MIGRATORY AND UPLAND GAME BIRDS IN NORTHWESTERN COLORADO THE STATUS OF OUR KNOWLEDGE, 1982*

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NORTHWEST COLORADO WILDLIFE

CONSORTIUM

University of Northern Colorado

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University of Colorado

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Synopsis: The available data concerning geese, dabbling ducks, diving ducks and mergansers, chukars (Alectoris chukar), ring-necked pheasants (Phasianus colchicus), blue grouse (Dendragapus obscurus), sage grouse (Centrocercus urophasianus), sharp-tailed grouse (Tympanuchus phasianellus), wild turkey (Meleagris gallopavo), Gambel's quail (Callipepla gambelii), wetland dependent species (Virginia rail [Rallus limicola], Sora [Porzona carolina], American Coot [Fulica americana], common snipe [Gallinago gallinago]), band-tailed pigeons (Columba fasciata), and mourning doves (Zenaida macroura) in northwestern Colorado were reviewed and summarized. The distribution of most species and groups is poorly defined at the county level. Habitats are most restricted for ring-necked pheasants, Gambel's quail, the wetland dependent group, ducks, and geese. All of these groups and species will be severely impacted by changes in water distribution and use with concomitant changes in irrigated, riparian, and wetland habitats. Although little is known concerning ring-necked pheasants and Gambel's quail in northwestern Colorado, these species should respond favorably to mainpulation designed to improve their habitat. Chukars, while presently limited in distribution, could be positively impacted by range impoverishment which included creating disturbed areas dominated by cheatgrass brome (Bromus tectorum). Development of energy resources should have little impact on wild turkey and blue grouse habitats although knowledge of wild turkey in northwestern Colorado is exceedingly limited Both sage and sharp-tailed grouse may be impacted by energy development. Sage grouse are relatively well studied and intensive studies of sharptails in northwestern Colorado are presently

ongoing. Both of these species may be positively impacted by well-designed mitigation programs. However, hypotheses concerning effective mitigation techniques such as fertilization, use of fire, reseeding of shrubs, etc. need to be tested in several different areas. Emphasis should be placed on improving the data base for most species, maintenance of presently occupied habitats, and experimentation designed to learn if more animals can be maintained (through habitat manipulation) per unit of area then at present.

GEESE

Order Anseriformes, Family Anatidae, Anser albifrons, Branta canadensis, Chen caerulescens, C. rossi

DISTRIBUTION AND OCCURRENCE IN NORTHWESTERN COLORADO

Four species of geese (greater white-fronted, Canada, snow, and Ross' geese) migrate through (greater white-fronted, snow, and Ross' geese) and/or breed (Canada geese) in northwestern Colorado (Bailey and Niedrach 1965). Canada geese in northwestern Colorado belong to the Rocky Mountain Population of the western Canada goose (B. c. moffitti). This population has been formerly known as the Great Basin Canada goose, the Intermountain Population of the western Canada goose, and the Great Basin Population of the western Canada goose (Krohn and Bizeau 1980). Most nesting of western Canada geese occurs in Moffat and Routt counties along the Green, Yampa, and Little Snake rivers. Canada geese also nest along the Colorado River from Silt to the state line and along the White River from Meeker to the state line (Fig. 1). Geese are not known to nest away from the major rivers in northwestern Colorado and an early study (Frary 1954) did not report geese on the White River Plateau in Garfield County.

Snow geese are listed as transients and uncommon winter residents by Bailey and Niedrach (1965). Reports of snow geese date to 1904 when Rockwell (1908) observed flocks at Grand Junction in April and October. Bellrose (1976) estimated that between 10,100 and 50,000 migrate south through western Colorado in the fall. Few, if any, winter in northwestern Colorado.

