

conservation of the living resources of the marine upwelling system in Peru, and provide examples of how small attitude changes in the conservationist can produce a large change in the desired results.

ASSESSING FUNCTIONAL HEALTH OF A RIPARIAN SITE ^{TWS}

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An increased public awareness of the benefits of the need for ecosystem functional health has driven a movement to identify factors that operate on the landscape to enhance or degrade natural ecologic function. In cooperation with various agencies, we have developed a rapid assessment procedure for evaluating functional health of a stream reach and its associated riparian zone. The procedure quantifies an array of parameters indicating the ability of different aspects of the system to function. These quantities are weighted and factored into a formula to produce a comparative rating of riparian functional health. A land manager can use the evaluation to: 1) assess present functional health of a stream reach, 2) identify specific factors needing remedial attention, and/or 3) through repeated evaluation as a monitoring tool for assessing effectiveness of management change. The procedure, designed for use by land management professionals as well as landowners with minimal training, can be used to evaluate health of a 200 ft representative reach of stream in about 2 hours. The evaluation does not require precise measurements, but instead relies on visual estimations of readily observable parameters grouped into three categories of factors: vegetation, soils/geology, and hydrology/streambank. Estimates of ten such factors are used to develop an overall health rating. With minimal training, evaluators using this procedure have demonstrated success at calibrating their observational skills to attain consistent and repeatable results.

BIOLOGICAL SCIENCES - TERRESTRIAL

WHO GETS PARASITIZED BY BROWN-HEADED COWBIRDS? THE IMPORTANCE OF EVERYDAY HOST ACTIVITY ^{TWS}

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The recent range expansion of the Brown-headed Cowbird (*Moluthrus ater*) in North America has introduced brood parasitism as a new selective force for many host species. High parasitism rates cause greatly reduced reproductive success for many species. Parasitism rates vary dramatically among species, but factors affecting the probability of parasitism remain poorly understood. Cowbirds are thought to find nests by watching adult behavior, and nest defense behavior correlates with parasitism rates among some species. Other more prominent behaviors (e.g. nest-

building visits, mate-feeding, vocalizations) centered around the nest during early nesting phases may also serve as cues to nest searching cowbirds. I test an "everyday activity" hypothesis in which pairs more active around their nests during the early nesting phases have a higher probability of being parasitized than less active pairs. I measured behaviors of American Redstarts (*Setophaga ruticella*), Yellow Warblers (*Dendroica petechia*), Dusky Flycatchers (*Empidonax oberhólseri*), and Warbling Vireos (*Vireo gilvus*) nesting in the same habitat but differing in parasitism rates. I find a positive correlation between male singing rates near nests and parasitism across species. Within species, too, parasitized males sing more than unparasitized males. Female activity and frequency of nest visitation appear uncorrelated or inversely correlated with parasitism. These data suggest that cowbirds may exploit male behaviors when searching for nests and that we might expect the frequencies of such behaviors to change over time in response to parasitism pressure.

DISPERSAL AND GENETIC RELATIONSHIPS OF RECOLONIZING WOLVES IN THE ROCKIES ^{TWS}

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Gray wolves (*Canis lupus*) have recently recolonized western Montana, southeastern British Columbia, and southwestern Alberta, 50 years after their systematic extirpation from the region. Recovery of recolonizing wolf populations depends on successful dispersal from source populations, subsequent reproduction, and maintenance of genetic variation. We tagged 56 wolves in the Glacier National Park area during 1984-1996. We used a combination of telemetry and field data to determine the characteristics of dispersers, including age, sex, season of dispersal, longevity, dispersal distance, direction traveled, temporary associations with other packs, and reproductive success. Thirty-two of the tagged wolves dispersed 20-832 km from their natal home range. Fourteen dispersers produced at least one litter of pups each. Gene flow due to dispersal must be maintained to prevent a population bottleneck and consequent reduced genetic variation. We used DNA microsatellite genotyping to examine the genetic relationship of recolonizing Rocky Mountain wolves. For genetic analyses, we combined samples from adjacent Canadian wolf studies, Montana wolves tagged by the U.S. Fish and Wildlife Service, and our data (n=91). We found high genetic variation, measured in terms of heterozygosity and allelic diversity, indicating a lack of a founding population bottleneck. To maintain high genetic variation, gene flow between wolf subpopulations must be assured through dispersal. Combining field data with genetic analyses yielded information that neither study alone could determine, including the synergetic synthesis of long dispersal distances, high dispersal rates, and adequate gene flow among colonizers.

SPATIAL CHANGES IN HABITAT USE BY ELK IN WESTERN MONTANA ^{TWS}

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Comparing radio locations of cow elk (*Cervus elaphus*) taken from 1977-1983 and 1993-1996 revealed changes in landscape use. Yearlong, calving season, summer, rut, and hunting season patterns of use for two adjacent elk herds were examined by comparing the relative use of grid cells overlaid upon the study area. These changes span the time frame from before logging was initiated in the upper Chamberlain Creek drainage, in westcentral Montana, through 15 years of logging activity to the present. This presentation represents only a portion of the Chamberlain Creek Elk Study, which is investigating the long-term effects of habitat fragmentation on elk habitat use and home ranges.

