Literature Review of

Montana Upland Game bird Biology and Habitat Relationships

As Related to Montana Fish, Wildlife, and Parks'

Upland Game bird Habitat Enhancement Program

by

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PURPOSE AND SCOPE

The Upland Game Bird Habitat Enhancement Program (UGBHEP) administered by the Montana Department of Fish, Wildlife, and Parks (FWP) was established by the Pheasant Enhancement Bill, which was passed by the Montana Legislature in 1987 in response to declining pheasant populations in the state. The Pheasant Enhancement Bill was designed to provide reimbursement of $3 per bird to cooperators for raising and releasing pheasants in suitable habitat. Funding for reimbursements was provided by setting aside portions of upland game bird license fees. The program was expanded in 1989 to allow unused funds to be devoted to projects for improving and enhancing habitat for all upland game bird species. These projects are enacted via annual to perpetual contracts with individual landowners. The primary habitat improvement projects include planting trees to create or expand shelterbelts, seeding grasses to create nesting cover, developing range management plans to maintain and improve habitat, planting plots for winter food, and restoring wetlands (Montana FWP 1998).

One step in FWP's on-going process of refining and improving the UGBHEP is to assess the extent to which current management prescriptions are based on the best understanding of the biology of the species of interest. To that end, we compiled this report on the peer-reviewed literature pertaining to upland game birds in Montana relative to the management prescriptions of the UGBHEP. This document organizes and synthesizes selected literature on habitat requirements, general biology, and habitat management for upland game birds. The species considered in this document include the native species of Greater Sage-grouse (*Centrocercus urophasianus*), Sharp-tailed Grouse (*Tympanachus phasianellus*, "sharptails"*)*, Blue Grouse (*Dendragopus obscurus*), Spruce Grouse (*Dendragopus canadensis*), Ruffed Grouse (*Bonasa umbellus*), and introduced species of Wild Turkey (*Meleagris gallopavo* spp.), Ring-necked

Pheasant (*Phasianus colchicus*), Gray (or Hungarian) Partridge (*Perdix perdix*), and Chukar Partridge (*Alectoris chukar*). In Montana, however, populations of chukar partridge are small and isolated relative to more abundant upland game species (Bergeron et al. 1992), and chukar partridge provide little hunting opportunity to Montana hunters. Thus, direct management of chukar habitat is not a current objective of the UGBHEP.

We focused on peer-reviewed literature published in professional journals and included some un-refereed "gray" literature (such as state wildlife agency reports, theses, and dissertations) where appropriate. We restricted our selection of papers to include studies conducted in near or comparable areas to those experienced by Montana populations. We favored recent papers (generally those published later than 1960), with the exception of some older, but particularly informative, descriptions of natural history and basic biology.

This document is organized into four parts: (1) an introduction that provides some background on the history of upland game bird management in the United States since the mid-1900s, (2) brief accounts of each species' habitat requirements and applicable life-history traits, (3) a relating of that species-specific information to each of the primary management prescriptions of the UGBHEP, and (4) a summary of the major themes identified during the literature review. We explicitly avoided speculative evaluations or judgments of the UGBHEP prescriptions; our intent was to provide a concise summary of what is known about relationships between populations of upland game birds and their habitats and the observed responses of populations to UGBHEP activities.

INTRODUCTION

The history of upland game bird management since the mid-1900s is marked by evolving operational perspectives. The past 50 years of upland game bird management in the United

States can be generally characterized as a period of (1) shifting perspectives on the relative importance of habitat management and predator control, and (2) an increase in the scale of consideration.

The role of habitat management in producing game birds was well established by the 1950's, but the perspective was generally small-scale – a food plot and an old-field here, a nesting-cover plot and a brush patch there. During the same period, interestingly, the perspective on predator control shifted from local to regional extermination of predators. This perspective was reinforced by the fact that predator control is often effective at meeting the immediate goal of upland game bird management: to increase harvestable post-breeding populations (Cote and Sutherland 1996).

Management perspectives grew broader as knowledge of game bird ecology increased and became accessible to game managers, land-use practices changed, and some game bird species began or continued to decline. Management grew beyond localized habitat improvement projects and started to look at habitat condition at larger scales. With improved techniques for estimating population parameters, managers were able to go beyond abundance indices and quantify population growth or decline in relation to habitat characterization or hunting pressure. This trend has continued, and further analytical developments now allow managers to assess population viability, simulate and project population response to different management alternatives, analyze the relative impacts of individual vital rates on population growth, and investigate observer effects on the individuals they study.

Trends in perspectives toward predator control since the 1950s are less clear. Predator control has always been a component of human interaction with our wild competitors for resources. It is a foundational component of upland game bird management and the period

considered here is no exception. What have changed over the last 50 years, however, are public attitudes toward predator control and the vigor and extent of its application.

Direct, lethal control of predator populations was a common and widely-used management strategy during the first half of the 20th century, but fell from favor as environmental awareness increased among wildlife professionals and the public (Ball 1996). There were many reasons for this change, but they included "the recognition of negative ecological consequences associated with the extirpation of large carnivores, problems associated with some control methods (i.e., bounties and toxicants), changes in values among both the public and wildlife professionals, and the increasingly common view that conservation and restoration of habitat provided an effective and more ecologically sensitive alternative" (Ball 1996:197). Management of North American upland game bird populations is currently addressed by manipulating habitat, because it is believed to be the most economical, efficient, and feasible long-term strategy to enhance populations of upland game birds (see also Geisen and Connelly 1993, Connelly et al. 2000, Hewitt et al. 2001, Schroeder and Baydack 2001).

The primary goal of current management strategies is to manipulate habitat to support self-sustaining populations. Several declines in abundance of widely distributed species (e.g., Ring-necked Pheasants, Sage Grouse, Columbian sharptails, Attwater's, Greater-, and Lesser-Prairie Chickens, and, recently, Bobwhite Quail [*Colinus virginianus*]) have generated regional and range-wide conservation and management concern. Furthermore, many upland game bird species are managed for hunter harvest. Current management is thus faced with two main issues: (1) maintaining harvestable local populations of native and desired non-native species, and (2) addressing the conservation of species experiencing long-term, range-wide declines.

SPECIES ACCOUNTS

Sharp-tailed Grouse (*Tympanachus phasianellus*)

Historically, sharptails were found in steppe, grassland, and mixed-shrub habitats throughout much of central and northern North America (Connelly et al. 1998). They still range from the Great Lakes west to Alaska and south to Colorado, but numbers have declined greatly in the southern and eastern portions of their range, and many populations now depend on cropland for food to varying degrees (Connelly et al. 1998). Less literature is available for Plains (*T. p. jamesi*) than for Columbian (*T. p. columbianus*) sharptails, and we use information from those two here. The range of Plains sharptails has contracted northward since the 1930s (Aldrich 1963). Populations in New Mexico and Kansas have been extirpated, and only remnant populations remain in Colorado (Johnsgard 1983). Reductions in abundance and distribution have been attributed to habitat losses due to modern agricultural practices, domestic livestock grazing, fire suppression, and increases in predator populations (Kirsch et al. 1973, Bergerud 1988, Bousquet and Rotella 1998). Despite the noted declines and range contraction, few studies have examined reproductive success of sharptails (Gunderson 1990, Meints 1991, Bousquet and Rotella 1998).

Leks tend to be geographically central to habitats used throughout the year and usually occur on elevated areas (Baydack 1988, Meints 199, Tsuji 1992, Giesen and Connelly 1993) with gentle slop and less vegetation than surrounding areas (Baydack 1988, Klott and Lindzey 1989). Lek locations may shift if the specific location is covered by snow or water or if burned, but tend to remain stable from year to year (Sexton and Gillespie 1977, Baydack and Hein 1987, Baydack 1988, Bergerud and Gratson 1988, Tsuji 1992). Individuals can disperse up to 190 km (118 mi); annual home range sizes are typically small but may vary seasonally (15-32 ha (37-79

ac) in spring and summer and 100-400 ha (247-988 ac) in fall and winter; Buss 1984, Connelly et al. 1998).