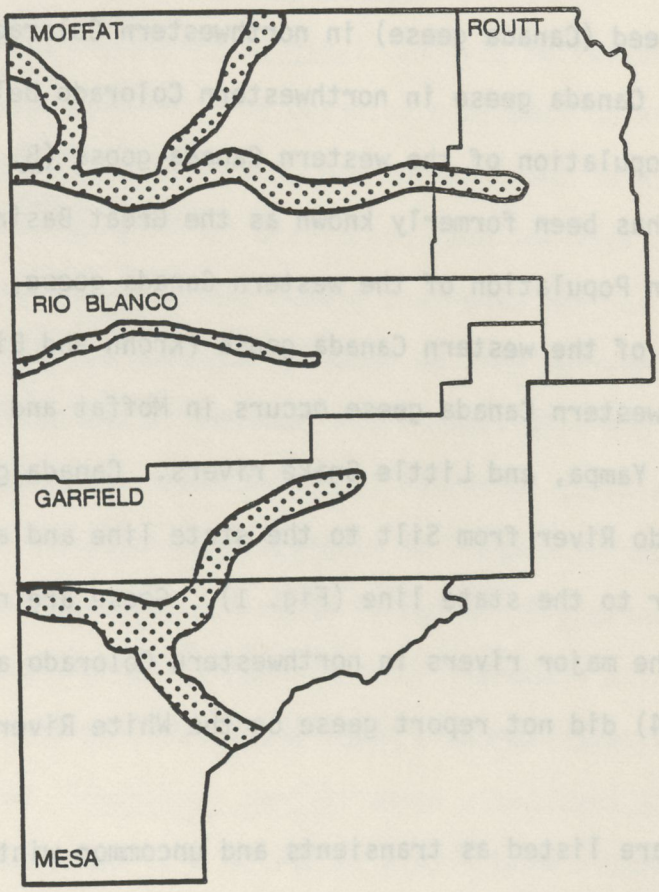

Fig. 1. Major concentration areas of geese, northwestern Colorado (after Donoho 1980).

The only other species normally observed in Colorado is the greater white-fronted goose. It is an uncommon migrant and winter resident. Although most sightings have been along the front range and and in eastern Colorado, white-fronted geese have been observed in Brown's Park in the fall (Bailey and Niedrach 1965). There have been few reports of Ross' goose in northwestern Colorado.

TIME OF YEAR PRESENT

Canada geese are common summer and winter residents of northwestern Colorado. Those wintering elsewhere arrive on the Green and Yampa rivers in early March (Boeker 1953, Tester 1953). Krohn and Bizeau (1980) estimated that the total number of geese in spring flocks along those 2 rivers is about 480, of which 25% are breeders. More recent estimates are that about 1,500 geese are present in northwestern Colorado in the spring (H. Funk, pers. commun.).

Estimates of the number of geese wintering in Colorado west of the Continental Divide have varied. Bellrose (1976) believed that approximately 500 Canada geese wintered in western Colorado. Krohn and Bizeau's (1980) estimate was 1,500 and was limited to that area covered by Moffat, Routt, Rio Blanco, Garfield, Mesa, Delta, and Montrose counties. Results of January aerial surveys (from the files of H. D. Funk, Colo. Div. Wildl.) revealed the following areas in northwestern Colorado to be important to wintering geese: the Colorado River from Silt to DeBeque and from Horsethief Canyon to the Utah border; the Gunnison River from Delta to Grand Junction; and Highline Lake, the Walker Wildlife Area, and agricultural fields near Grand Junction, Fruita, Loma, and Mack, all in Mesa County. Based on band recoveries, there is some evidence that at least some of the geese wintering in northwestern Colorado nest in central Montana and central Wyoming (Krohn and Bizeau 1980).

Snow and greater white-fronted geese are uncommon winter residents and do not breed in Colorado. Snow geese have been observed during January and April at Brown's Park in Moffat County, in April and October at Grand Junction in Mesa County, and in January at the Walker Wildlife Area in Mesa County (Rockwell 1908, Tester 1953, files of H. D. Funk). Fall and winter sightings of greater white-fronted geese in Brown's Park have been recorded (Bailey and Niedrach 1965, files of H. D. Funk).

Krohn and Bizeau (1980) estimated that about 1,500 geese winter in northwestern Colorado (including Montrose and Delta counties) along the Colorado, Gunnison, and Uncompahgre rivers. The highest number recorded during any winter in that area was 2,392. Approximately 390 km of stream habitat and 70 ha of non-flowing water habitat are used by the wintering geese.

HABITAT REQUIREMENTS

Throughout the range of the Rocky Mountain Population of western Canada geese, the following wetland types are used in almost equal proportions: flooded bottomlands and rivers, lakes and reservoirs, marshes and waterfowl impoundments. Because most wetland habitat in northwestern Colorado occurs as riverbottoms, that is the type primarily used (Grieb 1965, Hopper 1968).

Nesting

Canada geese use a greater diversity of nest sites than any other species of waterfowl (Bellrose 1976). Birds of the western race nest primarily on islands in natural lakes, reservoirs, streams, and rivers (Dow 1943, Geis 1956, Ball et al. 1981). They also nest in marshes on mats of bulrush (Scirpus spp.), muskrat (Ondatra zibethica) houses,

haystacks, cliffs, dikes, and ditch banks (Bellrose 1976). Elevated and floating man-made structures are readily used by Canada geese (Yocom 1952, Craighead and Stockstad 1961, Will and Crawford 1970, Rienecker 1971).

