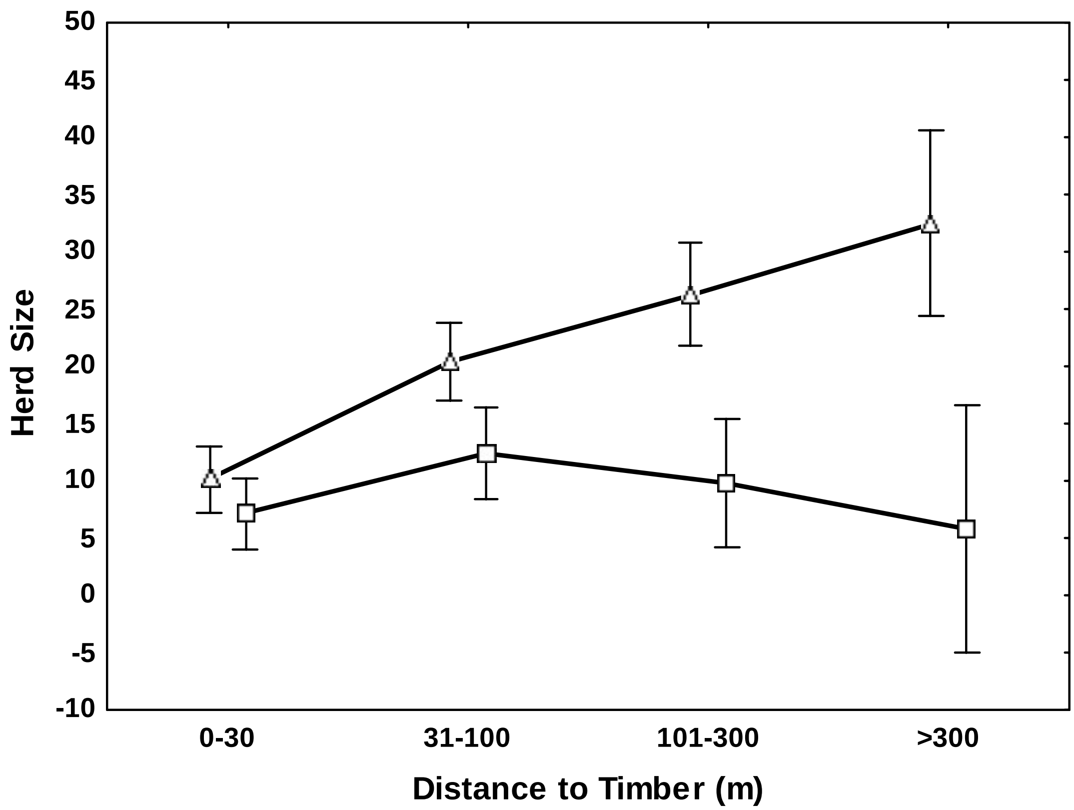



Figure 3. The response of elk herd size to the interaction of spatial and temporal variation in predation risk. Squares represent observations of elk when wolves were present in drainages, triangles represent observations when wolves were not detected. Elk aggregated far from cover when wolves were absent, but not when they were present. (from Creel and Winnie 2005).

Through use of GPS collars that attempted to recorded elk locations every 2 hours, Creel et al. (2005) also found that "elk moved into the protective cover of wooded areas when wolves were present, reducing their use of preferred grassland foraging habitats that also had high predation risk" (Creel and Winnie 2005). A visual representation of this relationship is presented in Figure 4 (a) and (b).

Further, the presence of wolves appeared to have greater impact than the presence of humans on elk habitat use (Fig. 5).

These findings indicated that the presence of wolves impacts elk (and possibly other ungulates) in indirect ways beyond the direct killing that receives much study. Further work in this area and others will investigate whether these indirect effects have individual and population consequences for elk.

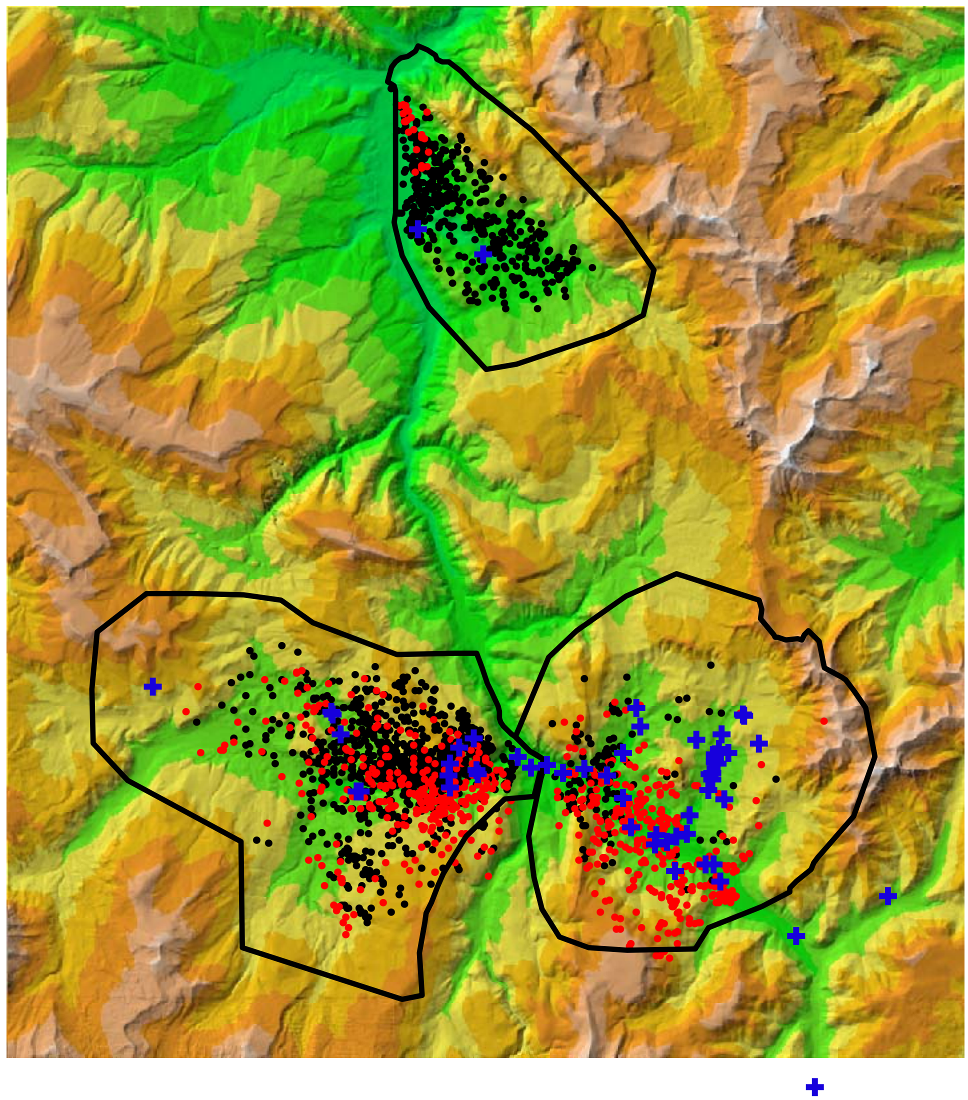


Figure 4. (***a***) Study drainages and elk locations within the Gallatin Canyon. Top polygon is Porcupine drainage, bottom left polygon is Taylor Fork drainage, and bottom right polygon is Tepee and Daly drainages. The base map shows elevation. Points show elk locations (*N*= 2288) on days that wolves were known to be present or thought to be absent from each drainage. Red = wolves present. Black = wolves not detected. Blue crosses = wolf kills. (from Creel et al. 2005).

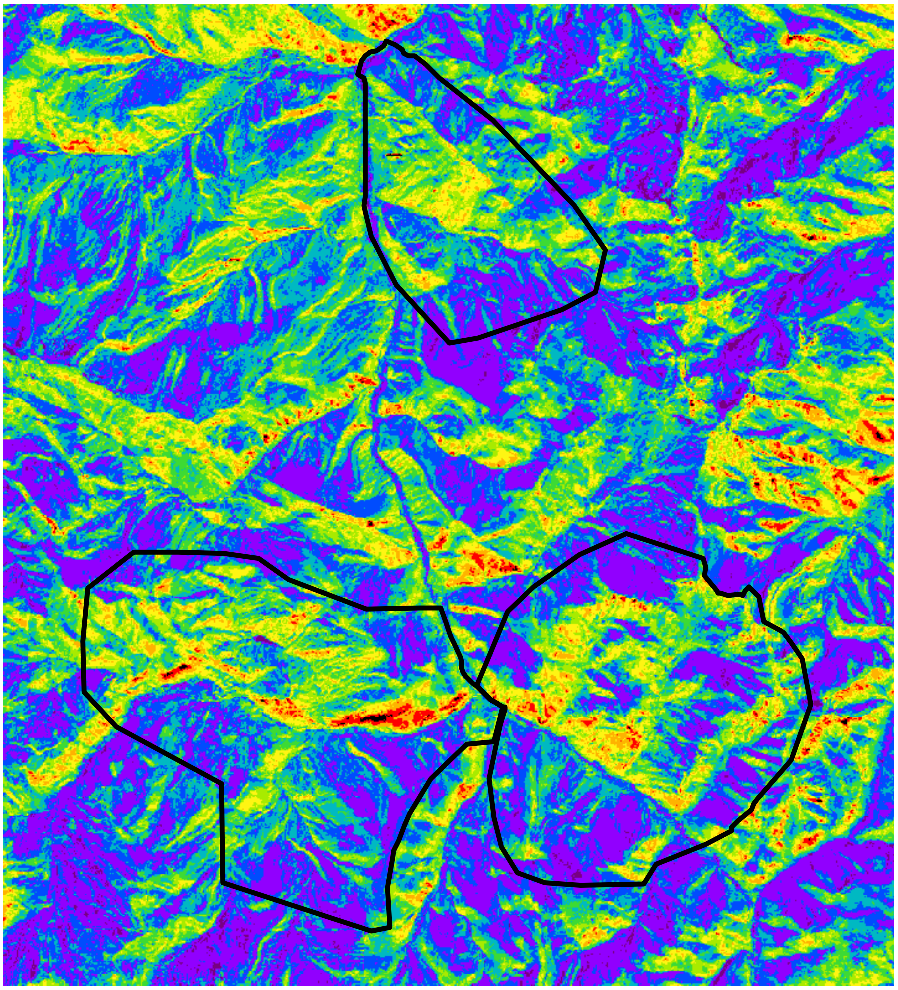
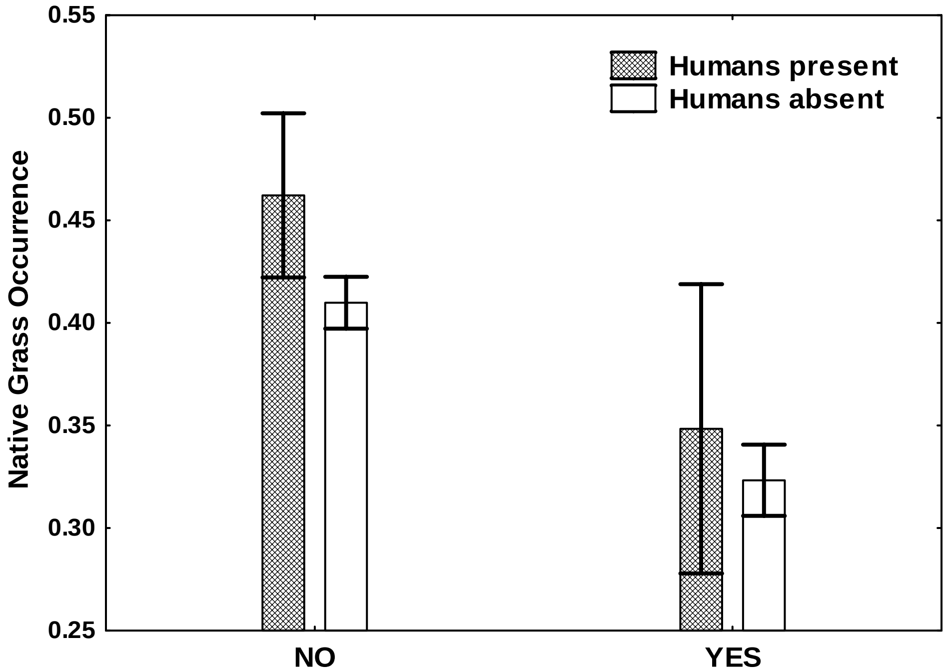
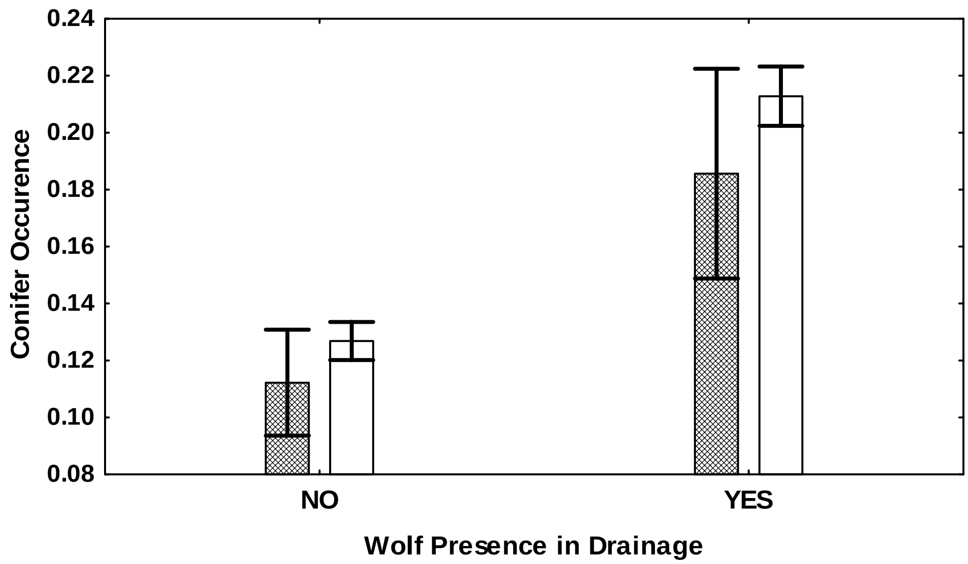


Figure 4(***b***). Vegetation map for the same area. Locations with a high probability of conifer occurrence and a low probability of native grass occurrence are shown by violet and blue: a decreasing probability of conifer occurrence and increasing probability of native grass occurrence are shown by green, yellow, orange and red.

John Winnie, Jr. radio-tracking elk and wolves.




(a)




(b)

Figure 5. Effects of wolf (and human) presence on habitat use by elk. (***a***) Probability of native grass occurrence at elk locations. (***b***) Probability of coniferous forest occurrence at elk locations. Bars show means and standard errors. (from Creel et al. 2005).

**Lower Madison Study**

Project personnel have 1 manuscript accepted and 1 submitted for review to professional Journals. These manuscripts provide more detailed findings than the summaries provided here and are listed below. Also, annual reports for the Lower Madison study can be viewed at: http://www.homepage.montana.edu/~rgarrott/wolfungulate/reports.htm

Justin A. Gude, Robert A. Garrott, John Borkowski, and Fred King. (*submitted 2004).* Prey Risk Allocation in a Grazing Ecosystem. (*Ecological Applications*).

Robert A. Garrott, Justin A. Gude, Eric J. Bergman, Claire Gower, P. J. White, and Kenneth L. Hamlin. (*accepted 2005*). Generalizing Wolf Effects Across the Greater Yellowstone Area: a cautionary note. (*Wildlife Society Bulletin*).

