WOLF MONITORING PLAN
YELLOWSTONE NATIONAL PARK

2nd Edition - updated November 2003

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INTRODUCTION

At the end of 2002, Yellowstone National Park (YNP) was inhabited by at least 148 wolves (*Canis lupus*) in 14 packs, including 12 breeding pairs. In the eight years following the initial release of wolves in 1995, wolves have recolonized YNP as well as portions of the adjacent 72,800 km^2 Greater Yellowstone area (GYA) – a testament to the success of the restoration effort thus far. Following the objectives outlined in the first edition of the Wolf Monitoring Plan (Smith and Phillips 1996), we have been successfully monitoring the changes in wolf population dynamics crucial to fulfilling the ultimate goal of wolf delisting. In addition, we are beginning to understand the ecological implications of wolf restoration on the ecosystem (Smith et al. 1999, Smith et al. 2003). Initial monitoring objectives have provided a foundation for both long and short term ecological studies in many aspects of wolf ecology and behavior including: population dynamics, predator-prey relationships, multi-carnivore interactions, wolf-scavenger relationships, reproductive and denning behavior, genetics and disease. Collaborative relationships with biologists outside Yellowstone have been, and will continue to be, crucial to the success of monitoring the effects of wolf restoration to the Yellowstone ecosystem.

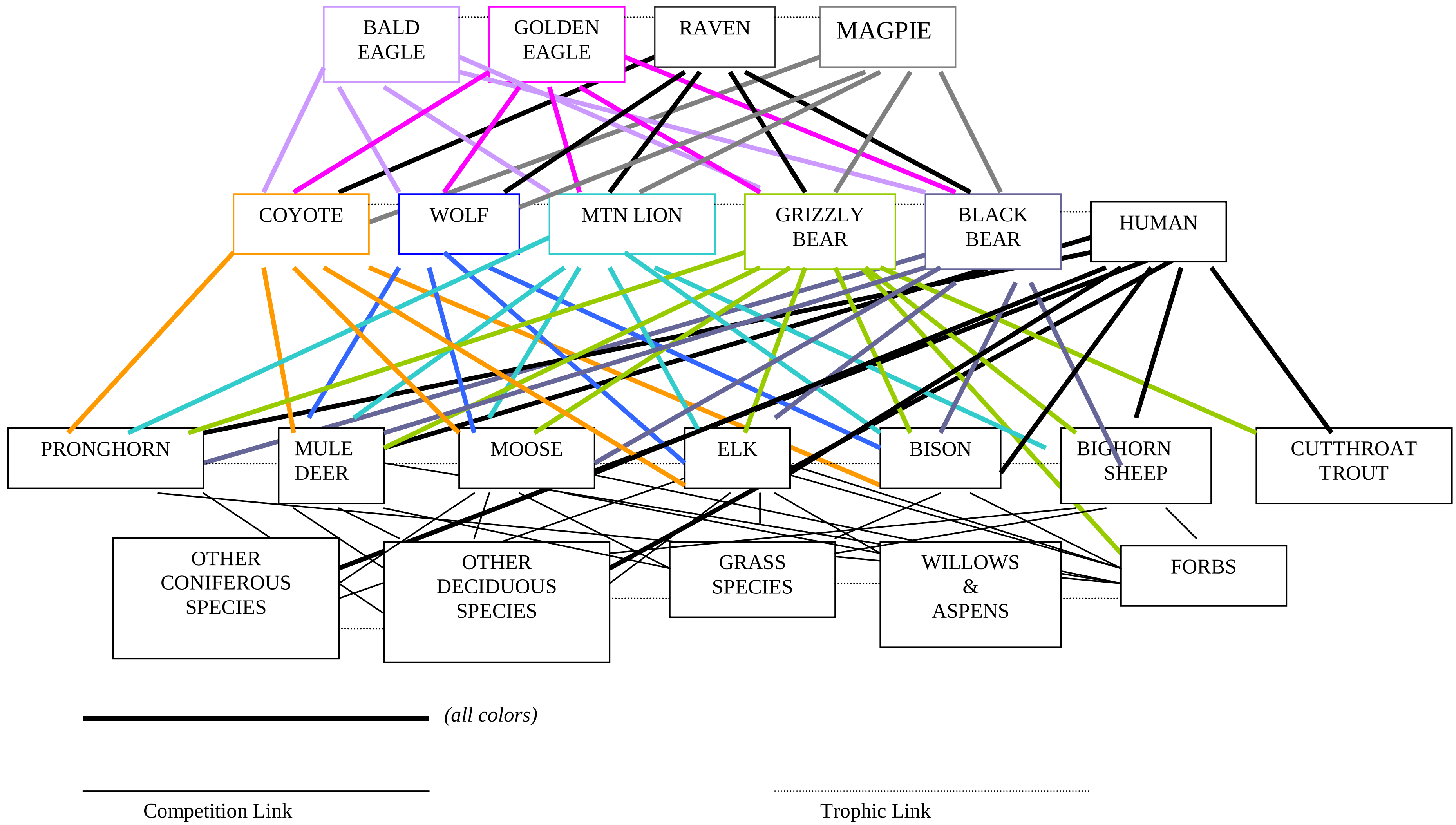
Our goal now, after wolves have re-established themselves as an ecological force in Yellowstone, is to revise this original guiding document, updating it for the future and re-focusing our objectives. The original Wolf Monitoring Plan (Smith and Phillips 1996) emphasized restoration of wolves to the ecosystem. This phase of the project is complete; wolves are restored and it is now necessary to revise this original vision making the new plan more sensitive to the ecological and management issues wolves now face in Yellowstone National Park.

It should be noted that this document does not cover all operations of the Yellowstone Wolf Project, five other supporting documents are also available covering specific aspects of those programs in more detail: 1) Safety, Equipment Care, and Protocol Manual, 2) Yellowstone Wolf Project Winter Study Handbook, 3) Wolf Capture Operations Plan, 4) Management of Habituated Wolves in Yellowstone National Park, and 5) Druid Peak Pack Road Management in Lamar Valley. We encourage the reader to consult these plans as needed, as this plan is not intended to be redundant with those other documents. Most importantly, this document is not intended to be a protocol or review of safety procedures, a NPS/YNP priority fully incorporated into all aspects of wolf project functioning. Instead we encourage the reader to consult the Wolf Project Safety Manual.

Long-Term Monitoring

In this second edition of the Wolf Monitoring Plan, we reiterate the importance of comprehensive monitoring and long-term ecological research of wolves and other wildlife species affected by wolf restoration (Figure 1). We emphasize this approach because two other wolf programs have successfully monitored wolves in protected areas for decades and provide a good example for our program in YNP. Isle Royale National Park has monitored wolves since 1958 (Allen 1979, Peterson 1995), and the U.S. Fish and Wildlife Service (now USGS/BRD) has monitored wolves in Superior National Forest, Minnesota since 1966 (Mech 2000).

Figure 1. A representation of the terrestrial food web of the Northern Range of Yellowstone National Park.



Both studies are world renowned for their length and importance to wolf management and research. These are the only two studies to follow a wolf population through several cycles of prey fluctuations, which influences wolf population dynamics, predator-prey relationships, and conclusions regarding wolf management (Allen 1979, Mech 1966, Mech 2000, Peterson 1977, Peterson 1995). Results from these studies have had a major bearing on resolving management dilemmas that center around wolves (Carbyn et al. 1995, Mech and Boitani 2003).

The wide distribution of wolves across the northern hemisphere has challenged people and managers for centuries (Rawson 2001). We expect no less in and around YNP. Solid long-term data will be necessary to solve new dilemmas unique to this situation; indeed snapshot studies will not be adequate. It will also not be possible to understand ecological change brought about by wolf restoration without a long-term program. After eight years invested in wolf monitoring, YNP staff are ideally situated to gain more per unit effort because baseline data already gathered, and interim program improvements, make any new data more valuable and interpretable now that the background scientific work is completed.

Continuation of monitoring is also important because scientifically this may be one of the great ecological opportunities of the century: reintroduction of an apex carnivore after a 70-year absence that has the capability of restructuring the entire ecosystem. This restructuring will take decades (NRC 2002), therefore we recommend in addition to a long-term approach, that there be periodic reevaluations of the goals and objectives of this plan to keep it relevant and fresh over a long period of time. The reintroduction of this species to the world's first national park will surely rank as one of the most significant ecological events in its history, certainly as significant, if not more so, than the fires of 1988.

Legal Mandates

Besides monitoring to aid management and understanding, we are still legally mandated under requirements of the Endangered Species Act (1973) to monitor the Yellowstone wolf population. As of November 2003, wolves are biologically recovered (43 breeding pairs in the northern Rockies), but delisting requires approved state management plans, which do not look forthcoming in the immediate future (E. Bangs, USFWS, personal communication).

YNP represents the heart of the Yellowstone recovery area, and the park has provided the habitat and protection that has made the program a spectacular success; recovery will hinge on the park's wolves. Delisting depends on the core-protected population of wolves that reside in YNP - it cannot succeed without them. Any data voids will be fatal to delisting, and litigation will play a prominent role in this process. Solid population numbers are centerpiece to this plan.

Strategy

Given the size and complexity of a long-term monitoring program, and considering that our staff and resources are limited, our monitoring activities will focus on critical aspects of wolf population ecology and predator-prey relationships.

Ultimately, our daily on the ground goal or – our mission statement – is:

Increasing understanding and conservation of wolves through research and management.

Similar to our original plan, but with revision, we will focus on seven primary activities. Activities concerning other important aspects of wolf restoration must continue to result from collaborative relationships that we develop with biologists outside Yellowstone (Table 1). For example, our monitoring objectives do not include vegetation and elk components to the trophic cascade studies as these fall under the research objectives of other park employees and collaborators.

Table 1. Collaborative Work with the Wolf Project.

Topic	*Collaborator*	*Institution*
Wolf-cougar interactions	Toni Ruth	Wildlife Conservation Society
Wolf-coyote interactions	Robert Crabtree, Jennifer Sheldon	Yellowstone Ecosystem Studies
Wolf-bear interactions	Charles Schwartz, Mark Haroldson, Kerry Gunther	Interagency Grizzly Bear Study Team, YNP
Wolf-scavenger relationships	Chris Wilmers, Wayne Getz; R. Crabtree	University of California at Berkeley; Yellowstone Ecosystem Studies
Wolf-elk relationships-Firehole Watershed	Robert Garrott, Lee Eberhardt	Montana State University
Wolf-pronghorn	John Byers, PJ White	University of Idaho, YNP
Wolf-willow	Francis Singer, Evelyn Merrill, Duncan Patten	USGS, University of Alberta, MSU
Wolf –aspen	William Ripple	Oregon State University
Wolf –trophic cascades	L. David Mech, Shaney Evans, Shannon Barber; Mark Boyce, Julie Mao, Nathan Varley; Rolf Peterson	USGS; University of Alberta; Michigan Technological University
Wolf predation	Tom Drummer, Rolf Peterson	Michigan Technological University
Wolf survival	Dennis Murray	Trent University
Wolf genetics	Karl Broman, Janet Ziegle, Michael McClelland	Diversa Corp., Applied Biosystems, John Hopkins University

We recognize that opportunities will arise to do more than is outlined in the monitoring program. Due to unprecedented opportunities to directly observe wolves in Yellowstone on a regular basis, the Wolf Project along with collaborators, have already conducted important studies that have contributed valuably to wolf behavioral ecology (MacNulty et al. 2001; MacNulty 2002, Peterson et al. 2002; Smith et al. 2000; Stahler et al. 2002a, Stahler et al. 2002b; Thurston 2002). Efforts will be made to capitalize on as many of these opportunities as possible as long as they do not detract from successful accomplishment of our stated goals.

Our priorities will be the seven activities highlighted below, which have been chosen to address both the ecological aspects of wolf restoration, as well as the binding legal mandate of wolf population dynamics. The long-term commitment, routine data gathering, and collaborative efforts with other researchers, will make YNP wolf studies remarkable in their value to science, YNP, and state wildlife managers.

The philosophy behind this plan has subtlety changed compared to the original plan, which was structured toward reintroducing and establishing a population of wolves, thereby focusing more on management (Smith and Phillips 1996). This revised plan recognizes that wolves are now established as a restored population, and shifts the emphasis and focus to more monitoring and research. This progression and change in the status of wolves was also an impetus for plan revision. Also different from the original plan, data are available from the first 8 years of wolf restoration – the early results of this program -- and we will include those data as a way of updating the reader on the status of wolves and achievement of program objectives since reintroduction in 1995 and 1996 (Bangs and Fritts 1996, Phillips and Smith 1996). Included also is a complete bibliography of papers published by personnel from the Yellowstone Wolf Project.

The next section is a *project overview or executive summary* and lays out our seven critical program objectives. The rest of the plan fleshes out those objectives and provides the details for successful plan implementation. Although, the following objectives seem daunting in their scope, our history shows that we have been able to successfully complete the stated tasks, so will continue to plan to do so in the future.

OBJECTIVES

Activity 1 – Wolf capture

Contact will be maintained with all wolf packs via VHF (very high frequency) radio telemetry and GPS (global positioning system) radio collars through winter capture efforts. All aspects of this plan hinge on having a marked population of wolves, so this is our most important objective. The primary objectives of wolf capture and radio collaring are to ensure that we collar: 1) breeding pairs in each pack; 2) individuals of dispersal age; 3) young wolves within each pack; and 4) wolves with older and/or failing collars. These objectives will allow us to collect population data for delisting, document wolf dispersal, document new breeding pairs both inside and outside YNP, and aid in wolf management activities. Aerial darting will be our primary method of wolf capture (See Wolf Capture Operations Plan 2001) and leghold traps will be used in special circumstances where aerial darting is not feasible. Number of wolves collared in each pack will not exceed 50% of the early winter pack size. Processing of each captured wolf will include: 1) collaring; 2) drawing blood; 3) weight and body measurements; 4) sexing; 5) general condition evaluation; and 6) age determination (pup, yearling, adult) and color (gray or black). (See Wolf Capture Operations Plan 2001 for details also see Appendix I).

Activity 2 – Population Monitoring

Using radio collars, weekly telemetry flights will be conducted in order to determine: 1) wolf survival, mortality, immigration, and emigration; 2) location of dens, rendezvous sites, and pup numbers; 3) pack structure, spatial organization, and territory size; and 4) seasonal food habits. Wolf kills of ungulates will be inspected opportunistically in order to document patterns of prey selectivity by species, age, sex, and condition.

Activity 3 – Predator and Prey Relationships

Daily wolf monitoring of all packs will occur during our biannual 30-consecutive day Winter Studies (early and late winter) to determine wolf kill rates, conduct behavioral studies, and document interactions with prey, other carnivores, and scavengers (see Wolf Project Winter Study Handbook). Efforts to visit all wolf kills occurring during Winter Study will be made to determine species, sex, age, and condition of prey killed by wolves. This monitoring will be accomplished aerially throughout YNP and from the ground on the northern range. Summer kill rates and prey use will also be monitored through the use of downloadable GPS collars, ground monitoring, and summer diet analysis from scats collected at dens and rendezvous sites. A volunteer field technician program will be maintained in order to accomplish both Winter Study and Summer Study objectives.

Activity 4 – Genetics and Disease

Baseline genetic profiles (using DNA microsatellite genotyping) will be established for all wolves handled and recovered dead. These population pedigrees will allow determination of parental relationships, paternity and maternity of multiple litters, relatedness among wolves, reproductive performance of individuals, detection of immigration to the YNP population, and emigration between YNP packs. In addition, passively collected samples (e.g. hair snares, fecal samples) will be genotyped to develop population estimates. Analysis of blood and tissue samples will also be performed in order to determine the presence or absence of diseases and their contribution to mortality.