SMALL MAMMALS IN BURNED AND UNBURNED HABITATS ON THE BEARTOOTH WILDLIFE MANAGEMENT AREA ^{TWS}

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Small mammal trapping was conducted on the Beartooth Wildlife Management Area near Wolf Creek, Lewis and Clark County, Montana, to determine species occurrence by habitat type, and to survey for special interest or concern species. Seven traplines using Sherman live traps, snap traps, and pitfall traps were run during August and September, 1996. Three traplines were located in areas that were partially or severely burned during the 1990 fire. A total of 414 mammals were captured with eleven species represented. Captures/100 trap-nights ranged from 3.1 in burned ponderosa pine forest to 46.3 in willow-riparian habitat. Species richness was highest in unburned cottonwood riparian (n=6) and burned aspen habitats (n=7), lowest in intermountain grassland habitat (n=3), and intermediate in unburned Douglas-fir-ponderosa pine forest (n=5) burned ponderosa pine (n=4) and unburned willow-riparian habitats (n=4). Trapping results compared favorably with those from studies conducted by the Montana Nongame Program in similar unburned ponderosa pine habitats. Results suggest that small mammal productivity and diversity in burned habitats is variable, but generally comparable with similar unburned habitats in Montana. However, forest obligates such as the Red-backed Vole (*Clethrionomys gapperi*) were absent from 6-year post-burned areas. Riparian and aspen habitats supported the highest diversity and density of small mammals, further emphasizing the importance of properly managing these habitats to maintain their high species diversity and productivity.

A LANDSCAPE PERSPECTIVE ON THE EFFECTS OF CLEARCUTTING ON BIRDS IN CEDAR/HEMLOCK FORESTS ^{TWS}

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Landscape patterns in cedar/hemlock forests in northern Idaho have been modified by clearcutting. I investigated the effects of these changes in landscape patterns on birds by examining bird distribution and nesting success (1992-1994) in three landscapes: (1) a continuous old-growth forest landscape, (2) an old-growth landscape with recently embedded clearcuts, and (3) a landscape composed of selectively harvested forest fragments and older clearcuts. Three species (Brown Creeper (*Certhia familiaris*), Winter Wren (*Traglydytes traglydytes*), and Golden-crowned Kinglet (*Ragulus satrapa*)) were clearly associated with continuous old-growth cedar/hemlock; these may be interior forest species. Twenty species were associated with landscapes fragmented by clearcuts. Surprisingly, many forest species were as abundant or more abundant in clearcut landscapes as in continuous forest. Probability of daily nest success did not differ significantly between the continuous and modified old-growth landscapes for five species. The trend for four of these five species (all cavity-nesters), however, was lower nesting success in the modified landscape, with lower nesting success on clearcut edges than in interiors. Management recommendations are tentative, because the nesting success data is based on small samples and only two landscapes. Maintaining continuous, unlogged, old-growth cedar/hemlock forest is a reasonable, conservative strategy for maintaining interior-associated birds. But this study indicates that more research is needed on nesting success of birds, especially cavity nesters, in clearcut landscapes to ascertain whether leaving trees and snags in clearcuts is a good universal strategy for maintaining cavity nesting birds.

HABITAT USE AND BEHAVIORAL ACCLIMATION BY BIGHORN SHEEP INTRODUCED IN NORTH UNIT OF THE THEODORE ROOSEVELT NATIONAL PARK ^{TWS}

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Nineteen radio-collared California bighorn sheep (*Ovis canadensis californiana*) (14 ewes/5 rams) were introduced in the North Unit (Mckenzie County, North Dakota) on January 26, 1996 and monitored at 2-3 day intervals with the use of telemetry equipment for one year. Since their introduction, sheep have slowly increased their range inside and outside the park boundaries. The predictions of the North Unit bighorn sheep Geographical Information System (GIS) habitat model were generally validated by field observations. Sheep activities were focused in *Stipa comata*/*Carex filifolia* and *Artemesia tridentata*/*Agropyron smithii* habitat types. Vegetation analysis suggests percent utilization for areas used by sheep averaged 62% before the study animals moved to other foraging territories. Plant species composition in sites identified as used was highly variable. The physiographic type most frequently used

by the sheep was the Badlands type. Feeding was heaviest during the mid-morning and late evening hours for the entire year. Bighorn sheep interaction with other ungulate species (*Bison bison* and *Odocoileus hemionus*) and predators was frequent and rare, respectively. Sheep generally habituated to the presence of humans. Fourteen adult ewes produced eight lambs in 1996, three of which died of undetermined causes.