Wolf Kill Rates and Selection of Prey

Gude and Garrott (2003) reported wolf-kill rates of 11.2 elk/100 wolf-days (0.112/WD) during winter 2001-02 and 13.8 elk/100 WD (0.138/WD) during winter 2002-03. These rates are higher than others reported in the literature, including those reported earlier here for the Gallatin Canyon and those reported in the Northern Range (Smith et al. 2004b) and Madison-Firehole (Garrott, pers. comm.) areas of Yellowstone National Park. For those areas, reported wolf-kill rates of elk were about 6 elk/100 WD or slightly higher. Wolf-kill rates were also variable throughout winter during each year and among years (Gude and Garrott 2003). The loss of kills to scavengers in the relatively open habitat here (Gude and Garrott 2003) and because the small size wolf packs (3-5) may be less capable of protecting kills from scavengers (J. Winnie, Jr., pers. comm.) may contribute to unusually high kill rates here.

During 4 winters, 2001-02 through 2003-04, elk comprised 85.5% of wolf ungulate prey, mule deer 10.2%, and pronghorn 4.2% (Table 3, Gude and Garrott 2001, 2002, 2003 and Fuller and Garrott 2004). Of wolf-killed elk, calves comprised 69.0% of the total, while comprising about 15% of the population, indicating selection of calves by wolves. Male elk were not selected for here as they were in the Gallatin study area.

Impacts of Wolves on Elk Behavior, Habitat Use, and Other Indirect Impacts

For the Lower Madison study area, type of habitat and human hunting impacted elk group size, but there was no evidence that wolf predation risk influenced elk group size (Gude and Garrott 2003, Gude et al. 2005). There was evidence that wolf predation risk influenced elk distribution (Gude et al. 2005). That is, after a wolf predation event, elk moved from the area. This may affect distribution of elk grazing and browsing pressure compared to pre-wolf patterns (Gude et al. 2005).

Table 3. Species and sex/age composition of definite or probable wolf-killed ungulates on the Lower Madison study area, winters 2000-01 through 2003-04[a].

| Year | Elk | | | | |
|---|---|---|---|---|---|
| | Total | Adult Males | Adult Females | Calves | Unknown |
| 2000-01 | 56 | 7 | 13 | 36 | - |
| 2001-02 | 17 | - | 2 | 15 | - |
| 2002-03 | 43 | 2 | 14 | 27 | - |
| 2003-04 | 26 | 2 | 4 | 20 | - |
| **Total** | **142 (85.5%)[b]** | **11 (7.8%)[c]** | **33 (23.2%)[c]** | **98 (69.0%)[c]** | **-** |
| | **Mule Deer** | | | | |
| | Total | Adult Males | Adult Females | Fawns | Unknown |
| 2000-01 | 5 | - | - | 3 | 2 |
| 2001-02 | 5 | 1 | 2 | 1 | 1 |
| 2002-03 | 6 | 1 | 2 | 3 | - |
| 2003-04 | 1 | - | - | 1 | - |
| **Total** | **17 (10.2%)[b]** | **2** | **4** | **8** | **3** |
| | **Pronghorn** | | | | |
| | Total | Adult Males | Adult Females | Fawns | Unknown |
| 2000-01 | 1 | - | 1 | - | - |
| 2001-02 | 0 | - | - | - | - |
| 2002-03 | 4 | - | 1 | 1 | 2 |
| 2003-04 | 2 | 2 | - | - | - |
| **Total** | **7 (4.2%)[b]** | **2** | **2** | **1** | **2** |
| **Total Ungulates** | **166** | | | | |

[a] Two wolf-killed coyotes were also found during winter 2000-01.
[b] Figure in (parentheses) is percent of total ungulates.
[c] Figure in (parentheses) is percent of total elk.

A captured wolf and elk grazing during winter on the Lower Madison study area (Photos by Julie Fuller).

## Extensive Studies - Greater Yellowstone Area

Trends in Elk Population Size

*Gallatin Canyon Study Area*

Counts of the Gallatin elk herd have been conducted for longer than anywhere else in Montana (Fig. 6). Unfortunately, one of the periods without data is the recent pre-wolf period of 1986-1995 (Fig. 6). An interpretive problem that has always occurred is that a portion of the population migrates through the Taylor Fork drainage up over the Madison crest to winter on slopes along the east side of the Madison River. These numbers vary among years and also the timing of their movements varies. Thus, depending on the weather and timing of the early winter flight, elk that spend most of winter in the Madison Valley may or may not be included in the count. This probably accounts for much of the year-to-year variation seen in Figure 6. To smooth this variation, I have presented average counts by time period in Figure 6. Average counts were 2,078 elk for 1929-1948, 1,599 elk for 1953-1962, 1,640 elk for 1964-1972, 1,532 elk for 1975-1985, and 1,128 for 1996-2005 (Fig. 6).

There appear to be clear differences among average population levels for 3 periods: prior to 1949, from 1953-1985, and 1996-2005 (Fig. 6). It is possible that delaying the start of the late hunt until early January after 1989 (compared to early-mid-December prior to 1990) may have allowed some movement of elk over the Madison divide that were kept "staged" in the Gallatin drainage by the pressure of the late hunt. However, recent data on elk movements indicates that they move whenever they want and can cross the divide within a day, or overnight. Also, calf survival has been unusually low in recent years (see later), which could also have contributed to the recent average population decline. For whatever reason, recent population counts have averaged 26% lower than pre-1985.

Harvests of antlerless elk have been at historically low levels from 2000 to the present, averaging 73 antlerless elk annually compared to 226 antlerless elk from 1986-1996. The implied hunter harvest of about 5% of the preseason antlerless elk should not have contributed significantly to a population decline.

This elk population is one of the few in Montana with a recent decline in population counts compared to past years (MFWP, Wildlife Division, 2005). Although we can track this population for periodic changes to long-term average level, it will be difficult-to-impossible to relate influencing variables to year-to-year changes in elk counts.

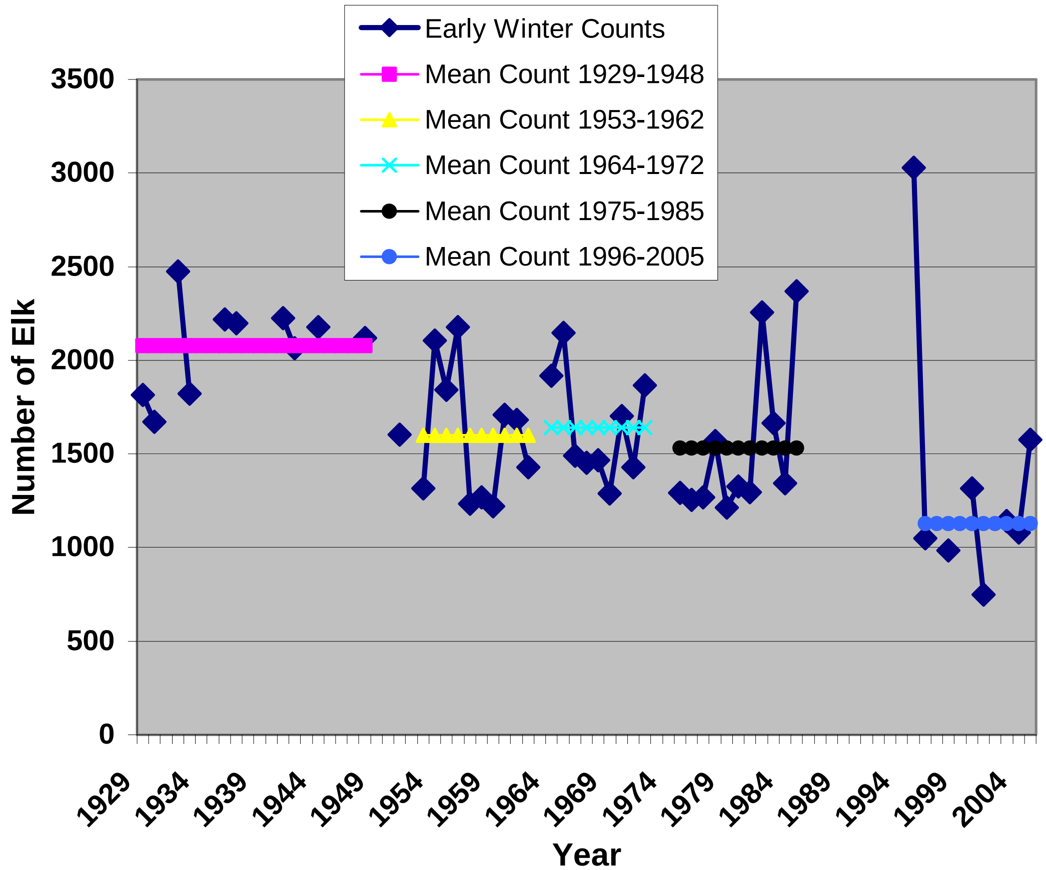



Figure 6. Early-winter aerial counts of elk in the Gallatin Canyon study area, 1929-2005.

*Lower Madison Valley Study Area*

Aerial counts of elk during winter along the east face of the Madison Range indicate a population that has increased over the years, perhaps stabilizing recently (Fig. 7). The population segment from Indian Creek to Quake Lake (green squares in Fig. 7) includes the Lower Madison study area. Many of these elk spent winter 2003-2004 north of the study area and information for the separate segments could not be presented for spring 2004 (Fig. 7). More intensive information from ground observations indicated that near the end of winter, about the same number of elk used the Lower Madison study area as in recent previous years (Fuller and Garrott 2004). Numbers of elk in this population may have stabilized in the last few years. Average late-season antlerless harvests have increased for this population segment by 3.5 times (181 more antlerless elk) from 1993-1999 to 2000-2003. This increased antlerless harvest, combined with lower calf survival in recent years, is likely contributing to stabilizing the population.

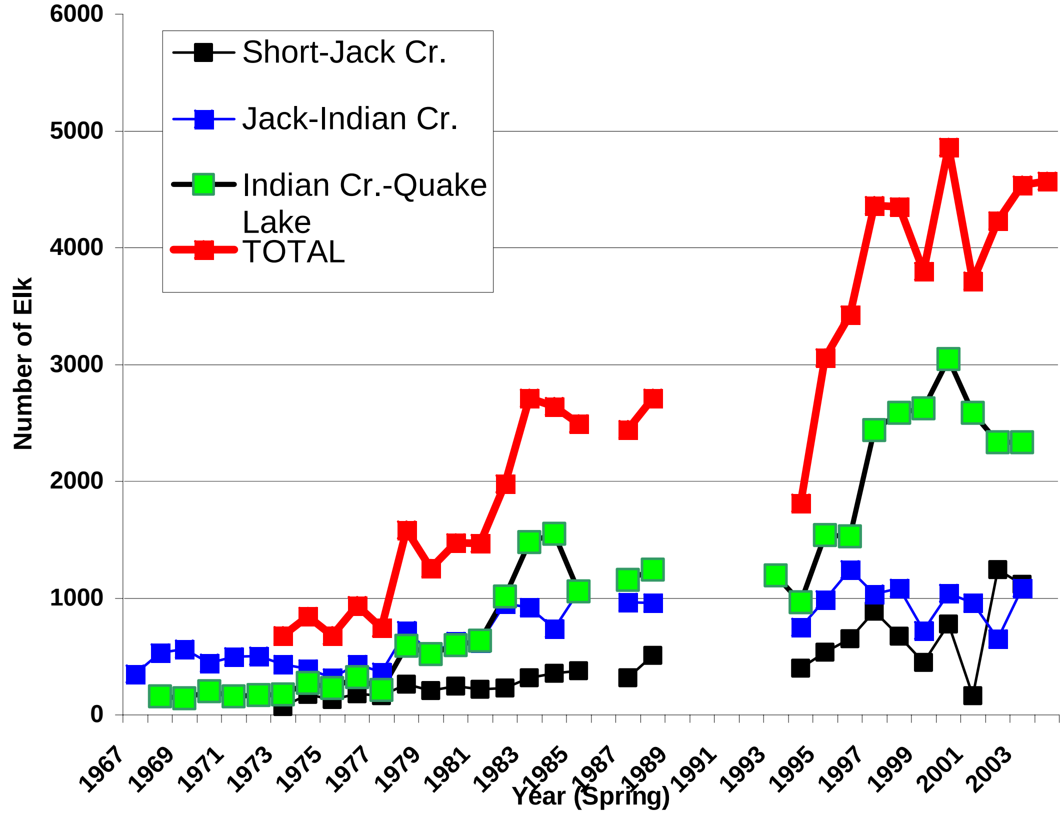



Figure 7. Aerial counts of elk during mid-to-late-winter along the east face of the Madison Range. Indian-Quake Lake area includes the Lower Madison study area.

*Gravelly-Snowcrest Area*

The Gravelly-Snowcrest elk population is one of the largest and more heavily hunted elk populations in Montana, averaging about 8,000-9,000 counted elk post-season in recent years (Hamlin and Ross 2002, Fig. 8). Harvest rates have been high, averaging 16% for adult females during 1984-1996 and occasionally reaching more than 20% during some years (Hamlin and Ross 2002). These high harvest rates have maintained a relatively stable population since about 1987, though a series of poor harvest years recently may have resulted in an increased population recently (Fig. 8). The 2 major sub-populations show differing trends (Fig. 9) with the Wall Creek WMA wintering population continuing to increase and the Blacktail-Robb-Ledford WMA population showing stability since 1990. The Wall Creek WMA population receives the lightest harvest pressure (Hamlin and Ross 2002).

These populations occur just to the west of the Lower Madison study area and the furthest from YNP of our studied elk populations in the Greater Yellowstone Area (Fig. 2).

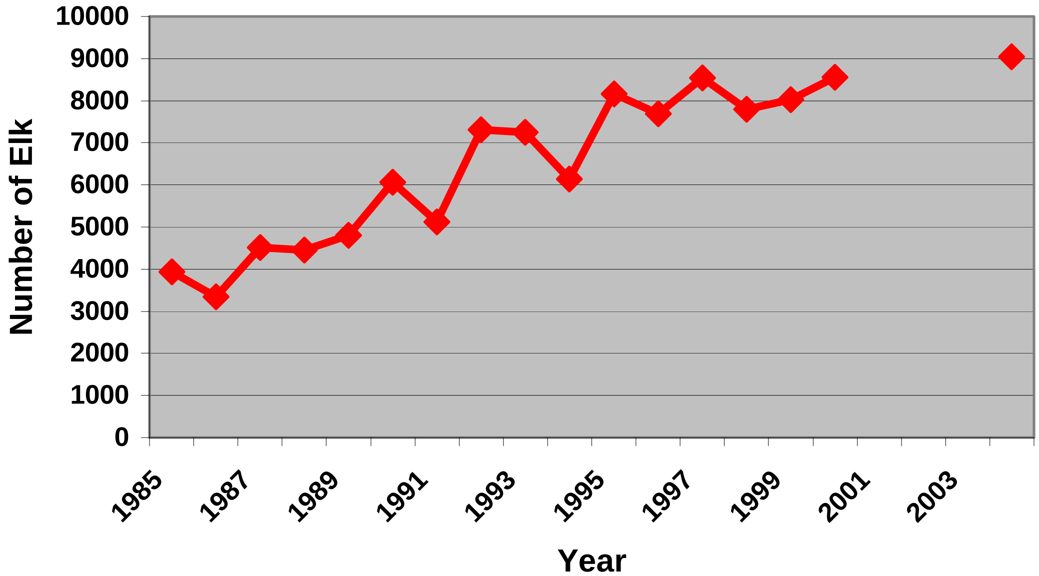



Figure 8. Aerial trend counts of elk during winter for the entire Gravelly-Snowcrest complex, 1985-2004.