Activity 5 – Wolf and Carnivore Interactions

Research on wolf and carnivore interactions will be conducted in order to determine the importance of these interactions on carnivore community structure, population dynamics, and impact on prey populations. Collaboration with other researchers will continue to document spatial and temporal habitat use by wolves, bears, and mountain lions inhabiting the northern range using GPS collar technology. In addition, wolf-grizzly interactions will be documented to examine the population and community-level consequences that may stem from the outcome of their behavioral interactions (e.g. population-level benefits and costs; increased wolf predatory pressure on prey populations attributed to kleptoparasitism of wolf kills by bears; changes in seasonal carcass biomass availability).

Activity 6 – Den Study

Den and rendezvous sites will be monitored during the denning season in order to determine pup production, survival, and pack activities around such sites. Both direct observation by ground and air, as well as the use of remote telemetry and camera technology, will be used as monitoring tools. Behavioral observations will be conducted opportunistically to document food provisioning behaviors of adults, identify maternal females should multiple litters occur, and other aspects of pup development and reproductive biology of wolves. Effort will be made to visit den and rendezvous sites annually once wolves have abandoned them to collect scats for summer diet analysis and to record site characteristics.

Activity 7 – Wolf and Scavenger Relationships

An important aspect to research on trophic cascades as it relates to wolf restoration is the effect on scavenger guilds in the Yellowstone ecosystem. Research on wolf and scavenger interactions will be conducted in order to determine the population and community-level outcomes that wolves and scavenger species have on one other. This research will monitor how wolves influence the abundance and distribution of carrion, both spatially and temporally, as well as how they facilitate food acquisition by other carnivores. Specifically, we will monitor wolf-killed carcasses to document: 1) numbers of individuals and species feeding 2) species feeding rates to calculate biomass consumption rates; and 3) behavioral interactions at and away from carcasses. Collaboration with other biologists looking at other predator-scavenger relationships will allow us to understand important scavenger community dynamics system-wide.

BACKGROUND AND HISTORY

Restoring wolves to areas where they were eradicated has been a conservation issue for well over 25 years (Weaver 1978, Tilt et al. 1987, Peek et al. 1991, Mech 1995). YNP, with its plentiful ungulates and large protected ecosystem, has figured prominently in all discussions concerning wolf restoration (Weaver 1978, Tilt et al. 1987, Peek et al. 1991, Fritts et al. 1997). For many years it was hoped that wolves would naturally recolonize the Greater Yellowstone Area (GYA) as they did in northwestern Montana around Glacier National Park (Ream et al. 1987). However, after in-depth considerations of all aspects related to wolf recovery in the northern Rocky Mountains, it was decided to reintroduce wolves to the Yellowstone ecosystem as part of a program to also return self-sustaining wolf populations to suitable habitat in northwestern Montana and central Idaho (USFWS 1980, 1987, 1994a). Following an extended period of public outreach and scientific discussion, wolf restoration to the GYA and central Idaho began in 1995 (Fritts et al. 2001).

At the end of 2002, there were between 650-700 wolves in about 43 breeding pairs distributed throughout Montana (120 wolves in 11 breeding pairs), Idaho (285 wolves in 9 breeding pairs), and the GYA (270 wolves in 23 breeding pairs). These three populations together constitute biological restoration of wolves to the northern Rocky Mountains. At this stage, the gray wolf can be proposed to be delisted from the endangered species list once adequate state wolf management plans and state laws are in place in Montana, Wyoming, and Idaho. As of November 2003, state plans were not approved and were not likely to be approved into the foreseeable future (E. Bangs, USFWS personal communication).

Despite the success of the program, much work still remains. Expectations from the public are high that wolf managers and researchers will adequately monitor wolf recovery and impacts. Historically wolves have proven to be controversial wherever they occur (Young and Goldman 1944, Lopez 1978, McIntyre 1995), more so than other wildlife (Bangs et al 1998, Smith et al. 1999, Oakleaf et al. 2003, Smith et al. 2003, Smith et al. in press). The Yellowstone Wolf Project and YNP have evolved into one of the primary entities for studying wolf-prey interactions in the northern Rockies (Mech et al. 2001, Smith et al. 2003, Smith et al., in press). Monitoring these relationships are important for management and basic ecological monitoring on the impacts wolves will have on the Yellowstone ecosystem. From now and into the future, it will be vital that our early efforts and program continue to address the emerging issues that will only get more volatile and complex. The start we have in place will make future data all the more important. Accordingly, this plan describes our actions necessary to address these concerns.

It must be emphasized that this monitoring plan does not address every significant question related to wolf restoration in the Yellowstone ecosystem (Figure 1). Activities concerning other important aspects of wolf restoration must result from collaborative relationships that are developed with other biologists and institutions (Table 1).

WOLF MONITORING IN YELLOWSTONE NATIONAL PARK

Wolf Capture

Marking wolves to track them is the most basic aspect of the wolf program, all monitoring and research hinges on this effort (Mech 1974, Wolf Capture Plan 2001). We recognize that criticism of collaring and aerial tracking is increasing in the National Park Service, and we are striving to reduce the impacts and safety concerns of wildlife telemetry or replace it, but as of yet no substitute is currently available (Mech and Barber 2002). Mech and Barber (2002) reviewed techniques to study wildlife in National Parks and concluded that radio tracking is still the best technology available for wildlife monitoring and research. They recognize improvements in technology, but none of them replace current techniques. Therefore, we will continue to rely on radio tracking technology, at least for the near future, but work toward reducing its intrusiveness while adhering to strict safety protocols (see Wolf Capture Plan 2001).

Initially all wolves were radio collared as per the objectives of the reintroduction plan (USFWS 1994). Through time the number of wolves collared in YNP has decreased.

At the end of 1995, 86% of the wolf population was collared, but at the end of 2002 it was only 37% of the population. The 1995-2002 average was 52%, but since 1997 it has been 42%. The first monitoring plan identified 50% as the maximum number collared per pack. Feedback from park staff and administrators has been positive, so we propose no increases over allowable number of animals collared per pack.

Target individuals in a pack to collar will be the breeders as they typically anchor the pack, do not disperse, breed each year, and die on their territory. The other primary target will be pups of the year because they are easy to catch, usually remain with the pack for a couple of years (Gese and Mech 1991), but eventually disperse allowing documentation of new packs and areas of wolf activity both in and outside of YNP. Wolf pups are also more likely to become problem wolves than adults (see Management of Habituated Wolves in YNP), so collaring juveniles has potential benefits for management.

We anticipate that radio collaring wolves will continue after delisting because of YNP objectives associated with monitoring wildlife, and because of the importance wolves have for restructuring the Yellowstone ecosystem (e.g., trophic cascade) making wolves a centerpiece for many other research efforts (Smith et al. 2003). Also, the wolf-elk controversy is predicted to escalate in the future so sound data through radio tracking will continue, post delisting, to be extremely important (Smith et al. in press).

In accordance with YNP objectives, we are also actively pursuing alternative, less intrusive technology in the form of Global Positioning System (GPS) radio collars that rely on satellites rather than overflights. To date, 6 wolves have been collared with GPS collars, so it is unknown at this time the level of overflight reduction possible. Preliminary results indicate that it is unlikely that GPS collars will replace VHF technology, but the technique does hold promise. Therefore, we plan to continue this effort in the future.

Aerial darting will be used to capture wolves for collaring (Mech 1974; Wolf Capture Plan 2001). Leghold trapping will be used only in special circumstances and approved on a case-by-case basis. Once captured the animal will be processed according to a standard protocol (Appendix I; also see Wolf Capture Plan 2001). Processing of each captured wolf will include: 1) collaring; 2) drawing blood; 3) weight and body measurements; 4) sexing; 5) general condition evaluation; and 6) age determination (pup, yearling, adult) and color (gray or black). (See Wolf Capture Plan 2001 for details).

When possible, wolves will be aged as pups (1 to 12 months), yearlings (12 to 24 months) or adults (> 24 months). Aging yearlings can be difficult in which case wolves will be aged as pup or adult. The ages of many of the animals that are born in the ecosystem will often be known exactly because of ease of identifying pups and knowledge about the habits of their natal pack. Ages for animals that are less well known can be sometimes estimated from the air (Peterson and Page 1988, R.O. Peterson personal communication) and by inspection of teeth during processing that follows capture (Mech 1970, Landon et al. 1998). Sex of individuals will be determined if captured or possibly by direct observation of sex-specific behaviors (e.g., courtship and scent marking behavior; R.O. Peterson personal communication).

Most capture work has been completed in January and February when the snow is deepest and wolves are easier to spot and catch. Some early season (December) captures have occurred because of seasonal migration of the prey causing wolves to leave the park into Wilderness areas where helicopter capture of wolves is prohibited. We will continue to primarily capture wolves in January and February when visitation is less, thereby reducing visitor impacts. Situations may arise, however, when capture during other winter months will be necessary.

Since 1998, when formal capture and collaring of wolves began in YNP, we have made 229 captures averaging 25.4/year. Only two mortalities resulted from these capture efforts, and one may not be due to capture, although this is unknown (the wolf was killed by other wolves the day after capture/handling and assumed to not be fully recovered from the drug). The other mortality was due to a dart injury, which caused us to switch to powder charges of lower impact decreasing the likelihood of injury to the wolf. We have had no injuries since this change was made.

Pups are the most frequent age class captured due to naïveté to the technique; after being captured one time, wolves quickly learn to avoid the helicopter and extra effort is needed to capture them. Average weight by age class for wolves captured has been gradually declining since capture efforts began (Figure 2).

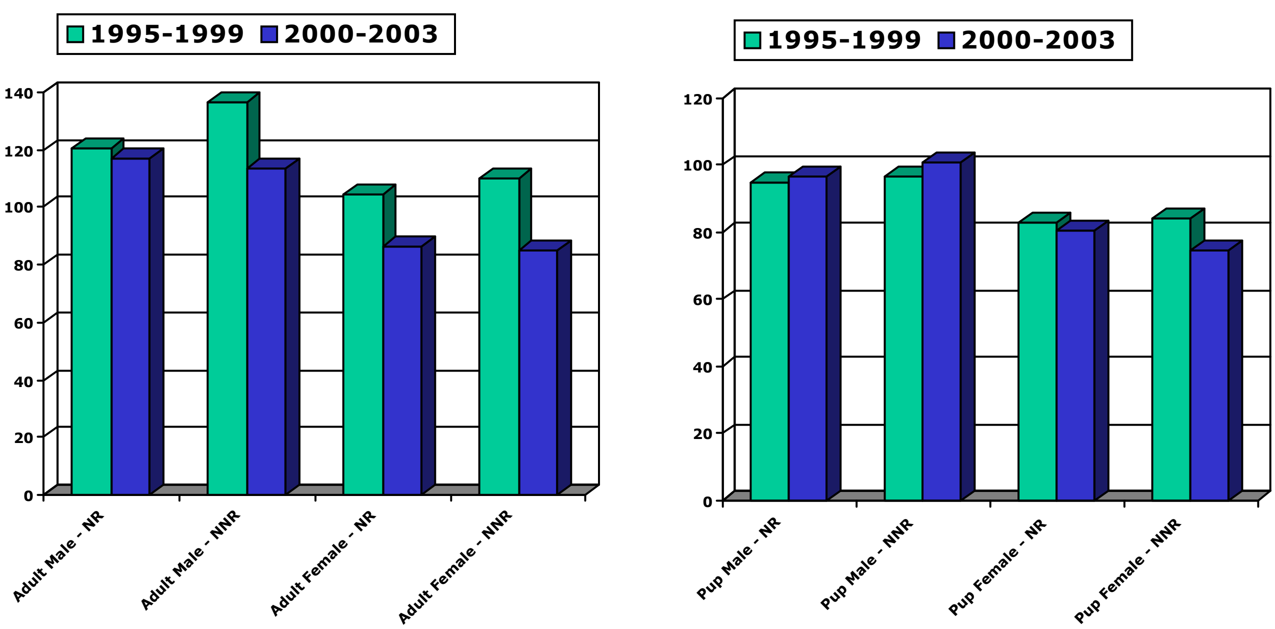


Figure 2. Yellowstone Northern Range and Non-Northern Range average winter wolf weights (lbs) by age class and sex, 1995-2003.

Population Dynamics

Wolves have successfully reoccupied the GYA (Figure 3). After release in YNP, wolves have dispersed and settled much of the public land in and around the park. Currently (December 2002), 273 wolves in 31 packs occupy the GYA, 148 wolves in 14 packs occupy YNP (Tables 2 & 3). Monitoring of all GYA packs in not the responsibility of YNP staff, as the USFWS outside YNP also monitors wolves.

Thirty breeding pairs with an equitable distribution throughout the three recovery areas (GYA, northwestern Montana, and central Idaho) for three successive years is the goal for delisting (USFWS 1994, E. Bangs, personal communication). As defined under the criteria for delisting, a "breeding pair " is an adult male and female who survive with at least two pups-of-the-year until December 31, and can include only one pair per alpha male (USFWS 1994). This is a stringent definition of a pack; probably the most stringent for any management plan and requires intensive monitoring. For example, in Idaho in 2002, >50% of the packs were not counted toward delisting because it was not known based on this definition if the wolf pack qualified as a breeding pair (USFWS et al. 2003).

Figure 3. 2002 Greater Yellowstone Area Wolf Pack Territories.

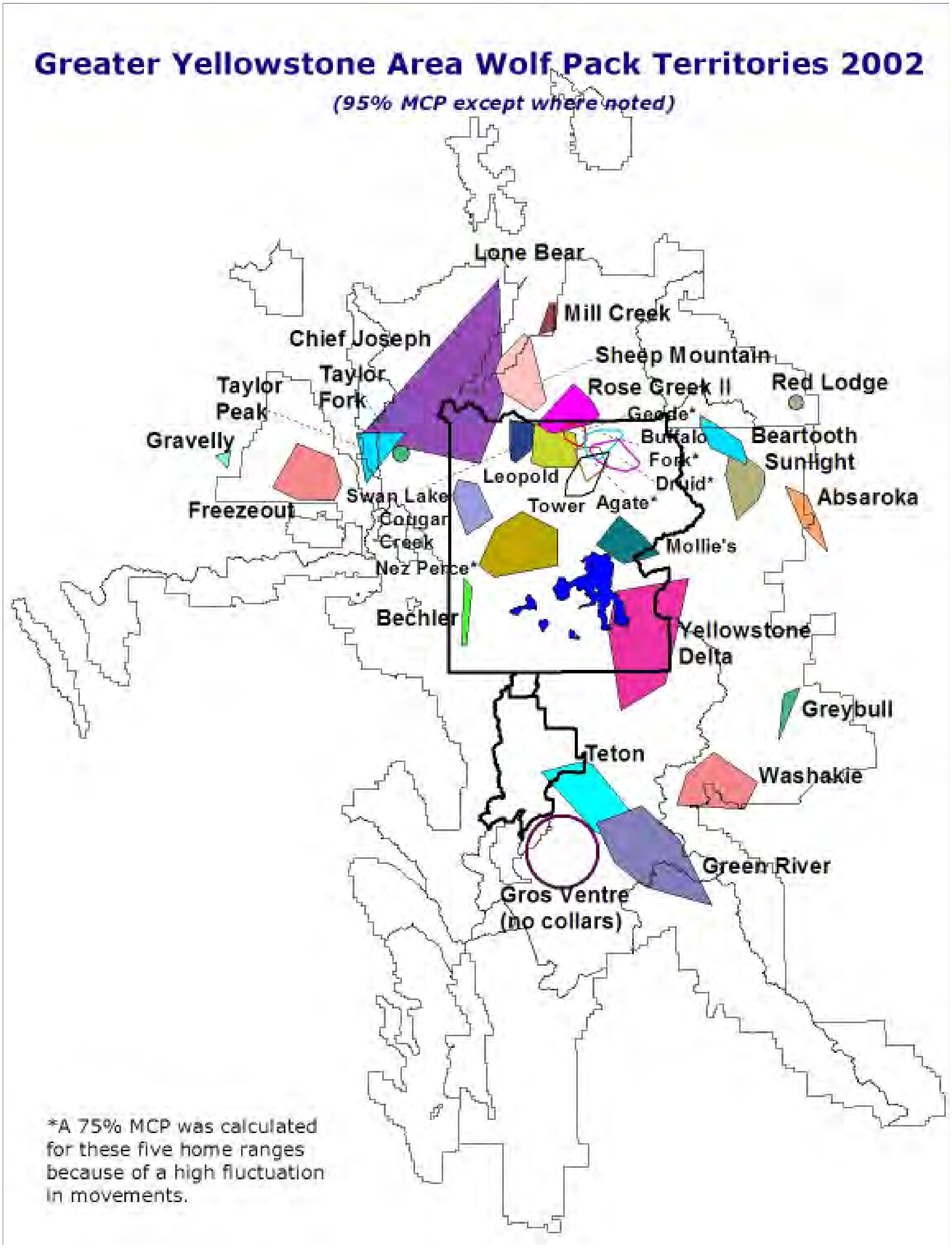


Table 2. 2002 Summary of the wolf population in Yellowstone National Park.