The reproductive pair bond lasts only through courtship on the lek prior to mating, and few males obtain a large proportion of matings (Connelly et al. 1998). Breeding habitats used by sharptails are dominated by relatively dense herbaceous cover and shrubs (Connelly et al. 1998, Baydack 1988, Saab and Marks 1992). High-quality nesting habitat is generally provided by structural diversity including stands of grasses, shrubs, and forbs (Meints et al. 1992). Nests are usually located in heavy cover, often under a shrub in vegetation at least 30 cm (12 in) high with dense foliage, including relatively tall residual cover (Meints 1991). Clutch size ranges from 10-12 eggs. Hens will often renest after a failed prior attempt; up to four nesting attempts have been documented, and incubation is 21-23 days (Connelly et al. 1998). Broods depend on areas with abundant forbs and insects, often with a high diversity of shrubs and interspersion of cover types (Marks and Marks 1987). Important brood-rearing areas include farm fields and sites with dense forb cover (Klott and Lindzey 1990, Marks and Marks 1987).

In fall and winter, sharptails feed primarily on buds, seeds (especially cereal grains), herbaceous matter, and fruits (Connelly et al. 1998). Grain fields, shrub stands, grasslands (during mild winters), hardwood draws, riparian areas, and deciduous woodlands are important foraging areas (Ulliman 1995). In severe winters, hardwood draws and tree rows become especially important for foraging (Swenson 1985, Ulliman 1995). During spring and summer, important food items include forbs and grasses, insects, fruits (e.g., buffaloberry [*Shepherdia* spp.]), and flowers (Jones 1966, Prose 1987). Cultivated crops and areas with dense forb cover, and sparse or moderate grass and shrub cover are important forage areas in spring and summer months (Marks and Marks 1987). There is no direct evidence that sharptails require open water

(Prose 1987), though mesic areas may be an important source of moisture during summer and individuals may eat snow during winter (Connelly et al. 1998).

In winter, sharptails rely on riparian areas, deciduous hardwood shrub draws, and deciduous and open coniferous woods (Moyles 1981, Swenson 1985, Marks and Marks 1988, Giesen and Connelly 1993). Deciduous trees and shrubs are important throughout the range of sharptails for feeding, roosting, and escape cover; common species include serviceberry (*Amelanchier* spp.), snowberry (*Symphoricarpos* spp.), sagebrush (*Artemesia tridentata*), hawthorne (*Crataegus* spp.), and willow (*Salix* spp.); Geisen and Connelly 1993, Connelly et al. 1998). During mild winters, sharptails will also use grain fields and CRP fields (Meints 1991, Schneider 1994, Ulliman 1995). Winter sites are characterized by taller shrubs and less snow than random locations (Meints 1991, Ulliman 1995, Connelly et al. 1998).

Adult mortality is due largely to predation and hunting, with high mortality in severe winters suspected to be due to increased vulnerability to raptors (Ulliman 1995, Connelly et al. 1998). Chick mortality is due to environmental conditions and predation (Connelly et al. 1998). Known predators of adult sharptails include coyote (*Canis latrans*), weasels (*Mustela* spp.), red fox (*Vulpes vulpes*), and many raptor species (Connelly et al. 1998). Predation appears to be particularly important for breeding-age birds during the breeding season (Bergerud 1988, Schroeder and Baydack 2001) and may also be substantial during severe winters due to increased risk of predation, especially from avian predators (Ulliman 1995, Connelly et al. 1998, Schroeder and Baydack 2001).

Greater Sage-grouse (*Centrocercus urophasianus*)

Greater Sage-grouse (hereafter, "sage grouse"), North America's largest grouse, are obligates of sagebrush (*Artemesia tridentata*) habitats through the western United States and

southern Alberta, Canada (Schroeder et al. 1999). Populations range-wide have declined by as much as 99% from historic levels (USFWS 2004), largely attributable to habitat loss, fragmentation, and degradation associated with expansion of farming and grazing activities (Connelly and Braun 1997). Populations through the eastern two-thirds of Montana are non-migratory, though some birds in southwest Montana migrate seasonally between Montana and Idaho (J. Connelly, J. Roscoe, pers. comm.).

Sage grouse rely heavily on sagebrush habitats throughout the year, and these habitats have a tremendous amount of variation in vegetative composition, habitat fragmentation, topography, substrate, weather, and frequency of fire (Schroeder et al. 1999). Consequently, sage grouse are adapted to a mosaic of sagebrush habitats throughout their range, including (1) relatively tall sagebrush, (2) relatively low sagebrush, (3) forb-rich mosaics of low and tall sagebrush, (4) riparian meadows, (5) steppe dominated by native grasses and forbs, (6) scrub-willow (*Salix* spp.), and (7) sagebrush savannas with juniper (*Juniperus* spp.), ponderosa pine (*Pinus ponderosa*), or quaking aspen (*Populus tremuloides*) interspersed (Patterson 1952, Dalke et al. 1963, Wallestad 1975, Schroeder et al. 1999). Though sage grouse may make some seasonal use of altered habitats such as alfalfa (*Medicago sativa*), wheat (*Triticum* spp.) and crested wheatgrass (*Agropyron cristatum*), the usefulness of such habitats depends largely on their configuration with native habitats (Patterson 1952, Braun et al. 1977, Braun 1998, Schroeder et al. 1999).

Breeding habitat consists of lekking areas, nesting habitat, and brood habitat. Leks are typically placed on sites surrounded by potential nesting habitat (Wakkinen et al. 1992), and are often located on broad ridge tops, grassy swales, dry lake beds (Patterson 1952, Wallestad 1975, Klott and Lindzey 1989) and black-tailed prairie dog towns (B. Moynahan, pers. obs.); they are

characterized as having less herbaceous and shrubby vegetation than surrounding areas (Patterson 1952, Wallestad 1975, Klott and Lindzey 1989). Nests are placed in relatively thick cover, usually dominated by sagebrush (Wallestad and Pyrah 1974, Wakkinen 1990, Gregg 1994). Vegetatively diverse habitats may provide the best nesting environments by ensuring both horizontal and vertical concealment (Connelly et al. 1991, Sveum 1998a, Schroeder et al. 1999). Broods use a mosaic of habitat including sagebrush, riparian meadows, greasewood (*Sarcobatus vermiculatus*) bottoms, and alfalfa fields; the common feature of brood areas is that they are rich in forbs and insects (Dunn and Braun 1996, Klott and Lindzey 1990, Drut et al. 1994a, Pyle and Crawford 1996, Sveum et al. 1998b).

Winter range is similar to breeding range, but often with taller and denser sagebrush (Eng and Schladweiler 1972, Wallestad 1975). Variation in topography and height of sagebrush ensures availability of sagebrush in different snow conditions (Beck 1977, Hupp and Braun 1989, Schroeder et al. 1999). Females may use denser sagebrush than males (Beck 1977).

Adult sage grouse forage predominantly on sagebrush in all seasons, and almost exclusively from late autumn through early spring (Wallestad et al. 1975). Insects are important for juveniles, particularly during the first 3 weeks of life (Drut et al. 1994b, Pyle and Crawford 1996). Forbs are particularly important for hens during the egg-laying period (Barnett and Crawford 1994). Common forbs important to juveniles and hens include common dandelion (*Taraxacum officinale*), yellow salsify (*Tragopogon dubius*), prairie pepperweed (*Lepidium densiflorum*), clover (*Trifolium* spp.), alfalfa, yarrow (*Achillea* spp.), sweet clover (*Melilotus* spp.), vetch (*Vicia* spp.), and prickly lettuce (*Lactuca serriola*; Patterson 1952, Wallestad et al. 1975, Barnett and Crawford 1994, Schroeder et al. 1999).

Sage grouse survival is generally high relative to other upland game birds (Zablan et al. 2003), but may vary widely both annually and seasonally (Moynahan 2004). Predation likely accounts for most sage grouse mortality, but there have been few studies that specifically quantify predation rates (Schroeder et al. 1999). Predation attempts on leks by Golden Eagles disrupt and often terminate displays for the morning (B. Moynahan, pers. obs). Predation appears to be particularly important for incubating and brood-rearing females and for males displaying in the breeding season (Schroeder and Baydack 2001).

Ruffed Grouse (*Bonasa umbellus*)

The ruffed grouse is distributed throughout deciduous and coniferous forests of North America, but is most abundant in early-successional forests dominated by aspens and poplars (*Populus* spp.; Stauffer and Peterson 1985a, Rusch et al. 2000). Ruffed grouse in the western United States are closely associated with aspen (particularly quaking aspen [*Populus tremuloides*]) and riparian habitats (Brewer 1980, Rusch et al. 2000). Optimal year-round habitat is described as a mixture of young and old forest, providing both cover and food; larger, contiguous blocks of upland aspen habitats are better than smaller, isolated or fragmented woodlots surrounded by agricultural fields (Rusch et al. 2000).