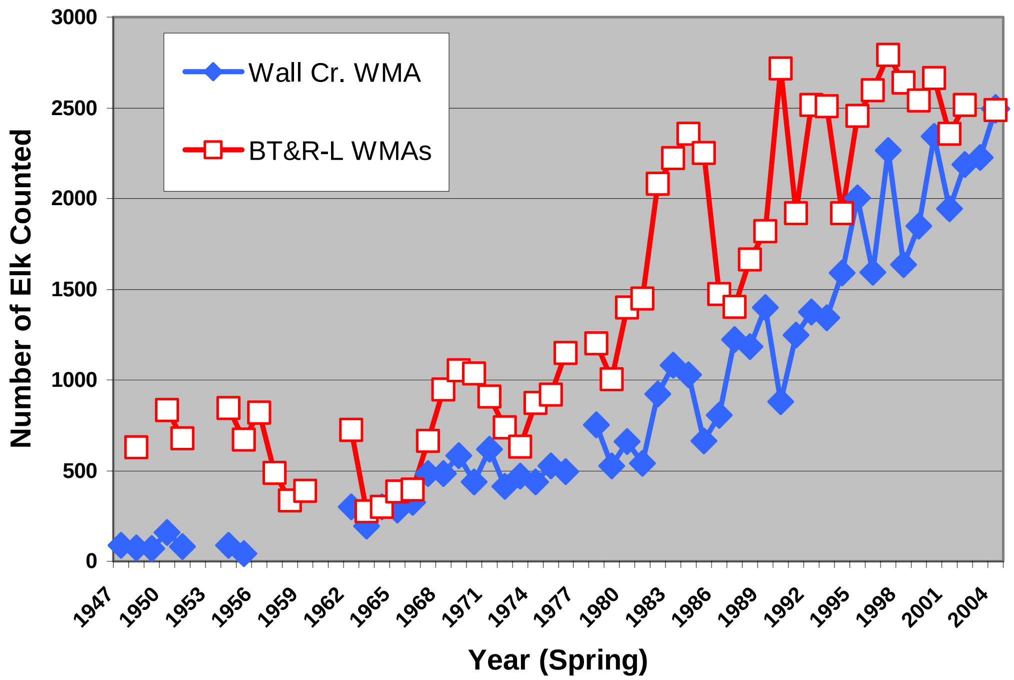



Figure 9. Aerial trend counts of elk during winter on the Wall Creek Wildlife Management Area and Blacktail and Robb-Ledford Wildlife Management Areas in the Gravelly-Snowcrest Mountains, 1947-2004.

*Madison-Firehole Study Area (Dr. Robert Garrott & students)*

From 1965-2002, the estimated fall population of elk in the Madison-Firehole region of YNP fluctuated around a stable equilibrium of 541 elk (Fig. 10). Recently, the population trend has broken the equilibrium trendline downward, coincident with a downward trend in calf survival (Fig. 10, Dr. R. Garrott, pers. comm.). The population may have declined further, after the last estimate (R. Garrott, pers. comm.) This elk population remains yearlong in YNP and is not subject to human hunting.

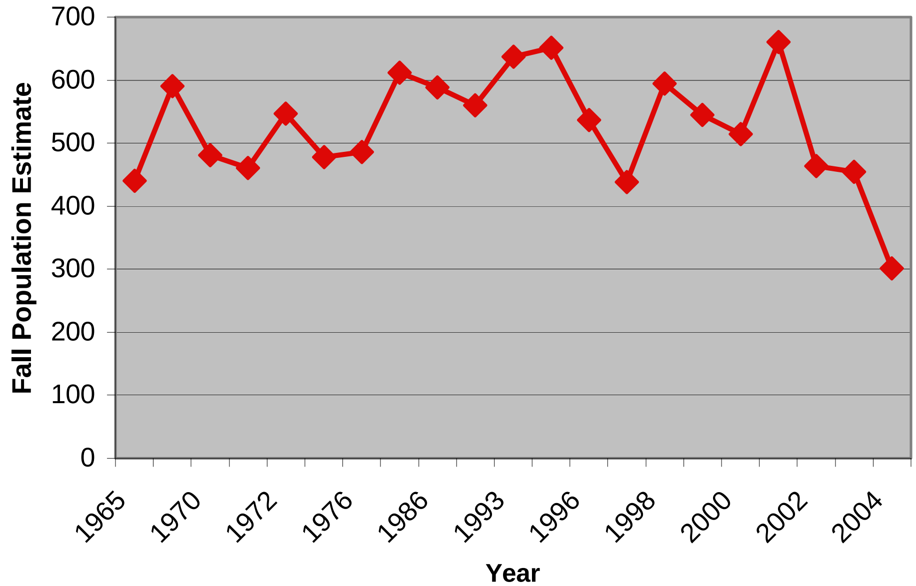



Figure 10. Estimated fall population of elk in the Madison-Firehole study area, 1965-2004 (courtesy Dr. Robert Garrott, MSU).

*Northern Yellowstone Elk Population*

Numbers of elk counted during cooperative censuses of the Northern Yellowstone elk herd are presented as uncorrected counts (Fig. 11) and data for some years such as 1988-89 and 1990-91 represent poor counting conditions. Counted numbers ranged from a low of 3,172 in 1967-68 at the end of reduction efforts to a high of 19,045 during 1993-94. The count in December 2004 was 9,545 elk.

A portion of the Northern Yellowstone elk population winters outside YNP and that proportion varies annually, especially with weather conditions during winter (Fig. 12). The numbers presented in Figure 12 represent early winter and the numbers of elk that winter north of YNP sometimes increase from these levels during mid to late winter. Generally, the number of elk harvested during the late season has reflected the number wintering north of YNP during early winter (Fig. 12), but harvest has declined relative to numbers wintering north of YNP since 2002 (Fig. 12).

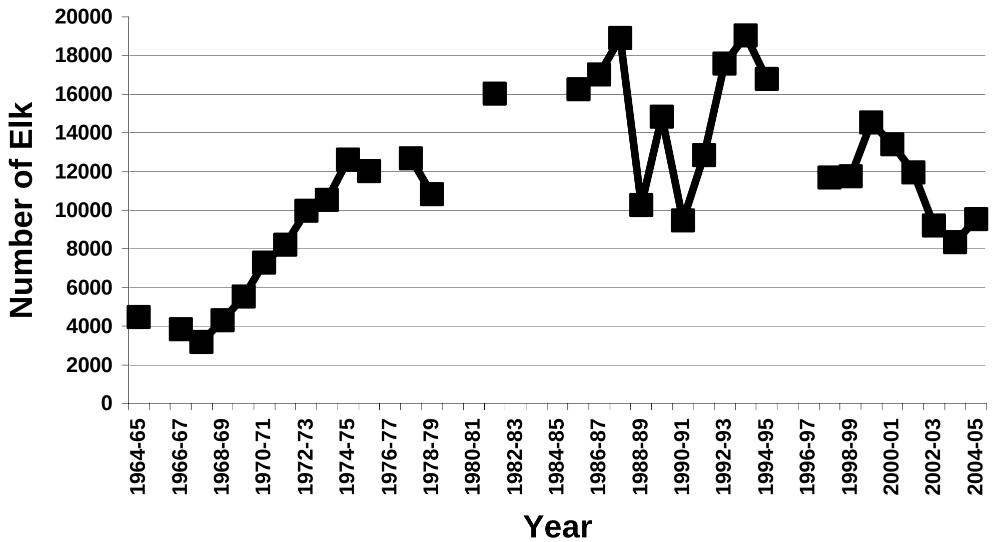



Figure 11. Trend in number of elk counted in early winter during the cooperative Northern Yellowstone elk counts, 1964-65 through 2004-05.

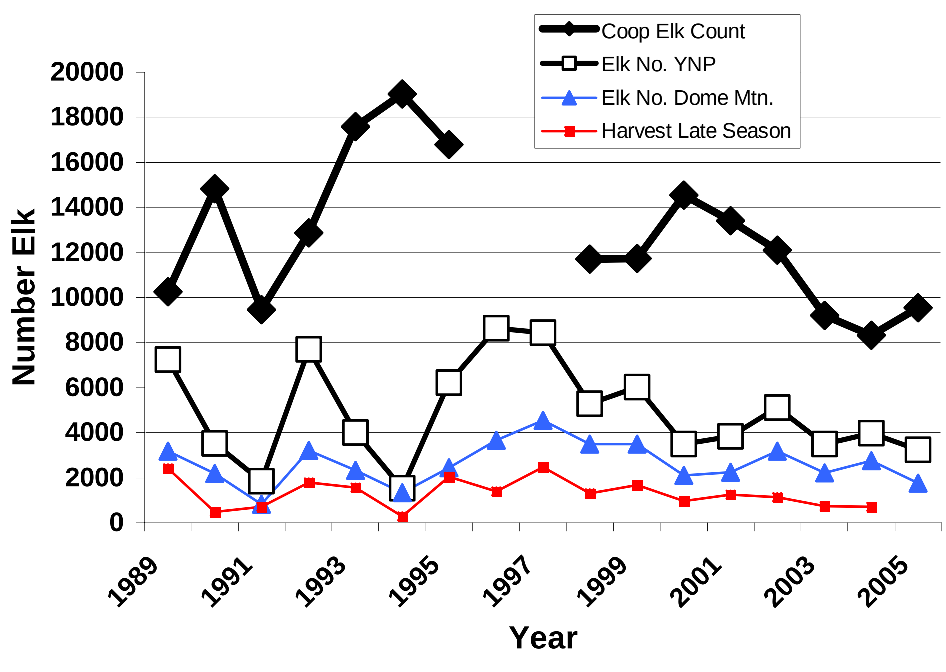



Figure 12. Number of elk counted for the Northern Yellowstone elk herd, including partitioning by numbers observed outside YNP, north of Dome Mountain, and number of elk harvested during the late season, 1988-89 through 2004-05.

In many analyses, the Northern Yellowstone elk herd is treated as one homogenous population. Based on movements, area used, and mortality risks, however, there are at least 3 segments, perhaps more. One segment remains in YNP yearlong, one almost always winters north of YNP, and the wintering location of another large segment varies with weather conditions. Thus, different segments of the population are subjected to different levels of hunting mortality and wolf and other predator density and mortality. Hunting mortality only occurs for those elk wintering north of YNP and this mortality level varies not only with the numbers of permits issued, but with weather conditions that affect the proportion of the elk population wintering north of YNP.

Since 2000, the early winter trend in number of total elk counted and number of elk counted inside YNP is significantly down while the number counted north of YNP (subject to hunting) has been stable (Fig. 13). Thus, it appears that the recent decline in numbers of elk counted has been disproportionately among the portions of the elk population not subject to hunting, or variably subject to hunting. Relatively mild winters since 1996-97 has resulted in a relatively lower proportion of the elk population being subjected to late season harvests. The segment of the Northern Yellowstone elk population showing the greatest decline in numbers (Fig. 13) appears to be the one subject to the least hunting mortality and the greatest wolf density and predation pressure.

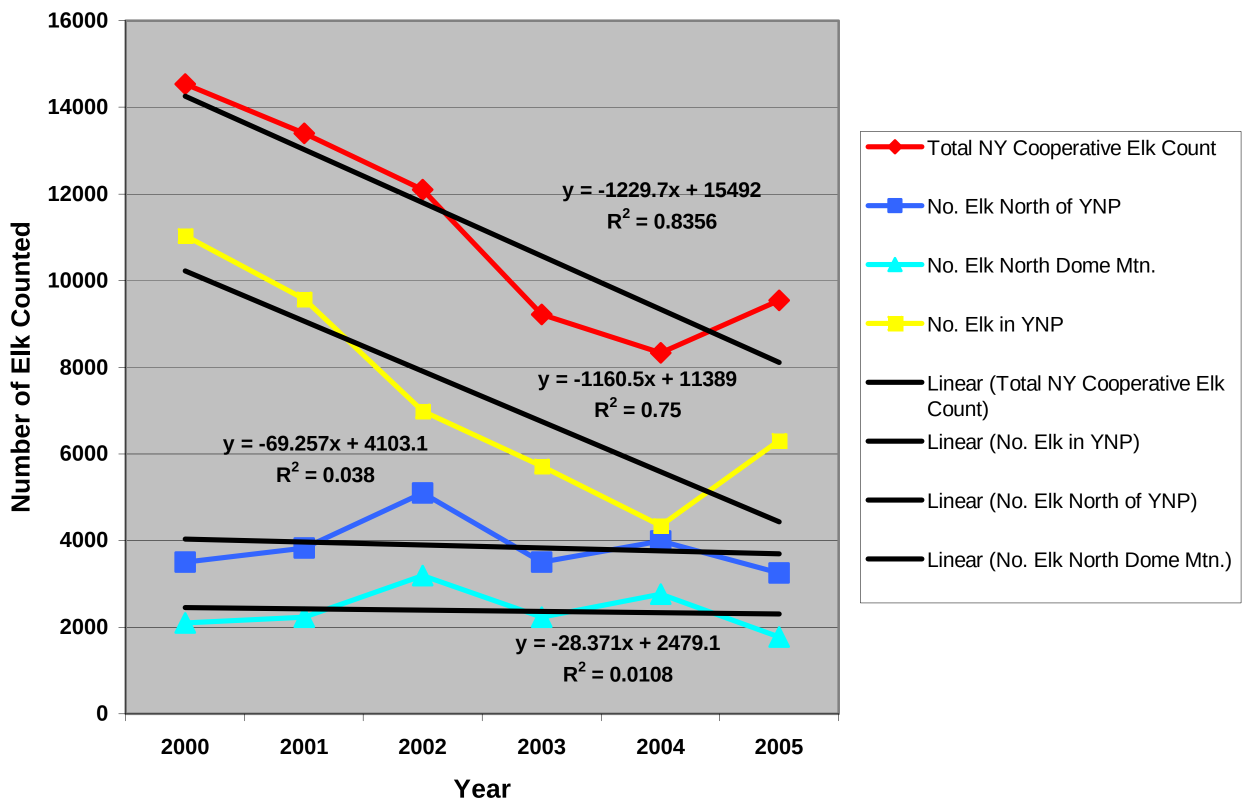



Figure 13. Number of elk counted and trend line for various segments of the Northern Yellowstone elk herd, 2000-2005.

Elk Production and Recruitment Trends

*Pregnancy Rates*

Recently, the trend in recruitment of elk calves has been down in the Greater Yellowstone Area and to some extent, throughout Montana. To examine causes for this, we try to determine when declines in production or increases in mortality of calves occur during the yearly cycle. During February 2002-2004 we tested blood samples of 61 adult females captured in the Gallatin Canyon for level of Pregnancy Specific Protein B. For the entire sample, 56/61 (91.8%) were pregnant and 93.3% of those 2 years and older were pregnant. The 1 yearling captured was not pregnant, 35/36 (97.2%) of 2-8 year-olds were pregnant, 15/16 (93.8%) of 9-13 year-olds were pregnant, and 4/6 (66.7%) of those 14 years or older were pregnant.

One of 3 yearling and 27/29 (93.1%) of female elk 2 and older [28/32 (87.5%) of total females) were pregnant for a sample captured on the Lower Madison study area in February 2005.

These percentages are normal-to-high for elk and do not indicate a problem with initial pregnancy rate in the Gallatin Canyon or Lower Madison elk populations. Analysis of fecal progesterone levels to estimate pregnancy for these populations is not yet completed.

Similar data for the Gravelly-Snowcrest Mountains during 1984-1994 indicated a 38.6% pregnancy rate for yearling females and a 95.7% pregnancy rate for females 2 years and older (Hamlin and Ross 2002). At the average of 20% yearlings for the population at that time, this was equivalent to an 84.3% pregnancy rate for a random sample of adult (yearling and older) females. For the reduced percentage of yearlings estimated in the population recently (12%), a randomly collected rate of 88.8% pregnancy would be equivalent to 1984-1994 values. Pregnancy rate for adult females wintering on the Wall Creek WMA and Blacktail WMA estimated from fecal samples of adult elk collected during late March 2002-2004 (Table 4) averaged 85.4%, similar to equivalent estimates for 1984-1994.

Table 4. Estimated pregnancy rate of female elk on the Wall Creek Wildlife Management Area (WMA) and Blacktail WMA based on fecal progesterone level, March 2002-2004.

| | Wall Creek WMA | | | | Blacktail WMA | | | | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| Year | N | Est. No. Ad. ♀♀[a] | No. Preg.[b] | % Preg.[c] | N | Est. No. Ad. ♀♀[a] | No. Preg.[b] | % Preg.[c] | Ave. % Preg. |
| 2002 | 50 | 44.2 | 36 | 81.5 | 60 | 54 | 54 | 100 | 90.8 |
| 2003 | 100 | 94 | 79 | 84.0 | 100 | 85.1 | 76 | 89.3 | 86.7 |
| 2004 | 100 | 91.7 | 63 | 68.7 | 50 | 47.5 | 42 | 88.5 | 78.6 |
| Mean | | | | **78.1** | | | | **92.6** | **85.4** |

[a] Based on % that females comprised of adults estimated from classifications
[b] Based on a ng p4 / g dry feces value equal to or greater than 900.
[c] Number pregnant/ estimated number of adult females in the sample.