Western Canada geese in northwestern Colorado prefer areas associated with slow-moving, meandering rivers that have an abundance of islands. They also use bodies of standing water and readily adapt to man-made impoundments. Boeker (1953) reported that preferred breeding grounds in the Yampa River Valley were sagebrush (Artemisia spp.) valleys and canyons, where islands, hay stacks, sagebrush, and sandbars were used. Krohn and Bizeau (1980) estimated that in northwestern Colorado (a 7-county area including Delta and Montrose counties), 662 km of stream habitat and 290 ha of waterfowl impoundment habitat were used by 132 and 34 breeding pairs, respectively. They stated that nesting occurs primarily along the Green, Yampa, and Little Snake rivers, and identified the Green River from Brown's Park National Wildlife Refuge through Dinosaur National Monument as the single most important breeding area.

Brood habitat in northwestern Colorado is similar to nesting habitat. While areas with abundant aquatic plants are preferred, food is available in nearby meadows and alfalfa fields (Grieb 1965).

Feeding

Canada geese feed entirely on plant material. They browse on leaves of clovers (Trifolium spp.) and grasses and consume cultivated grains (Bellrose 1976). Martin et al. (1951) listed important food items in the mountain-desert area (data from Bear River National Wildlife Refuge in Utah), which included saltgrass (Distichlis spp.), pondweed (Potamogeton)

spp.), alkali bulrush (Sicrpus paludosus), widgeongrass (Ruppia spp.), and wheat. Boeker (1953) and Rutherford (1970) noted large numbers of geese feeding in wheat fields in Colorado in late summer and winter. Bell and Klimstra (1970) documented regular daily flights of Canada geese from loafing/resting sites to areas of corn and other grains.

Snow and greater white-fronted geese are more adapted to clipping rootstocks of bulrush and cattails (Typha spp.). With the expansion of agriculture, these 2 species have shifted to feeding in pastures and croplands, especially barley, wheat, and rice (Martin et al. 1951, Bellrose 1976).

Loafing/Resting

Boeker (1953) and Tester (1953) observed Canada geese loafing on islands and sandbars along the Yampa and Green rivers in Moffat and Routt counties. Hopper (1968) reported that geese use lakes and reservoirs as resting habitat throughout the winter.

Water

Geese (and other species of waterfowl) are dependent upon water during all times of the year. Wetland losses affect those species more than any other group. The continued welfare of waterfowl populations is directly related to the quality and quantity of wetland habitat available (Hopper 1968).

Special Requirements

No molting areas have been identified in northwestern Colorado (Krohn and Bizeau 1980). Grieb (1965) believed that yearling non-nesters moved to large reservoirs in Wyoming to molt.

EFFECTS OF HABITAT ALTERATION

Canada geese have both benefited and suffered from habitat alterations, many of which have been brought about by agricultural production. To the detriment of geese, wetlands have been subject to drainage, filling, and other types of destruction because they are obstacles to increased agricultural production, industrial and residential expansion, and construction of highways and large impoundments. Ball et al. (1981) stated that the loss of nesting islands by unundation due to new impoundments was a problem in Washington. Hansen (1968) commented on the same problem, but observed that some of the habitat loss was offset by man-made marshes and irrigation reservoirs which create new nesting habitat. Canada goose nesting habitat along the Green River is secure from development, but because flooding has decreased due to the construction of Flaming Gorge Dam, island vegetation is increasing. The effect of dense vegetation on the availability of suitable nesting sites has not been determined (Krohn and Bizeau 1980).

Perhaps more than any other species of waterfowl, Canada geese have benefited from agricultural production. Geese feed on grains (especially corn and wheat in Colorado) on migration and wintering grounds (Bellrose 1976). Heavily-grazed pastures and mowed alfalfa fields in Washington are used as brood habitat (Ball et al. 1981). Non-agricultural operations that benefit geese in northwestern Colorado include gravel mining, which results in pits that often become ponds. Krohn and Bizeau (1980) concluded that the Rocky Mountain Population of Canada geese has not

only been helped by man-made and man-maintained areas, but is dependent upon them, especially during winter.