ASSESSING GRAY WOLF RESTORATION IN IDAHO: PROGRESS AFTER TWO YEARS ^{TWS}

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At least 29 of 35 gray wolves (*Canis lupus*) translocated to central Idaho and released on-site at selected backcountry locations in 1995 and 1996 have survived into winter, 1997. Two wolves died as a result of human-caused mortality; 1 of apparent starvation, 1 wolf death remains under investigation, and the status of 2 wolves is unknown. Of 29 regularly monitored wolves, at least 18 have joined with other radioed and non-radioed wolves (N=4) to form 11 potential breeding pairs. Three potential breeding pairs are located north of the Salmon River and 8 potential breeding pairs are distributed to the south. Nine wolves of reproductive age remain alone within the experimental area: a male and female remain north of the Salmon River and 5 males and 2 females are south. Translocated wolves did not reproduce in 1995 but 3 litters were produced during 1996. Radioed wolves have been located from fixed-wing aircraft every 10 days (approximate) since July, 1996 but once every 3 weeks prior to that time. Wolves moved extensively within the experimental area from 1995 through winter, 1996. However, only 5 of 33 wolves have permanently vacated or dispersed long distances outside the experimental area. Paired wolves were increasingly predictable in their movements during summer, 1996 but less so during winter, 1996-1997. Wolves preyed on elk (*Cervus elaphus*), moose (*Alces alces*), mule deer (*Odocoileus hemionus*), beaver (*Castor canadensis*), and domestic sheep and cattle. We responded to 9 livestock depredation incidents; 3 were confirmed wolf depredations. The distribution of Canadian wolves released in Idaho is similar to the distribution of historical wolf reports during the past 70 years. Surveys in 8 areas where wolves were known to occur in 1996 found hunter and outfitters were accepting or positive about their return to Idaho. On the ground management following wolf restoration has proven more complex and time consuming than anticipated.

PRODUCTION AND SURVIVAL OF ELK CALVES IN RESPONSE TO HABITAT IMPROVEMENT IN NORTHWEST MONTANA: METHODOLOGY ^{TWS}

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The purpose of my study is to learn the effects of winter range habitat improvement on elk (*Cervus elaphus*) pregnancy rates and calf survival in the Southfork of the Flathead river. Habitat enhancement is often done to mitigate losses to wildlife. The enhancement at Firefighter Mountain, completed in the summer of 1996, was done to mitigate the loss of elk winter range that resulted from the construction of Hungry Horse Dam. Determination of pregnancy uses a radio-immuno assay of fecal steroids. These assays successfully determined pregnancy in 10 elk during my first field season. Vaginal implants are being used to find out timing and location of birth sites in adult cow elk. Previous use of vaginal implants by researchers on ungulates has met with mixed and often poor results. Recently, a new type was developed for white-tailed deer (*Odocoileus virginianus*) and used with high success. This new design has been adopted and adjusted for elk. The implants consist of an inert plastic base from a progesterone implant, designed for domestic swine, attached to a radio transmitter. Although my sample size was small (n=5), retention rates were 100%, and I could determine time and place of parturition. Preliminary results are positive on the effectiveness of these methods.

TRENDS IN BISON MANAGEMENT: WHAT IT MEANS FOR THE SPECIES ^{TWS}

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We have observed several common trends in recent literature and conferences on commercial bison production. These include: artificial seeding of native range, pest/parasite treatment, feedlot "finishing", dehorning, small herd sizes, highly skewed sex ratios, and culling or other selection based on subjective characteristics. The rationale for these activities is rarely articulated, and appears to be a carry over from the livestock industry. However, these techniques add unnecessary expense and labor when applied to bison. We argue that they are biologically and ecologically counterproductive as well. The history of ungulate domestication and management suggests that producers are forcing a native ungulate adapted to North American grassland ecosystems, with few pests/parasites/diseases, high reproductive

capability and low natural mortality into an artificial, expensive, labor intensive management system. We recommend producers adapt specific management strategies and activities to bison ecology and behavior, rather than vice versa. These strategies include: large herds on adequate acreages of native range, natural sex ratios, maintaining older age classes, exchange of yearlings between herds, random harvest strategies, and minimizing disease treatments. Strong artificial selection will likely result in another poorly adapted, less successful ungulate. Managers of public bison herds are in a unique position to preserve bison as a wild ungulate because they are not under the economic constraints of private producers. However, a review of public herd management shows there is a need to apply knowledge of conservation biology to bison management on public lands.

DIETARY OVERLAP OF WOLVES AND COUGARS WITHIN AND NEAR GLACIER NATIONAL PARK, MONTANA ^{TWS}

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We compared patterns of prey selection among wolves (*Canis lupus*), cougars (*Puma concolor*), and humans to ascertain the effects of wolf recolonization and multiple predators on prey and on each other. Characteristics of prey selected by wolves and cougars in the same ecosystem have not been reported. White-tailed deer (*Odocoileus virginianus*) made up the greatest proportion of both wolf (0.83) and cougar diets (0.87), but elk (*Cervus elaphus*) and moose (*Alces alces*) made up a larger proportion of wolf (0.14, 0.03, respectively) than cougar (0.06, 0.02, respectively) diets. Wolves and cougars selected the same age classes in both deer and elk. They both selected older and younger deer and elk than human hunters did. They both selected fewer males than hunters did and they both selected more fawns and more males than expected based on availability. Cougar predation on elk was more male-biased than was wolf predation on elk. Cougars generally killed animals in poorer condition than wolves did, especially in elk. These data may be used by predator/prey managers to anticipate effects of wolf and cougar presence on populations of prey and may also be used to determine potential impacts of one predator on the other. We suggest possible management alternatives to mitigate effects.