PACK	ADULTS/ YEARLING	PUPS	TOTAL EST. PACK SIZE	BREEDING PAIR? (YES/NO)	NO. OF LITTERS	GENERAL LOCATION
AGATE CREEK	6	4	10	YES	2	AGATE TO ANTELOPE CREEKS, YNP
BECHLER GROUP	2	2	4	YES	1	BECHLER REGION, YNP
CHIEF JOSEPH	2	8	10	YES	1	W/NW YELLOWSTONE NATIONAL PARK
COUGAR CREEK	5	5	10	YES	1	WESTERN YELLOWSTONE NATIONAL PARK
DRUID PEAK	8	3	11	YES	2	LAMAR VALLEY TO HELLROARING CREEK, YNP
GEODE CREEK	6	3	9	YES	1	GEODE CREEK, YNP
LEOPOLD	8	8	16	YES	1	BLACKTAIL PLATEAU TO MT EVERTS, YNP
MOLLIE'S	10	2	12	YES	1	PELICAN VALLEY, YNP
NEZ PERCE	15?[1]	3?[1]	20[1]	YES	1	CENTRAL YNP
ROSE CREEK II	7	3	10	YES	1	HELLROARING CRK TO CREVICE CRK, YNP
SLOUGH CREEK GROUP	4	0	4	NO	0	SLOUGH CREEK, YNP
SWAN LAKE	5	11	16	YES	1	GARDNER'S HOLE/SWAN LAKE FLAT AREA, YNP
TOWER	2	0	2	NO	0	TOWER AREA, YNP
YELLOWSTONE DELTA	10	4	14	YES	1	THOROFARE REGION, YNP
14 Packs	90	56-58?	148	12	14	

[1]Adult and yearling count is estimated; pup count is at least 3; total pack size is accurate.

Table 3. 2002 Summary of wolf the population in the Greater Yellowstone Area, excluding Yellowstone National Park.

Pack	Adults & Yearlings	Pups	Total	Breeding Pair?
Teton	3	11	14	Yes
Gros Ventre	3	0	3	No
Washakie	10	5	15	Yes
Sunlight Basin	8	4	12	Yes
Absaroka	6	3	9	Yes
Beartooth	4	3	7	Yes
Greybull River	4	3	7	Yes
Green River	2	0	2	No
Taylor Peak	2	2	4	Yes
Taylor Fork	2	0	2	No
Freezeout	?	?	9	Yes
Gravelly	0	0	0	No
Mill Creek	4	3	7	Yes
Sheep Mountain	6	?	6	No
Red Lodge	?	?	5	No
Lone Bear	4	2+	11	Yes
Spanish Peaks	?	1+	5	No
Loners/Others	6		6	No
Total	64+	37+	124+	10

Demographic parameters being monitored that relate to the above recovery goals include: number of breeding pairs, pack size, pup counts, mortality (including cause of death), survival, reproductive success, and age structure. Intimate knowledge of wolf movements from our population monitoring will greatly facilitate management actions (Fritts et al. 1984, Fritts 1992; Bangs 1994; Niemeyer et al. 1994, Bangs et al. 1998, Smith et al. 1999). Wolves that leave Yellowstone will be monitored so data are available on dispersal and colonization. Wolf population restoration throughout the northern Rockies depends on dispersal to connect the populations so they can operate as a metapopulation (USFWS 1994). Yellowstone is more isolated from the other two recovery areas making data on immigration and emigration vital to management decisions. Much of this effort will need to be interagency because of the very large areas over which wolves can disperse.

Aerial surveys from fixed-wing aircraft (Supercub PA-18) of radio-collared wolves will be the primary technique for determining 1) wolf survival, mortality, immigration, and emigration; 2) location of dens, rendezvous sites, and pup numbers; 3) pack structure, spatial organization, and territory size; and 4) seasonal food habits (Mech 1974, 1983, Peterson et al. 1984, Fuller 1989; Figure 4). Wolf-killed ungulates discovered during population monitoring will be inspected opportunistically in order to document patterns of prey selectivity by species, age, sex, and condition (see Predator-Prey section below). Throughout most of the year, telemetry flights will occur approximately every week. Population data will be recorded on a data form (Appendix II) designed to document individual wolf and pack locations, pack size, missing individuals, mortality signals, den and rendezvous sites, pup counts, wolf kills, and behavioral interactions with other species (Appendix III). In addition, ground-based telemetry and visual observations from project staff will be used to supplement and confirm data collected aerially for the population parameters previously described.

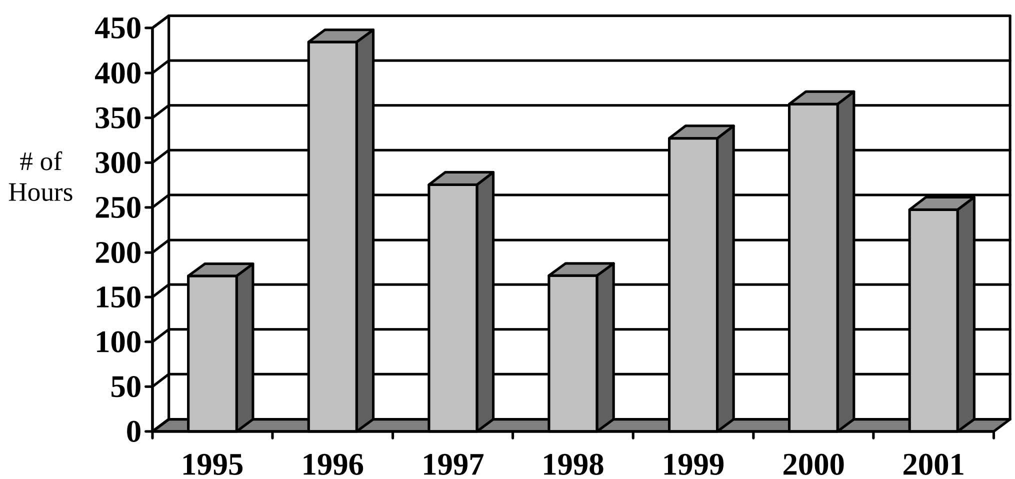


Figure 4. Yellowstone Wolf Project hours flown per year to moniter wolves 1995 - 2001 (does not include ferry time).

The wolf population will be monitored for mortality rates and causes. Keith (1983) and Fuller (1989) concluded that an annual mortality >30% usually resulted in a wolf population decline. A serious decline could require management intervention (USFWS 1994b). Causes of mortality for radio-collared wolves will be determined to

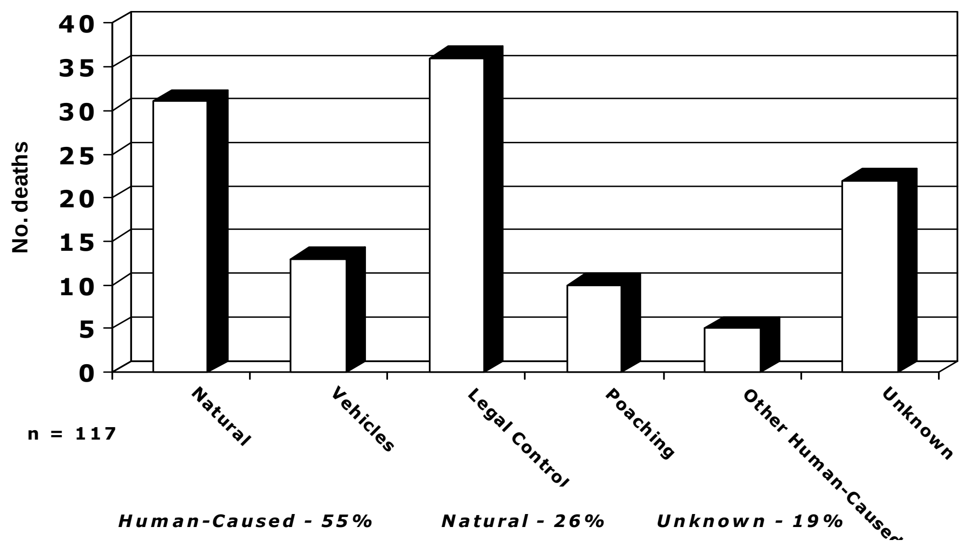


Figure 5. Causes of death for wolves in the GYA, 1995 – 2002.

better understand the ecological and socio-political parameters influencing wolf population dynamics in the GYA. To date, causes of mortality for radio-collared wolves in the GYA are attributed largely to humans (Figure 5). Currently, an interagency effort, led by YNP, is underway looking at wolf survival in the northern Rockies from 1982-2002.

Motion sensitive radio-collars will be a primary technique for detecting mortality. When a telemetry signal from a particular wolf is in mortality mode (a pulse twice the rate of an active transmitter), the collar will be located to determine if the wolf is dead or the collar has slipped. Upon discovering a dead wolf, project staff will examine the carcass and field site, and law enforcement personnel from USFWS or NPS will be notified and/or accompany project staff into the field. If cause of death can be absolutely or reasonably determined as not attributed to illegal activity, then project staff will conduct necropsies -- both pre- and post-delisting. When possible, the skull and hide of dead wolves will be collected by project staff for research or interpretive purposes, or they otherwise will be left in the field. Under suspicion of illegal activity, the site will be investigated by law enforcement personnel and necropsies will be performed by the USFWS Forensics Laboratory in Ashland, Oregon or the Montana Fish, Wildlife, and Parks laboratory in Bozeman, Montana, as will be the case when mortality is unknown, based on field examination.

If an individual wolf cannot be located for several flights, a search within and surrounding YNP will be conducted in an attempt to locate the missing individual.

Reports from reliable sources (i.e., local, federal, and state agencies, etc.) and unsolicited sightings reported by the general public may be used as "leads" to locate lost wolves. After that, lost frequencies will be monitored during routine flights to determine if the animal returns (Fuller 1989) and by interagency tracking efforts outside YNP. If the missing wolf is not located again within the next year, it will be considered to have an unknown fate and routine monitoring for that animal will decrease and occur only during interagency high altitude flights.

Using data gathered through our routine population monitoring protocol, we will estimate the total wolf population size for a specified area (e.g. GYA, YNP, Northern Range YNP;Figure 6) by summing individuals for all packs and known lone wolves. The number will be converted to wolves/1000km2, a standard measure of wolf population density (Fuller 1989). The overall population size will be determined for a given year after completing early winter study (Nov-Dec.), as increased aerial and ground monitoring during this time more accurately identifies pack size/composition.

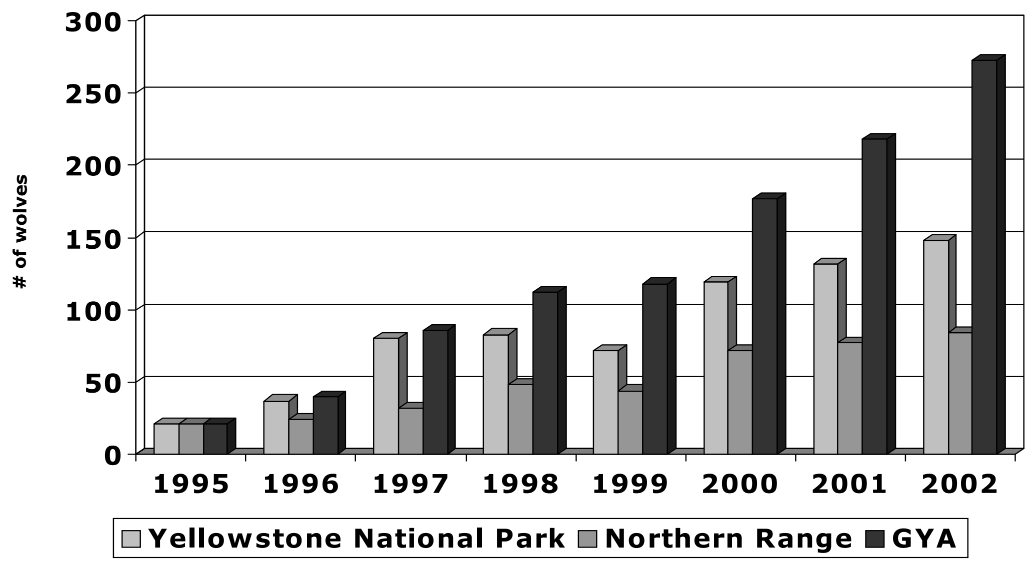


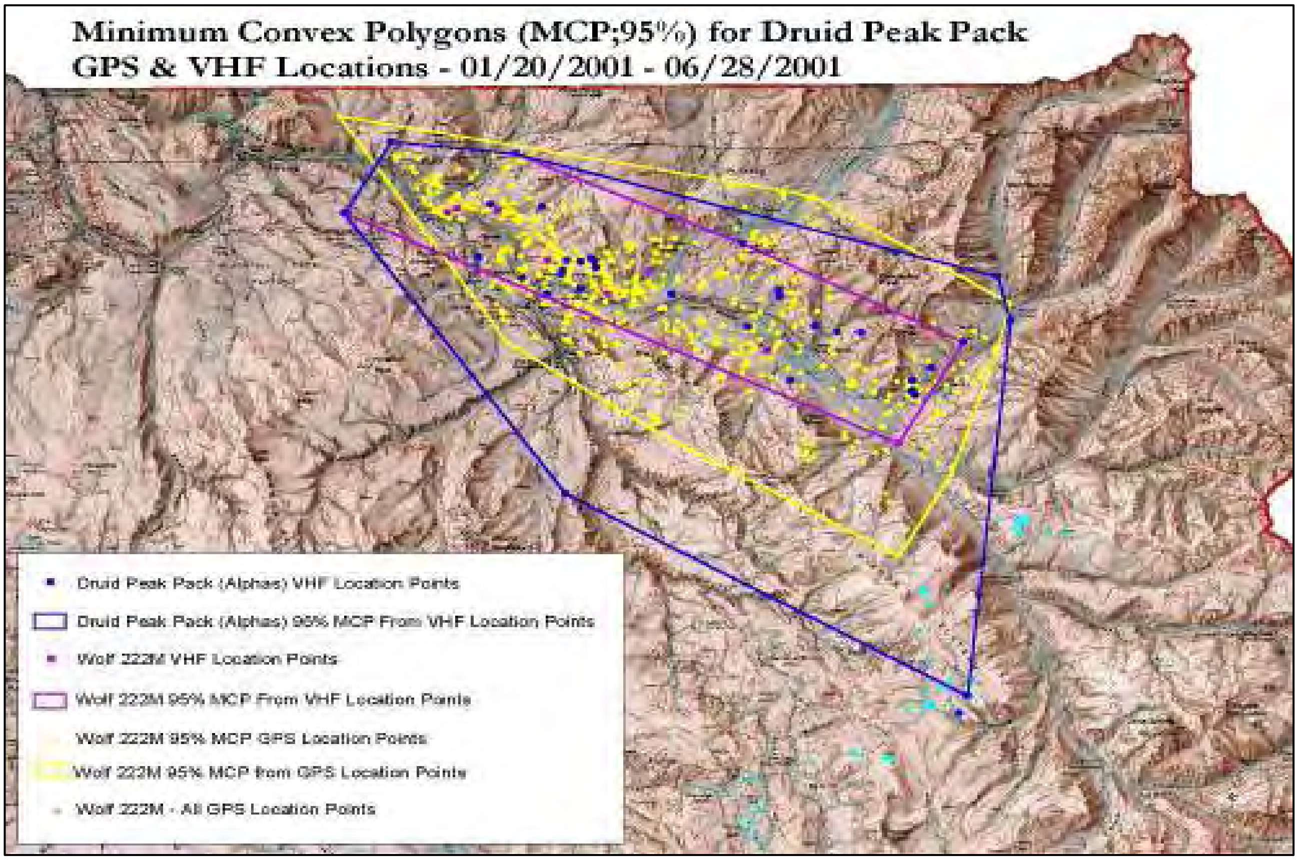
Figure 6. Greater Yellowstone area wolf population, 1995 – 2002.