In spring, males perform a drumming display, which presumably attracts females and wards off other males (Rusch et al. 2000). A fallen log is typically used, though occasional use may be made of large rocks, mounds of dirt, stumps, exposed tree roots, or other elements that elevate grouse above the ground (Gullion 1967). Vegetation structure around drumming sites has been described as early-seral-stage hardwood forest, where understory stem densities are high (i.e., vertical cover provided by brush, saplings, and young trees) but visibility at ground level is good for detecting terrestrial predators and other grouse, and where dense overstory

cover provides protection from avian predators (Boag and Sumanik 1969, Rusch and Keith 1971, Boag 1976). Thick understory cover generally supports high male densities, but dense shrubs and saplings devoid of overstory apparently do not (Rusch and Keith 1971). Gullion (1967, 1970) suggested, however, that dense overstory (>60% canopy closure) provides hunting cover for raptors and may result in elevated mortality of ruffed grouse. Impenetrable ground cover, caused by thick ground cover, logging slash, or wind-thrown trees, is unsuitable (Rusch et al. 2000).

Ruffed grouse nest in hardwood or aspen stands (or riparian stringers) with open understories (presumably for good visibility to detect ground predators) and dense overstory cover (Rusch et al. 2000). In the western United States, broods use aspen or mixed aspen-conifer stands in drainage bottoms during late summer when upland conditions are hot and dry (Stauffer and Peterson 1985b). In winter, aspen stands are preferred (Gullion 1970), though birds in Idaho have been shown to make heavy seasonal use of conifers (Hungerford 1951, 1953). Food may be more important than cover shortly before the onset of winter and, at that time of year, birds may be found in areas with a higher abundance of fruit- and berry-producing trees, shrubs, and vines (Rusch et al. 2000). In winter, mature aspen and hardwood stands are used for foraging, and nearby or adjacent stands of dense saplings for cover. When available, ruffed grouse will use snow roosts; they will otherwise use dense hardwood or conifer saplings for roosting in cold temperatures (Rusch et al. 2000).

In spring and summer, ruffed grouse consume leaves from a variety of herbaceous plants, as well as soft fruits; insects and other invertebrates are important to chicks, and are also eaten by adults (Rusch et al. 2000). Buds and catkins of aspen, willows (*Salix* spp.), and birches (*Betula* spp.) are important winter food (Rusch et al. 2000).

Most mortality in ruffed grouse is caused by predators, and cyclic declines have been associated with predators (particularly Goshawks [*Accipter gentilis*] and Great Horned Owls [*Bubo virginianus*]) switching from their main prey item of snowshoe hares (*Lepus americanus*) to ruffed grouse and other alternate prey items (Rusch et al. 2000). Eggs, chicks, and adults are taken by a wide variety of predators, including weasels and mink (*Mustela* spp.), fishers (*Martes pennanti*), red foxes, American Crows, coyotes, lynx (*Lynx canadensis*), bobcats (*Lynx rufus*), and a wide variety of raptors. In general, however, localized predator control has not been shown to result in an increased abundance of ruffed grouse (Hewitt et al. 2001).

Blue Grouse (*Dendragopus obscurus*)

Blue grouse are endemic to mountainous regions of western North America and exhibit a restricted range (Zwickel 1992). Virtually all populations winter in conifer forest, where conifer needles comprise the main winter food (Zwickel 1992). Their distribution appears to be determined, in part, by the proximity of suitable breeding areas to montane forest acceptable for winter use (Zwickel 1992).

Male territories in Montana were typically 0.8 ha (2.0 ac) in size, characterized by open, herbaceous cover, and almost always contained a relatively small thicket of young (10-60 year old) coniferous trees (Martinka 1972). Most populations are locally migratory, moving from lower elevation, relatively open breeding areas to higher elevation, denser conifer habitats in winter (Zwickel 1992). Winter habitats are nearly exclusively montane conifer forest (Stauffer and Peterson 1985a, Cade and Hoffman 1990), though some birds in Colorado will remain on "brush range" up to 16 km (10 mi) from conifers (Rodgers 1968, Zwickel 1992).

Nest sites are selected by females and are usually outside male territories (Zwickel 1992). Nests are almost always on the ground, very rarely on a stump, and are located through all

community types occupied during the breeding season (Bendell and Elliot 1966, Zwickel 1992).

Most nests have overhead cover (Zwickel 1992). In interior forests, nests (*n*=49) were located

under shrubs (39%), rock overhangs (24%), or logs or stumps (14%; Zwickel 1992). In shrub-

steppe habitats, nests (*n*=61) were located under shrubs (70%) or large grasses (18%), especially

bunchgrasses (Zwickel 1992). Nests are a shallow scrape in the ground, often poorly lined with

dead vegetation and perhaps a few contour feathers (Zwickel 1992). Clutch sizes in Montana are

typically 6-10 eggs (unpub. data, Zwickel 1992). Incubation lasts 25-28 days (Zwickel 1992).

During spring and summer months, blue grouse feed on a variety of leaves, flowers,

berries, conifer needles, invertebrates (especially young juveniles; Zwickel 1992). Food items

recorded by Beer (1943) in Oregon, Washington, and Idaho include hawthorne, currants (*Ribes*

spp.), kinnick-kinnick or bearberry (*Arctostaphylos uva-ursi*), huckleberries (*Vaccinium* spp.),

salal (*Gautheria shallon*), and small amounts of other plants. Stewart (1944) also recorded

dietary use of buffalo berry (*Shepherdia canadensis*), chokecherry (*Prunus* spp.), buckwheat

(*Eriogonum* spp.), and vetch (*Vicia* spp.). Conifer needles are staple food items from late

autumn through early spring, with some consumption of conifer buds, twigs, and staminate cones

(Zwickel 1992). Blue grouse in Colorado exhibit a preference in winter for Douglas fir

(*Pseudotsuga menziesii*) and lodgepole pine (*Pinus contorta*), and often fed on young needles in

the upper canopy of older trees (Remington and Hoffman 1996).

Most nest failures result from predation (Zwickel et al. 1988, Hewitt et al. 2001), though

average nest loss across 7 studies is relatively low at 32% ± 4.0 (Hewitt et al. 2001). Known

predators of adults are Northern Goshawk (*Accipter gentilis*), Red-tailed Hawk (*Buteo

jamaicensis*), Golden Eagle, Prairie Falcon (*Falco mexicanus*), Great Horned Owl (*Bubo

virginianus*), and Canada lynx (*Lynx canadensis*). Circumstantial evidence implicates Bald Eagle

(*Haliaeetus leucocephalus*), coyote, wolf (*Canis lupis*), red fox, black bear (*Ursus americanus*), badger, mountain lion, bobcat, and mustelids; smaller hawks (*Accipiter* and *Buteo* spp.) and falcons (*Falco* spp.) are known to take juveniles (Zwickel 1992). Effects of predator removal on forest grouse abundance are not clear, and in some cases have corresponded with decreases in population abundance (Hewitt et al. 2001). Further, Hewitt et al. (2001) suggest that predator removal would have little if any impact on abundance of blue grouse.

Spruce Grouse (*Dendragapus canadensis*)

Spruce grouse inhabit the boreal forest from Newfoundland to Alaska, and the Franklin's subspecies (*D. c. franlinii*) occurs in the northern Rocky Mountains from northwestern Wyoming to southern British Columbia and central Alberta (Aldrich 1963). It is a conifer specialist, feeding on pine (*Pinus* spp.) or spruce (*Picea* spp.) needles for much of the year (Boag and Schroeder 1992). Populations appear to fluctuate, primarily in response to the degree of maturation of post-fire regrowth and secondarily to predation pressure (Boag and Schroeder 1992). A mosaic of forest ages, historically created by fire, is necessary for sustaining spruce grouse populations, as islands of young post-fire regrowth support maximum densities for only 10-15 years (Boag and Schroeder 1987, Boag and Schroeder 1992).

Franklin's spruce grouse use forest communities dominated by lodgepole pine or mixed stands of lodgepole pine and Douglas-fir throughout the year (Stoneberg 1967, Keppie and Herzog 1978, Boag et al. 1979, Ratti et al. 1984). Birds may make heavy use of Englemann spruce (*Picea engelmanii*) but forage mostly in lodgepole pine (Hohf et al. 1987), prefer pine over spruce (Hohf et al. 1987), and apparently prefer relatively young successional stands (Boag and Schroeder 1992). Chicks feed predominantly on animal matter in the first months of life,

increasing plant matter through late summer, and diets mirror adults by November (Pendergast and Boag 1970).