Although there may have been a decline in pregnancy rate at WCWMA during 2004, there was no evidence of a recent broad decline in pregnancy rate in the Gravelly-Snowcrest Mountains. The apparent difference between the two areas (Table 4) should be investigated further.

Information on pregnancy rate of elk has been collected for years for the Northern Yellowstone population. These rates are based on hunter reports during the late hunts, so they are likely an underestimate because some hunters may not recognize some small fetuses. However, the results should be consistent from year-to-year as a **relative index** of pregnancy rate. Mean hunter-reported pregnancy rate of cows 2 years and older has been at or slightly below average for the last 8 years (Figure 14) compared to the previous 11 years. This difference is relatively minor, however. Pregnancy rate of yearling cows (Figure 15), which should be a more sensitive indicator, has been above average for 5 of the last 6 years. *In utero* twinning rate, which should also be a sensitive indicator, has been at or above the long-term average for the last 5 years (Fig. 16).

In none of the areas do pregnancy rate data or other condition indicators indicate that the elk have been nutritionally stressed sufficiently to significantly affect these indicator values in recent years. The exceptions occurred after the 1988 fires in YNP, and severe winters of 1988-89 and 1996-97. Allantoin:creatinine ratios for 1996-97 also indicated severe nutritional stress that year (Pils et al. 1999).

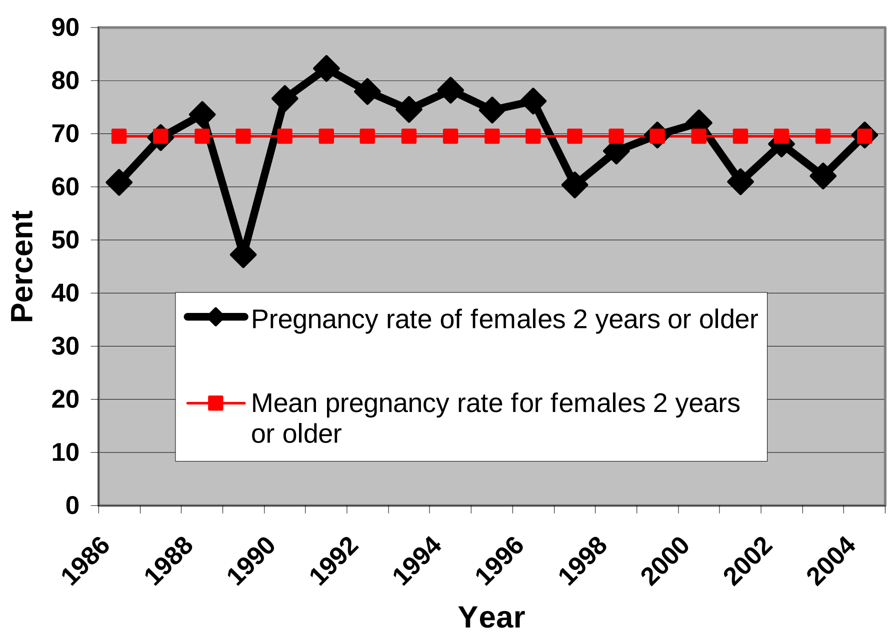



Figure 14. Pregnancy rates of cow elk 2-years-old and older in the Northern Yellowstone population, 1986-2004 (as reported by hunters, T. Lemke, unpubl. data).

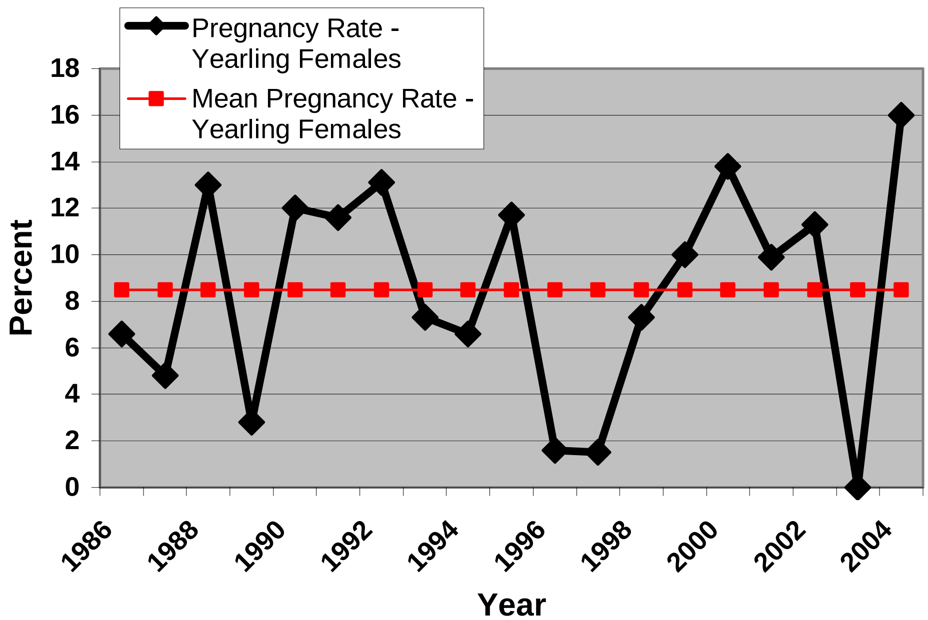



Figure 15. Pregnancy rate of yearling cow elk, Northern Yellowstone population, 1986-2004 (as reported by hunters, T. Lemke, unpubl. data).

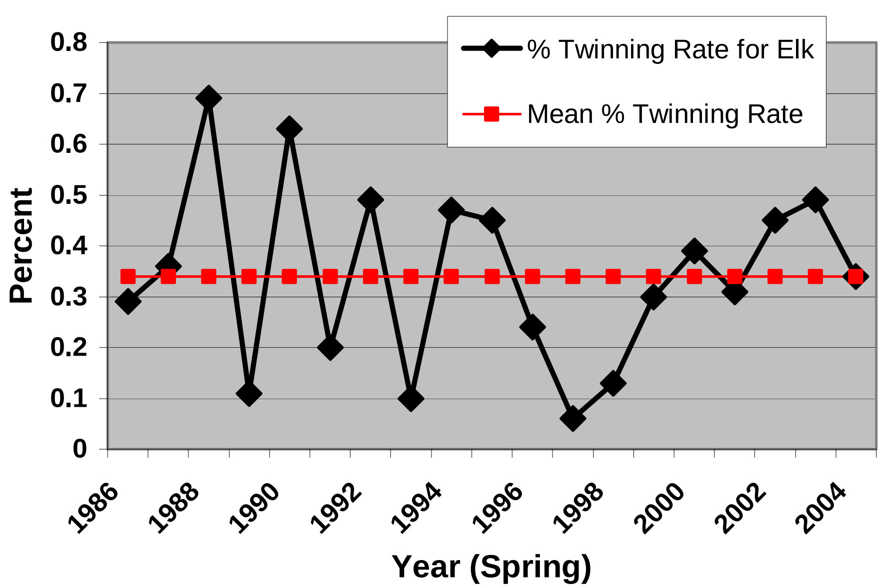



Figure 16. Twinning rate for Northern Yellowstone elk, 1986-2004 (as reported by hunters, T. Lemke, unpubl. data).

*Age Classifications and Calf Survival*

Mid- to late- winter calf:100 cow ratios have declined from long-term averages since 1995 in the Gallatin, Madison, Gravelly-Snowcrest, Northern Yellowstone, and Madison-Firehole areas (Figs. 17 and 18). This decline coincides with the re-introduction of wolves to Yellowstone National Park, but began before those wolves could have impacted areas such as the Gravelly-Snowcrest Mountains. Little impact would have occurred for the other populations for the first few years of reintroduction.

Classification data also indicate that calf:100 cow ratios have been substantially below average by mid-summer (late July) in both the Gallatin and Gravelly-Snowcrest areas since about 1995 (Fig. 19). This decline has been more severe in the Gallatin drainage than the Gravelly-Snowcrest Mountains (Fig. 19), but in both areas calf:100 cow ratio was low before much wolf predation would be expected. Elk calf production/survival has been unusually low prior to winter, when much of the research on mortality occurs.

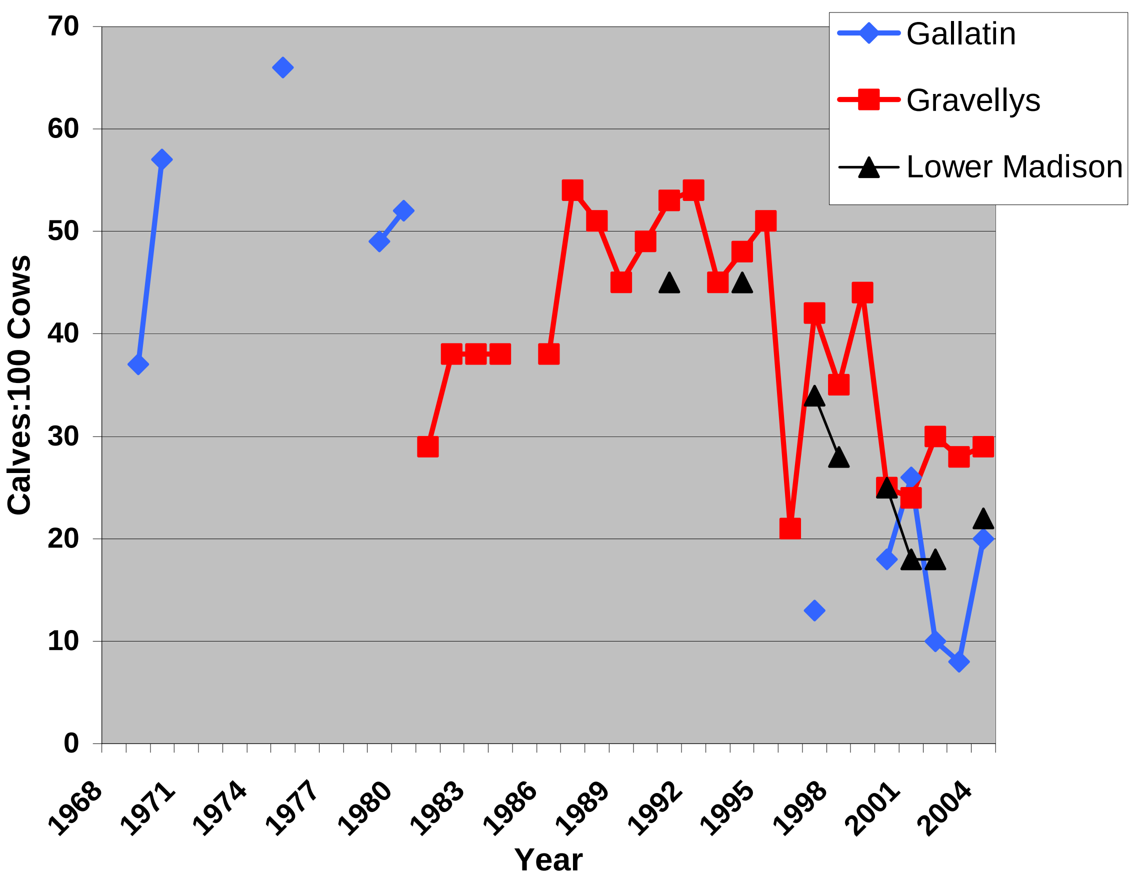



Figure 17. Winter calf:100 cow ratios in the Gallatin, Madison and Gravelly-Snowcrest elk populations, 1948-2004.

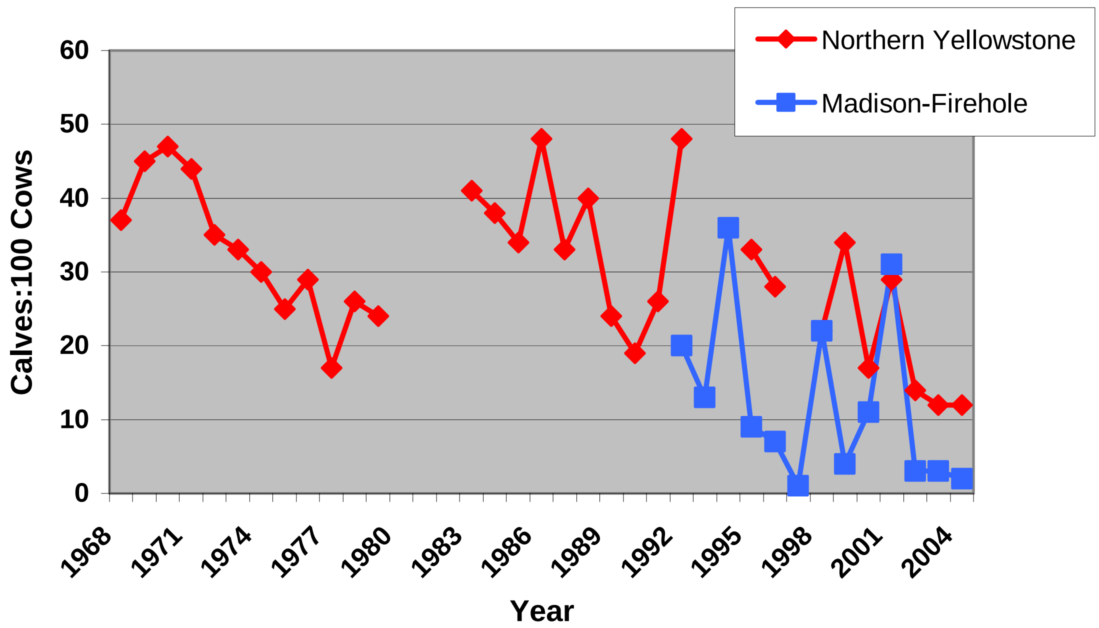



Figure 18. Winter calf:100 cow ratios, Northern Yellowstone and Madison-Firehole elk populations, 1968-2004.

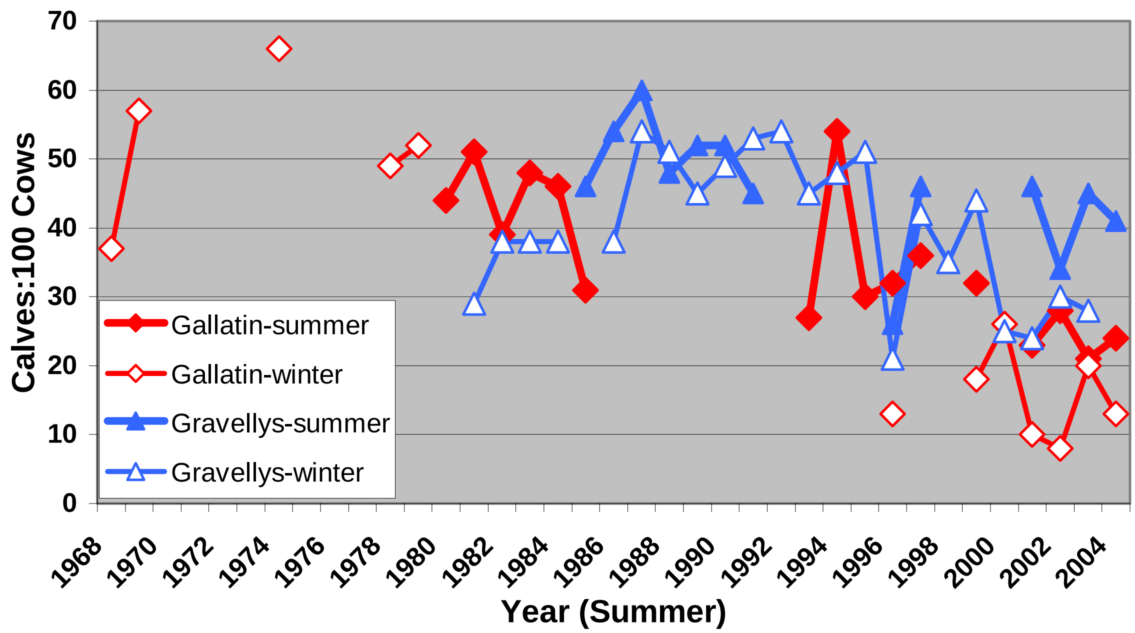



Figure 19. Mid-summer and mid-winter calf:100 cow ratios for the Gallatin and Gravelly-Snowcrest elk populations, 1968-2004.