In addition to a total population count, reproductive success can be determined by counting pups at den sites, and aerially observing wolves in fall and early winter when pups are smaller and distinguishable from adult wolves to determine survival rates for pups reaching maturity (Peterson 1977; see Den Study Section).

Data on the aforementioned parameters will be used to compute rate of growth for the population. A "leveling off" of population growth will be one indicator of a saturated wolf population, which is a population level of interest when studying wolf-prey relationships (Van Ballenberghe and Ballard 1994, Messier et al. 1995). In the eighth year of YNP wolf recovery, population trends based on the demographic parameters show population stabilization within the park and expansion outside.

Data will be organized according to two seasons: 1) whelping and pup-rearing lasting from April 1 to September 30, and 2) winter lasting from October 1 to March 31. These periods roughly correspond to changes in pack cohesiveness due to the reproductive cycle (Fuller 1989). Movement data will be used to determine wolf pack territory sizes and seasonal fluctuations. Universal Transverse Mercator (UTM) coordinates recorded from aerial locations (NAD 83) will be the basis for generating territory maps, documenting movement patterns, den and rendezvous sites, and kill sites. Ground locations using UTM's (NAD27) will supplement aerial locations on an opportunistic basis (Appendix IV), but cannot be a substitute for aerial locations because territory maps derived from only ground locations are biased (Fuller and Snow 1988). Wolf pack territories will be calculated by the minimum convex polygon (MCP) method (Odum and Kuenzler 1955) or with a kernel estimator (Worton 1989) depending on the number of locations. For accurate determination of wolf territory size, past research has identified a minimum of 30 locations for MCP (Fuller and Snow 1988). Hence, it becomes essential for seasonal analyses of wolf territory size that telemetry flights occur at least once a week. Other wolf studies have adopted a similar standard (Mech, Fuller, Peterson, personal communication). Wolf territory maps will be produced by project staff using ArcView GIS and used to analyze changes in population expansion, territorial shifts and overlap, and habitat use. Such maps will also be used for management, peer-reviewed publications, internal documents, and presentations. Seasonal territory maps are important because wolf use changes by season and is related to ungulate distribution and density. Territory size is small and shrinks when prey are abundant (Fuller 1989), and seasonal shifts in territory size and use will be indicative of ungulate movements (Ballard et al. 1987, Heard and Williams 1992, Carbyn et al. 1993).

With increased use of GPS collars that store data on board, as well as those that can be downloaded remotely, more accurate wolf movement and activity data can be determined without relying on aerial locations. GPS collars currently deployed are recording 8-12 locations per 24 hours (Figure 7). We will also use GPS technology to examine wolf kill rates seasonally (e.g., summer kill rates, elk calf mortality) by investigating clustered locations for evidence of kills, as well as document interactions with other carnivores (See Wolf and Carnivore Interactions Section). However, location data collected by GPS collars cannot provide important information on pack size, pup counts, prey selection, or behavioral interactions, thus the need to continue aerial and ground based monitoring.



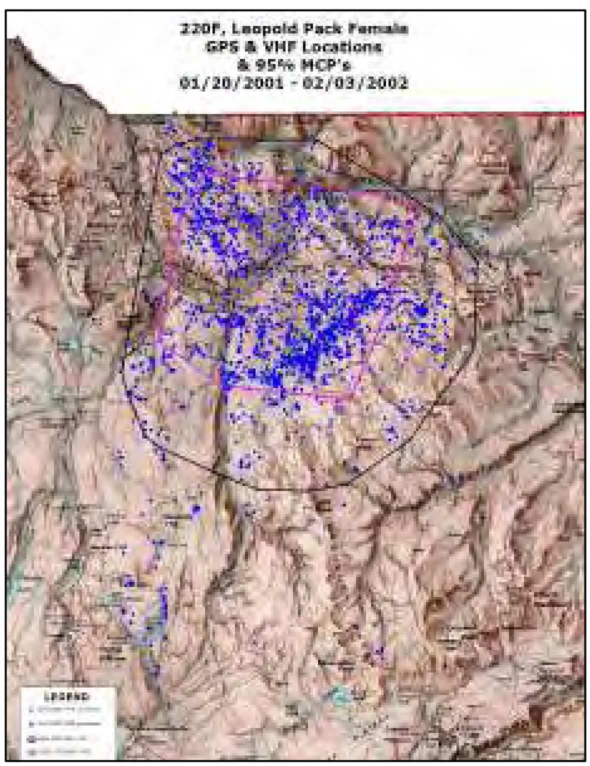


Figure 7. Radio locations of a wolf from the Druid Peak (2001) and Leopold (2001-

2002) packs comparing locations derived from GPS (locations via satellite) versus VHF (locations via fixed-wing aircraft) radio collars.

Predator and Prey Relationships

The 1995 restoration of wolves to YNP aroused considerable public concern and scientific debate regarding the potential impacts of wolves on the Park's ungulate populations, particularly the renowned Northern Yellowstone elk herd (Lemke et al. 1998). The relationship between wolves and their prey in YNP will likely be an ecosystem-altering event. The recent surge in research by both park staff and outside researchers attests to the significance of this relationship. Besides ecological research, wolf-prey interactions generate much public controversy (Smith et al. 2003) and will probably always do so. This controversy has bearings on interagency and political relationships. Issues of accountability have been raised.

To understand this important aspect of restoration, data on the number, species, and condition of wolf-killed ungulates is a requirement, as well as information on how often wolves make a kill (e.g., kill rate; Fuller and Keith 1980, Messier et al. 1995, Smith et al. 2003, Smith et al, in press). Besides wolf-prey interactions, documenting what wolves eat, and how often, is a good indirect measure of the well being (through documentation of wolf demographics) of the wolf population (kg/wolf/day; Peterson et al. 1984, Ballard et al. 1987, Van Ballenberghe and Ballard 1994).

Estimation of wolf kill rate is an imperfect science. During our winter studies (see section below), when we have a ground and aerial crews searching for kills, we developed a double-count technique to determine the error in our kill rate estimates (Eberhardt and Simmons 1987, Smith et al., in press). Using this method we determined that wolves killed at a higher rate in late winter, compared to early winter (Smith et al., in press; Figure 8). We also found a high degree of variability one year to the next.

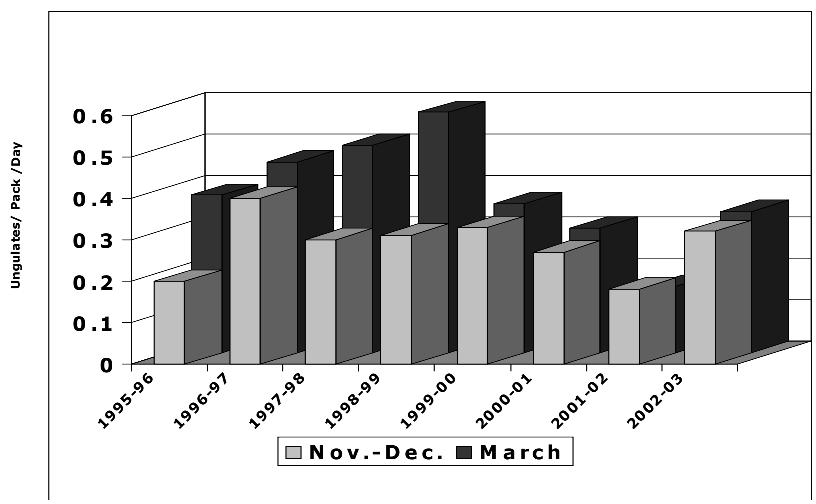


Figure 8. Kill rates (ungulates/pack/day) in early (Nov 15-Dec 14) and late (Mar) for wolves occupying the northern range 1995 – 2003. Rate is a minimum estimate or represents actual kills found.

During hard winters (e.g. 1996-1997), kill rates were elevated above other years, during mild winters (e.g.1999-2000) kill rate did not differ between early and late winter (Figure 8).

Monitoring kill rate through time will be an important indicator of wolf impacts on elk. As part of the preparation of the first wolf monitoring plan, Smith surveyed wolf biologists across North America asking them what they thought were the most important data to obtain on the newly reintroduced wolves. A majority of respondents said information on wolf kill rate through time (e.g., numerical and functional response of wolves). Continuing to monitor this parameter is a cornerstone of wolf studies in YNP.

In the future, we intend to expand our measures of wolf kill rate throughout the year without increasing flight frequency. We are currently involved with two such efforts. The first is to develop an index measuring wolf kill rate in non-winter study months. We plan to have this new method ready to test by the winter of 2003-2004. Also, during the summer of 2003, we are using GPS collars in a pilot study to estimate kill rates at that time of year.

Besides kill rate, prey selection has important bearing on wolf-prey interactions. Numerous predator-prey studies have examined the kinds of prey taken by wolves (Mech 1966, Peterson 1977, Nelson and Mech 1981, Peterson et al. 1984, Van Ballenberghe 1987, Gasaway et al. 1992, Huggard 1993a,b, Weaver 1994). Some studies have indicated prey selectivity (wolves select and kill vulnerable prey; Murie 1944, Mech 1966, Mech et al. 1971, Peterson 1977, Fritts and Mech 1981, Nelson and Mech 1981, Peterson et al. 1984, Boyd et al. 1994) while others have not (wolves kill both vulnerable and healthy prey; Bergerud et al. 1983, Gasaway et al. 1983, Bergerud and Ballard 1988). Some studies on prey selectivity have made a distinction between established and colonizing wolf populations suggesting a difference in the kinds of prey taken (Boyd et al. 1994). What and how often will wolves kill, for example, during the initial stages of recovery (colonizing population) versus later on (saturated population) are important data for analyzing wolf welfare and wolf/ungulate relationships.

Thus far wolves in YNP have relied primarily on elk (Figure 9). Bison, deer, and moose have been killed as well, but only during particular times of the year (bison in late winter), or at certain locations (moose in Thorofare), and none of these prey categories any year exceed 2% of the wolf take (Smith et al. in press). For elk, wolves are selecting calves (40% of the wolf take compared to 16% of the population) and older cows (against prime aged cows), and proportional to availability for bulls (Figure 10).

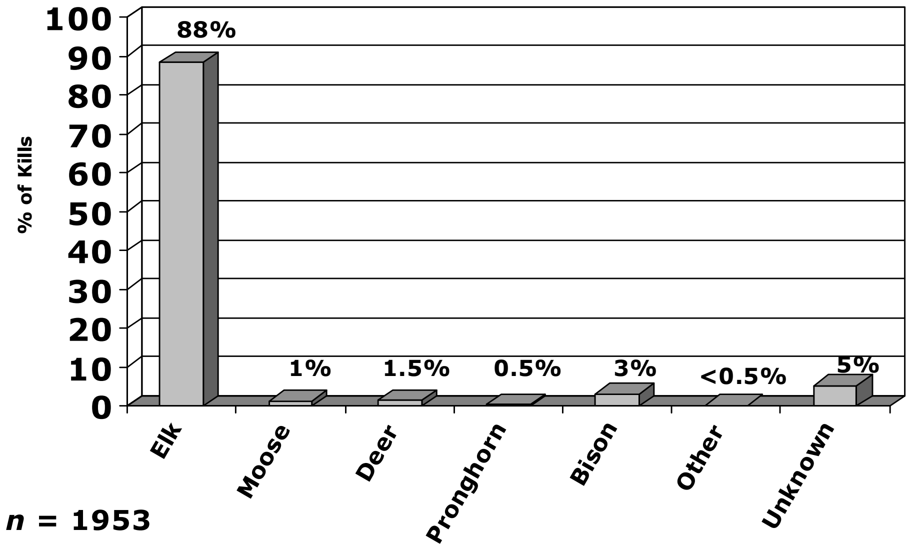
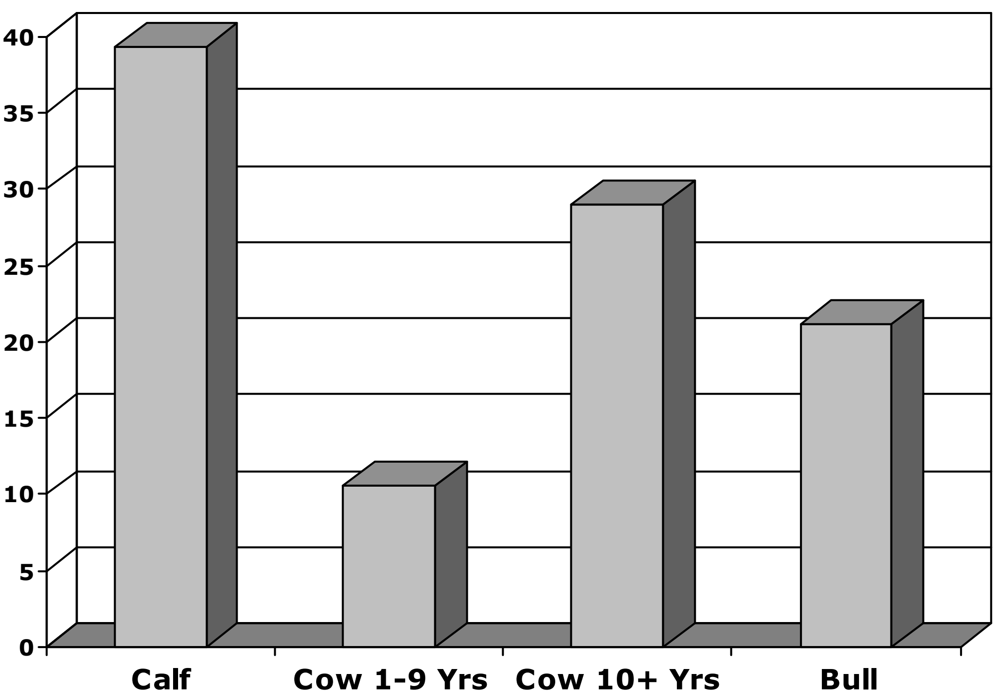


Figure 9. Prey killed by wolves in YNP 1995-2002.