Males select territorial sites with greater canopy cover and stem density overall, but less shrub cover, than non-territorial sites (Boag and Schroeder 1992). Both sexes are capable of breeding their first year, and most females nest (Boag and Schroeder 1992). Average clutch size of Franklin's grouse is 4.8 eggs (Keppie 1982). Females with broods tend to select more open canopy than broodless females (Boag and Schroeder 1992). Nests are a depression in the ground with the common feature of overhead cover, usually provided by the nest's location at the base of a coniferous tree (Boag and Schroeder 1992). Incubation lasts approximately 21 days (Boag and Schroeder 1992).

A major egg predator appears to be the red squirrel (*Tamiasciurus hudsonicus*), though corvids are also suspected (Boag et al. 1984). A wide variety of mammalian (canids and mustelids), raptors are known to take juvenile and adult birds, and it is assumed that most mortality is attributable to predation (Boag and Schroeder 1992). Individuals avoid predators with a combination of camouflage and immobility (Boag and Schroeder 1992). Survival varies widely, especially between subspecies; Franklin's grouse annual survival ranges from 60-75%, with males generally having higher survival than females and both sexes having higher survival overwinter than during the breeding season (Keppie 1979). The effects of predator removal on forest grouse abundance are not clear, and Hewitt et al. (2001) suggest that predator removal would have little if any impact on abundance of spruce grouse.

Ring-Necked Pheasant (*Phasianus colchicus*)

The ring-necked pheasant was introduced to North America from Asia in the 1880s and quickly became established in agricultural landscapes throughout the temperate latitudes of the

United States and Canada. The largest pheasant populations were observed during the period from 1930 to 1950; pheasant populations declined 30% range-wide during 1966-1998 (Giudice and Ratti 2001). This decline is thought to be related to habitat change (Jarvis and Simpson 1978, Warner and Etter 1985, Riley 1995, Perkins et al. 1997). Over the past 50 years, agricultural practices have shifted from small, diversified farming and ranching operations with interspersion of frequently rotated, idle areas (e.g., fencerows, fallow fields) to larger and more intensive operations, which leave few idle areas (Warner et al. 1999, Eggebo et al. 2003). Reduced abundance notwithstanding, the pheasant remains a popular game bird throughout its range and continues to generate substantial interest among hunters (Riley and Schulz 2001). Therefore, understanding the responses of pheasant populations to changes in the quality and quantity of available habitat is important to wildlife managers. These responses are related to the life history characteristics, diet, and habitat selection behavior of pheasants and external influences such as predation, climate, and land use practices (Hill and Robertson 1988).

The life history of pheasants is characterized by a relatively short lifespan (1-3 years) and high reproductive rate (Hill and Robertson 1988, Giudice and Ratti 2001). They breed in their first year, are polygynous, lay clutches of 9-10 eggs, and persistently renest (Giudice and Ratti 2001). Incubation lasts for 23-25 days (Hill and Robertson 1988). Pheasant young are precocial, fledge within 14 days of hatching, and become independent at 10-12 weeks of age (Hill and Robertson 1988). Chick survival averages approximately 50% (Riley et al. 1998, Giudice and Ratti 2001). Survival of adult females averages (21%-46%); survival of males is much lower (7%). Disparity in survival of males and females is largely attributable to mortality from hunting (Giudice and Ratti 2001).

Pheasants are sedentary: most observed dispersal movements are <5 km (3 mi; Giudice and Ratti 2001). Home ranges of pheasants are small (36-135 ha; 89-334 ac) and vary between sexes and seasons (i.e., males have larger home ranges than females, and winter-spring home range is generally smaller that summer-fall home range; Perkins et al. 1997, Schmitz and Clark 1999, Giudice and Ratti 2001).

The diet of pheasants is mostly composed of seeds (especially grain), wild fruits, and insects (Hill and Robertson 1988). In the mid-western and western United States, 70%-90% of the fall-winter diet is composed of grain and row-crop seeds (Giudice and Ratti 2001). Domestic seeds also largely dominate the diet of adult pheasants during the spring-summer period (Giudice and Ratti 2001). Insects are an important source of protein for chicks during the first 8-10 weeks of life and for females during breeding (Meyers et al. 1988, Hill and Robertson 1988, Riley et al. 1998).

Habitat selection during the spring-summer period is related to the need for cover for nesting and brood rearing (Camp and Best 1994, Riley et al. 1998, Clark and Bogenschutz 1999, Giudice and Ratti 2001, Grove et al. 2001). Female pheasants select nest-sites on the ground in tall (>30 cm; 12 in) stands of dense vegetation (Camp and Best 1994, Giudice and Ratti 2001). Nesting begins in mid to late April with peak of hatching in mid June across most of the mid western and western states (Giudice and Ratti 2001), thus residual cover from the previous growing season is commonly selected for nesting (Camp and Best 1994). Preferred vegetation for nesting is typified by mixed stands of grass and forbs; alfalfa (*Medicago sativa*) is a very common plant at nest sites (Schmitz and Clark 1999, Eggebo et al. 2003). Nests are most often located in idle areas with dense residual cover (e.g., fields of planted cover, roadsides, fencerows; Warner et al. 1987, Clark and Bogenschutz 1999). Pheasants also nest in crop fields

(Snyder 1984) and hayfields (Warner et al. 1987), although many nests in these habitats are renests (Clark and Bogenschutz 1999). After hatch, females and broods often forage and roost in similar habitats to those used for nesting (Warner 1984, Riley et al. 1998). Movement distances increase as chicks become older (>7 days), and females with broods begin using crop fields and hay meadows as foraging habitat (Riley et al. 1998).

Throughout fall and winter, pheasants generally forage in crop fields during the day and roost in dense cover at night (Giudice and Ratti 2001). The density of roosting cover selected by pheasants is related to temperature and snow depth (Leptich 1992, Gabbert et al. 1999, Hohman et al. 2000). Pheasants will roost in crop fields and conservation plantings in fall, but cold weather and snow will cause movements to roosting sites in shelterbelts and shrub plantings (Warner and David 1985, Hohman et al 2000). During cold weather (minimum temperatures < -15° C; 59° F) and periods of deep snow cover (>30 cm; 12 in), wetland margins, patches of shrub cover, shelterbelts, and tree rows are selected for roosting (Gabbert et al. 1999, Hohman et al 2000).

Predation is the primary source of direct mortality for all life stages of pheasants, but severe weather often increases vulnerability of pheasants to predation (Trautman and Fredrickson 1974, Riley and Schulz 2001). Mammalian predators (e.g., Red Fox [*Vulpes vulpes*]) are the apparent cause of most nest failures (Giudice and Ratii 2001) and mortality of pheasant chicks (Riley et al 1998). Avian and mammalian predators, including red fox, coyote (*Canis latrans*), red-tailed hawks (*Buteo jamaicensis*), and great-horned owls (*Bubo virginianus*), are the primary identified cause of mortality in studies of radio-marked female pheasants (Leif 1996, Hohman et al. 2000). Removal of predators has often been shown to substantially increase the survival and reproductive success of pheasants at local scales, further illustrating the strong

influence of predation on pheasant populations. (Trautman and Fredrickson 1974, Riley and

Schultz 2001).

Other sources of mortality include weather, agricultural activities, and hunting (Giudice

and Ratti 2001). Severe weather events cause mortality of adult and juvenile pheasants by

hypothermia and starvation and by increasing vulnerability to predators (Warner and David

1982, Gabbert et al. 1999, Hohman et al. 2000). Hay cutting and crop cultivation can cause

destruction of nests and mortality of females and chicks (Warner and Etter 1989, Riley et al.

1998). Hunting mortality reduces survival of pheasants, but wildlife management agencies

generally restrict harvest to male birds; female mortality due to illegal harvest is probably much

lower (Giudice and Ratti 2001).

Gray Partridge (*Perdix perdix*)

The gray partridge was introduced to the North America in the early 1900s. Like the

ring-necked pheasant, the gray partridge is a bird of agricultural landscapes. Established

populations of gray partridge occur throughout agricultural areas in the mid-western and western

United States (Wiegand 1980, Carroll 1993). There is little information about trends in

abundance of partridge populations, but gray partridge have declined in some areas with

intensive agricultural land-use (Carroll 1993, Rotella et al. 1996). These birds are harvested as

game species across most of their range; however, specific habitat management for gray

partridge is uncommon (Carroll et al. 1993). Rather, it is generally assumed that partridge

populations respond positively to land management efforts that benefit other upland bird species

(e.g., ring-necked pheasant; Carroll 1993). Life history, diet, and habitat use are similar between

ring-necked pheasants and gray partridge (Carroll 1993). Extrinsic influences such as land use

practices, severe weather, and predation may also affect partridges and pheasants in similar ways (Carroll 1993, Giudice and Ratti 2001).