THE EFFECTS OF WOLF COLONIZATION ON COYOTE BEHAVIOR, MOVEMENTS AND FOOD HABITS ^{TWS}

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The Flathead area in western Montana is one of the last ecosystems in the United States still containing a full complement of mammalian predators and their prey. Recolonizing wolves (*Canis lupus*) may affect congeneric coyotes (*C. latrans*) by altering food habits, social behavior, movements and habitat use. We examined the effects of colonizing wolves in northwestern Montana on the resident coyote population. Radio-collared wolves and coyotes were monitored from June 1994 through December 1996 to determine home ranges and movements. Home ranges for eleven coyotes were distributed between the two wolf pack territories or on the edge of the territories, and did not overlap with core wolf areas. Locations for a 24-hour period on one canid were used to determine if temporal partitioning occurred between the canids. Coyote movement was the greatest between 1100-1400 and wolf movement between 0200-0400 hours. Some food partitioning does occur in that coyote diets consist of small mammals (i.e. snowshoe hare (*Lepus americanus*) and microtines), however, white-tailed deer (*Odocoileus virginianus*) are also consumed. Elk and white-tailed deer comprise the main diet of the wolf packs. Complex interrelationships between the predators in the North Fork occurs as well as interrelationships between the predators and the prey. Predators in fact account for 80 percent of the coyote mortality in the North Fork. Wolf presence may be beneficial to coyotes as a source of additional food through scavenging, but it also appears that the wolves are affecting coyote distribution and survival.

TRACKING ELK HUNTERS WITH THE GLOBAL POSITIONING SYSTEM ^{TWS}

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In a study of elk-hunter behavior in western Montana, we used battery powered Global Positioning System (GPS) units to record hunter locations at 15-second intervals during 99 hunting expeditions in 1993, 1994, and 1995. Subsequent analysis within a Geographic Information System (GIS) enabled us to determine time and motion budgets for hunter effort, estimate the departure distance from roads and hunting camps, and evaluate the influence of closed roads on elk hunting techniques. Hunter locations were overlaid on other GIS layers to determine time spent in different vegetation classes and identify topographic situations selected for hunting. Hunters averaged 4.7 hours per hunt, while moving at a speed of 40 m/min for a distance of 10.7 km. Only half of all hunters got more than 2.5 km from their starting point, and only 5 percent went more than 5 km. The average distance from the nearest road while hunting was only 267 m, and hunters on foot spent 26 percent of their hunting time on roads. Hunters who spent the most time on roads also

recorded the greatest distances from their starting points. Sixty percent of all hunting was done on slopes less steep than the study area average, and westerly aspects were favored. Among the forest types available to them, hunters selected open Douglas-fir and Western Larch while avoiding Lodgepole pine and Sagebrush.

DEMOGRAPHY AND TREND OF A LOCAL GRIZZLY BEAR POPULATION IN A SOURCE-SINK LANDSCAPE. ^{TWS}

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Demographic characteristics and local population trend of grizzly bears (*Ursus arctos horribilis*) were studied in the Swan Mountains of western Montana during 1987-1996 using capture and telemetry methods. We captured 50 grizzly bears in 108 capture episodes (1 bear/72 snare-nights). Using radio collared bears only, there were between 19 and 30 bears in the 1,457 km² study area each year (≈ 1.6 bears/100 km²). Density of bears in a 692 km² high-use area termed the Core Area averaged 2.5 bears/100 km². Twenty-eight cubs were produced from 17 litters for a mean litter size of 1.64 ± 0.12 cubs/litter. The reproductive rate for female cubs was estimated to be 0.389 ± 0.104 . We obtained 170 bear/years of censored telemetry data from all classes of radioed grizzly bears, 25 of which died. The observed annual total mortality rate of 13.4 percent for all classes was higher than those found in expanding brown bear populations. Most mortalities occurred in roaded areas near private lands at the edge of the study area (Rural Zone) that exhibited a lower bear density than the Core Area. Dispersal movements of young females were confined to areas near the natal home range, away from the Rural Zone, while young males were more likely to utilize the Rural Zone. Using a derivation of Lotka's equation, our estimate of lambda during the entire study was 1.009 (95 percent confidence interval = 0.896 - 1.096). There was a 59 percent probability that the population was stable to increasing, a 55 percent probability that the population was increasing, and a 41 percent probability of population decline. The spatial occupancy of the Core Area suggested that the study area was at or near capacity under present landscape conditions. Differential bear densities within the study area, movement patterns, spatial occupancy, and vital rate characteristics suggested a "source-sink" situation.