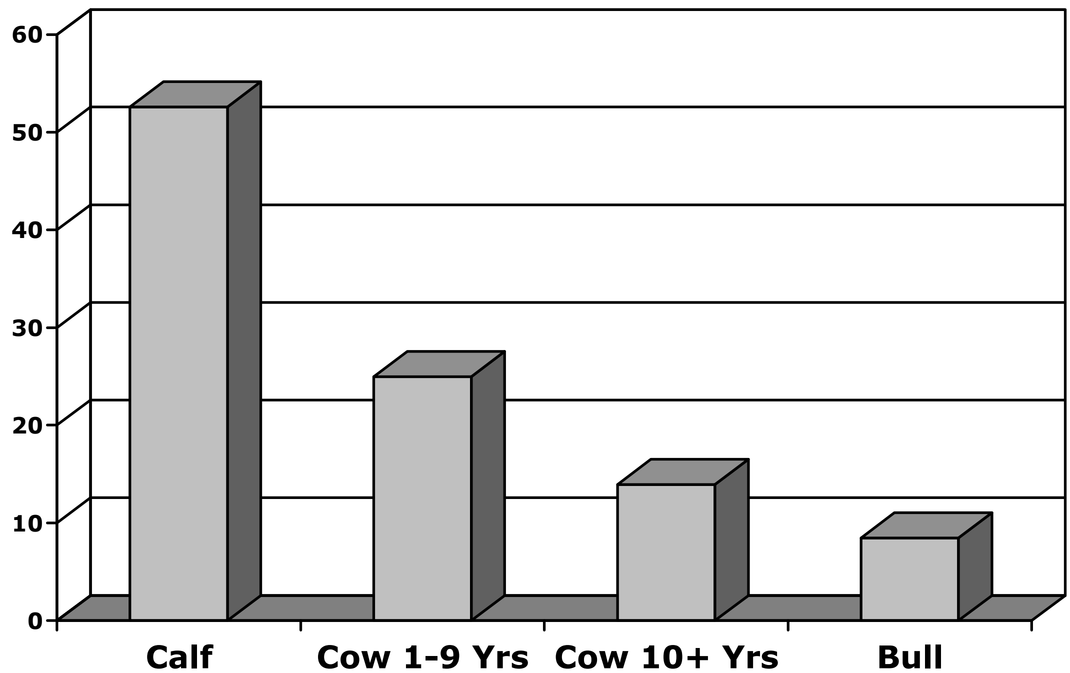


Figure 10. Age Class of wolf-killed elk on Yellowstone's northern range (1st graph) & non-northern range (2nd graph), 1995-2002.

The above data gathered on wolf kill rate and prey selection will be necessary to evaluate wolf-prey relationships, and provide data for collaborative relationships with other researchers interested in Yellowstone ecosystem studies. Once collected, these data can be used to calculate the numerical and functional response of wolves, two widely studied and modeled aspects of wolf-prey interactions. Also, wolf impacts on prey will probably vary depending on ungulate density and their population relative to carrying capacity. Whether or not wolf predation is compensatory or additive will depend on synergism between wolf and elk studies in YNP (Kunkel et al.1999). Without data on wolf killing, none of these relationships can be elucidated. Without data on summer kill rates, any data collected on elk calf mortality will be less valuable as it will be only part of the story. We detail below the strategy for gathering these vital data.

Winter Study

The idea of "winter study" was first conceived by biologists investigating wolf predation on Isle Royale in Lake Superior in 1958 (Mech 1966, Allen 1979). The study consisted of an annual winter monitoring period where the daily movements and activities of wolves were closely followed to reveal particular aspects of wolf predation on moose; namely kill rate, prey selection, and prey availability. The purpose of winter study was to develop an understanding of the factors that influence wolf-moose interactions. To this day, the winter study remains the principle method by which biologists monitor and study the long-term fluctuations in predator-prey dynamics on Isle Royale.

The Yellowstone Wolf Project instituted its own winter study program beginning in November 1995, modeled after Isle Royale, and studies of wolves in the Brooks Range of Alaska, which used the 30-day period sampling period that we selected as well (Dale et al. 1994). Sustaining a winter-long effort is not feasible (but see Jaffe 2001 and Garrott et al. 2003), so we selected early and late winter to examine kill rates when elk were in good compared to poor condition, which has been shown to be a significant factor affecting wolf kill rates (Peterson 1977).

The primary objective of Winter Study was to study wolf predation, but because the wolves are visible for hundreds of hours each winter study (Figure 11), other objectives were developed. Data on activity, movements, behavior, and interactions with other species are also gathered (Appendix V). Specifically, we want to document the frequency at which wolves kill and the kinds of prey killed (Appendix VI).

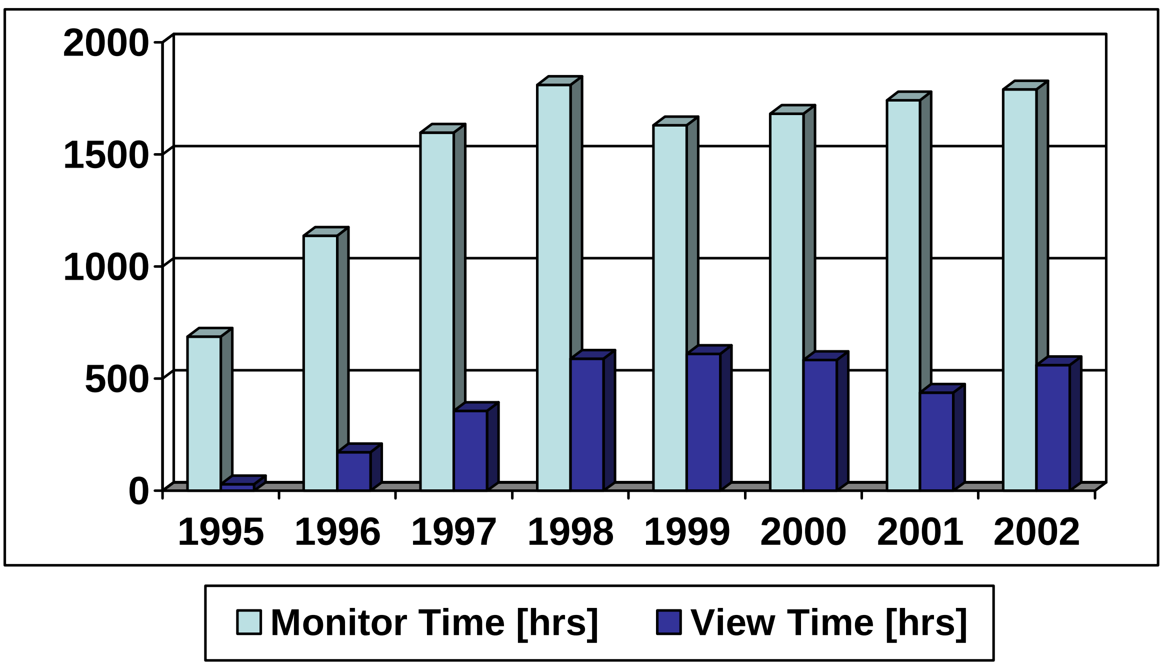


Figure 11. Monitor time and time in view of wolves in Yellowstone, 1995-2002.

Inherent in studying wolf predation, is understanding a multitude of factors that influence both kill rate and prey selection. These factors include season, prey density, winter severity, wolf demographics (pack size, density, etc), and inter- and intraspecific interactions (interference competition). Because Winter Study provides an unprecedented opportunity to observe wolf behavior, we are able to study how wolf-prey interactions (e.g. wolf hunting behavior and killing technique) and wolf-carnivore-scavenger interactions (e.g. kleptoparasitism and competition) affect predator-prey ecology and ecosystem dynamics (Appendix VII) .

Finally, to fully understand wolf predation, it is necessary to assess the quality and quantity of prey available to wolves. In an effort to address this critical question the winter study has incorporated air and ground ungulate surveys to count and classify prey available to wolves (Appendix VIII).

The focus of Winter Study is park-wide. On the northern range and in the Madison-Firehole, ground crews will operate. Across the rest of YNP, only aircraft will monitor wolf packs, except in Pelican Valley where a ground crew is stationed during March. R. Garrott at Montana State University is responsible for the ground crews in the Madison-Firehole (Jaffe 2001, Garrott et al. 2003). A data sharing agreement is in place to facilitate the exchange of information and biological samples.

The overall design of winter study is based on 30-day monitoring periods twice a year in early (mid-November to mid-December) and late winter (March; except in the Madison-Firehole where sampling occurs from November through April; Jaffe 2001). The study is conducted during winter to take advantage of snow cover as an aid in detection of kills, as summer kill rates have yet to be empirically documented anywhere in North America. In addition, an increase in ungulate vulnerability from early to late winter provides an opportunity to observe any changes due to winter severity (Farnes 1991, Garrott et al. 2003).

Volunteer field crews are used as staff and receive intensive training prior to each study period (see Yellowstone Wolf Project Winter Study Handbook for more details and information on safety issues). Wolves are ground-monitored every day from dawn to dusk for the entire 30-day period by the volunteers. Weather permitting, an air crew independently determines kill rate to assess error via a double count method (Eberhardt and Simmons 1987, Smith et al. in press).

The specific Winter Study objectives are: 1) document kill rate; 2) record the sex, age, condition, and utilization of every ungulate killed by wolves during a study period; 3) record the length of time wolves spend at a carcass from the time they make the kill to the time they abandon it; 4) record the movements and activities of wolf packs between known kills; 5) record the amount of time spent monitoring wolves and the amount of time wolves were in view; 6) record wolf-wildlife interactions; 7) record who leads (alpha or non-alpha) a pack while traveling, chasing, or killing; 8) record the number, sex, and age of elk and other ungulates in assigned count units; and 9) record data on number and behavior of scavengers utilizing wolf-killed carcasses. Overall, our goal is produce the most accurate picture of wolf predation and behavior as possible during this 30-day period. Following in the footsteps of Isle Royale's long-term predator-prey research, the Yellowstone Wolf Project's Winter Study program already has made significant and original gains in understanding these complex relationships (Smith et al., in press and see Winter Study Handbook for details on objectives and methods).

Weather and Snow Conditions

Wolf/ungulate relationships are strongly affected by short and long-term weather conditions; primarily snow (Mech et al. 1971, Peterson and Allen 1974, Peterson 1977, Gasaway et al. 1983, Mech et al. 1987, Jedrzejewski et al. 1992, Messier 1995, Garrott et al. 2003). Snow depth can affect the ungulates' ability to escape predators, limit their access to forage, and increase the energy expended to forage (Peterson 1977, Nelson and Mech 1981, Huggard 1993c, Garrott et al. 2003). Snow density and crusting also affect predator-prey relationships; wolves are lighter and have broader feet than most of their ungulate prey, which allows for easier maneuvering over snow (Nasimovich 1955, Peterson 1977) while ungulates are burdened by breaking through the crust (Peterson 1977). Hence, wolf-prey relationships are influenced by snow depth and the length of time deep snow (belly-deep on the animal) prevails (Mech et al. 1987, Peterson 1977, Gasaway et al. 1983). In order to evaluate YNP wolf-ungulate relationships in response to weather, Farnes' (1991) index of winter severity for ungulates will be used in evaluating wolf/prey interactions. Standard descriptive statistics (mean, standard deviation, range) will be computed for all weather and snow conditions. Correlation coefficients will be computed for weather parameters versus wolf killing rates, distance each pack travels per day, kill utilization, and prey selectivity (age, sex, condition, species). Relationships between snow parameters and wolf killing rates and travel (see above) will also be estimated with multiple-linear regression. Snow water equivalents (SWE) have also been found to be important indicator of ungulate survival in the Madison-Firehole (R. Garrott, personal communication) and will be used in addition to, and possibly as an alternative to Farnes' index.

Summer Study

Documenting the predatory habits of wolves in summer is problematic (Peterson 1977, James 1983, Ballard et al. 1987). Aerial backtracking to kills is not possible because of a lack of snow and because vegetation conceals evidence of kills on the ground (Mech 1970, Fuller 1989, Peterson 1977). A pilot study in September, using techniques similar to wintertime, but for just one pack, found only 1 wolf kill in 30 days (Ruth et al. in press) when typically >10 kills are found for the same time period in winter. Also, in summer wolf pack cohesiveness is less, packs operate as individuals and sub-units because prey size are smaller and more easily handled by one/few wolves, therefore making tracking of all the seperate groups difficult. This problem has yet to be solved by wolf researchers.

Preliminary data indicate that some kills will be observed while watching dens and rendezvous sites. Traditionally, the best data concerning wolf summer food habits have come from analysis of the contents of scats collected at den and rendezvous sites. Through the use of remote-downloading GPS collars, however, more detailed studies of summer predation patterns and prey selectivity are possible. Using this new technology, GPS location data can be remotely downloaded from the collar on a regular basis while still on the animal. Using spatial and temporal location analysis, probable kill sites can be identified from clustered points, which can then be investigated to determine if a wolf kill is present and what the species, age, and sex of the prey animal was. Combining field observations of wolf predation in summer, which was successfully done in summer 2002, with downloadable GPS location data can substantially improve our understanding of summer predation and prey selection.

Similar to Winter Study, the specific objectives of Summer Study are to: 1) document kill rate; 2) record the species, sex, age, condition, and utilization of every ungulate killed by wolves during a study period; 3) record the length of time wolves spent at a carcass from the time they make the kill to the time they abandon it; 4) record the movements and activities of wolf packs between known kills and den sites; 5) record wolf-wildlife interactions; 6) record data on number and behavior of scavengers utilizing wolf-killed carcasses.

Another way wolf food habits can be examined is by collecting wolf scats (Voight et al. 1976, Floyd et al. 1978, Weaver 1993). Scats collected so far in YNP show a different pattern in food consumption compared to winter. The influx of mule deer from winter range in summer is mirrored in wolf scat collections, from virtually no use of mule deer in winter to summer scats that indicate an increase of about 25% (Figure 12).

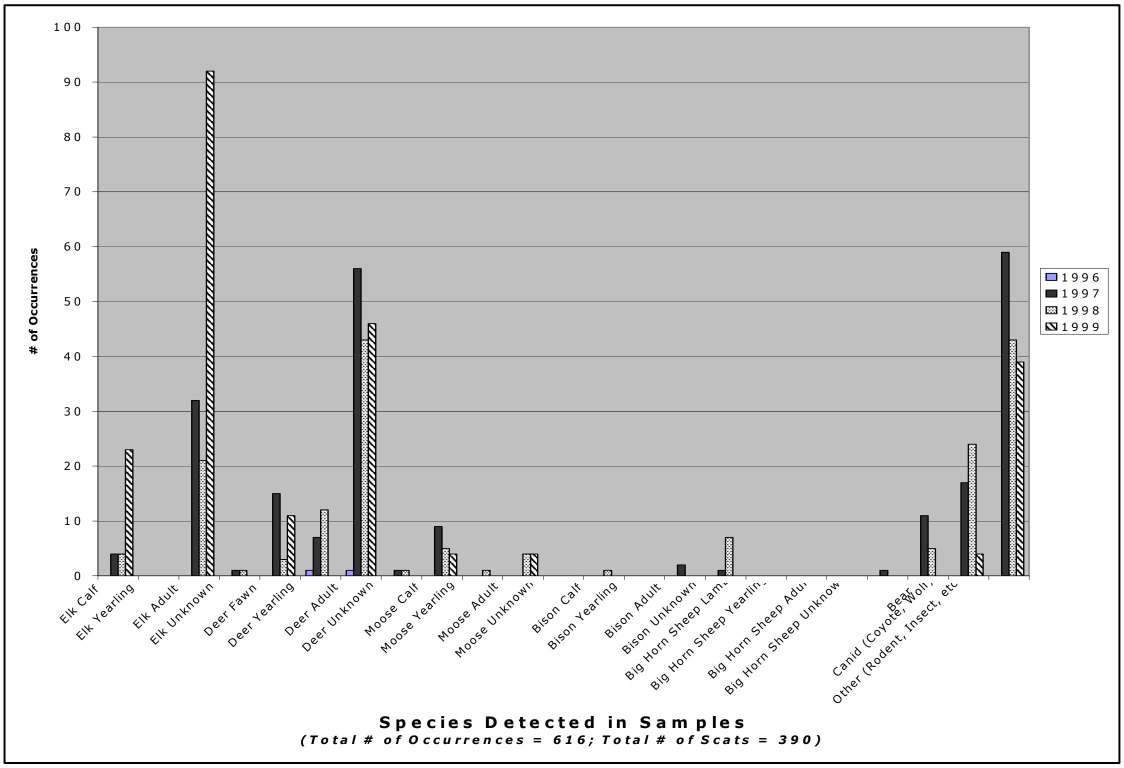


Figure 12. Prey occurence (% of total) found in wolf scats that were gathered in summer (May-Aug) at wolf dens and rendezvous sites 1996-1999.