Gray partridge have short life spans (1-5 years), high annual mortality, and high reproductive rates (Weigand 1980, Carroll 1993). Partridge breed in their first year, lay large clutches (10-22 eggs), and are persistent renesters. Incubation lasts 25 days; young are precocial and fledge in 13-15 days (Carroll 1993). Breeding success ranges from 41%-82%. Chick survival varies from 57%-75% in northern states (Carroll 1993). Mortality is highest during winter and breeding (Rotella et al. 1996), and average annual mortality is near 70% (Carroll 1990).

Partridge are non-migratory and dispersal varies between sexes; movements are <25 km (Carroll 1993, Carroll et al. 1995). In North Dakota, mean home range size was 8-23 ha in spring (Carroll et al. 1990). Fall home range in South Dakota was 16-310 ha; winter home range in South Dakota was 105-392 ha (Smith et al. 1982).

The diet of gray partridge includes grain, row crop seeds (e.g., sunflower seeds), wild fruits and seeds, insects, and leaves of forbs and shrubs (Weigand 1980, Hupp et al. 1988, Carroll 1993). Diet varies seasonally, in fall and winter, grains comprise the majority of the diet, in spring and summer more insects, wild seeds, and leaves are consumed (Carroll 1993). Insects are the major source of nutrition for chicks less than 10 weeks old (Weigand 1980, Hupp et al. 1988).

Habitat selection of gray partridge reflects changing food and cover needs during different periods of the annual cycle. During the breeding season, females select nest sites in dense grass or shrub cover (Weigand 1980, Carroll 1993, Rotella et al. 1996). Nests are usually located in patches of idle land (e.g., roadsides, shelterbelts) within a matrix of agricultural fields

that are used for feeding; however, late-initiated nests are often located in active grain fields (Carroll et al. 1995). Adults with chicks use crop fields, meadows, and hay fields, as well as conservation plantings for foraging and roosting (Smith et al. 1982, Hupp et al. 1988). Partridge forage, loaf, and roost in grain and row crops during fall and winter and roost in shrub and tree cover during periods of severe winter weather (Carroll et al. 1995).

The major cause of mortality for gray partridge in all stages of their life cycle is predation (Wiegand 1980, Carroll 1993). Mammals, including red fox and striped skunk (*Mephitis mephitis*) are major predators of partridge nests and chicks (Carroll et al.1991). Avian predators (e.g., great-horned owls and snowy owls [*Nyctea scandiaca*]) prey on adult and juvenile partridge during winter (Carroll 1990). Experimental predator control indicates that partridge populations can increase by a factor of 3-5 when mammalian predators are removed (Tapper et al. 1996). Exposure to cold temperatures, deep snow, and cold, wet spring weather also causes direct mortality of adults, chicks and eggs and is influential to populations (Carroll 1990).

Chukar Partridge (*Alectoris chukar*)

Chukar partridge were introduced to North America in the 1890s, and populations of chukar are currently established from northern Arizona to southern Washington (Christensen 1996). Chukars are birds of rugged, mountainous habitats characterized by interspersion of grass-forb and shrub cover. Chukar habitat is typified by the high desert rangeland of the Great Basin (Christensen 1996). Chukar partridge are an important game bird in Nevada, Idaho, and Washington where the largest populations have been established (Christensen 1996). There is limited information available about habitat relationships and population dynamics of chukars in North America (Lindbloom et al. 2003).

The life-history of chukar partridge is similar to that of gray partridge. Chukars have high reproductive output and low survival rates. These birds breed in their first year, have average clutch sizes of 14-16 eggs, and annual hen success of 40%-80% (Christensen 1996, Lindbloom et al. 2003). Chukar populations appear to fluctuate in response to severe winter weather, and precipitation cycles (Christensen 1996).

Diet of chukar partridge consist largely of seeds and leaves of wild grasses and forbs, with some seasonal use of insects (Christensen 1996, Lindbloom et al. 2003). Chukars do not use grain crops as food; their foraging habitats have little overlap with cultivated areas (Christensen 1996)

Habitat of chukars consists of high-elevation shrub-grassland communities with steep and rugged topography (Christensen 1996). Chukars use grass-forb habitats and rocky areas for nesting; chukar broods forage in shrub cover and grass-forb cover (Lindbloom et al. 2003). In winter, chukars are found in steep draws characterized by dense shrub cover.

Chukar populations appear to be influenced by winter severity, periodic cycles of drought during the breeding season, predation, and hunting (Christensen 1996). The most important source of overwinter mortality for chukars is heavy snows, which obscure shrub cover. Severe winter storms often lead to substantial mortality in these populations (Christensen 1996). During the breeding season, breeding success is influenced by the timing, intensity, and relative amount of precipitation. Brood to adult ratios are highest in years of average precipitation (Lindbloom et al. 2003). Avian and mammalian predators of adult chukars include coyotes and red-tailed hawks; we are unaware of published information about predators of chukar nests and chicks (Christensen 1996). Nonetheless, unidentified predators accounted for 45% of failures of chukars in Idaho (Lindbloom et al. 2003). Hunting mortality appears to have limited influence

on the abundance of chukars; they are not subjected to high harvest rates in most of their range (Christensen 1996).

Wild Turkey (*Meleagris gallopavo*)

The wild turkey historically ranged across the United States from Arizona to New York; however, introduction programs in the 1950s expanded the range of wild turkeys far north of their historic limit (Eaton 1992). The Merriam's subspecies (*M. g. merriami*) comprised most of the turkeys introduced to the Great Plains states (Montana, South Dakota, Wyoming) although eastern subspecies (*M. g. silvestris*) turkeys were also introduced to some parts of western Montana (Dickson 1992). Turkey populations have been established in coniferous forest and riparian grassland habitats in the Great Plains states (Dickson 1992). These populations are managed for hunter harvest in most areas where they occur (Eaton 1992). Habitat relationships of wild turkeys in the west are influenced by life-history and diet, as well as human activities such as forest management and livestock grazing (Day et al. 1992, Thompson 1993, Rumble and Anderson 1996). Climate also influences populations of wild turkeys (Porter et al. 1983, Eaton 1992).

Wild turkeys have lower reproductive output and higher annual survival than most upland game birds (Eaton 1992). Wild turkeys are capable of breeding in their first year, but the proportion of first-year females that breed is variable (Eaton 1992). Turkeys lay 8-10 eggs, will renest if first nests are destroyed, and have one brood per season (Wertz and Flake 1988, Eaton 1992, Rumble and Hodoroff 1993). Incubation lasts 28 days on average, young are precocial and able to fly at 10-13 days of age, and poults become independent from brood females at about 10 months (Dickson 1992, Eaton 1992). Survival of chicks and poults ranges from 30%-90% (Eaton 1992). Annual survival of adult turkeys ranges from 44%-90% (Eaton 1992).

Diet of wild turkeys is largely composed of seeds, leaves, and fruits of wild plants, insects, and, grain (when available; Dickson 1992, Eaton 1992). Insects are a major component of the diet of developing chicks (i.e., hatch to fledge; Healy 1985, Dickson 1992, Eaton 1992).

Wild turkeys are birds of mixed forest, grassland, and riparian habitats (Eaton 1992). These birds roost in large (>25 cm; 10 in dbh), mature trees year-round (Lutz and Crawford 1987, Rumble 1992, Thompson 1993). During summer, turkeys select open forest stands with dense understory vegetation for feeding and loafing (Rumble and Anderson 1996). During winter turkeys use forest habitats with open understories and high levels of canopy cover; often winter habitat occurs on south-facing slopes (Rumble and Anderson 1993). During the breeding season, female turkeys select nest sites on steep forested slopes with dense understory cover (Lutz and Crawford 1987, Rumble and Hodoroff 1993, Thompson 1993). Females with chicks and poults forage along forest edges in meadows of grassy and herbaceous vegetation, and use stands of small trees (5-15 cm; 2-6 in dbh) and dense shrubs for loafing and escape cover (Day et al. 1991, Thompson 1993, Rumble and Anderson 1996).

Survival of wild turkey nests, young, and adults is influenced by predation, severe weather, and availability of food during winter (Eaton 1992). Mammalian and avian predators are the most common direct source of mortality in studies of radio-marked individuals (Thompson 1993). Severe weather in winter also causes mortality of adults and poults (Porter et al. 1983).