EFFECTS OF SELECTIVE HUNTING ON PRONGHORN BEHAVIOR
AT FORT BELKNAP INDIAN RESERVATION ^{TWS}

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Sport hunting usually is not considered to impact wildlife populations negatively. However, trophy hunting, a highly selective form of hunting, raises some concern among biologists because a distinct group of males is removed from the population. Among other effects, selective hunting can produce changes in breeding patterns. The objective of this study was to investigate effects of a selective hunt, which occurred during the breeding season, on behavior patterns of male pronghorns (*Antilocapra americana*). We compared demographic variables, activity patterns, and interaction rates among individually recognized males that were subjected to light, moderate and heavy amounts of hunting pressure at Fort Belknap Indian Reservation in northcentral Montana. Although group size, time budgets and interaction rates changed from the prerut time period to the rut, males living in areas subjected to the three treatments did not vary significantly in the amount of time they spent active, walking or reclining, nor did they vary in interaction rates. The number of fawns present in a male's group, however, was lowest in areas that received the heaviest hunting pressure. We conclude the trophy hunt, which is restricted to a maximum of 100 tags, did not adversely affect the reproductive activity of pronghorns in this population. However, biologists should continue to monitor age structure, sex ratio, and productivity in order to detect any changes that may occur as a result of the hunt. Furthermore, genetic diversity should be monitored to detect any changes that may result from a loss of prime males from the population.

MONTANA BLACK-FOOTED FERRET REINTRODUCTIONS, 1994-1996 ^{TWS}

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Black-footed ferrets (*Mustela niaripes*) reached the brink of extinction in the 1980s. Successful captive-breeding efforts have produced ferrets for release in the wild in 4 states since 1991. Montana reintroductions to establish a wild population began in 1994 with the release of 40 ferrets, another 36 in 1995, and 43 in 1996. Releases were on black-tailed prairie dog (*Cynomys ludovicianus*) colonies on the UL Bend National Wildlife Refuge in southern Phillips County, northcentral Montana. Five wildborn kits from 3 litters were observed during 1995 and 18 from 7-8 litters in 1996. Approximately 35 animals were in this population during December 1996. Many variables affected success including; ferret age and rearing method, predator management, and habitat quality. Ferret kits pre-conditioned prior to release survived better than naive counterparts. Short-term ferret survival was apparently increased by exclusion of coyotes (*Canis latrans*) from release sites with electrified netting and/or lethal coyote control, but significantly higher survival through the following breeding season was not evident. We present and discuss results from these reintroductions and current assessments of techniques to establish wild black-footed ferret populations .

COUGAR FOOD HABITS, PREY SELECTION, AND PREDATION RATES IN THE NORTHERN YELLOWSTONE ECOSYSTEM^{TWS}

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Cougar (*Puma concolor*) predation was studied from 1987 to 1996 in northern Yellowstone National Park and vicinity. Eighty-eight cougars were captured, 84 were radio-collared, and kills of 46 individuals were documented. Elk (*Cervus elaphus*) and mule deer (*Odocoileus hemionus*) comprised 98 percent of prey biomass and 81 percent of 302 cougar kills. Bighorn sheep (*Ovis canadensis*), moose (*Alces alces*), and pronghorn (*Antilocapra americana*) represented less than 5 percent of cougar kills. Among deer and elk, elk calves were the most important prey, mule deer were intermediate, and cow and bull elk were the least important prey relative to their availability. Predation rates averaged 9.4 days per ungulate kill and varied by cougar hunting experience (measured by age), weight, and ambient air temperature. Cougars killed only 2-3 percent of elk and 3-5 percent of deer on the study area each year. Migratory behavior, habitat use patterns, and the size of prey reduced the effects of cougar predation. Cougars did not effectively limit growth rates of elk and moose populations on the study area, because cougars selected their young preferentially to adults. Strong limitation of mule deer populations was more likely, because all sex-age classes were preyed upon more equitably. Our results indicated that altering the structure of cougar populations (e.g., by hunting) could change the influence of cougars on the numbers and sex-age structure of their ungulate prey. In other words, if the age structure of a cougar population in an area is skewed toward adults, cougar predation would more likely occur on larger ungulates such as elk over deer.

¹Deceased

NUMERICAL AND FUNCTIONAL RESPONSES OF A GENERALIST PREDATOR: FIELD EXAMINATION OF A SIMPLE PREDATOR-PREY SYSTEM^{TWS}

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Many predators exhibit numerical and functional responses to fluctuating prey densities. Although it is often practical to measure the numerical response in field settings, functional responses are usually determined in laboratory experiments

because quantifying the components of predator consumption rates (handling time, search rate) in the field is difficult when predation events are rarely observed. However, more field testing is needed because some species show variable functional responses as ecological conditions (resource distribution, age composition of foraging groups) change. Understanding predator behavior is also prerequisite to interpreting the consequences of predator-prey interactions on community dynamics. We determined the numerical and functional responses of bald eagles (*Haliaeetus leucocephalus*) feeding on spawning kokanee salmon (*Oncorhynchus nerka*) at an autumn migratory concentration in west-central Montana. Bald eagles tracked the fluctuating number of salmon during four of five years. This ability was manifest in immigration and emigration rates, which were similar across years, and appeared facilitated by behavioral (group foraging, communal roosting) and physical attributes (keen eyesight) of bald eagles. Eagles exhibited a Type II functional response. Handling time remained constant across the range of prey densities, whereas attack rate increased with increasing salmon numbers. Functional responses differed between eagle age classes and among foraging modes, which reflected age-specific foraging behavior and suggested that eagles view live and dead salmon as alternative prey types. Overall, bald eagle predation on kokanee salmon is inversely density-dependent over most prey densities.