An investigation of mortality rates and causes for newborn elk calves on the Northern Yellowstone Range was conducted during 1987-1990 (Singer et al. 1997) prior to wolf restoration and a follow-up study began in 2003 (Barber et al. 2003, 2004). Results for the most recent study are preliminary, but will supply valuable information when completed.

Thus far, elk calf mortality during summer (birth through September) was higher during 2003 and 2004 than during any pre-wolf years of 1987-90 (Table 5) and averaged twice as high as the early period. Too little data has been collected post-wolf to compare winter and annual periods at this time. The causes of mortality averaged 92% predation during 2003 and 2004 compared to 72% during 1987-90 (Table 6). Thus far, the increase appears to be related to an increase in mortality caused by bears of both species (Table 6, species not differentiated yet for 2004). Wolf predation on elk calves during summer has been minor thus far, approximately offsetting a decrease in mortality caused by coyotes from levels observed during 1987-90 (Table 6). Grizzly bear numbers in the GYA have increased since 1995 (Figs. 20 and 21), possibly explaining increased mortality caused by bears.

As part of a study of nutritional conditions for newborn elk calves, we will monitor survival rates and causes of mortality in the Gallatin study area during summer 2005 by use of eartag transmitters on newborn elk calves. A similar study conducted during summers 2002-2004 in the Garnet Mountains, where wolf presence is nil to minimal, will be summarized later in this report.

Table 5. Mortality rate of newborn elk calves, Northern Yellowstone Range, 1987-1990 and 2003 and 2004.

| | | Mortality Rate (%) | | |
|---|---|---|---|---|
| Year[a] | No. Marked | Summer[b] | Winter[c] | Annual |
| 1987[d] | 30 | 44 | 14 | 52 |
| 1988[d] | 29 | 15 | 84 | 86 |
| 1989[d] | 36 | 32 | 8 | 38 |
| 1990[d] | 32 | 50 | 6 | 53 |
| **TOTAL[d]** | **127** | **35** | **28** | **57** |
| | | | | |
| 2003[e] | 50 | 68 | 12 | 72 |
| 2004[e] | 44 | 70 | | |

[a] Year = year of birth.
[b] Summer = mid-May (birth) through September.
[c] Winter = October – May.
[d] from Singer et al. 1997.
[e] Barber et al. 2003 and 2004 annual accomplishment reports, NRPP Project # 71604.
**Preliminary data only – subject to change**.

Table 6. Cause of mortality (%) for radio-transmitter marked newborn elk calves, Northern Range, 1987-90 and 2003 and 2004 (Singer et al. 1997 and Barber et al. 2003, 2004 - **Preliminary data only – subject to change**).

| Cause of Mortality | 1987-1990 Summer | | 2003 Summer | 2004 Summer | 2003-04 Mean | | 1987-90 Winter | 2003-04 Winter |
|---|---|---|---|---|---|---|---|---|
| Wolf | | | 15 | 10 | 13 | | | |
| Bear (both species) | 39 | | 54 | 58 | 56 | | | |
| Wolf or Bear | | | 6 | 3 | 5 | | | |
| Coyote | 28 | | 9 | 13 | 11 | | | 50 |
| Eagle | 3 | | | 3 | 1 | | | |
| Mountain Lion | | | 3 | | 1 | | 3 | |
| Wolverine | | | 3 | | 1 | | | |
| Unknown Predator | 3 | | | 7 | 4 | | | |
| **TOTAL PREDATION** | **72** | | **91** | **94** | **92** | | **3** | **50** |
| Starvation | 3 | | | | | | 58 | |
| Disease | 8 | | | | | | 3 | |
| Hunter Harvest | | | | | | | 15 | 50 |
| Accident | 6 | | | | | | 3 | |
| Unknown | 13 | | 9 | 7 | 8 | | 15 | |
| **TOTAL OTHER** | **28** | | **9** | **7** | **8** | | **97** | **50** |

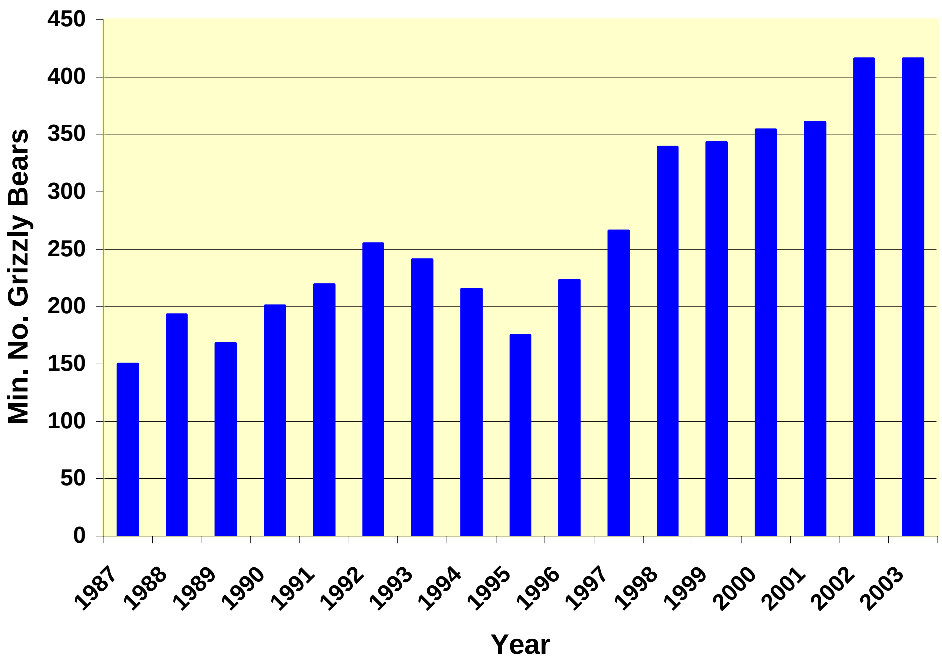



Figure 20. Minimum population estimates for Grizzly Bear, Greater Yellowstone Area, 1987-2003 (from Haroldson et al. 1998; Haroldson & Frey 2003).

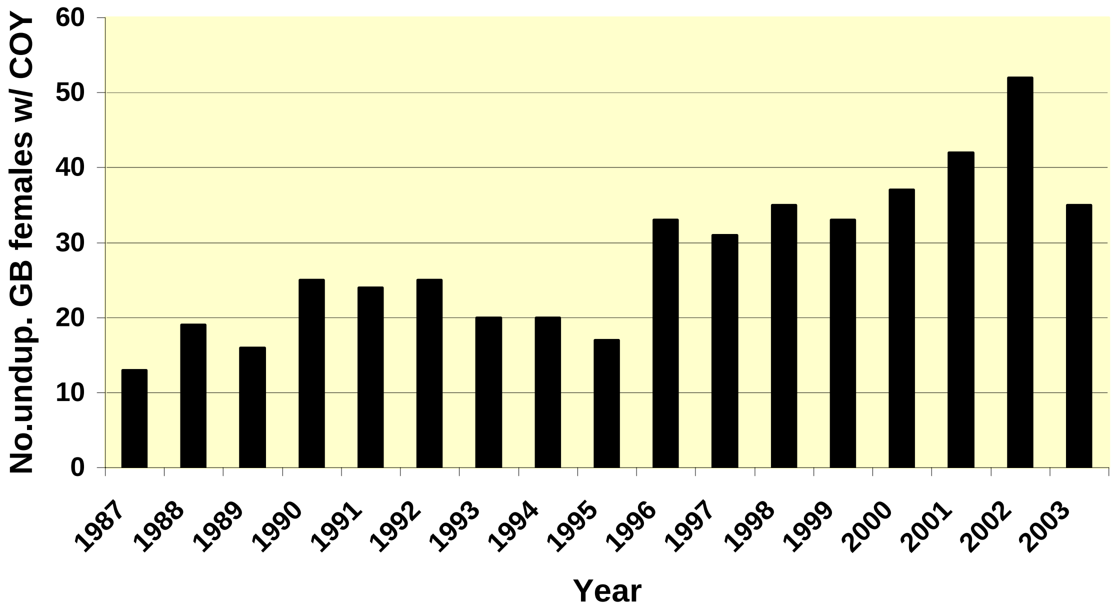



Figure 21. Unduplicated Grizzly Bear females with cubs-of-the-year, GYA, 1987-2003 (from Haroldson et al. 1998; Haroldson & Frey 2003).

Elk Calf Survival Relative to Weather/Forage/Nutritional Conditions and Elk Condition

Montana in general and southwestern Montana in particular has been in a drought period of historic severity for about 5 years (2000-2004). The Palmer Drought Severity Index for southwestern Montana (Fig. 22) indicates the recent period has been as or more severe than any since 1895 and results for the Western and Central Montana Divisions are similar. There has been some speculation that this recent drought could be contributing to reduced recruitment of elk calves and increased mortality of adults to predation through its effects on forage, nutrition and elk condition (Hamlin 2003, Vucetich et al. 2004, unpubl.). However, the recent pre-wolf period of 1987-1992 was also a period of severe drought (Fig. 22).

Most areas in southwestern Montana and YNP have experienced reduced recruitment of elk calves recently (Figs. 17, 18, 19). Similarly, other areas in Montana have also experienced reduced recruitment of elk calves recently (Table 7). However, the areas with the highest wolf and bear densities (Table 7, Northern Yellowstone, Madison-Firehole, Gallatin Canyon, Lower Madison) have experienced the greatest decline (average decline 54.0% compared to 7.0% average decline for other areas). Such declines did not occur during the 1987-1992 period of drought (Figs. 17, 18, 19, 22 and Table 7). Somewhat lower elk numbers in some areas characterized the 1987-1992 period, but elk numbers were higher in the Northern Yellowstone and Madison-Firehole populations at that time and calf recruitment was higher there than currently.

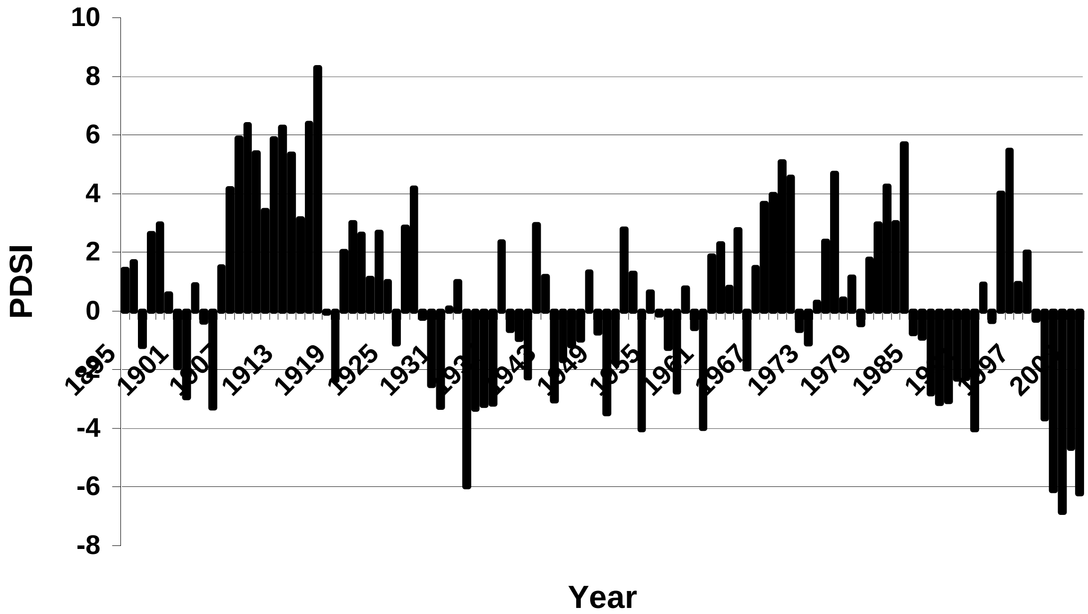



Figure 22. Palmer Drought Severity Index for May, Southwestern Montana Division, 1895-2004.

Table 7. Average winter calf:100 cow ratios for selected elk populations during the pre-2000-05 drought period compared to the 2000-05 drought period and the 1987-92 drought period.

| Area | Calves:100 Cows Pre-2000-05 drought period | | Calves:100 Cows 2000-05 drought period | | % reduction /increase in calf:100 cow ratio from pre-2000 | Calves:100 Cows 1987-92 drought period | | % reduction /increase in calf:100 cow ratio from pre-2000 |
|---|---|---|---|---|---|---|---|---|
| | Period (n) | Mean | Period (n) | Mean | | Period (n) | Mean | |
| Northern Yellowstone | 1968-96 (24) | 33.5 | 2000-04 (5) | 16.8 | - 49.9 | 1987-92 (6) | 31.7 | - 5.4 |
| Gallatin Canyon | 1968-80 (5) | 52.2 | 2000-05 (6) | 15.8 | - 69.7 | | | |
| Madison-Firehole | 1992-96 (5) | 17.0 | 2000-04 (5) | 9.8 | - 42.4 | 1992-93 (2) | 16.5 | - 2.9 |
| Lower Madison | 1991-94 (2) | 45 | 2000-04 (4) | 20.8 | - 53.8 | | | |
| Gravelly-Snowcrest | 1981-96 (15) | 43.5 | 2000-05 (6) | 28.8 | - 33.8 | 1987-92 (6) | 50.1 | + 15.2 |
| Elkhorns | 1983-91 (9) | 32.8 | 2000-05 (6) | 22.7 | - 30.8 | 1988-91 (4) | 33.7 | + 2.7 |
| Tobacco Roots (HD 320) | 1987-99 (13) | 36.0 | 2000-05 (6) | 35.2 | - 2.2 | 1987-92 (6) | 41.7 | + 15.8 |
| Tobacco Roots (HD 333) | 1988-99 (12) | 32.9 | 2000-05 (6) | 32.2 | - 2.1 | 1987-92 (6) | 36.0 | + 9.4 |
| Garnets | 1988-99 (12) | 28.8 | 2000-04 (5) | 25.2 | - 12.5 | 1988-92 (5) | 36.2 | + 25.7 |
| Bitterroot | 1987-99 (10) | 29.9 | 2000-04 (5) | 32.2 | + 7.7 | 1987-92 (6) | 32.2 | + 7.7 |
| Missouri River Breaks | 1977-99 (16) | 52.3 | 2000-05 (5) | 50.2 | - 4.0 | | | |
| HD 520 – Morris Creek | 1977-99 (23) | 33.7 | 2000-04 (5) | 40.0 | +18.7 | 1987-92 | 32.3 | - 4.2 |
| HD 520 – Silver Run | 1977-99 (23) | 35.1 | 2000-04 (5) | 33.6 | - 4.3 | 1987-92 | 35.3 | + 0.6 |

The effects of drought, if severe enough to affect elk condition, could be indicated in pregnancy rates (not observed, see earlier) or weights. Data on weights of elk in the GYA is limited, but weights of elk calves of the Northern Yellowstone population harvested during the late hunt have been at or above long-term averages since 1998 (Fig. 23, T. Lemke, unpubl. data). Similarly, weights of elk calves and yearling female elk were at long-term averages on the Flying D Ranch during 2000, 2001, and 2002 (Arnaud 2003). These limited data and general observations of harvested elk at check stations do not indicate severe condition problems that might contribute to poor calf survival and mortality. This, plus the fact that elk calf survival is lowest in areas with the highest wolf and bear densities indicates that at least some of the predation loss is not compensatory.