Additional negative effects that could occur are increased flooding of nesting habitat by water projects and toxic water from tailings ponds. An increase in human population would be accompanied by an increase in hunting pressure on a population that has already had restrictive hunting regulations placed upon it due to possible overshooting.

MITIGATION

Ball et al. (1981) discussed possible methods of mitigation for western Canada goose nesting habitat in Washington. Concerning erosion of nesting islands (particularly new islands), some mitigation of erosion losses may be possible through the use of artificial nesting structures. However, Ball et al. (1981) stated that such structures were usually not cost-effective. Other possibilities are the establishment of adequate plant cover on islands to prevent erosion and the creation and/or reinforcement of islands before flooding due to water project development occurs. Nesting structures can best be used in mitigation where islands are absent but good brood cover remains. Brood habitat can be established or replaced by establishing moderately-grazed pastures or by planting small grains or alfalfa.

DATA BASE

Waterfowl in North America are censused annually in late spring-summer (breeding ground counts) and winter (mid-winter inventories). The only reliable year-to-year population data for geese are obtained from the mid-winter inventory.

Data on Canada geese in northwestern Colorado are available from a variety of sources. Intensive studies were conducted by Tester (1953) in Brown's Park along the Green River and Boeker (1953) in the Yampa River Valley. Prior to that, sporadic counts of geese were made in Brown's Park during spring, summer, and fall 1948-51 by the U.S. Fish and Wildlife Service and the Colorado Department of Game and Fish (Tester 1953). Data collected by Boeker (1953) and Tester (1953) included breeding pair counts, brood counts, and documentation of spring migration (Grieb et al. 1961).

Presently data are collected in northwestern Colorado on an annual basis from 4 sources: breeding pair counts (spring), brood counts (late spring-early summer), mid-winter inventories (Jan), and hunter surveys. Geese observed during aerial surveys of the Green, Little Snake, Yampa, Colorado, Gunnison, and White rivers are classified as singles, breeding pairs, non-breeding pairs, and groups. Production estimates for Moffat County are made from counts of hatched or active nests and brood sizes. Data have been collected since 1956 for the Yampa and Green rivers (Brown's Park), 1962 for the Little Snake River, 1970 for the Green River (Dinosaur National Monument), and 1977 for the Colorado, Gunnison, and White rivers (Szymczak and Steinert 1981).

RECOMMENDATIONS

Research

1. Investigate the feeding ecology of Canada geese on wintering and nesting areas and how it relates to physical condition and variations in clutch size, nesting success, and gosling survival (Krohn and Bizeau 1980).

2. Investigate locations of Canada goose nesting and brood sites as related to food resources, reproductive success, and survival (Krohn and Bizeau 1980).
3. Determine the relationship between vegetation density on islands and availability of suitable nest sites.
4. Determine the effects of any new or expanded change in land use in northwestern Colorado on Canada goose distribution, production, and nesting success.

Management

1. Refine and standardize spring and winter surveys (Crissey 1968, Krohn and Bizeau 1980).
2. Continue to survey the northwestern Colorado population of western Canada geese on an annual basis (Grieb et al. 1961).
3. Continue to obtain annual estimates of Canada goose harvest in northwestern Colorado.
4. Intensify efforts to band Canada geese in northwestern Colorado.
5. Consider the use of artificial nesting structures in areas with few nest sites but good brood habitat and food (Boeker 1953, Ball et al. 1981).
6. Improve the management, where possible, of important nesting areas by discouraging indiscriminate burning of large areas of emergent vegetation, discouraging the use of marsh areas as holding sites for livestock, controlling grazing in preferred nesting areas, and maintaining constant water levels on major marsh areas and sloughs (Boeker 1953).
7. Maintain water flows to prevent predation of nests of geese on islands.

DABBLING DUCKS

Order Anseriformes, Family Anatidae, Aix sponsa, Anas acuta, A. americana, A. clypeata, A. crecca, A. cyanoptera, A. discors, A. platyrhynchos, A. strepera.

DISTRIBUTION AND OCCURRENCE IN NORTHWESTERN COLORADO

Scattered reports of occurrence and nesting of dabbling ducks in northwestern Colorado date to 1871 and 1887, respectively (Bailey and Niedrach 1965). Observations in Moffat, Routt, Rio Blanco, Garfield, and Mesa counties since 1887 have been noted by Rockwell (1908), Felger (1910), Hendee (1929), Boeker (1953), Tester (1953), Frary (1954), and Bailey and Niedrach (1965). Waterfowl habitats in northwestern Colorado are mostly wetlands associated with the Green, Yampa, Little Snake, White, Gunnison, and Colorado rivers (Fig. 2).