PROGRAM TREATMENTS

Each specified management treatment of the UGHEP is discussed below. We make no mention of particular treatment/species combinations (i.e., food plots for sage grouse) when no pertinent literature is available. Where appropriate, we consider the mountain grouse (ruffed, blue, and spruce grouse) as a group.

Nesting and Security Cover

Undisturbed stands of dense grass-herbaceous vegetation are planted to provide secure nesting, brood-rearing, and roosting cover for upland game bird populations in agricultural landscapes (Warner and Etter 1985, Kirsch et al. 1978, King and Savidge 1995).

Sharptails make use of dense herbaceous plantings (including CRP fields and grain fields) for nesting in spring and for foraging during mild winters (Meints 1991, Connelly et al. 1998). When available, however, sharptails often nest under a shrub or in areas with a diversity of dense ground cover (Meints 1992). Investigating habitats used by broods, Klott and Lindzey (1990) found that sharptails exhibited a strong preference for mountain shrub (consisting of sagebrush, snowberry, serviceberry, and chokecherry) and sagebrush-snowberry habitats. Gratson et al. (1990) found that males selected summer home ranges with higher percentages of cropland and native shrub-grass, and less wooded and more mesic habitats than available across the landscape. Males also used cropland more frequently than expected, but increased their use of deciduous shrubby and tree habitats during winter months (Gratson et al. 1990). Sharptails in western Idaho were closely associated with mountain shrub and riparian cover types during winter months, and these were the only habitat types that provided food and escape cover regardless of snow depth (Marks and Marks 1988). This pattern of greater use of upland cropland and native grasses during spring and summer, and increased use of hardwood draws in autumn and winter was echoed by Swenson (1985) working in Glendive, Montana, and by Moyles (1981) in Alberta, Canada.

Dense cover can greatly influence both nest success and chick survival of sharptails, as evidenced by the effect of the biennial yellow sweet clover (*Meliltous officinalis*) in central Montana (Bousquet and Rotella 1998). When sweet clover was dense, nest success and chick

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survival were high (0.93, 0.44, respectively) compared to when sweet clover cover was minimal (0.56, 0.09, respectively; note that cold, wet weather was suspected as having a strong influence on chick survival being low in the second year). It is worth noting that the addition of yellow sweet clover in this study was growth in otherwise intact native habitats, and not specifically use by sharptails of cultivated cover plots.

Planting of nesting and security cover would likely benefit sharptails, especially during spring and summer months and mild winters, but should not come at the expense of native habitats in general and hardwood draws in particular. Care should be taken to maintain, protect, and restore native hardwood draws and mountain shrub communities, as they become exceptionally important for food and cover during severe winters (Swenson 1985). The benefit of cover plantings appears to be determined by their context within a matrix of diverse native habitats (Connelly et al. 1998).

Sage grouse populations are not likely to benefit greatly from planting of dense nesting and security cover, as they rely on native sagebrush habitats throughout the year. Sage grouse exhibit a strong preference for nesting in sagebrush habitats and under sagebrush bushes, but broods will make some seasonal use of alfalfa and irrigated fields in hot summer months (Schroeder et al. 1999). Though an increase of sweet clover cover within diverse sagebrush habitats corresponds with high nest success and brood survival (Moynahan 2004), the literature does not suggest that planting monotypic cover plots for sage grouse would measurably benefit population-level survival and reproduction.

Pheasants and gray partridge tend to occur in the highest densities when and where agricultural landscapes are characterized by small grain and row crop fields with substantial interspersion of relatively large blocks of undisturbed perennial grass and herbaceous cover,

wetland edges, and shrub cover (Weigand and Janson 1976, Weigand 1980, Riley 1995, Rotella et al. 1996). For example, pheasant population increases and declines have been directly related to the amount of land enrolled in federal farmland diversion programs (Jarvis and Simpson 1978, Riley 1995). Nonetheless, pheasant populations do not always increase in response to increases in the amount of cover (Vandel and Linder 1981, Rodgers 1999, Eggebo et al. 2003), indicating that other habitat-related factors (e.g., configuration of grass cover in the landscape, amount of edge, and overall size of patches) require consideration when evaluating potential pheasant habitat (Perkins et al. 1997, Riley et al. 1998, Clark et al. 1999, Schmitz and Clark 1999).

Reproductive success of pheasants is higher in diverse landscapes and lower in landscapes dominated by intensive agriculture (Haensley al. 1987, Riley et al. 1998, Clark and Bogenschutz 1999, Grove et al. 2001). In Iowa, nest survival was 40% higher in undisturbed CRP fields than in roadsides or hayfields regardless of the overall proportion of cover in the landscape, fewer females renested on the intensively farmed portion of the study area, and hen success (i.e., the product of nest survival probability and renesting probability) was more variable among years on the intensively farmed site (Clark and Bogenschutz 1999). Grove et al. (2001) observed lower nest survival (13% vs. 35%), lower renesting probability (46% vs. 83%), and smaller clutch size (7.8 eggs vs. 9.5 eggs) for radio-marked females on the intensively farmed portion of their study area in California. Survival of pheasant chicks was related to hatch date and mass at hatch in Iowa; in a landscape with about 10% cover and 90% crop fields, chicks hatched later and were lighter than in a landscape with about 25% perennial cover. Furthermore, there was higher variability in chick survival among years in the intensively farmed area (Riley et al. 1998).

Survival of female pheasants is related to landscape composition, land-use, and cover characteristics (Perkins et al. 1997, Hohman et al 2000). During the breeding season, females that initiate nests in hay fields experience considerable mortality depending on the timing of nesting relative to hay-cutting (Warner and Etter 1989).   Schmitz and Clark (1999) reported that females with greater proportions of edge in their home ranges had lower spring survival regardless of overall proportion of cover in the landscape. Grove et al. (2001) showed lower annual survival for females in an intensively farmed landscape than on a site with less agricultural disturbance.   Snyder (1985) concluded that low spring survival on his Colorado study area was related to a lack of escape cover for females. Female pheasants in Iowa that wintered on a site with 10% perennial cover had larger home ranges and higher variability in winter survival than females wintering in an area with 25% perennial cover (Perkins et al. 1997). Winter survival of female pheasants in North Dakota was negatively related to daily temperatures, and wintering pheasants used cattail (*Typha* spp.) cover on wetland margins for roosting during prolonged cold periods (Hohman et al. 2000).

Gray partridge populations also respond to changes in available nesting cover. Changing land-use patterns that result in reduced availability of nesting cover for partridge appear to be associated with reduced reproductive output (Wiegand 1980, Carroll and Crawford 1991). Partridge, however, do not appear to require large blocks of nesting cover. They will nest successfully in roadsides and crop field margins (Carroll and Crawford 1991).   In Montana, Weigand (1980) noted that hay-cutting led to reduced nest survival of gray partridge and suggested that increased amounts of idle residual cover could benefit partridge on his study area.

Survival of adults during the winter and spring period is important to the maintenance of gray partridge populations (Carroll et al. 1993, Rotella et al. 1996). Predation rates, as well as

mortality due to severe weather events, are often highest during these seasons (Weigand 1980, Carroll et al. 1995, Rotella et al. 1996). Residual vegetation, such as conservation plantings, can provide necessary cover for partridge to escape predators during this period (Weigand 1980, Carroll et al. 1995).

Management strategies that create substantial interspersion of dense grass and herbaceous cover can lead to larger and more stable pheasant and gray partridge populations. Reproductive success and breeding-season survival of pheasants can be supported by the addition of large (>15ha) blocks of planted cover to landscapes dominated by intensive cultivation (Riley et al. 1998, Schmitz and Clark 1999). Gray partridge are also likely to benefit from cover plantings through increased nesting success (Weigand 1980, Carroll and Crawford 1991). Cover plantings may also improve survival of partridge and pheasants during the winter-spring period (Weigand 1980, Carroll 1990, Perkins et al. 1997).

Shelterbelts and Shelterbelt Expansion

Planting of trees and shrubs for upland game birds in agricultural landscapes is a habitat management strategy intended to provide shelter from extreme weather and predators. Tree and shrub cover, however, appears to be unrelated to survival of pheasants in some regions. Pheasants in Illinois experienced high mortality during two severe winters regardless of the amount, configuration, or structure of woody cover present (Warner and David 1982). In South Dakota, however, Gabbert et al. (1999) noticed increased use of shelterbelts by pheasants during a severe winter and concluded that this type of cover was important during unusually cold periods accompanied by deep snow.   Nonetheless, the majority of the radio-marked pheasants in their study died from predation rather than exposure. Some researchers have speculated that plantings of mature trees may provide habitat for avian predators, such as owls (Carroll 1990,

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Hohman et al. 2000), and when game birds move into these areas during periods of severe weather, their mortality rates may increase considerably due to predation.