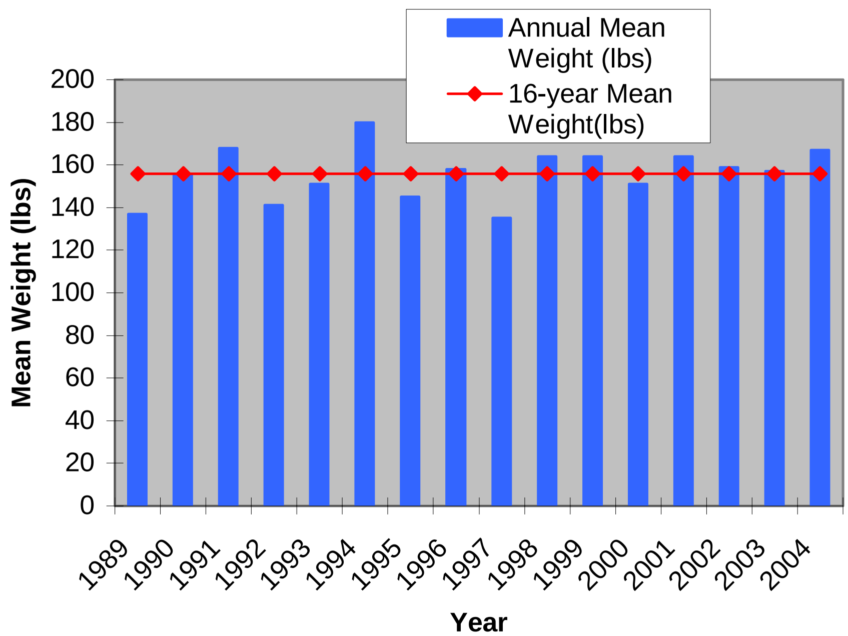



Figure 23. Mean weight (lbs) for elk calves harvested during the Gardiner late hunt, 1986-2004 (T. Lemke, unpubl. data).

Vagnoni et al. (1996) established that a significant, positive relationship existed between digestible dry matter intake and urinary allantoin:creatinine (A:C) ratios of elk. Garrott et al. (1996) and Pils et al. (1999) established the potential of the A:C ratio index for free-ranging elk from snow-urine samples and refined collection protocols and analytical techniques. Pils et al. (1999) also presented results for the severe winter of 1996-97 for the Northern Yellowstone range, the Madison-Firehole, the Wall Creek Wildlife Management Area, the National Elk Refuge (supplementally fed after mid-February), and the Hungry Horse herd in northwestern Montana.

Since 2001-02, we have collected snow-urine samples for some of these same areas but because data is not fully analyzed, we present only average data for mid-winter

(February) for comparison (Fig. 24). These data indicate that energy content of winter diets of elk in the Gravelly-Snowcrest Range, Gallatin Canyon, Lower Madison, and Madison-Firehole areas have been equal to or above that observed during the winter of 1996-97 (Fig. 24). Quality of the diet may have been slightly reduced in 2002-03, but was higher in all areas in 2003-04 compared to 1996-97 (Fig. 24). Also, A:C values have been higher during some of the recent drought years than for the supplementally fed National Elk Refuge population during 1996-97. These data are preliminary and not fully analyzed, but they do not indicate a reduction in digestible dry matter intake and energy content of the winter diet during the recent drought period. Mild winter conditions during the drought period may have to some extent, offset probable poor nutritional conditions during summer. This also may explain the fact that early winter fawn:100 doe ratios and spring fawn:100 adult ratios for mule deer in the Northern Yellowstone have been at or above long term averages during the recent drought (T. Lemke, unpubl. data).

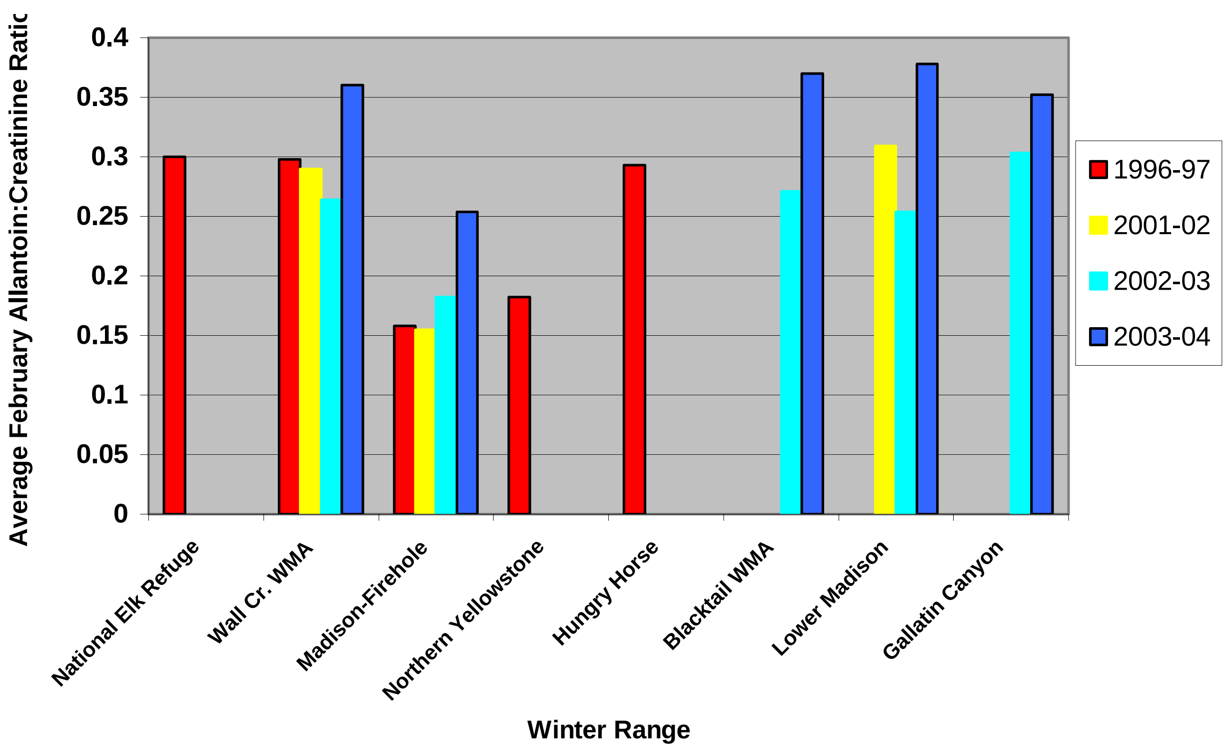



Figure 24. Average allantoin:creatinine (A:C) ratios from elk urine collected in snow during February for selected elk populations. Higher A:C ratios equals higher digestible dry matter intake in recent elk diet.

Limited data on winter survival of elk calves (Fig. 25, Madison-Firehole only, R. Garrott, unpubl. data) suggests that wolves have introduced some additive winter mortality to this population normally controlled by effects of winter severity (especially snow depth) on calf recruitment rates (Garrott et al. 2003). The information in Figure 25 indicates that, controlled for snowpack conditions, elk calf recruitment has been lower during the post-wolf period than during the pre-wolf period.

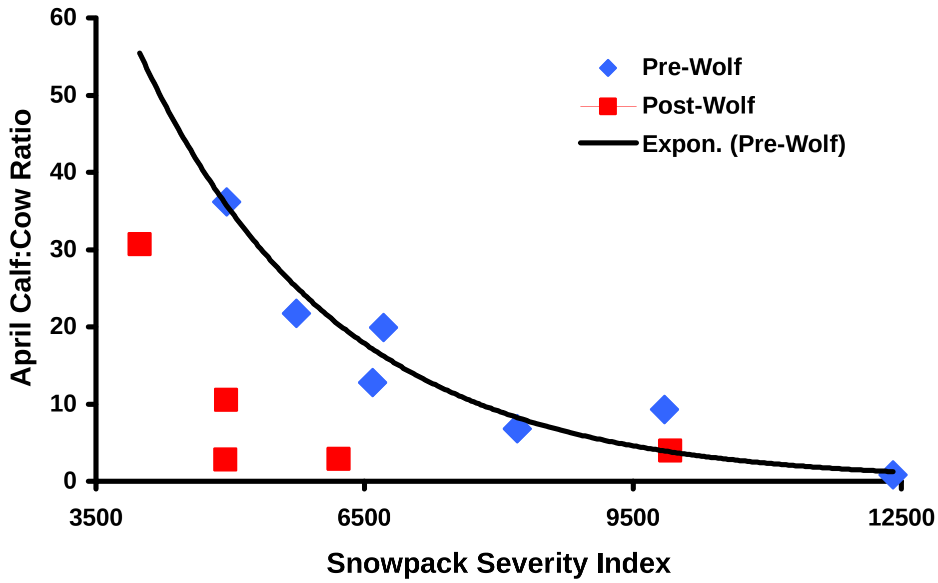



Figure 25. Elk calf recruitment in the Madison-Firehole population in relation to snowpack severity index during pre- and post-wolf periods (Figure courtesy of R. Garrott).

Offtake

Following, I estimate relative contributions of wolf predation and hunter harvest to elk population trends in the GYA (Tables 8 and 9). Similar estimates have been made by others [White et al. 2003, White and Garrott 2005 and Vucetich et al. 2004 (unpubl.)], however some of my assumptions/estimates are different. Most other estimates [White and Garrott 2005 and Vucetich et al. 2004 (unpubl.)] have used unadjusted elk counts as the base from which to estimate offtake. I estimate actual pre-season elk numbers in all areas by adjusting counts based on available data (Singer et al. 1997, Hamlin and Ross 2002) including observability estimates, sightability, population modeling, and hunter harvest (FWP annual harvest surveys). For some years, this included using averages or ranges based on observing conditions during flights. Although any estimates are subject to question and interpretation, I believe it is important to use estimated pre-season elk numbers so that offtake estimates are not higher than reality.

Wolf kill-rates of elk and sex/age composition of that kill were taken from the published and unpublished literature for the areas. In the case of the Gallatin Canyon and Gravelly-Snowcrest Mountains, an estimated moderate wolf kill-rate of elk was used (White et al. 2003). The following wolf kill rates of elk during winter were used for calculations in Tables 7 and 8: Northern Range – 0.061elk kills/wolf day (Smith et al. 2004b); Madison-

Firehole – 0.0604 elk kills/wolf day (Garrott, unpubl.); Lower Madison – 0.125 elk kills/wolf day (ave. Gude and Garrott 2003, 2004); Gallatin Canyon – 0.075 elk kills/wolf day; Gravelly-Snowcrest – 0.075 elk kills/wolf day. Where available (Smith et al. 2004b, see earlier for other areas) sex and age of kills were partitioned by observed selection. Other estimates used a winter period of October-May (White and Garrott 2005) and a summer (June-September) kill rate of 70% of the winter kill rate based on estimates by Messier (1994). To be conservative, I used a winter period of November-April and a kill rate of 50% of the winter rate for October and May and 25% of the winter rate for June-September.

Numbers of wolves using each area were based on published reports and sometimes modified based on personal communications with field researchers (Smith et al. 2004b, USFWS et al. 1999-2004, Gude and Garrott 2003, 2004, Garrott pers. comm., Winnie, pers. comm.). For some areas, some wolf packs used the study area only at some times of the year and others used the general area yearlong, but were only on the study area on some days. For the Madison-Firehole area, I used 35% of total wolf numbers using the area at some time, which also coincided with an estimate of about 1,500 wolf days during winter estimated by Garrott et al. (2005) recently. For the Gallatin study area, I used 50% of maximum wolf numbers based on known wolf movements in and out of the area. All these should be relatively conservative estimates of wolf numbers impacting elk.

Total wolf-kill estimates (Tables 8 and 9) do NOT include calves from birth through September. Estimated kill is calculated by multiplying kill rate (kills/wolf day) partitioned into sex and age classes and partitioned into time period times number of wolves using the area.

Regular and late season hunter harvest was estimated based on Montana's hunter harvest questionnaire. In contrast to most other estimates, I incorporated estimates of crippling loss in the total using estimates from Hamlin and Ross (2002). Total harvest **including** crippling loss was 1.2 times reported harvest for females and 1.1 times reported harvest for males.

Estimates of offtake in Tables 8 and 9 are dependent on published/unpublished estimates of the individual component data. Given the incorporation of estimated "true" elk population size and hunter crippling loss, I believe the estimates to be relatively accurate. Compared to other estimates, estimates here are probably inherently biased a little high for hunter offtake and a little low for wolf offtake.

For the Northern Range, estimated wolf numbers were 32, 42, 44, 72, 77, 87, and 106 wolves for 1997-98 through 2003-04 (Smith et al. 2004b, USFWS et al. 2004). The results indicating increased offtake by wolves (Table 8) are highly influenced by these numbers because that is the factor changing annually in the calculations. Total estimated offtake by wolves has exceeded offtake by hunters during the last 2 years in numbers and percentages (Table 8, Fig. 26). This trend is likely to continue because even though the increase in wolf numbers may have stabilized or declined for 2004-05 (D. Smith, pers. comm.), hunter harvest in 2004-05 will be about half the previous years level (T. Lemke, pers. comm.) and will decline much further in 2005-06. Although kill rates of elk on the Northern Range did not change through 2003 (Smith et al. 2004), they may have declined in 2004-05 (D. Smith, pers. comm.), which would affect future calculations of offtake.

Total offtake, including both hunters and wolves, has averaged about 7% higher during the post-wolf years of 1997-98 through 2003-04 than during the pre-wolf years of 1985-86 through 1991-92. The pre-wolf period included heavy hunter harvest during 1988-89 and 1991-92 and also heavy winter loss during 1988-89. Thus, the decline in counted elk (Figs. 11, 12, 13) reflects the increased total offtake and very low calf recruitment recently (Fig. 18). Because many of these elk spend much of the general hunting season within YNP and bulls are lightly hunted with permits during the late season, wolves have taken a much higher proportion of the male population (including calves) than females (including calves) in recent years (Table 8). Hunter harvest has been on a stable–to-decreasing trend (Table 8, Fig. 26), thus it appears that wolf predation plus low recruitment of calves during summer is becoming increasingly important in elk population trends for the Northern Range.

The rate of increase for wolves on the Northern Range has been near biological maximum (Eberhardt et al. 2003) and densities are very high. There were about 9.4 wolves/1,000 elk in 2003-04 (110 elk/wolf), which is fewer elk/wolf (more wolves/elk) than the 166 elk/wolf ratio predicted by Boyce (1993), but lower than a potential of 40 elk/wolf estimated possible by Eberhardt et al. (2003).

Except for the Madison-Firehole population, offtake by hunters and wolves estimated for other GYA area (Table 9) do not indicate the same degree of probable impact by wolves as for the Northern Yellowstone elk population. Kill rate estimated for the Lower Madison (HD 362) area is twice as high as for the Northern Yellowstone or Madison-Firehole populations, but with only 3-5 wolves impacting 3-4,000 elk, mortality due to wolf predation has been relatively minor (Table 9, Fig. 7). The increasing rate of offtake by wolves estimated for the Madison-Firehole elk population (Table 9) combined with recent trends in recruitment (Fig. 18) and population trend (Fig.10) indicate that this unhunted (by humans) elk population may be substantially impacted by wolf predation. Although not at levels observed for the Northern Yellowstone or Madison-Firehole elk populations, an increasing trend in wolf offtake combined with low calf recruitment recently (Fig. 17) indicates the Gallatin Canyon elk population should be monitored closely. The Madison-Firehole and HD 362 Madison study areas are only about 25 airline miles apart, indicating that impacts of wolf predation can be substantially different over short distances (Garrott et al. 2005).

A graphic comparison (Fig. 27) of estimates of offtake for the 5 areas indicates that probable impact of wolf predation on elk populations has varied considerably among areas and wolf density or a predator/prey ratio may be an important determining factor in wolf impact on elk populations. Additionally, survival of elk calves to fall/winter is also important. This survival to fall/winter has been below historical levels recently, but has been especially low in areas in and near YNP.