TIME OF YEAR PRESENT

All species except the wood duck are quite common in northwestern Colorado during spring and fall migrations. Northwestern Colorado is not a major duck breeding area; only mallards nest in relatively large numbers (Bailey and Niedrach 1965, Hopper 1968). Boeker (1953), in the Yampa River Valley, and Tester (1953) at Brown's Park National Wildlife Refuge documented spring migration of dabbling and diving ducks. Tester (1953) stated that mallards and green-winged teal were the earliest arrivals, first appearing in February. Gadwall and cinnamon teal arrived in early April while the latest species to arrive were northern pintail, northern shoveler, and blue-winged teal (late Apr). Boeker (1953) first observed mallards, green-winged teal, and pintails (late Mar), followed by cinnamon teal, blue-winged teal, and gadwalls (Apr).

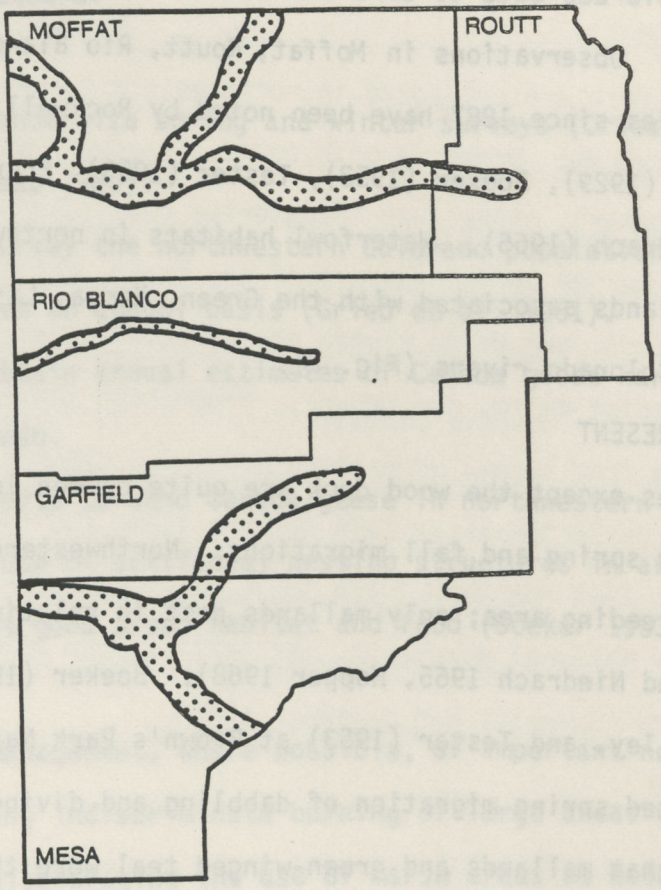

Fig. ?. Major concentration areas of ducks, northwestern Colorado (after Donoho 1980).

Neither Boeker (1953) nor Tester (1953) documented fall migration. Analyses of mallards banded in western Colorado indicated that they had a strong affinity for the Pacific Flyway. Nearly 80% (78.9) of all band recoveries were in that flyway compared to only 10.9% in the Central Flyway (Hopper 1981). Evidently, among mallards in northwestern Colorado (and probably other dabbling species), there is little cross-over to the Central Flyway during migration. Boeker (1953) identified mallard and green-winged teal as the most common wintering species in the Yampa River Valley.

HABITAT REQUIREMENTS

Most waterfowl habitat in northwestern Colorado occurs as river-bottoms as there are few marshes and ponds (Hopper 1968). Rivers that supply important waterfowl habitat in northwestern Colorado include the Green, Little Snake, Yampa, White, Colorado, and Gunnison.

Nesting

Rivers and marsh areas provide the majority of nesting habitat in northwestern Colorado (Boeker 1953, Tester 1953). Frary (1954) found exceptions to that generalization on the White River Plateau where ponds and small lakes were present and used. Dabbling ducks are primarily upland nesters. Adaptability to different types of nest sites varies. Mallards are the most adaptable, and although they prefer upland sites that contain dense vegetation within 100 m of the water, they will use a wide range of areas and objects for nest sites, including trees and walls (McCabe 1963, Nickell 1968, Bellrose 1976). Other dabbling species nest primarily in dense vegetation near streams, ponds, and

marshy areas (Boeker 1953, Bellrose 1976). Some species have more specific preferences. For example, gadwalls prefer to nest on islands, if present, and pintails select open areas for nest sites more than other species. Although most dabblers will use vegetation that is characteristic of an area, northern shovelers prefer grass for nest sites (Bellrose 1976).