Pheasants and partridge do not, however, prefer tree and shrub cover for roosting under average winter conditions. Use of woody habitats for loafing and roosting tends to take place only when deep snow cover (>30 cm; 12 in) renders preferred cover such as row crop stubble, and wetland margins unusable (Gabbert et al 1999, Hohman et al. 2000). Gray partridge use row crops and shrubby draws as winter roosting habitat in North Dakota and Montana (Weigand 1980, Carroll et al. 1995). Pheasants roost in fields of planted cover, crop stubble, or along dense wetland margins in South Dakota and Montana (Gabbert et al. 1999, Hohman et al. 2000). Winter dependence of sharptails on deciduous trees and shrubs for food and cover may limit populations within the sagebrush-steppe habitat; loss of this habitat component has been associated with declining populations in Utah and Washington (Giesen and Connelly 1993). Sharptails clearly require a deciduous shrub component for forage and roosting, particularly in severe winters (Connelly et al. 1998), but it is not clear whether shelterbelts provide an equivalent contribution. As was noted with pheasants, some sharptail researchers have speculated that mature, closed-canopy stands may result in increased predation of grouse because such stands provide hunting perches and cover for raptors (Gullion 1967, 1970).

Food Plots

Plots of grain or sunflowers can be planted by wildlife management agencies to provide food for upland game birds during winter. Female pheasants that maintain higher body-fat reserves during winter have higher survival probability and may also have higher reproductive success in the following year (Gatti et al. 1989). Location and size of food plantings determine levels of use by pheasants (Riley 1992, Larsen et al. 1994). Food plots located near roosting and

loafing sites are more highly used by pheasants (Larsen et al. 1994). Area of the plot is also weakly related to use by pheasants (Riley 1992). In South Dakota, Pheasants used food plots located in areas where wetland cover and grass cover >30cm (12 in) high was present within 300-600 m (1000-2000 ft; Larsen et al. 1994). Pheasant use of food plots increased with size in Iowa and South Dakota; however, these researchers concluded that juxtaposition of the plot relative to other habitat types was probably more important to determining use by pheasants (Riley 1992, Larsen et al 1994). Gray partridge were also observed using food plots in South Dakota, but use by partridge was not quantitatively described (Larsen et al. 1994). Gabbert et al. (1999) concluded that food plots located near shelterbelts on their South Dakota study area were important to survival of pheasants during severe winter weather. Establishment of food plots of at least one hectare in area and less than one kilometer from preferred roosting and loafing sites has been recommended for pheasant management (Larsen et al. 1994).

Little peer-reviewed information specifically addresses the benefits of planted food plots for sharptails. However, the bird's use of cropland and CRP land in all seasons and in mild winters suggests that sharptails would make use of food plots (particularly cereal grains and wheat). (Giesen and Connelly 1993, Connelly et al. 1998). Use of agricultural crops by sharptails is predominantly in late autumn and winter (Marshall and Jensen 1937, Jones 1966).

Sage grouse rely on leaves and buds of sagebrush through late autumn, winter, and early spring. Attempts to bait sage grouse into trap areas in central Montana using oats, mixed grains, and alfalfa were entirely unsuccessful (B. Moynahan, pers. obs.). Some broods will make seasonal use of alfalfa and irrigated fields in hot summer months, and such forbs may be an important dietary component on an individual basis (Schroeder et al. 1999).

Grazing Management

Because all species considered in this document appear to either rely on or benefit from a dense herbaceous understory for nesting and brood cover (see species accounts), intense grazing of native prairie, idle areas, crop stubble, forest habitats, and riparian zones has potential to negatively affect habitat quality for all of Montana's upland game bird species. Timing and intensity of grazing can affect the availability of food and cover for upland game birds (Weigand and Janson 1976, Wertz and Flake 1988).

All considered species breed and nest in spring. Hens likely select nest sites when little new growth has occurred, and therefore select from residual cover remaining from the previous year's growth and cover removal factors (grazing, mowing, burning, and snow flattening; Svedarsky and Van Amburg 1996). In Montana, the largest breeding areas, "without exception," were located in areas surrounded by extensive, heavy stands of residual herbaceous cover (Brown 1966:220). The early availability of good residual cover provides a decided advantage to nesting birds because it permits early nest initiation and increases the total period available for nesting, which may be important to accommodate 1 or 2 renesting attempts if needed (Kirsch 1969, Svedarsky and Van Amburg 1996). In the Sheyenne National Grasslands of North Dakota, most prairie grouse nests were in 3-pasture deferred systems, and the deferred pasture was used by brood and non-brood hens much more than other pastures (Newell et al. 1988, Sedarsky and Van Amburg 1996). For these reasons, grazing management strategies that result in higher retention of residual herbaceous cover may result in higher survival and reproduction – and higher abundance – of targeted upland game bird species.

Nesting habitat for Merriam's turkey in South Dakota and Montana is characterized by low-elevation ponderosa pine (*Pinus ponderosa*) forest with high structural diversity of shrubs

and grasses in the understory (Thompson 1993, Rumble and Anderson 1996). Female Merriam's turkeys with broods in southeast Montana use brushy creek bottoms as loafing and feeding sites (Thompson 1993). In South Dakota, turkey broods in grassland regions feed in meadows of dense herbaceous vegetation located near (<100 m; 328 ft) from forest edges (Wertz and Flake 1988). Summer habitat for these birds is generally composed of herbaceous meadows within a matrix of forest and shrubby riparian areas (Thompson 1993, Rumble and Anderson 1993, 1996). The spring and summer habitat requirements of Merriam's turkeys are thought to be compatible with light to moderate grazing regimes (Wertz and Flake 1988, Rumble and Anderson 1993).

In Montana, grazing of idle areas such as roadsides and conservation plantings may reduce the suitability of nesting and brood-rearing cover for pheasants (Weigand 1973). Patches of snowberry (*Symphioricarpos* spp.), within grazed creek bottoms were identified by Weigand (1980) as important for escape and nesting cover for gray partridge. Thus, grazing management that conserves available cover is likely to benefit these species (Weigand 1980).

Abundant residual cover is important to sharptails, and their nesting and brood-rearing are negatively affected by annual grazing or haying which reduces the quantity of residual cover (Kirsch et al. 1978). Sharptails apparently select areas least modified by livestock grazing (Saab and Marks 1992); grouse locations have been characterized by greater herbaceous cover and less bare ground than random sites (Klott and Lindzey 1990, Saab and Marks 1992). As such, attempts to improve population status or abundance may be dependent on reducing disturbance that may damage the natural diversity of shrub-steppe habitat, including overgrazing by livestock and agricultural development (Klott and Lindzey 1990, Saab and Marks 1992). Grazing management strategies that use rest-rotation systems likely benefit sharptails by increasing

standing herbaceous cover and maintaining a diversity of native grasses and herbaceous species, both of which are important for cover and forage for bird throughout the year.

Sage grouse would likely benefit from rest-rotation grazing systems. Historic grazing markedly reduced herbaceous understory vegetation across large areas of sagebrush habitats, and increased sagebrush in some localities (Vale 1975). In Wyoming big sagebrush habitats (as in Montana) resting areas from livestock grazing may improve understory production as well as reduce sagebrush cover (Wambolt and Payne 1986). There is little experimental evidence linking grazing practices to sage grouse population levels (Connelly et al. 2000), but there is evidence that grass height and cover affect sage grouse nest site selection and nest success (Gregg et al. 1994, Delong et al. 1995, Sveum 1998a). Therefore, indirect evidence suggests that grazing by livestock or wild herbivores that significantly reduces the understory herbaceous cover in breeding habitat may negatively affect sage grouse populations (Braun 1987, Connelly et al. 2000). Conversely, grazing management practices that resulted in large areas of breeding habitats with relatively tall and dense herbaceous cover may benefit sage grouse populations.

There is little information on the effects of grazing on mountain grouse populations, but it may negatively affect blue grouse (Zwickel 1992). Zwickel (1972) reported that blue grouse density, nest success, and brood size did not vary between a grazed and an ungrazed site, but suggested that the proportion of successful breeding hens may have been higher on ungrazed areas. Blue grouse and ruffed grouse in particular rely on herbaceous vegetation for spring and summer forage (Zwickel 1992, Rusch et al. 2000).