Scats will be collected primarily at den and rendezvous sites to avoid misidentification as coyote scats (Weaver and Fritts 1979). All wolf scats that are found will be collected and organized by collection date, known or estimated drop date, and location (Van Ballenberghe et al. 1975, Voight et al. 1976; Appendix IX). When the specific origin of a scat is uncertain, size will be used to differentiate between wolves and coyotes (Weaver and Fritts 1979). Genetic markers may be used to identify scats to individual wolves (Sands et al. in press). Prey remains in the scats will be identified by comparing with known material. If necessary, hair in the scat will be examined microscopically (Weaver 1993). Biomass and relative numbers of prey consumed will be estimated according to standard procedures (Floyd et al. 1978, Kelly 1991, Weaver 1993).

Genetics and Disease

Besides population monitoring through radio collars, advancing technologies are allowing population monitoring using genetic samples (Taberlet et al. 2001). Currently, those techniques for wolves still involve capturing them. Nonetheless, we intend to use these techniques as another population monitoring tool as familial and population relationships can be determined without radio collars.

Using this method, baseline genetic profiles for all reintroduced and captured wolves will be established. These profiles will allow determination of the relatedness among wolves (Lehman et al. 1992), reproductive performance of individual animals, and develop population estimation procedures possibly for future use (e.g., scat sampling for genetic material). This final objective may promote the evolution of the monitoring program from reliance on relatively invasive and intensive field techniques (e.g. live capture and radio-tracking) to more passive field techniques (e.g. howling surveys and passive recovery of individual specific genetic samples).

Thus far, genetic sampling has been used to create a wolf pedigree and determine maternity and paternity for wolf packs where multiple litters have occurred. This work documented for the first time wolf pups breeding in the wild (Murphy et al., submitted Journal of Mammalogy). In addition these techniques represent another way to document exchange between Yellowstone and the other wolf recovery areas through matching of genotypes to specific wolf populations.

Besides genetic material (whole blood), all wolves captured will be sampled for various diseases (blood serum; Johnson 1992, Johnson et al. 1994). The purpose of disease monitoring will be to identify the presence of diseases that may impede the restoration process or population viability (i.e. canine parvovirus, distemper, and mange), to provide insight into the ecology and health of wolves (i.e. brucellosis, plague, etc.), and to monitor for diseases contagious to humans (i.e. Echinococcus). Samples collected from live animals for disease monitoring will be blood, external parasites, and fecal samples. Serum samples will be tested for canine parvovirus, canine distemper, infectious canine hepatitis, leptospirosis, brucellosis, and plague (Braend and Roed 1987). Some serum will be banked for future needs. External parasites will be keyed to species. Fecal samples will be examined for internal parasites, including Echinococcus sp. Some fecal samples will be frozen and stored for future needs.

Genetic and other samples will be taken from dead wolves as part of this objecvtive. All of these sample collections are consistent with the disease monitoring protocols of the USFWS wolf reintroduction program (Johnson 1995) and the disease-monitoring program for western gray wolves.

Wolf and Carnivore Relationships

The reintroduction of wolves into YNP has provided an opportunity to examine interactions among a full suite of carnivores and their prey. Preliminary evidence from concurrent field studies focusing on the park's large carnivores (wolves, cougars, grizzly bears, and black bears) already suggest that these interactions have significant effects on carnivore community structure, population dynamics, and prey population impacts. We have documented so far two grizzly bear cubs that were probably killed by wolves, and with T. Ruth, 4 cougar kittens and one adult female cougar killed by wolves. Cougars have probably killed two wolves. Collaboration with interdepartmental (Bear

Management, Ungulate Project, Bison Management) and interagency (Interagency Grizzly Bear Study Team, Montana Fish, Wildlife, and Parks) researchers have already been productive in pursuing science-based questions on multi-carnivore relationships. The use of new technologies such as GPS telemetry collars, will advance our ability to understand the carnivore community and its interactions, as well as their impact on prey populations.

One such project has already been completed and been submitted for publication (Ruth et al. in press) that involved daily VHF monitoring before and after the human hunting season north of YNP. Currently both cougars and wolves are instrumented with GPS collars with grizzly and black bears scheduled to be collared in the summer of 2003. These GPS collars will operate on similar schedules so landscape use of the four carnivores together can be understood. We expect to expand and continue this program in the future.

Den Study

During spring and summer, den and rendezvous sites will be monitored to document pup production and survival, den site attendance by yearlings and adults, food provisioning of pups, and other behaviors associated with pup rearing. Some of YNP wolves den in open locations that can be observed from safe distances, providing a unique opportunity to observe denning behavior. Most other den studies on wild wolf populations have occurred in areas of heavy forest cover making observation difficult (Harrington et al. 1983). Directed and opportunistic monitoring of den sites from distances (e.g. 1.5 to 2.5 km) that will eliminate "observer affect" will be begin when alpha females show affinity to dens, usually early to mid-April. Both ground-based observers using spotting scopes and hand-held telemetry, and remote-operating telemetry systems, will be used for continuous den monitoring. Den observations will continue as pups mature and the packs begin to utilize rendezvous sites. Monitoring den and rendezvous sites will allow determination of pup production and survival, parental and alloparental care (Thurston 2002), interactions with other wildlife species, and other poorly understood aspects of wolf natural history like pseudopregnancy (Harrington et al. 1983, Heard and Williams 1992, Mech et al. 1995).

Thurston (2002) was able to successfully monitor wolf dens in YNP in the above described fashion in 1997 and 1998. Remote telemetry, which does not require the observer to be on site, was used to monitor dens from 1997 through 2002.

Wolf and Scavenger Relationships

An important aspect to trophic cascade research as it relates to wolf restoration is the effect on scavenger guilds in the Yellowstone ecosystem. Research on wolf and scavenger interactions will be conducted in order to determine the population and community-level outcomes that wolves and scavenger species have on one other. This research will monitor how wolves influence the abundance and distribution of carrion, both spatially and temporally, as well as how they facilitate food acquisition by other carnivores.

Since 1997, the Wolf Project, in collaboration with other researchers, have conducted a study called "Food for the Masses," a broad scaled effort designed to quantify the diversity and abundance of species utilizing wolf kills (Wilmers et al. 2003a, 2003b). Prior to wolf reintroduction, carrion availability was primarily a function of winter severity (Crabtree and Sheldon 1999), with specifically high snow levels and cold temperatures causing elk to weaken and die usually at the end of winter (Gese et al. 1996). Since wolf reintroduction, however, most scavenging appears to occur at wolf kill-sites on a year-round basis. By changing the distribution and abundance of carrion availability, wolves facilitate the acquisition of carrion by other carnivore species, which is crucial to the growth and fitness of many Yellowstone species (Wilmers et al. 2003a, 2003b). The primary scavengers in Yellowstone are, in order of dominance, grizzly bear, coyote, golden eagle, bald eagle, raven and magpie. It has been demonstrated in YNP that wolves mediate the flow of carrion subsidy to scavengers by controlling the timing and quantity of carcasses (Wilmers et al. 2003a), and in doing so, this carrion subsidy contributes significantly to the biodiversity of the region (Wilmers et al. 2003b). In a short time, members of the scavenger guild have adopted behavioral strategies to successfully kleptoparasitize wolf kills, such as ravens following wolves to locate their kills (Stahler et al. 2002a), and grizzly bears adopting a similar strategy (Yell. Wolf Project, unpubl. data). Baseline studies have now been completed on the ecological and behavioral effects of wolves on scavengers (Stahler et al 2002a, Wilmers and Stahler 2002, Wilmers et al. 2003b) which will provide a platform to extend wolf and scavenger research and the changes that may occur through time.

Specifically, we will continue to monitor wolf-killed carcasses to document: 1) numbers of individuals and species feeding 2) species feeding rates to calculate biomass consumption rates; and 3) behavioral interactions at and away from carcasses (Appendix VII). In addition, we will help facilitate research on additional aspects of wolf and scavengers, such as summer scavenging rates and carrion insect communities. Collaboration with other biologists looking at other predator-scavenger relationships will allow us to understand important scavenger community dynamics system-wide.

SUMMARY AND CONCLUSIONS

Our general approach is to build on the foundation of the program already established. Based on other wolf studies, the slowness of ecosystem change, and the controversy wolves generate, a long-term wolf monitoring effort will be required. Therefore, we will continue routine gathering of data for decades. Other studies, of shorter duration, will augment long-term monitoring as funding and opportunity allow.

The primary objectives of the Yellowstone Wolf Project are to monitor wolf population dynamics and predator-prey relationships. Population monitoring is important because the legal mandate to delist wolves depends on a minimum population size for each recovery area. Currently, delisting does not appear to be probable in the near future. The other project priority is to monitor predator-prey relationships due to their importance in ecosystem restructuring. Also, wolf predation is a controversial topic to the public and information on this relationship will help defray volatile management issues.

Secondary objectives are to monitor wolf diseases and genetics. Monitoring of disease is important because should it become a major mortality cause, management action may be necessary. Genetic monitoring will determine breeding relationships and genetic diversity of wolves in the system, but is also another way to determine connectivity between the three recovery areas. This is important because the GYA is isolated, and adequate interchange is an important issue to the recovery process including reclassification and delisting (USFWS 1994). A GYA wolf pedigree also has law enforcement implications as it can determine the identity and origin of a wolf under investigation. Wolf-carnivore relationships are also considered a secondary objective of this plan because of their importance to management (the GYA has a large number of carnivores in the system which warrant study and management attention) and play into ecosystem change possibly triggered by wolf reintroduction.

Tertiary objectives are to study wolf behavior and interactions with scavengers. Because wolves are so visible in YNP direct observation has yielded important not-before-documented information about wolves. Den study and observation during all times of the year, especially Winter Study will be used to achieve these objectives. Wolf-kills, which are also visible, are small-scale eco-centers for animals that depend on scavenging for a living. Species and interactions at carcasses can also be directly observed and data gathered.

The primary method used to achieve these objectives will be following wolves via radio telemetry. Both VHF and GPS radio collars will be used, but the program will rely more on VHF collars because of their cheaper cost (VHF = $350; GPS = $3,000) and longevity (VHF = 5 years; GPS = 1 year). Most radio tracking will be done aerially and augmented by ground tracking, especially when direct observation of wolves is required. Attachment of radio collars will be accomplished through winter helicopter darting (see Wolf Capture Plan) and specially approved leghold trapping operations. Two 30-day studies in early and late winter will be the primary method of documenting predator-prey relationships, but a winter-long predation index is in development and a summer predation study is in the pilot project phase.

An overview of our annual work schedule is summarized in Table 4. Many of the activities are not listed as they fall under a major project activity. For example, disease and genetic samples are obtained while handling wolves during wolf capture and therefore are not specifically mentioned in the annual work plan. Detailed information on protocols for handling wolves, Druid Peak pack road management, wolf habituation, and safety are dealt with in detailed fashion in other plans. We did not specifically discuss statistical analyses because they are complex, change, and are specific to the project.

Table 4. Yellowstone Wolf Project Annual Work Schedule, Fiscal Year.

Oct	Nov-Dec	Jan-Feb	Mar	Apr	May
• Data Analysis • Writing • Winter Study Preparation • GPS Retrieval	• Interagency Wolf Meeting • Winter Study Training • Winter Study • Early Wolf Capture • Scavenger Study • Bone Boiling from wolf kill samples	• Wolf Capture [VHF &GPS collars] • Annual Report Preparation • Scavenger Study • Winter Study Training • Bone Boiling from wolf kill samples • Winter Study analysis • Compile yearly population estimates • Compile yearly home range data and map	• Winter Study • Scavenger Study • Bone Boiling from wolf kill samples	• Den Study • Annual Report Edits/Final • Interagency Wolf Conference • Bone marrow fat analysis • Cementum aging of teeth from wolf kills • Scat sample analysis	• Den Study • Training Talks for Summer Staff • Druid Road Mgmt • Winter Study analysis

Jun	Jul	Aug	Sep
• Summer Predation Study [GPS Downloads] • Den Visits/Scat Collection • Data Analysis • Writing • Scavenger Study • Druid Road Mgmt	• Summer Predation Study • Den Visits/Scat Collection • Data Analysis • Writing • Scavenger Study • Druid Road Mgmt	• Summer Predation Study • Den Visits/Scat Collection • Data Analysis • Writing • Scavenger Study • Druid Road Mgmt	• Den Visits/Scat Collection • Outfitter Outreach • Data Analysis • Writing

*Other responsibilities scheduled throughout the year:

- Weekly population/monitoring flights [outside of winter study periods]
- One professional scientific meeting – date unknown
- 50-60 talks requested from Wolf Project personnel per year
- Database management – continuous
- Retrieval of wolf carcasses and/or collars

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Appendix I. Yellowstone Wolf Project Capture Form.

❐ Entered in Capture Database
❐ Entered in Morphometrics Database

YELLOWSTONE WOLF CAPTURE FORM

path: x:\wolf\admin\data forms\processing & handling\New Capture Form.doc

updated: 2/05/2001

Wolf #____________ Radio Freq _______________ Sex M F Age_______Date Captured

Time

Recapture *(circle one)*? Yes No Relocated to different site? Yes No Relocation Livestock Related?

Yes No

If capture management related, re-released same site? Yes No UTM __________________\

NAD 27 (topo map) or NAD 83 Northern Range *(circle one)*?: Yes No Pack

Capture Location ____ Pelt Color

Capture Method (circle): a) helicopter dart b) helicopter net-gun c) trap d) net on ground (pen)

e) other

Capture Personnel ____ Place PIT Tag Label Here ▶ [ ]

HANDLING INFORMATION

Record your steps in the handling process, including drugs administered, all times of significant events, wolf responses and behavior, and behavior of wolf while it recovers including times.

Time	Drug	Drug Amt (mg)	How Injected[1]	Temp (F)	Pulse (min)	Resp
________	______________	______________	_____________	________	_________	_____
________	______________	______________	_____________	________	_________	_____
________	______________	______________	_____________	________	_________	_____
________	______________	______________	_____________	________	_________	_____
________	______________	______________	_____________	________	_________	_____
________	______________	______________	_____________	________	_________	_____
________	______________	______________	_____________	________	_________	_____
________	______________	______________	_____________	________	_________	_____
________	______________	______________	_____________	________	_________	_____

HANDLING CHECKLIST

Put an "X" in the space as each item has been completed. Also record appropriate numbers as requested.

__ Place animal on side with head slightly uphill __ Check breathing _ Be sure airway is clear

__ Check mouth carefully for wedged-in sticks __ Check capillary refill time __ Apply eye ointment

__ Put on blindfold __ Clean and treat any wounds __ Penicillin (1ml per 15 lb, subQ)

__ Radio collar attached __ Radio sig. verified (Radio freq # _______) __Radio serial #

__ PIT tag inserted __ PIT tag signal verified (PIT tag # _________) ___Place PIT tag on data form

MEASUREMENTS

[1]Method injected can include: Dartgun, Tel-inject, blowgun, pole syringe, hand syringe.