HARLEQUIN DUCK (*HISTRIONICUS HISTRIONICUS*) BEHAVIOR AND HABITAT USE IN A NORTHERN ROCKY MOUNTAIN STREAM ^{TWS}

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The harlequin duck is a valuable case study for behavioral research because only 110 harlequin duck pairs are known to breed in Montana (Genter 1992). In spite of this regional rarity, McDonald Creek, in Glacier National Park (GNP) has the highest known density of harlequins in the intermountain region. The harlequin duck has been listed as Category 2 status, declining trend, under the Endangered Species Act. The USDA Forest Service lists the harlequin duck as a "Sensitive Species" in Region 1 USDA and Montana of Fish, Wildlife and Parks lists it as a "Species of Special Concern". The harlequin duck's vulnerability creates the urgent need to characterize the species habitat use, and define effective riparian assessment practices. Harlequin duck range throughout North America has decreased dramatically from the historical record. Solutions to this decrease are likely to be as varied as the biomes in which the species lives. This study is an initial component of a multidisciplinary, multiorganizational approach to harlequin conservation. This study site is important for harlequin duck research because of the extensive historic data collection at the site during 1973-75 and 1992-1994). This 2-year study began in fall, 1994 with initial habitat use surveys. Observed behavioral responses by males during the breeding season showed significant sensitivity to human presence. Responses by males varied from immediate flight, to stress behaviors such as physical positioning of the male between the intruder and the female, accompanied by repeated headbobbing. Males engaged in courtship displays culminating in mating and intraspecies aggression were significantly less sensitive to human presence. Observed behavioral responses by females during the breeding season, nesting and broodrearing showed less

sensitivity to human presence than the males, although flight or drift responses still occurred at ranges of less than 100 m. Immature ducks before full flight showed less sensitivity to human presence than the females, with flight or drift responses still occurred at ranges of less than 70 m. All classes of harlequin ducks used riparian habitat features such as exposed, in channel boulders for loafing. No classes of this species used study stream reaches with substrates smaller than large gravel.

RARE CARNIVORES AND HIGHWAYS: MANAGEMENT PROBLEMS AND SOLUTIONS ^{TWS}

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The impacts of highways is a serious conservation issue facing rare carnivores (grizzly bear, *Ursus arctos*; gray wolf, *Canis lupus*; wolverine, *Gulo gulo*; lynx, *Lynx canadensis*; fisher, *Martes pennanti*). Carnivores are vulnerable to highways because of their large spatial requirements, which require frequent crossings of busy roads. Highways are habitat and ecosystem issues. Highways affect carnivores by increasing direct and indirect mortality, habitat loss, habitat fragmentation, and displacement. The impacts of highways on carnivores are permanent and severe. The author hypothesizes that: 1) there is an increasing effect on carnivores as the standard of road or highway is increased and 2) that extirpation of rare carnivores in the lower 48 states is partially a factor of highway density. Suggested priorities for reducing highway impacts on carnivores include: 1) educating agency personnel, biologists, engineers, and the public on highway/wildlife impacts; 2) emphasis on research; 3) identification and protection of land corridors; 4) implementation of highway crossing structures; and 5) improving wildlife/highway mitigation policies.

INTEGRATING WILDLIFE CONSERVATION AND ECOSYSTEM HEALTH: AN
EXAMPLE FROM THE COLUMBIA RIVER BASIN, USA ^{SAF}

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The theory and practice of ecosystem management is pivotal to the debate over how to sustain the health and productivity of our environment. Despite substantial and recent effort to implement ecosystem management in the United States and elsewhere, to date considerable uncertainty remains about how to evaluate the historic and natural spatial-temporal variation in ecosystems, secure present and future management options by maintaining essential parts of an ecosystem (including wildlife), analyze wildlife information—habitat, distribution and abundance—that often is insufficient at the ecosystem scale, predict wildlife habitat and other requirements at the ecosystem level to satisfy national and agency legal and policy requirements, and offer recommendations that vary with taxa to ecosystem change—historic and future (i.e., restoration)—at an ecosystem scale that matches both planning strategies and implementation opportunities of land and resource management agencies. Our central goal in assembling this paper is to examine these five aspects—in essence the concept of ecosystem health and its relation to wildlife management—in a contemporary landscape, the Columbia River Basin in the Pacific Northwest of the United States. Our Interagency Working Group report begins with brief description of the extent and ecological significance of the major departures in the nature, distribution and structure of vegetation since intensive European settlement. Second, all vertebrate wildlife species within the Basin are evaluated based on trend, habitat and other information to identify those in need of consideration in management to meet legal and policy requirements. Third, given the lack of habitat and other natural history information for many species, we

describe a process to build and evaluate species' habitat information, recognizing that effects of environmental change on individuals is more easily detected than on populations (although the latter are often needed to meet legal and policy requirements under the Endangered Species Act, the National Forest Management Act and similar legislation). The fourth aspect is not a trivial task whether in scale, theory or practice. Specifically, characterize the distribution and abundance of habitats for species groups (related to geographic scale and species-specific ecology and behavior) and/or individual species; and determine whether such habitats may serve as "sources" of individuals—a consideration to the maintenance of viable species populations—or "sinks" where populations may be expected to decline without regular immigration; and map the results of task four. Unfortunately, most available wildlife and ecosystem theory and scientific literature addresses ecosystem management at a scale far less than that needed to implement, greatly increasing the difficulty in developing reasonable implementation ecosystem management strategies. We conclude with lessons learned in linking ecosystem health and wildlife management.