Table 8. Estimated number and percentage of pre-season (15 Oct.) Northern Yellowstone elk population harvested by hunters and killed by wolves, 1985-1992 and 1997-2004. Male and female columns each include one-half of calves. Does not include newborn calves, birth - 15 October.

| Year | Est. No. Elk Pre-season[a] | ♂♂- Hunter Harvest[b,d] | ♂♂- Wolf-kill[c,d] | ♀♀ - Hunter Harvest [b,d] | ♀♀ - Wolf-kill[c,d] | Total Hunter Harvest[d] | Total Wolf-kill[d] | Total HK+WK[d] |
|---|---|---|---|---|---|---|---|---|
| 1985-86 | 22,821 | 637 (8.9) | - | 1,094 (7.0) | - | 1,731 (7.6) | - | 1,731 (7.6) |
| 1986-87 | 20,504 | 684 (12.4) | - | 818 (5.5) | - | 1,502 (7.3) | - | 1,502 (7.3) |
| 1987-88 | 21,887 | 276 (4.6) | - | 264 (1.7) | - | 540 (2.5) | - | 540 (2.5) |
| 1988-89 | 21,555 | 732 (12.0) | - | 2,556 (16.5) | - | 3,288 (15.3) | - | 3,288 (15.3) |
| 1989-90 | 18,301 | 396 (8.6) | - | 474 (3.5) | - | 870 (4.8) | - | 870 (4.8) |
| 1990-91 | 18,422 | 416 (9.7) | - | 752 (5.3) | - | 1,168 (6.3) | - | 1,168 (6.3) |
| 1991-92 | 21,953 | 2,833 (35.6) | - | 1,814 (13.0) | - | 4,647 (21.2) | - | 4,647 (21.2) |
| Pre-wolf Mean | 20,778 | 853 (13.1) | - | 1,110 (7.5) | - | 1,964 (9.3) | - | 1,964 (9.3) |
| | | | | | | | | |
| 1997-98 | 15,709 | 449 (7.0) | 206 (3.2) | 1,340 (14.5) | 241 (2.6) | 1,789 (11.4) | 447 (2.9) | 2,236 (14.2) |
| 1998-99 | 15,848 | 490 (8.3) | 269 (4.6) | 1,735 (17.4) | 316 (3.2) | 2,225 (14.0) | 585 (3.7) | 2,810 (17.7) |
| 1999-00 | 19,199 | 302 (4.1) | 283 (3.8) | 956 (8.1) | 331 (2.8) | 1,258 (6.6) | 614 (3.2) | 1,872 (9.8) |
| 2000-01 | 17,912 | 474 (6.6) | 462 (6.5) | 1,257 (11.7) | 540 (5.0) | 1,731 (9.7) | 1,002 (5.6) | 2,733 (15.3) |
| 2001-02 | 15,906 | 328 (6.4) | 494 (9.7) | 1,137 (10.5) | 578 (5.4) | 1,465 (9.2) | 1,072 (6.7) | 2,537 (15.9) |
| 2002-03 | 12,389 | 329 (12.1) | 559 (20.5) | 810 (8.4) | 654 (6.8) | 1,139 (9.2) | 1,213 (9.8) | 2,352 (19.0) |
| 2003-04 | 11,234 | 258 (9.9) | 681 (26.1) | 724 (8.4) | 795 (9.2) | 982 (8.7) | 1,476 (13.1) | 2,458 (21.8) |
| Post-wolf Mean | 15,457 | 376 (7.8) | 422 (10.6) | 1,137 (11.3) | 494 (5.0) | 1,513 (9.8) | 916 (6.4) | 2,429 (16.2) |

[a] Estimated based on population reconstruction, sightability, and harvests. Data from Singer et al. (1997) used and also applied to counts from 1997-2004. When counts were not made, estimates extrapolated from existing data.
[b] Hunter harvest estimates from Statewide harvest questionnaire, check station and also includes estimates for crippling loss based on data from Hamlin and Ross (2002) – Total harvest including crippling loss = 1.2x reported harvest for females and 1.1x reported harvest for males. Male and Female columns each include one-half of calves.
[c] Wolf kill estimates based on reported wolf numbers on the Northern Range, published kill rates partitioned among adult males, adult females, and calves as observed, and partitioned among 3 time periods (see description in text) ( also see Smith et al. 2004a, 2004b, and USFWS et al. 2004).
[d] Number (percent of estimated pre-season population).

Table 9. Estimated offtake by hunters and wolves for 4 elk populations in the GYA.

| Area | Year | % Hunter Offtake | % Wolf Offtake | % Total Offtake |
|---|---|---|---|---|
| Gallatin Canyon | 1991-92 | Range | | Range |
| | through | 6.9 - 22.2 | - | 6.9 - 22.2 |
| | 1995-96 | | | |
| | **Mean** | **15.0** | | **15.0** |
| | | | | |
| | 1999-00 | 16.7 | 3.2 | 19.9 |
| | 2000-01 | 14.8 | 6.1 | 20.9 |
| | 2001-02 | 9.6 | 6.3 | 15.9 |
| | 2002-03 | 9.6 | 9.4 | 19.0 |
| | 2003-04 | 15.2 | 9.8 | 25.0 |
| | **Mean** | **13.2** | **7.0** | **20.1** |
| | | | | |
| Gravelly-Snowcrest | 1991-92 | Range | | Range |
| | through | 16.8 - 25.7 | - | 16.8 - 25.7 |
| | 1995-96 | | | |
| | **Mean** | **21.6** | | **21.6** |
| | | | | |
| | 1999-00 | 17.8 | - | 17.8 |
| | 2000-01 | 27.7 | 0.6 | 28.3 |
| | 2001-02 | 15.3 | 1.3 | 16.6 |
| | 2002-03 | 16.3 | 1.2 | 17.5 |
| | 2003-04 | 16.3 | 0.5 | 16.8 |
| | **Mean** | **18.6** | **0.7** | **19.4** |
| | | | | |
| Lower Madison (HD 362) | 1999-00 | 7.5 | 1.5 | 9.0 |
| | 2000-01 | 14.4 | 4.0 | 18.4 |
| | 2001-02 | 9.2 | 2.8 | 12.0 |
| | 2002-03 | 12.3 | 3.7 | 16.0 |
| | 2003-04 | 16.2 | 3.5 | 19.7 |
| | **Mean** | **11.9** | **3.1** | **15.0** |
| | | | | |
| Madison-Firehole | 1996-97 | - | 9.5 | 9.5 |
| | 1997-98 | - | 8.2 | 8.2 |
| | 1998-99 | - | 11.3 | 11.3 |
| | 1999-00 | - | 12.3 | 12.3 |
| | 2000-01 | - | 22.0 | 22.0 |
| | 2001-02 | - | 18.6 | 18.6 |
| | 2002-03 | - | 33.2 | 33.2 |
| | 2003-04 | - | 44.0 | 44.0 |
| | **Mean** | **-** | **19.9** | **19.9** |

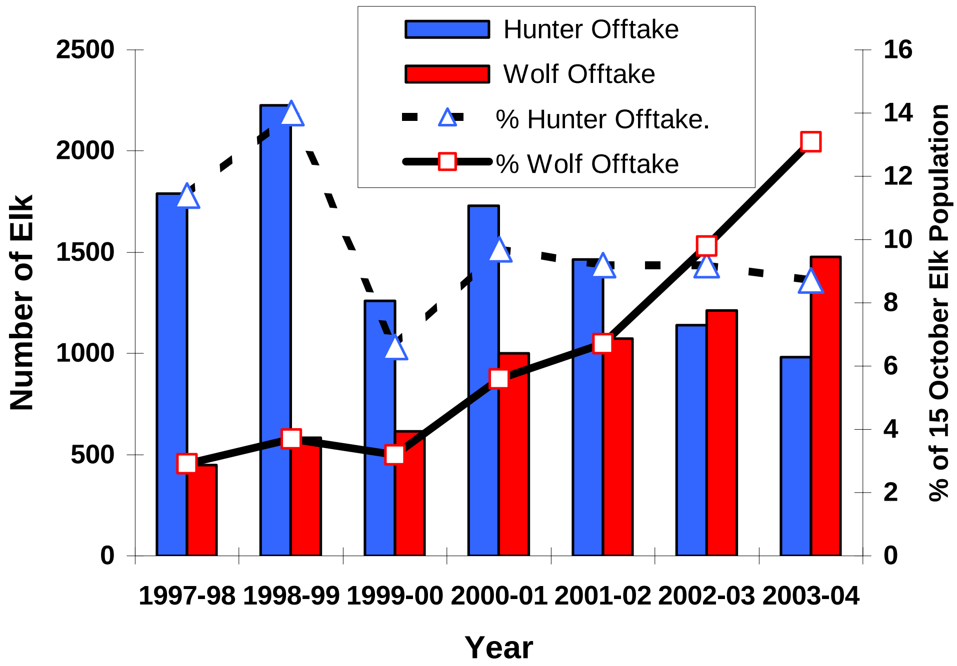



Figure 26. Estimated numbers and percentage of the pre-season Northern Yellowstone elk population killed by hunters and wolves, 1997-98 through 2003-04.

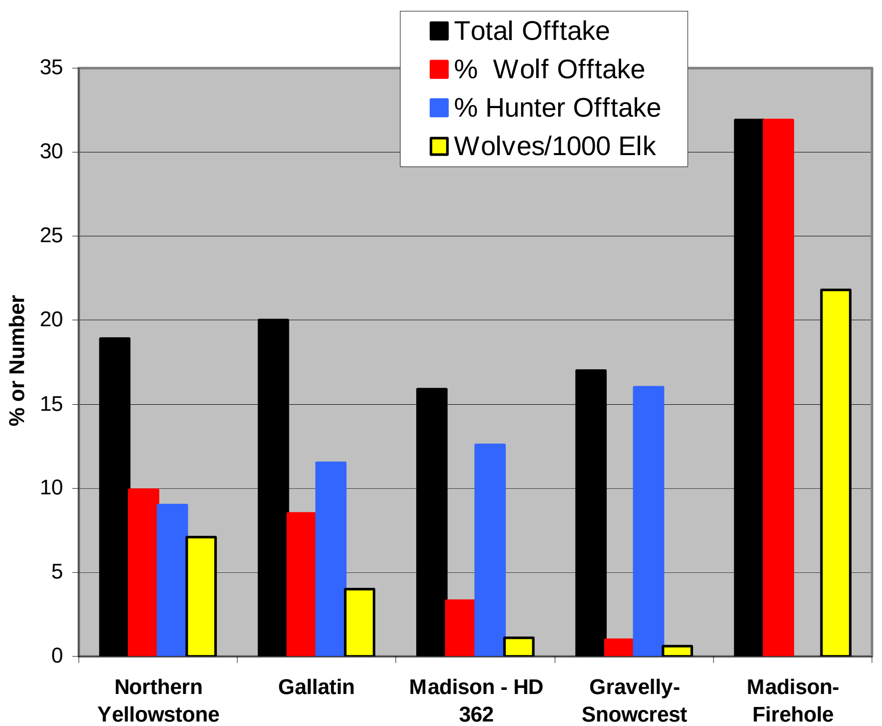



Figure 27. Comparison of estimated 3-year average (2001-02 through 2003-04) offtake by hunters and wolves among 5 elk populations in Southwestern Montana and Yellowstone National Park.

A healthy, productive Gravelly-Snowcrest elk population remained stable or slightly increased while supporting at least 17-26% (average 22%) total offtake by hunters (or somewhat higher – 16% females and 75% males, Hamlin and Ross 2002). Calf recruitment during that time was generally in the range of 35-55 calves:100 cows, averaging 45 calves:100 cows. The amount of offtake supported while maintaining a stable population will vary with recruitment level (Hamlin and Ross 2002). Recently, trends in calf recruitment in much of Montana have been substantially lower than observed in the Gravelly-Snowcrest Mountains during the mid-1980s through the mid-1990s. Levels of calf recruitment have been especially low for the Northern Yellowstone, Madison-Firehole, and Gallatin Canyon elk populations (Figs. 17 and 18), averaging 13, 3, and 13 calves:100 cows, respectively for the last 3 years. During the same period, recruitment has averaged 29 calves:100 cows in the Gravelly-Snowcrest Mountains and 22 calves:100 cows in the Lower Madison population.

A plot of estimated offtake by wolves versus wolves:1,000 elk in southwestern Montana and YNP study areas (Fig. 28) indicates that at about 15 wolves/1,000 elk (1 wolf:67 elk), wolf predation could take all "surplus" elk at a recruitment of about 45 calves:100 cows (based on Gravelly-Snowcrest data, Hamlin and Ross 2002). For the last 3 years, total offtake averaging about 19% (about 9.8% by wolves) in the Northern Yellowstone population has resulted in a declining elk population with an average recruitment of about 13 calves:100 cows, an average 7.1wolves/1,000 elk (1 wolf:140 elk), and hunter harvest averaging 9.2% of the pre-season population.

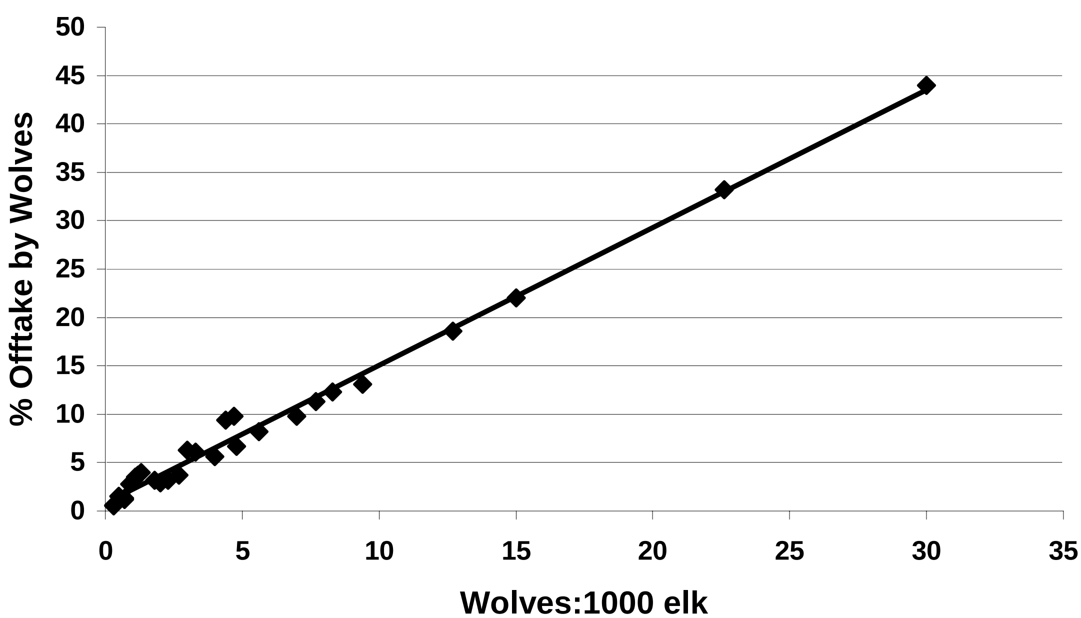



Figure 28. Estimated offtake by wolves of 5 elk populations in southwestern Montana and YNP at observed levels of wolves:1000 elk.

## Extensive Studies – Montana beyond the GYA

Garnet Mountains Study

As part of a FWP cougar study, newborn elk calves were captured and marked with radio-transmitter collars during 2002-2004 in the Garnet Mountains (Raithel 2005). Mortality through 31 August was much higher for the sample in 2002 (71%) than in 2003 (11%) or 2004 (14%) (Raithel 2005). For the 3 years combined, 25 of 98 (26%) non-censored elk calves died during summer. For 2002, the radio-collared sample indicated higher mortality than indicated by subsequent classifications of the entire population. For 2003 and 2004, subsequent classifications indicated additional mortality beyond that indicated by the radio-collared sample.