See figure on back; note letters refer to some measurements. Specify units (i.e. - cm preferred, but note if inches), and specify which side (right or left) of wolf is being measured.

General body condition (circle): poor good excellent

Weight __________ Body length (A) ______________cm Tail length (B) ____________cm Total length (A+B) ___________cm

Front foot length (C) _____________cm Width (D) ________________cm Neck girth ____________cm

Shoulder height[2] (E) ________cm Chest girth __________cm Pelt color + markings

Testicle length____________mm Width _____________mm Inguinal Teat length __________mm Width mm

If female - lactating? Y N Old injuries? Y N

TEETH

General condition (note broken or chipped teeth, staining, and wear):

Canines: UL ______mm UR ______mm LL ______mm LR ______mm

Circle Broken Canines: UL UR LL LR

If yes, circle which canines are broken: UL UR LL LR Top Incisor Wear (circle): None Light Moderate Severe

Upper Carnassial Wear (circle): None Capped Cusps Pitted Cusps Pitted Cusps + Valleys Heavy Wear

All Dentition Wear (circle): None Light Moderate Severe

Other dentition wear + staining: ____ Deciduous teeth present? Y N

Age _______years Age Class (check one): pup ____ yearling ____ adult

Age justification[3]

BLOOD

Ideally 4 samples each of both the red and purple top tubes should be collected. Rock purple tops 10 times each. Place blood in cooler. Centrifuge red tops same day as collected.

_____ # of purple top tubes collected _____ # of red top tubes collected

COLLECTIONS

Feces: ___________________________________ Hair:

RECOVERY

Move wolf to a shady, level spot cleared of debris that is at least 50 yards from any water or roads.

COMMENTS

____

____

____

[2]Measure shoulder height from top of scapula to leading edge of middle toe pad with leg straight.

[3]Justify age class by describing tooth wear, staining of teeth, and description of reproductive structures - be complete.

Appendix II. Yellowstone Wolf Project Telemetry Flight Form.

Obs _______________ Date ___/___/______ CC ____ PC ____ LP ___ TE ____ Flight
Start _________ Stop _________ Duration ______hrs Total ______hrs

Pack/ Wolf	Age	Color	Freq	Time	Easting	Northing	Vis	Act[2]	Loc[3]	Location & Comments *(e.g.-other wolves or prey present, kills, etc.)*
Wolves to Scan										
208M Tower	6-7 yrs	black								
210M Leopold	3 yrs	black								
215M Nez Perce	3 yrs	gray								
216F Druid	3 yrs	black								
241M Sheep Mtn	2 yrs	gray								
242F Sheep Mtn	2 yrs	gray								
248M Chief Joe	2 yrs	gray								
249M Nez Perce	3 yrs	gray								
260F Rose	2 yrs	black								
262M Mollie's	2 yrs	black								
301M 255F Grp	2 yrs	black								
Swan Lake *(about 14 wolves)*										
152F	5 yrs	gray								
204M	5 yrs	gray								
205M	3 yrs	gray								
206M	5-6 yrs	gray								
292M GPS	2 yrs	gray								
293F	1 yr	gray								
Leopold *(about 13 wolves)*										
209F	3 yrs	black								
220F	3 yrs	gray								
259F	3 yrs	black								
287M	2 yrs	black								

288F	2 yrs	gray								
289M GPS	2 yrs	black								
290F	1 yr	gray								
302M	3 yrs	black								
Pack/	Age	Color	Freq	Time	Easting	Northing	Vis	Act[2]	Loc[3]	Location & Comments
Wolf										*(e.g.-other wolves or prey present, kills, etc.)*
Rose Creek II *(about 8 wolves)*										
018F	8 yrs	black								NOT COLLARED; MISSING
150M	5 yrs	gray								
190F	4 yrs	black								
207M	4 yrs	black								
Geode Creek *(about 6 wolves)*										
106F	6 yrs	gray								
300M GPS	4-5 yrs	black								
Agate Creek *(about 8 wolves)*										
103F	6 yrs	black								
113M [out?]	adult	gray								
295M	1 yr	gray								
251F	3 yrs	black								
Buffalo Fork *(about 4 wolves)*										
105F	6 yrs	black								
Slough Creek *(about 5 wolves) [*Possibly 217F from Druid]*										
261M	2 yrs	gray								
217FB*	2 yrs	gray								
Druid Peak *(about 9 wolves)*										
021M [out]	8 yrs	black								
042F	8 yrs	black								
253M	3 yrs	black								

255F	2 yrs	black								
286F GPS	2 yrs	black								
Mollie's *(about 8 wolves)*										
174F	5 yrs	gray								
193M	6 yrs	black								
194M [out]	6 yrs	black								
Yellowstone Delta *(about 16 wolves)*										
044F [weak]	7 yrs	black								
126F	6 yrs	black								
226M [out]	3 yrs	gray								
243M	adult	black								
276M [Washakie]	adult	black								
225M	3 yrs	gray								
227M	3 yrs	gray								
244M	adult	gray								
245M	2 yrs	black								
246M	2 yrs	gray								
247M	2 yrs	gray								
Bechler *(about 4 wolves)*										
192M	6 yrs	gray								
Nez Perce *(about 14 wolves)*										
048F [out?]	7 yrs	gray								
070M	7 yrs	gray								
072M	7 yrs	gray								
213F	3 yrs	gray								
214M*	3 yrs	gray								
215M	3 yrs	gray								
249M	3 yrs	gray								

305M	1 yr	gray								
306F	1 yr	gray								
Cougar Creek *(about 10 wolves)*										
151F	5-6 yrs	gray								
257M	4 yrs	gray								
291M	1 yr	gray								
303M	5-6 yrs	black								
304M	4-5 yrs	black								
256M	4-5 yrs	black								
258M	3 yrs	black								
Chief Joseph *(about 10 wolves)*										
248M	2 yrs	gray								
Sheep Mountain *(about 6 wolves)*										
219M	3 yrs	gray								
Pack/	Age	Color	Freq	Time	Easting	Northing	Vis	Act[2]	Loc[3]	Location & Comments
Wolf										*(e.g.-other wolves or prey present, kills, etc.)*
Mill Creek *(about 3-5 wolves)*										
271F	adult	gray								
Lone Bear *(about 5 wolves)*										
283F	1 yr	gray								
284F	1 yr	gray								
285M	1-2 yrs	gray								
Other Wolves										
005F Crystal	adult	gray								PROABLY DEAD
033F Chief Joe										WOLF DEAD; COLLAR MISSING; CHECK FREQUENCY
055M Leopold	7 yrs	gray								
065F Sawtooth	7 yrs	gray								
104M Druid	6 yrs	black								
136F Crystal	6 yrs	black								COLLAR OUT

217F Druid	3 yrs?	gray								
222M Druid	3 yrs	gray								
223F Druid	3 yrs	gray								
Red Lodge [No Collars] *(about 2? wolves)*										
Sunlight Basin *(about 9-12 wolves)*										
041F	8 yrs	black								
052M	7 yrs	black								
231M	4 yrs	black								
263M	3 yrs	black								
Beartooth *(about 6 wolves)*										
009F [out]	adult	black								PROBABLY DEAD
077F	6 yrs	black								
Absaroka *(about 8 wolves)*										
153F	5 yrs	black								
164M	5 yrs	black								
236M	3 yrs	black								
240M	2 yrs	black								
280M	1 yr	black								
Gros Ventre [No Collars] *(about 3-4 wolves)*										
Pack/	Age	Color	Freq	Time	Easting	Northing	Vis	Act[2]	Loc[3]	Location & Comments
Wolf										*(e.g.-other wolves or prey present, kills, etc.)*
029M	8 yrs	gray								
Green River *(about ? wolves)*										
162M	5 yrs	gray								
237F	3 yrs	black								
Teton *(about 12 wolves)*										
200F [old # 137F]	4 yrs	black								
228F	4 yrs	black								
267M	2 yrs	black								

268F	2 yrs	black								
269M	2 yrs	gray								
270M	2 yrs	gray								
278F	2 yrs	black								
279F	1 yr	black								
Washakie *(about 5-7 wolves)*										
147M	6 yrs	gray								
233F	adult	black								
239M	2 yrs	black								
276M	adult	black								CURRENTLY WITH YELLOWSTONE DELTA PACK
282M	adult	black								
Greybull River *(about ? wolves)*										
274M [ID # B-58]	adult	gray								
275M	adult	gray								
Taylor Peak *(about 3 wolves)*										
198F	5 yrs	gray								
281M	1 yr	gray								
Centennial [old Taylor *Fork* pack] *(about ? wolves)*										
234M	adult	gray								
299M	1 yr	gray								
Freezeout *(about 6 wolves)*										
115F	5 yrs	gray								
161M	5 yrs	gray								
235M	2 yrs	gray								

Appendix III. Wolf Den & Rendezvous Physical Charactieristics Data Form.

WOLF DEN/RENDEZVOUS
PHYSICAL CHARACTERISTICS
path: x:\wolf\admin\data forms\den study\Wolf Den Physical Characteristics Data FormII.doc

(circle one)
OFFICIAL DEN/REND. NAME: ____DATE: ___/____/_______

IS DEN 1st, 2nd, 3rd,ETC. USED FOR YEAR (circle one): 1ST 2ND 3RD 4TH UNKNOWN

PACK: __________________________________ BREEDING FEMALE (if known): __________________

LOCATION: ____

EST. DATES USED: ______________ TO _______________ ELEVATION: ____________________ FT

DEN TYPE DESCRIPTION (tree, rock, hillside excavation, etc.): ____

UTM: EASTING: ______________ NORTHING: __________________ UTM SYSTEM: ________________
(NAD 27 = MAP; NAD 83 = AIRPLANE)

SCATS: NO. OF PUP SCATS: _______________________________ NO. OF ADULT SCATS: _____________________
EST. AGE OF PUP SCATS: __________________________ EST. AGE OF ADULT SCATS: ________________

FOOD OR OTHER REMAINS: ____

MACRORELIEF: ____

MICRORELIEF: ____

PERCENT SLOPE: _____________ ASPECT: __________________WIND EXPOSURE: from N S E or W
(e.g.-south-facing)

DEN ENTRANCE(S): DEN NO.: ____HT:__________cm WDTH:________cm EST. DEPTH: ___________cm
(SKETCH DIMENSIONS ON GRID PAPER)

DISTANCE TO WATER: ______________METERS WATER TYPE (pond, creek, etc.): __________________

VIEW FROM DEN: ________________________

TRAIL DESCRIPTIONS: ____________________DISTANCE FROM PAVED ROAD?: _________METERS

SOIL: TEXTURE: ___________________ FRIABILITY: _______________ PARENT MATERIAL: ________________
ROOT PENET.: ________________ MOISTURE: _________________ COLOR: ____________________________
ACTIVE FROST ZONE: ______________ DRY OR WET FROST: ________________
SLUMPLING?: _____________________ COLLECT SOIL SAMPLE? Y or N

VEGETATION: GROWTH FORM: ____
PLANT COVER (%): ____
COMM. ASSOCIATION: ____
SPECIES: ____

PREY POPULATIONS KNOWN TO BE PRESENT: ____

VISITED BY (USE 1ST INTIAL AND LAST NAME): ____

(RECORD ADDITIONAL COMMENTS ON REVERSE SIDE)

Appendix IV. Ground Tracking Data From

WOLF GROUND TRACKING DATA FORM

path: x\wolf\admin\data froms\other forms\Wolf Ground Tracking Data Form.doc

Enter all wolf ID #'s in Pack; Must Include <u>SEX</u>; e.g.- 021M;007F:

Pack Name: ______________________ Year: __________________

<u>CLOUD COVER (CC)</u>
0 = CLEAR
1 = UP TO ¼
2 = ¼ TO ½
3 = ½ TO ¾
4 = ¾+

<u>PRECIPITATION (PC)</u>
0 = NONE
1 = LIGHT/INTRM RAIN
2 = CONSTANT RAIN
3 = HAIL
4 = SNOW
5 = T-STORM

<u>OBS TYPE</u>
V = VISUAL
NV = NO VISUAL
T = SNOW-TRACK

<u>ACTIVITY TYPE</u>
1 - SLEEP
2 = REST
3 = TRAVEL
4 = HUNT
5 = FEED
6 = OTHER (SPECIFY)
7 = DISPERSE*

**Indicate possible, probable or definite dispersal on back of form; also indicate other activity like rest, feed, etc. under "ACT TYP"*
***Record each wolf number – do not record nicknames or terms such as "all collars"*

Obs	Date	Time 24 hr	F °	CC	PC	WOLF ID**	General Location	UTM (NAD 27)		Obs Typ	Act Typ	Total# in Pack	# of Blacks & Grays	Mort #
								East (6 digits)	North (7 digits)					

Appendix V. Wolf-Prey Interactions Data Form, Winter Study Daily Activity Data Form, and Wolf Leadership Data Form.

Wolf hunting behavior

OBSERVATION ID[1]	
DATE	
PACK NAME	
OBSERVATION TYPE	
HUNTING BOUT NO.	
PRE-OBSERVA	
OBSERVER(S)	

HUNTING Bout[1] → OBSERVATION ID

PREY ENCOUNTER[2] → ENCOUNTER ID

CAPTURE ATTEMPT[3] → ATTEMPT ID

***HUNTING** State*[4] → STATE ID

- ***TRAVEL***
- ***APPROACH***
- ***WATCH***
- ***ATTACK***
- ***TARGET***
- ***CAPTURE***

OBSERVATION ID	
ENCOUNTER ID	
ATTEMPT ID	
STATE ID	

Encounter ID[2]								
Prey Species								
Encounter No.								
Encounter Type/Rel.								
Location								
UTM (easting/nor								
Comments								

Attempt ID[3]										
Encounter No.										
Attempt No.										
Outcome/Mort. No.										

Attempt Type/Rel.										
Previous Kill/Mort.										

State ID[4]										
Encounter No.										
Attempt No.										
State No.										
State Type										
Start Time/End Time										
Duration(secs)/Time Type										

Wolf Identity Key						Wolf Behavior																			
Ke	Rank	Sex	Age	ID#	No.	PT	IN	AP	IJ	PT	IN	AP	IJ	PT	IN	AP	IJ	PT	IN	AP	IJ	PT	IN	AP	IJ

Prey Identity Key					Prey Behavior				
G#	SG#	ID#	Age-Sex	No.	Response	Response	Response	Response	Response

Data entered into database: (initials) ________
Data in database double checked:

Appendix V Continued.
Pack: __________________Date: __________________Year: _______Obs: ____________

Winter Study – Daily Activity Summary
path: x:\wolf\admin\data forms\winter study\Daily Activity Summary.doc
(EXAMPLE DATA ON BACK)

Point/ Route	Time Start	Time End	Activity Type 1	Sleep (minutes)	Rest (minutes)	Travel (minutes)	Hunt (minutes)	Feed (minutes)	OOS (minutes)	Other 2 (minutes)
A										
B										
C										
D										
E										
F										
G										
H										
I										
J										
K										
L										
M										
N										
O										
P										
Q										
R										
S										
T										
U										
V										
W										
X										
	Total Behavior times 3									

	Total Observation time 4	

Please give a short verbal summary of the day's events:

____
____

1 Record the predominant activity of the group. For each activity, calculate the number of minutes that the group engaged in that activity and enter into the appropriate column.
2 Please specify the other activities observed. These can include behaviors such as social interactions, group ceremony, or howling.
3 Add the number of minutes in each column for each activity type.
4 Add the number of minutes in the Total Behavior Times row.

Appendix V Continued.