HUNTER MANAGEMENT STRATEGIES UTILIZED BY MONTANA RANCHERS ^{TWS}

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A survey of private ranches was conducted to identify practices used in Montana to manage hunters. A questionnaire was sent to 989 ranchers from a population identified as typical working ranches larger than 400 ha. Respondents (42% return) indicated 80 percent had no restrictions or simple permission to hunt on most of their land. Twelve percent of the respondents indicated their ranch was closed to hunting and 12 percent had fee hunting operations or leased to outfitters. Past damage by hunters (42%) and conflicts with hunters (33%) were reasons most cited for closing ranches to hunting. Combinations of strategies were utilized with vehicle restrictions, advanced reservations and check in/out being most common. Ranch size influenced management strategies with 63 percent of ranches under 4000 ha requiring only simple permission to hunt compared to 28 percent of ranches larger than 4000 ha. Sixteen percent of the smaller ranches had 50 percent or more of their land closed compared to 5 percent of the larger ranches. Implications of study results include a need for programs to address landowner concerns and programs to impress upon hunters the importance of their behavior in affecting public access to private land.

NESTING SUCCESS IN DECIDUOUS RIPARIAN HABITAT: HOW LANDSCAPES AFFECT NEST PREDATION AND BROOD PARASITISM ^{TWS}

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Effective wildlife conservation programs depend on a thorough understanding of the processes that limit population growth and the scale at which these processes change. In the case of migratory birds, two of the primary processes that limit breeding productivity are nest predation by a host of predators, and brood parasitism by brown-headed cowbirds (*Molothrus ater*). The importance of these processes depend on the behaviors of the predators and brood parasites interacting with their environments over large spatial scales. We examined the relationship between patch size, edge effects and landscape composition in determining nest predation and brood parasitism rates for species nesting in deciduous riparian areas in western Montana. Predation and parasitism were monitored in sixteen riparian areas surrounded by different landscapes, eight of which are primarily forested, and eight of which are dominated by agriculture. Parasitism was strongly related to the density of farms and feedlots, and was higher in the agriculture treatment. However, predation pressure was consistently higher in forested landscapes. Parasitism may be more clearly related to certain landscape metrics because it reflects the behaviors and habitat use of a single species, the brown-headed cowbird. In contrast, predation rates are determined by interactions between predator community composition, predator behaviors, and the nesting patterns of potential prey in different landscapes, creating a more complex system.

ELK ON THE URBAN FRINGE: A CREDIBILITY CHALLENGE FOR WILDLIFERS ^{TWS}

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Plausibly 100,000 free-roaming elk (*Cervus elaphus nelsoni*) habitually occupy human settlements or activity centers across western North America on an occasional or seasonal basis. If elk that are conditioned to human presence realize increased survivorship by occupying residential areas and other refugia during hunting season, then numbers of conditioned elk probably are increasing more rapidly than other segments of the Rocky Mountain subspecies. While wildlife managers advocate retention of natural habitats to prevent elk displacement from urban fringe areas in Montana, elk populations are expanding beyond management control in the face of extraordinary human population growth along the Front Range of Colorado. Land developers and governing bodies may find it increasingly difficult to accept the concept of elk habitat loss, and wildlife managers may find the concept increasingly difficult to explain, as the public gains awareness of conditioned elk responses. We present a conceptual framework for understanding and assessing elk responses to urban expansion, based on literature review and experiences with open space

conservation in and around Missoula, Montana. Conflicting observations of elk tolerance and intolerance in response to humans and habitat alterations may be reconciled by understanding that elk adapt behaviorally to maximize reproductive fitness. Elk behavioral responses to human developments may be predicted with improved reliability if managers correctly identify the most important factors that influence reproductive fitness under a given set of circumstances. Input in planning processes should be linked with clearly communicated goals, recognizing that elk survival may be less at issue than diverse human desires.