Of 25 total summer mortalities during the entire period, 10 (40%) were attributed to black bear predation, 3 (12%) to cougar predation, 1 (4%) to coyote predation, 1 (4%) to unknown canid predation, 2 (8%) to unknown predators, and 8 (32%) to malnutrition/disease (Raithel 2005). Sixty-eight percent of summer mortality was attributed to predation and for this area without grizzly bears or an established wolf pack, black bears accounted for 40% of total summer calf mortality.

During fall, 3 (5.1%) of 59 elk calves died. Cougar predation, legal harvest, and unknown causes each contributed one mortality. Mortality of adult cow elk was low, averaging 8.7% during 2002-2004 (Raithel 2005). Radio-collared newborn elk calves will be monitored for several more years.

North Fork of the Flathead River

The North Fork of the Flathead River drainage on and west of the west edge of Glacier National Park and within MFWP HD 110 was the first area where wolves from Canada naturally reestablished breeding packs within Montana. Although some wolves were documented in this area during the late 1970s, a breeding pack was first documented in 1985-86. One or more breeding packs of wolves have been in this area for the past 20 years. During 2004, 2 breeding packs of 5 and 7 wolves (12 total) were documented within the North Fork area and another pack of 3 wolves used the western portion of HD 110 (USFWS et al. 2005).

The numbers of wolves in this area has fluctuated and has supplied dispersing wolves that have colonized other areas in Montana. Wolf densities apparently have never reached that observed in Yellowstone National Park or central Idaho. Rough densities of the multiple large predators in this system in 1990-1997 were 10 wolves/1000 $km^2$, 70 cougars/1000 $km^2$, 64 grizzly bears/1000 $km^2$, and 200 black bears/1000 $km^2$ (Kunkel and Pletscher 1999).

White-tailed deer (*Odocoileus virginianus*) were the primary prey of both wolves and cougar in this area (Kunkel et al. 1999). Wolf kills were 83% white-tailed deer, 14% elk, and 3% moose (*Alces alces*) and cougar kills were 87% white-tailed deer, 6% elk, and

2% moose (Kunkel et al. 1999). Predation was the cause for 78%, 72%, and 64% of the annual deaths of female white-tailed deer, elk, and moose, respectively on this area (Kunkel and Pletscher 1999).

Kunkel and Pletscher (1999) believed that predation was largely additive in this environment and that predation by multiple predators was the primary factor limiting ungulate populations here. They also believed that numbers of wolves and cougars were declining near the end of their study (1996).

Little long-term, consistent data on ungulate population levels are available for this area. However, over long periods, taking weather conditions into account, harvest levels of adult male deer and elk generally tracks total population level (G. Dusek, pers. comm. and K. Hamlin, unpubl. data). I compared harvest level of adult male white-tailed deer, mule deer, and elk in HD 110 from 1980-2003 with that from HD 130 for the same period. HD 130 (the Swan) has substantial populations of cougar, grizzly bear, and black bear, but has not had established wolf packs during the period. Also, no breeding packs of wolves were documented in HD 110 for the period prior to 1986 and few wolves were present for several years after that. Population levels of white-tailed deer, mule deer, and elk generally declined after the mid-late 1980s through the late 1990s on both areas and trends were similar as measured by harvest level of adult males (Figure 29a, b, and c). On both areas, population levels of all 3 species appear to be recovering after the severe winter of 1996-97 (Figure 29a, b, and c) and check station data indicate that this recovery continued through 2004 (J. Williams, pers. comm.). These data indicate that for **this area**, the addition of wolves to the mixture of other large predators (cougars, grizzly bears, and black bears) in HD 110 did not alter basic ungulate population trend compared to a nearby area without wolves. Also, population recovery after the severe winter of 1996-97 is occurring on both areas, possibly even faster for mule deer and elk in HD 110 than in HD 130, which does not have wolves.

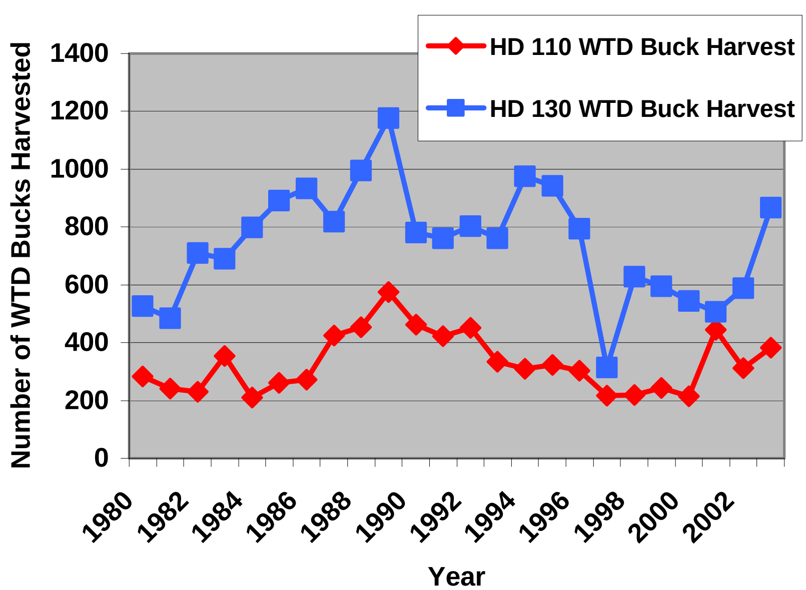



**Fig. 29a.**

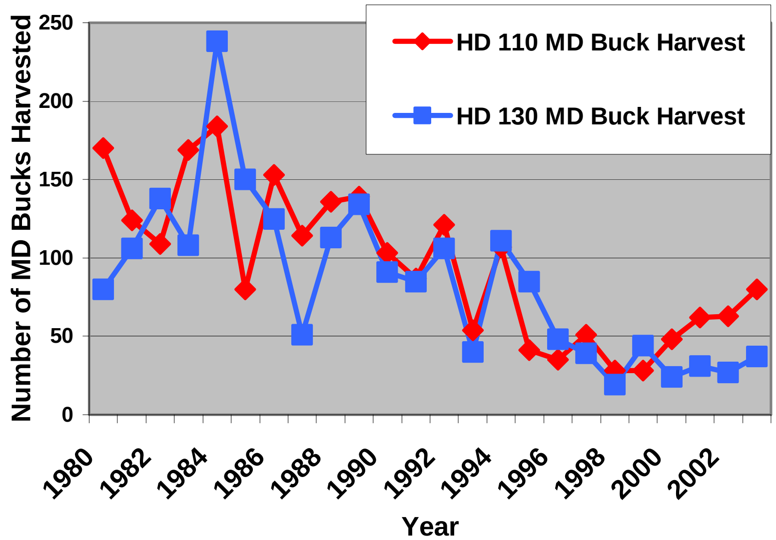



**Fig. 29b.**

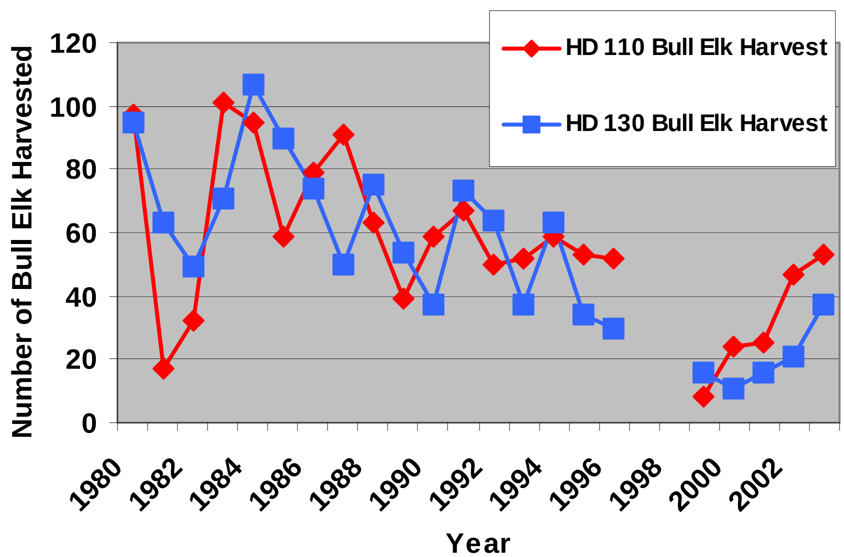



**Fig. 29c.**

Figure 29. Hunter harvest of buck white-tailed deer (**a.**), buck mule deer (**b.**), and bull elk (**c.**) during 1980-2003 in HDs 110 and 130.

The reduction in human hunting pressure on antlerless ungulates after the winter of 1996-97 undoubtedly aided in the recovery of the populations. However, it also appears that the presence of wolves for 20 years has not changed basic population trends for white-tailed deer, mule deer, and elk in HD 110 relative to those in HD 130 and the Region. It also appears that with temporary reductions in antlerless harvest, these ungulate populations have recovered from lows in the presence of a suite of large predators. Data on moose populations is very limited in this area and throughout the state and impacts of predation on a low density ungulate could be entirely different than for more numerous species.

### Wolf Population Growth Rates and Mortality

Restored wolf populations have grown at near maximum rates (Table 10). Growth rate peaked in 2002 and may have slowed recently. The wolf population in the Northern Yellowstone range may have declined during the last year for the first time since restoration (D. Smith, pers.comm.). The naturally established wolf population in northwestern Montana grew at a much slower rate and recently, the growth rate has been negative there. Growth rate has been higher in Wyoming and central Idaho with their large protected areas. Since 1999, however, growth rate of the wolf population in Montana outside of the NWMT area has been at rates observed earlier for the GYA and CID (Table 10). Much of this growth has been in areas near Yellowstone National Park [see maps, USFWS et al. (2000, 2001, 2002, 2003, 2004, 2005)] and has been fueled by wolves dispersing from YNP.

Table 10. Instantaneous rate (r) of population growth for wolves by recovery area, state, and time period. Data used from USFWS et al. (2005).

| **Recovery Area**[a] | 1985-1994 | 1985-2002 | 1995-2002 | 1995-2004 | 1999-2004 |
|---|---|---|---|---|---|
| NWMT | 0.145 | 0.125 | 0.070 | -0.013 | -0.013 |
| GYA | - | - | 0.365 | 0.304 | 0.202 |
| CID | - | - | 0.430 | 0.386 | 0.213 |
| | | | | | |
| **State**[b] | | | | | |
| MT | 0.145 | 0.156 | 0.146 | 0.093 | 0.145 |
| MT outside NWMT | - | - | - | - | 0.429 |
| WY | - | - | 0.334 | 0.280 | 0.178 |
| ID | - | - | 0.419 | 0.378 | 0.199 |

[a] NWMT = Northwest Montana, GYA = Greater Yellowstone Area, CID = Central Idaho.
[b] MT = Montana, WY = Wyoming, ID = Idaho.

To date, official control actions (primarily killing wolves) have been substantially higher per wolf-year in Montana than in Wyoming or Idaho (Table 11). This likely occurred because more of the Wyoming and Idaho wolf populations are in protected areas (YNP, Nez Perce Tribe lands, wilderness) and to some extent, more of the Montana wolves have come in conflict with agricultural operations. Also, some of the wolves killed in Montana

Table 11. Official control actions on wolves listed by state, 1995-2004. Data from USFWS et al. (2005).

| State | Wolf-Years[a] | Wolves Killed (Kills/Wolf-Year)[b] | Total Control Actions (Control Actions/Wolf-Year)[c] |
|---|---|---|---|
| Montana | 1,213 | 160 (0.132) | 247 (0.204) |
| Wyoming | 1,484 | 65 (0.044) | 66 (0.045) |
| Idaho | 1,926 | 61 (0.032) | 81 (0.042) |

[a] Estimated fall population + number of wolves killed (USFWS et al. 2005) summed for 1995-2004.
[b] Government control actions + wolves legally killed by ranchers.
[c] Includes moving wolves away from depredation sites – not done after 2001.

have been dispersers from YNP and Central Idaho, but their deaths are recorded where they get in trouble in Montana.

Higher rates of control actions may have slowed the overall growth rate of Montana wolf populations, but has not slowed the growth rates of wolf populations in southwestern Montana near YNP (Tables 10 and 11). Declines in wolf populations that may be beginning in YNP may result in a lower rate of dispersal to Montana. Also, any expansion of wolves beyond the immediate YNP area may result in an even greater frequency of control actions. During 2004, mange became relatively common among wolves in southwestern Montana outside YNP. This disease will likely cause an increased mortality rate. Thus, growth rate of the southwestern Montana wolf population may also begin to slow. Growth rate and ultimate density of wolves in local areas are important because impact of wolf populations on ungulates may be related to wolf density and wolf/prey ratios (see earlier).

**Research and Management Data Needs**

It is important to continue the approach we have used thus far by working in multiple areas with differing ecological characteristics, including wolf and other predator densities, different ungulate species and densities, and different climate, vegetation, terrain, and land use characteristics. It appears that impacts of wolf predation will vary as these environmental characteristics vary. This approach also includes enhanced monitoring of ungulate populations where wolves are absent or of very low density. Increasingly these areas will be in other than southwestern and northwestern Montana.

Monitoring of wolves has been a joint effort (USFWS et al. 2005) and this will continue, but Montana must take an increasing role. A monitoring program is described in the Montana Gray Wolf Conservation and Management Plan (Sime 2003). As time goes on, costs will likely reduce the use of radio-collared wolves in the monitoring program, so refinements, innovations and changes will likely be necessary. Maintaining cost-efficient radio-collared samples will require coordination of research and management priorities.

Monitoring of mule deer populations in Montana is well covered with the Adaptive Harvest Management Program (MFWP 2001). There are 13 census areas and 67 trend areas well distributed across the state where mule deer populations are monitored by aerial surveys. Census areas include 3 replicate surveys during spring to establish variability and confidence limits for results. At this time, further improvements or refinements of mule deer monitoring are not necessary for monitoring the effects of wolf restoration on mule deer.

In many areas, MFWP biologists conduct similar surveys for white-tailed deer as for mule deer. However, no coordinated Adaptive Management Program for white-tailed deer has been completed in Montana and surveys for white-tailed deer could be improved. This includes addition of replicate surveys in some areas and addition of new monitoring techniques. Because white-tailed deer are important prey of both wolves and cougars in northwestern Montana, developing reliable and consistently accomplished population surveys for white-tailed deer should be a priority in MFWP Administrative Regions 1 and 2. Dusek (in prep.) will provide recommendations for methods to estimate white-tailed deer populations in northwestern Montana.

A greater portion of Montana’s elk population is surveyed than any other ungulate species (MFWP Elk Management Plan, 2005). Many good and long series of population data are available throughout the state. Statewide coverage for elk population data is good, but elk surveys lack the replicates that occur for the 13 mule deer census areas and more observability indexes could be determined for different habitat/cover types. The Elk Management Plan specifies these improvements and when accomplished, they will improve interpretations for wolf-ungulate investigations. At this time, the greatest likelihood of wolf impacts on Montana elk populations are for areas near YNP. Population survey improvements for elk should be prioritized to southwestern and western Montana.

Moose and bighorn sheep are 2 other ungulate species of concern relative to wolf predation. The availability of more numerous species such as elk and white-tailed deer as prey for wolves may maintain high densities of wolves for longer periods than occurs in single prey systems. This could potentially result in greater population impacts on less numerous species such as moose and bighorn sheep. I could not find adequate past and current population survey information to compare pre-wolf and post-wolf population characteristics for moose or bighorn sheep in Montana. Priority should be given to establishing reliable and consistently conducted population surveys for moose (especially in MFWP Regions 1 and 3) and bighorn sheep statewide.

In much of Montana, wolf predation will occur in conjunction with predation by other large predators (cougars, grizzly bears, black bears) and several smaller predators such as coyotes and bobcats. Monitoring of population levels of these species should occur as well. This is a difficult task, but studies of cougars by DeSimone and Semmens (2005) and by Mace (pers. comm.) for black bears may improve our ability to monitor population levels of those species.

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