WOLF LEADERSHIP GROUND FORM
path: x:\wolf\admin\data forms\leadership study\ Leadership Data Form Ground Page 1.doc

Data entered into database: ________ (initials)
Data in database double checked: _______

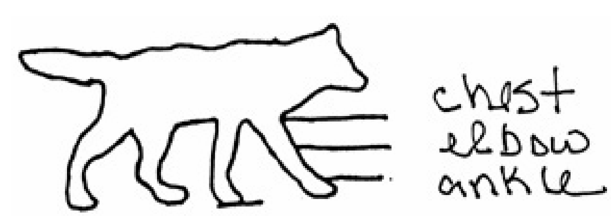
PACK _________________ OBS (Use 1st intitial and entire last name) _______________

*Leadership Bout is defined as a period of time that one wolf leads
** If you know who is First in Line, then mark either “alpha” or “non-alpha” and record identity number
*** Activity of Pack: T= Travel, CH= Chase, K= Kill

RECORD ADDITIONAL COMMENTS ON BACK

Date Winter Study Y / N	*Leadership Bout		Single File (Y/N)	**First in Line				Alpha place in line		***Activity of Pack			Group Size	Snow Conditions		1st in Line Initiate? (Yes, No, Unknown)	Non-Frontal Leadership Obs in Bout? (Yes, No, Unknown)
YEAR:	Begin Time	End Time		alpha	non-alpha	Breeder?	Wolf ID (include sex)	M	F	T	CH	K		snow depth[1]	crust[2] (Y/N)		
Example	7:45	7:55	y	X		yes	002M	1	3		X		8	E	N	yes	no

[1]Record depth of snow on wolf (see diagram) or 0 for no snow
OR
[2]Crusted is defined by wolf traveling on top of snow, usually without breaking through



Appendix VI. Winter Study Scorecard Data Form.

Winter Study Scorecard – Ground Crew
path: x:\wolf\admin\data forms\winter study\winter study scorecard ground.doc

Pack Name: ______________________________ Year: ______________ Study Period: ___________________________

REMEMBER: A kill interval begins the day following a kill and ends on the day the next kill is made.

Date	MORT #	INTRVL DAY (YES/NO)	GROUND CREW									AIR CREW					
			KILL FOUND	VIS. LOC.	RAD. LOC.	NO LOC.	NO TRY	MONITOR TIME HRS/MIN	TIME IN VIEW HRS/MIN	TRACK TIME HRS/MIN	TRACK DIST. KM	KILL FOUND	VIS. LOC.	RAD. LOC.	NO LOC.	NO TRY	NO FLGIHT

Appendix VII. Wolf-Non-Prey Interactions Data Form and Food For The Masses Data Form.

YELLOWSTONE WOLF & NON-PREY INTERACTION FORM

(Wolf and wolf, coyote, fox, cougar, eagle, raven, magpie, owl)

DO NOT FILL OUT THIS FORM IF INTERACTION IS NEUTRAL

path: x:\wolf\admin\Data Forms\Interaction forms\Wolf-Non-Prey Interaction Form.doc

- *Use Wolf-Prey Interaction Form For: Wolf & Elk, Deer, Bison, Moose, Bighorn Sheep, Mt. Goat, Pronghorn*
- *Use Wolf_Bear Interaction Form For Wolf & Bear*

Wolf and *(fill in non-prey species)*________________________________ Kill number ____ - _______ Index number________________________

Date: __________________ Time of day: ___________________ Duration of interaction: ____ hours ____min

Over what distance did interaction occur?: _______________(km/m)

Pack that Initiated Interaction: ____

Wolf ID's that Initiated Interaction: ____

General location: ____

UTM (at first point of encounter) Easting _______________ Northing__________________ NAD 27 / 83

Did interaction occur at *(circle one)* kill site den site neutral site *(specify):* _____________________

Topography *(circle one)*	Flat	Rolling Hills	Cover *(circle one)*	Upland grass	Sagebrush	Burn
	Slope	Ravine		Wet meadow	Conifer	Creek
	Ridge			Riparian brush	Aspen	Lake
					Thermal area	
Unvegetated						

Snow Depth (meters): ____________________ Temperature (F) : _________________________________

Interaction Type: *(circle all that apply)* Chase Attack Kill Play Other *(specify)*: _____________

Who initiated interaction *(circle one)*? Wolf Non-Prey [for wolf-wolf, circle if trespassing wolf initiated]

FOR WOLF-WOLF INTERACTIONS ONLY:

Was Interaction [circle]: Intra-Pack [within same pack] OR Inter-Pack [between different packs]

Did interaction take place between packs boundaries [circle]? Yes No Unknown

Wolf that was CHASED, ATTACKED, KILLED – Did they trespass [circle]? Yes No Unknown

Wolf or wolves that INITIATED interaction – Did they trespass [circle]? Yes No Unknown

---

WOLVES FROM PACK THAT INITIATED INTERACTION			
Wolves involved in interaction	ID # (s)	Wolves NOT involved in interaction	ID # (s)
#_____ pups		#_____ pups	
#_____ breeding adults		#_____ breeding adults	
#_____ unknown		#_____ unknown	
#_____ non-breeding adults*		#_____ non-breeding adults	
Total Involved ______		Total NOT Involved ______	

**> 12 months of age*

NON-PREY SPECIES PRESENT AND/OR INVOLVED IN INTERACTION *If Non-Prey species is wolf, indicate pack:* ______________________		
	Non-prey animals present	Non-prey involved in interaction
Total number of Non-prey		
Sex, age & ID # (if known)		
Social status (if known)		

If wolves attack other animal, what was point of contact: *(circle all that apply)*

Neck Nose Hind end Unknown Other (write details in comment section) No Contact

Repeat attack? *(circle one)*: Yes (Wolves attacked, came back) No N/A (Not Applicable)

Time between attacks ________Observers (Use 1st initial and entire last name): ______________________________

NARRATIVE OF WOLF & NON-PREY INTERACTION

Please try to use the following key words to describe the interaction(s).

Who	What	Where	When (times)	Why
Approach	Stay	Move	Leave	Defend
Postures	Gaits			

Does this narrative continue on to another data form? Y / N See ______________________________

Appendix VII Continued.

FOOD FOR THE MASSES – FORM 1

Date ________ Pack Name ___________ Location ______________________ UTM _________/__________ Date Detected ________ D.O.D ______ _ Observers _________

Species Killed ________Species Age calf/yearling/adult Species Sex m/f Mortality Number ____ ____ Autopsy Number ____ Weather sn/rn/cl/pc/s

Distance from observers to carcass: ____________ Distance from carcass to road: ___________Snow Depth ______cm

COVER: (If carcass is moved from present location fill out a new form for At Carcass and Carcass Arena and record time.)

At Carcass: Describe ground cover (snow/no snow), terrain (trees, shrubs, grass etc.), slope (%incline) and % of carcass visible. (If part of carcass is obscured from view, determine a correction factor for species concerned):

Carcass Arena: %visible ______ (% area not obscured by geographic features) Field of View: %visible ______

In the table below, record percent cover by Grass/Snow, Shrub and Trees for the visible areas of Field of View (FOV) and Carcass Arena (Arena). Arena and FOV percentages should each total 100%.

Grass		Snow		Shrub		Trees		Other	
Arena	FOV	Arena	FOV	Arena	FOV	Arena	FOV	Arena	FOV

ADDITIONAL INSTRUCTIONS:

At Carcass: To determine a correction factor, keep notes on the # of individuals within a species visible on a carcass compared to the # seen when they are scared off by another animal. For example, if you see 2 ravens feeding and then 10 fly away when a coyote approaches, make a note of before and after raven #'s.

Carcass Arena and FOV: To determine %visible for Carcass arena, make your best approximation. For Field of View, draw a circle on a topo map of 500m for FOV. Within this circle, shade in all areas that are obscured by geography(as if viewed from above). %viewable=%unshaded. Use the table above to record areas within the viewable area that are visible vs. not visible due to obstruction from vegetation.

Data Sheet: Record observations every 15 minutes(military time). For each defined area(ie. At Carcass, Carcass Arena,& Field of View)record the number and behavior code for each animal present under the appropriate species column. For example, if 2 wolves are feeding and 10 ravens are standing within 15 meters of carcass, data would be recorded as 2F under "At carcass - W" and 10G under "Carcass Arena - R." Use other category for uncommon species.

Defined Areas: "*At Carcass*" means in a position to eat without moving. "*Carcass Arena*" means within a 15m radius, but not "at carcass", "*Field of View*" means 500 meters centered around carcass but not "carcass arena".

Behavioral Codes: F=feeding; eating/ripping at kill. V=vigilent; standing or squatting, head up and looking around. RA=rest-alert; laying down, head up. RS=rest-sleep; laying down, head down. G=bird on ground T=travel P=perched S=any interspecies interaction O=other. For mammals use F,V,RA,RS,T,S,O. For birds use F,P,G,T,S,O.

Stage of Consumption: (1)*Evisceration* = initial opening of body cavity and feeding on organs(freshly killed). (2)*Major Muscle Mass* = organs primarily consumed, feeding on major portion of hindquarters (pelvis and femur), ribs and lower neck. (3) *Minor Muscle Mass* = ribs and pelvis fully exposed, feeding on lower quarters, neck, head and picking remains off bones. Slight disarticulation (4)*Bones/Hide* = Less than 1% of soft tissue remains, carcass generally disartuculated, feeding on hide and bones.

Protocol: Carcass should be monitored continuously until stage 3, at which point carcass should be monitored until nightfall, through the night (if possible) and 4 hours from first light the next morning. The carcass should then be monitored 4 hours on, 4 hours off until stage four or until kill is abandoned by all scavengers.

Bird Pecks: Pecking rates of birds should be sampled continuously through the life of a carcass. Pick a bird at random, record the species, position relative to the carcass (top or side), other scavenger species and numbers feeding, and conduct a timed 1 minute focal file counting the # of pecks within that minute.

Data entered (initials) into database: ________
Data in database double checked:

Appendix VIII. Elk Ground and Aerial Count Data Forms.

ELK GROUND COUNTS FORM
path: x:\wolf\admin\data forms\Elk Ground Counts Data Form.doc

Count Unit:________________

CLOUD COVER(CC)	PRECIPITATION (PC)	% SNOW COVER	SNOW DEPTH	ACTIVITY	VEG COVER	TOPOGRAPHY
0 = clear	0 = none	0 = none	0 = none	B = bedded	0 = open / none	1 = flat
1 = up to ¼	1 = light / intrm rain	1 = <30%	1 = 1-6in.	S = standing	1 = <30%	2 = rolling
2 = ¼ to ½	2 = constant rain	2 = 31-60%	2 = 7-12in.	M = moving	2 = 31-60%	3 = slope
3 = ½ to ¾	3 = hail	3 = 61-100%	3 = >12in.		3 = 61-100%	
4 = ¾ +	4 = snow				4 = gully	
	5 = t-storm				5 = other	

Date:____________ Year: ________ Observer: ____________Time start / stop (24 hr): ________________ / ______________

Weather: F______, CC______, PC______,% Snow Cover _______, Snow Depth _______, Crust on Snow? (circle) Y or N

Elk counts: Record the activity and classify for groups of elk seen in the count unit. Don't forget to plot each group on the map with the correct group number and take a UTM at the center of the group.
If a second data sheet is needed, please change the group numbers so they are continuous (Group 14, 15, 16, etc.)

	Activity	Veg Cover	Topography	No. of Cows	No. of Calves	No. of Bulls	No. of Spikes	No. of Unknowns	Total elk Counted	UTM (NAD 27) Easting / Northing
Group 1										
Group 2										
Group 3										
Group 4										
Group 5										
Group 6										
Group 7										
Group 8										
Group 9										
Group 10										
Total counts	———	———	———							__________

Total number of elk counted in this unit: ____________________

COMMENTS(specify if other ungulates were seen and how many): ____

FOR DATABASE MANAGER USE ONLY	
# of calves/100 cows:	# of bulls/100 cows:

Appendix VIII Continued.

ELK AND OTHER UNGULATE AERIAL COUNTS FORM

Wolf Pack Territory: ___________________________________ path: x:\wolf\admin\data forms\elk study

Data entered (initials) into database: ________
Data in database double checked:

Date:_________________________, Pilot:___________, Obs:___________, Time Count start/stop:____________________

CLOUD COVER (CC)	PRECIPITATION (PC)	%SNOW COVER	ACTIVITY	VEG COVER	TOPOGRAPHY
0 = clear	0 = none	0 = none	B = bedded	0 = open/none	1 = flat
1 = up to 1/4	1 = lite/intrm rain	1 = < 30%	S = standing	1 = < 30%	2 = rolling
2 = 1/4 to 1/2	2 = constant rain	2 = 31-60%	M = moving	2 = 31-60%	3 = slope
3 = 1/2 to 3/4	3 = hail	3 = 61-100%		3 = 61-100%	4 = gully
4 = 3/4+	4 = snow				5 = other
	5 = t-storm				

Weather: °F______, CC______, PC______

Elk counts: Record the activity and CLASSIFY for groups of elk (or other ungulates) seen in this wolf territory.

	Species	Total # ungulates	No. of Cows	No. of Calves	No. of Bulls	No. of Unknown	% Snow Cover	Activity	Veg Cover	Topo-graphy	UTM Easting/Northing
Group 1											
Group 2											
Group 3											
Group 4											
Group 5											
Group 6											
Group 7											
Group 8											
Group 9											
Group 10											
Group 11											
Group 12											
Group 13											
Group 14											
Grand Total											__________

FOR DATA MANAGER USE ONLY	
# of calves/100 cows:	# of bulls/100 cows:

Appendix IX. Yellowstone Wolf Project Scat Collection Data Form.

Wolf Project Scat Collection Form
path: x:wolf\admin\data forms\other forms\Scat Form.doc

Data entered (initials)
into database: ______
Data in database
double checked:

Scat No: ______________________ Pack: ______________________ OR Unknown

Date deposited: ______________________ Est: Y N Date collected: ______________________

Site: (circle one)
Direct from wolf (specify individual) → Individual: fill in wolf #:________________ OR (circle one) Pup Adult Unknown
Den
Rendezvous
Kill
Trail
Other (specify location below)

Confidence*: (circle one) Definite Probable

Official Den name or Official Rendezvous name or Kill no.: ______________________

If Trail or Other location, description of area: ______________________

Official UTM: Easting ______________________ Northing ______________________ NAD 83 (airplane) 27 (field map)
Collected By (Use 1st Intial and Last Name): ______________________

Scat No: ______________________ Pack: ______________________ OR Unknown

Date deposited: ______________________ Est: Y N Date collected: ______________________

Site: (circle one)
Direct from wolf (specify individual) → Individual: fill in wolf #:________________ OR (circle one) Pup Adult Unknown
Den
Rendezvous
Kill
Trail
Other (specify location below)

Confidence*: (circle one) Definite Probable

Official Den name or Official Rendezvous name or Kill no.: ______________________

If Trail or Other location, description of area: ______________________

Official UTM: Easting ______________________ Northing ______________________ NAD 83 (airplane) 27 (field map)
Collected By (Use 1st Intial and Last Name): ______________________

Scat No: ______________________ Pack: ______________________ OR Unknown

Date deposited: ______________________ Est: Y N Date collected: ______________________

Site: (circle one)
Direct from wolf (specify individual) → Individual: fill in wolf #:________________ OR (circle one) Pup Adult Unknown
Den
Rendezvous
Kill
Trail
Other (specify location below)

Confidence*: (circle one) Definite Probable

Official Den name or Official Rendezvous name or Kill no.: ______________________

If Trail or Other location, description of area: ______________________

Official UTM: Easting ______________________ Northing ______________________ NAD 83 (airplane) 27 (field map)
Collected By (Use 1st Intial and Last Name): ______________________

** Confidence codes: Definite = Collected directly from wolf (dead or alive) or seen deposited by the wolf*
Probable = Collected at den site, rendezvous site, kill site, on trail or at other location.