DEER MOUSE POPULATION STABILITY, SYNCHRONY, AND BIOMASS LOSS IN WESTERN MONTANA, 1994-1996^{TWS}

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Small mammal abundance has been speculated to have causal links to ecological processes ranging from human outbreaks of Hantavirus Pulmonary Syndrome (HPS) to predation on cervid fawns. During a study of hantavirus and deer mouse (*Peromyscus maniculatus*) ecology, we live-trapped 18 one-hectare grids at six sites in western Montana. We trapped monthly during the summers of 1994-1996. During 1994, the monthly minimum number alive (MNA) of deer mice on all grids ranged from 207 to 498 mice and monthly site average MNAs ranging from 0 to 66.7 mice. In 1995 populations were much lower, with monthly grid total MNAs ranging from 84 to 119 mice and monthly site average MNAs ranging from 0 to 16.7 mice. In 1996, populations increased with monthly grid total MNAs ranging from 141 to 452 mice and monthly site average MNAs ranging from 0 to 71.7 mice. In 1994 and 1996 the peak grid MNAs were at Polson and most grid populations increased to a peak in August or September. In 1995 the peak grid MNAs were at Cascade and most grid populations were bimodal with early and late summer peak MNAs. Within-site and between-site population synchrony will be examined. Values for monthly deer mouse biomass loss will be presented and discussed in terms of population stability.

WILDLIFE MANAGEMENT ON THE FORT BELKNAP RESERVATION^{TWS}

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The goal of wildlife management on Fort Belknap Reservation is to maintain populations within habitat carrying capacity. Harvest management objectives are established within the constraints of the population objectives. Hunting regulations are the primary tool used to fulfill management objectives. Hunting fees for tribal members are set a level comparable to Montana state resident fees. Non-member hunting license fees are market driven. An estimate of receipts for 1995 is \$86,500. Other examples of hunting regulations, income generated through license sales and evaluation of harvest management results are provided. Habitat management, law

enforcement, and education are also important components of wildlife management on Fort Belknap. The Fish and Wildlife program has grown from one full-time employee to 6 full-time employees during the past decade.

IDENTIFYING LANDSCAPE ELEMENTS IN RELATION TO ELK KILL SITES IN WESTERN MONTANA ^{TWS}

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The landscape elements that influence elk (*Cervus elaphus*) vulnerability during the hunting season were studied in the Chamberlain Creek area of western Montana. Locations of 84 hunter killed elk sites were compared to live elk locations and random points using discriminant function analysis. Elk kill sites could not be differentiated from random points, but locations of live elk were readily differentiated from both elk kill sites and random points. Elk selected elements of the landscape that 1) were not in close proximity to open roads, 2) had low road densities, and 3) contained forested cover in large patches that had not sustained timber harvest treatment within the past 10 years and provided substantial hiding cover.

THERE'S A MOUSE IN THE HOUSE!: THE ECOLOGY OF THE DEER MOUSE IN PERIDOMESTIC SETTINGS ^{TWS}

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Deer mice (*Peromyscus maniculatus*) are the principle reservoir of the Sin Nombre virus (SNV) that is the etiological agent of hantavirus pulmonary syndrome (HPS). Several studies of SNV in sylvan populations of deer mice are ongoing. However, most human cases of HPS are contracted in buildings (i.e., houses, trailers, barns, granaries, etc.). Unfortunately, virtually nothing is known about the ecology of deer mice in buildings. In October, 1996 we initiated a study to investigate the ecology of deer mice in peridomestic settings in western Montana. These data will be used to further our understanding of the SNV infection cycle in humans. The results of the first 6 months of our research will be discussed.

**BODY COMPOSITION AND MIGRATION POTENTIAL OF ARMY CUTWORM
MOTHS TAKEN FROM ALPINE AGGREGATION SITES
IN GLACIER PARK^{TWS}**

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Grizzly bears (*Ursus arctos horribilis*) consume army cutworm moths (*Luxoa auxiliaris*) from late June through mid-September on alpine talus slopes in Glacier National Park, Montana. To better understand the nutritional importance of army cutworm moths to grizzly bears in Glacier National Park, we determined temporal abundance patterns, body mass, total moisture, total nitrogen, total lipid, and gross energy of moths collected from alpine moth aggregation study sites throughout the summer. Army cutworm moths arrived in the alpine of Glacier National Park in early July in 1994 and in late June in 1995. We did not capture any army cutworm moths after 10 August in 1994 or after 30 July in 1995. Army cutworm moths showed a marked increase in body mass, total moisture, total lipid, and gross energy, and a decrease in total nitrogen over the course of the summer. We calculated that an army cutworm moth flying in late summer through still air, presumably at a speed that minimizes cost of transport, could fly 140 km using body lipid reserves alone.

ENVIRONMENTAL SCIENCES AND ENGINEERING

**PRELIMINARY STUDY OF THE BEAVERHEAD RIVER AND THE EFFECTS OF
THE DILLON COMMUNITY: BIOLOGY^{MAS}**

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Aquatic macroinvertebrate diversity and abundance are often used as a barometer of the health of riparian ecosystems. Aquatic macroinvertebrate counts, in conjunction with chemical analyses of specific stream reaches, may be useful harbingers of stream degradation. Sixty-two students from the 100 level biology class at WMC-UM participated in the field collection and in the laboratory identification of aquatic macroinvertebrates (to Order) sampled from four stations along the Beaverhead River in southwestern Montana. Stations were approximately 20 feet in length and located within the low water marks in areas with riffles and cobbles. Students collected 3 replicate samples of macroinvertebrates, with a surber stream bottom sampler, within each of the four river stations in January and again in February of 1997. Histograms were plotted to allow comparison of the distribution of invertebrate Orders within and across each of the four river sites. Two species