Height and density of ungrazed forage is influenced by both the grazing system and the stocking rate of allotments (Sedarsky and Van Amburg 1996). Grazing all pastures each year apparently leaves insufficient residual vegetation to meet minimum grouse nesting/brooding

requirements (Sedarsky and Van Amburg 1996). Even when grazing systems were implemented, nest location and nest fate (of Greater Prairie Chickens in North Dakota, for example) as related to residual cover, was dependent on approximately 1,000 pounds of forage per acre (Sedarsky and Van Amburg 1996). Using a rest-rotation system, rancher permittees were able to maintain livestock allocations while producing over four times as many prairie grouse as deferred rotation systems (Sedarsky and Van Amburg 1996). Grazing systems, however, are not a solution in and of themselves; indeed, they are effective only with appropriate stocking rates that do not result in overgrazing of active pastures (Sedarsky and Van Amburg 1996). Wilson (1986) stated a fundamental principle of effective grazing systems: the total stocking intensity is the most important factor affecting rangeland productivity and stability. It should be generally recognized that both livestock production and upland game bird (and other wildlife and plant) production cannot be simultaneously optimized (Sedarsky and Van Amburg 1996).

Conservation Easements

Cooperative agreements that provide perpetual or time-limited protection to preferred habitats of upland game birds can be used by managers to provide increased landscape diversity (e.g., increased interspersion of nesting brood-rearing, and escape cover) and to conserve specific areas (for example, roost sites for Merriam's turkey). For instance in North and South Dakota, wetland easements provide perpetual protection to substantial acreage of cattail and bulrush (*Scirpus* spp.) cover, which is highly selected by pheasants as roosting cover (Giudice and Ratti 2001).

Information presented in the species accounts suggests that conservation easements, so far as they maintain large, contiguous blocks of native habitats and herbaceous understory, could

benefit most Montana upland game bird species. The contribution of easements to mitigation of fragmentation of these species' habitats could help to maintain self-perpetuating, wild populations. Nonetheless, there is little published information explicitly addressing conservation easements as a management tool.

Forest Management

Management of forest habitat is important for populations of Merriam's turkey and mountain grouse in Montana (Boag and Schroeder 1987, Thompson 1993, Rusch et al. 2000). Turkeys and mountain grouse primarily occur in forested and riparian areas, thus forest management can affect the availability of habitat for these species.

Ruffed grouse mainly occupy early-successional deciduous forests created by fire, logging, or other large-scale disturbance (Rusch et al. 2000). Fire control and opposition to clear-cut logging practices have resulted in maturation of forests and, in some cases, conversion of aspen to conifer or grassland habitats, with assumed concurrent reduction in numbers of ruffed grouse (Rusch et al. 2000). Though Rumble et al. (1996) suggested that leaving logging slash was as effective as fencing for aspen regeneration when aspen stands were clear-cut, response of ruffed grouse response was not monitored and was presumed to have been greatly reduced until the stand successfully regenerated. Further, others have suggested that thick slash and downed timber with dense shrub or sapling growth does not provide suitable ruffed grouse habitat (Rusch et al. 2000). In Montana, where aspen stands are sparse, maintenance and restoration of extant aspen and other deciduous hardwood stands would benefit ruffed grouse (Johnson 1999).

Modern industrial forest exploitation, with its creation of open clear-cuts and subsequent single-species plantings, reduces spruce grouse populations locally and often eliminates them entirely (Boag and Schroeder 1992). In the case of spruce grouse, timber harvest apparently is

not a functional surrogate for fire (Boag and Schroeder 1987). Any apparent conflict of forest

management for ruffed grouse and spruce grouse is mitigated by minimal overlap between the

two species – elevation gradients and forest type (conifer v. deciduous) largely partitions the

range of the two species (Boag and Schroeder 1992, Zwickel 1992).

For Merriam's turkeys, interspersion of small clear-cuts (<20 ha) in the forest matrix

leaves more preferred nesting and brood-rearing habitat than extensive clear-cutting (Thompson

1993). Turkeys use large, mature trees (>25cm dbh) in stands with 19-25 m^2/ha for roosting,

thus timber harvest that thins roosting sites below this density or removes large trees reduces

roosting habitat (Rumble 1992).

Supplemental Feeding

Directly providing food to local populations of upland game birds is a management tool

that is often used to support populations of introduced upland game birds in ranges where winter

survival is thought to be limited by food availability (Wiegand and Janson 1976). There is little

evidence, however, to support or refute the idea that this management is cost-effective and

achieves its goal. Further research would be useful to inform managers about the effectiveness

of supplemental feeding to support upland game bird populations.

SUMMARY

Populations of upland game birds are not static; these populations fluctuate in abundance

relative to the influences of predation, weather, and land-use (Jarvis and Simpson 1978,

Johnsgard 1983, Gabbert et al. 1999). The goal of population managers in modern times is to

establish and maintain self-sustaining, harvestable populations of upland game birds. Identifying

and rectifying specific habitat deficiencies within the context of the existing landscape matrix

(rather than removing predators or stocking birds) is currently thought to be the most efficient,

effective, and feasible way to achieve this goal (Hewitt et al. 2001, Schroeder and Baydack 2001, Riley and Schulz 2001).

Removal of predators has been shown to temporarily increase reproduction and survival of pheasants and gray partridge (Tapper et al. 1996, Riley and Schulz 2001), and nest success of sage grouse (Batterson and Morse 1948). Predator control may increase nest success of mountain grouse, but has not consistently resulted in increases in autumn or spring population densities (Hewitt et al. 2001). Changes in predator communities can affect survival and reproduction of bird populations. For example, coyotes typically displace red fox, which are a more efficient nest predator; in areas with coyotes, nest success was twice that of areas with red fox (Sovada et al. 1995). Over time, predator population control does not produce economically justifiable (Trautman and Fredrickson 1974), or even consistently positive, results (Hewitt et al. 2001, Riley and Schulz 2001, Frey et al. 2003). Furthermore, there is little support for the use of predator removal as a long-term management tool in the scientific and public community (Ball 1996, Riley and Schulz 2001). Therefore, removal of predators at spatial and temporal scales that would produce positive changes in upland game bird populations has been recognized as short-lived, expensive, controversial, and ultimately unrealistic (Ball 1996, Riley and Schulz 2001, Schroeder and Baydack 2001).

Stocked birds contribute little to harvest or population growth in pheasant populations. In Montana, Weigand and Janson (1976) noted that hunters subsequently harvested only 13%-24% of pheasants released 1-3 weeks prior to hunting season opening. In one instance, hunters harvested 57% of birds that were released 24 hours prior to the season opening. Leif (1994) observed that one wild female pheasant had the potential to recruit as many broods as 10 pen-

reared females on his South Dakota study area, and moreover, that survival probability of wild female pheasants during the breeding season was nearly seven times greater.

Variation in weather patterns among years and locales will effect considerable variation in the size of most upland game bird populations. Extreme weather events (e.g., winter storms) can cause considerable mortality of sharptails, sage grouse, pheasants, gray partridge, and wild turkeys and may also affect body condition of survivors, which, in turn, can affect reproduction the following spring (Carroll 1993, Ulliman 1995, Giudice and Ratti 2001, Moynahan 2004). Late, wet springs can delay nest initiation and reduce survival of chicks (Weigand 1980, Bousquet and Rotella 1998, Riley et al. 1998). These events cannot be managed directly; however, an assumption of habitat management programs is that providing quality habitat will buffer the effects of severe environmental conditions, support the survival of enough individuals for populations to recover when conditions improve, and ensure the presence of suitable conditions for those surviving individuals to contribute to population recovery (Rotella et al. 1996, Riley and Schulz 2001, Moynahan 2004).

Many relationships between survival and reproductive success of upland birds and landscape characteristics have been identified; these relationships can be used to guide habitat management. For example, reproductive success of pheasants is higher when the landscape includes substantial interspersion of grassland and herbaceous cover (e.g., 25-30ha/km^2; 160-192 ac/mi^2) in blocks larger than 15ha (37 ac; Perkins et al. 1997, Riley et al. 1998, Clark et al. 1999). Stephens et al. (2003) reviewed the effect of scale on detection of landscape-level effects on nest success on upland-nesting birds. They concluded that relationships between population parameters of interest (e.g., nest success) and habitat characteristics may be difficult to detect at scales smaller than 10 km^2 (4 mi^2). For these reasons, management approaches that consider the

juxtaposition, configuration, and proportion of habitats across landscapes—and apply small-scale

projects within a coherent landscape context to address specific habitat deficiencies—are more

likely to support self-sustaining, harvestable populations of upland game birds (Geisen and

Connelly 1993, Schroeder et al. 1999, Connelly et al. 2000, Riley and Schulz 2001).

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