Feeding

A wide variety of areas are used for feeding by dabbling ducks. Mallards are more adaptable in food habits and use agricultural fields (especially grains) to a greater extent than other dabblers. Most species prefer to feed in marshy areas and shallow water of ponds and lakes with the exception of the northern shoveler which will also feed in deep water. In addition, green-winged teal often feed on mud flats (Bellrose 1976). Feeding flights to corn and small grain fields have been noted near Grand Junction in Mesa County (Hopper 1968). Native vegetative foods preferred by dabbling ducks in the western United States are primarily pondweed, bulrush, smartweed (Polygonum spp.), spikerush (Eleocharis spp.), and widgeongrass (Martin et al. 1951).

Loafing/Resting

Dabbling ducks tend to loaf on shoreline sites, with the exception of gadwalls, which prefer to loaf on open water (Duebbert 1966, Bellrose 1976). Tester (1953) stated that a lack of loafing/resting sites could have been the reason for fewer breeding pairs present in some areas of Brown's Park.

Water

Dabbling ducks are intimately associated with water during all phases of their life histories. In northwestern Colorado, the required water is primarily along river bottoms and their accompanying wetlands.

Special Requirements

Colorado, including the northwestern part of the state, provides migration stopovers for migrants in spring and fall. Many wetlands receiving heaviest use during fall migration are adjacent to grain fields. Immediately after the breeding season, large numbers of males and unsuccessful nesting pairs concentrate to undergo post-nuptial molt. Throughout Colorado, wetland areas smaller than those used for breeding often are adequate molt areas (Grieb 1965).

EFFECTS OF HABITAT ALTERATION

Wetland losses detrimentally affect waterfowl (including dabbling ducks) more than any other group. Waterfowl populations depend upon the quality and quantity of wetland habitat available to them. Due to changes in land use, such as increased agricultural production, industrial and residential expansion, and construction of highways and large impoundments, wetlands throughout the United States have been drained, filled, and otherwise altered (Hopper 1968).

In northwestern Colorado, wetlands are subject to alteration and destruction due to mining operations. With increased energy development, some direct mortality would occur due to the operation of machinery and equipment and from vehicle-wildlife collisions. A greater human population would result in increased recreational uses (especially hunting).

Additional detrimental effects on all migratory water birds include the presence of toxic materials and pathogens in surface water, instream flow changes, and the removal of impoundments (U.S. Dep. Inter. 1977, Horak and Olson 1980).

Boeker (1953), Tester (1953), and Frary (1954) acknowledged the potential effects of agricultural production and grazing, but believed that waterfowl in northwestern Colorado were not seriously affected by agricultural activities. Others have observed that several species of waterfowl have benefited from agricultural products, particularly small grains on migration and winter grounds (Bellrose 1976).

MITIGATION

Information is scarce on attempts to mitigate the detrimental effects on waterfowl that accompany past and present land use changes in northwestern Colorado. Wastewater areas that occur in conjunction with mining operations could be incorporated into such efforts. Another possibility is creation of wetland areas to divert waterfowl away from toxic water. Other ideas that have been mentioned, but that may lack cost-effectiveness include food plots and creation of pothole areas by blasting (Hopper 1978).

DATA BASE

The following data are collected annually on dabbling ducks in North America: breeding pair counts in May and June, brood counts in July, and mid-winter inventories (Bellrose 1976).

Sources of data for northwestern Colorado include theses by Boeker (1953), Tester (1953), and Frary (1954), breeding pair counts conducted in May and June, mid-winter inventories conducted in January, and surveys of small game hunters. Boeker (1953) documented arrival dates and

apparent peaks in spring migration in the Yampa River Valley for mallards, green-winged teal, blue-winged teal, cinnamon teal, gadwalls, and northern pintails. Breeding pair and brood counts that he conducted yielded information on the above species and northern shovelers. Data on the same species were collected in Brown's Park by Tester (1953). While conducting breeding pair and brood counts on the White River Plateau, 80 km east of Meeker, Frary (1954) noted that mallards and green-winged teal were the only species that regularly nested in that area.

Breeding pair count data for northwestern Colorado consist primarily of counts conducted in Brown's Park and the Yampa River Valley (Szymczak and Steinert 1981). Areas of interest that are presently being inventoried, or have been in the past, in January are the Gunnison and Colorado rivers, Brown's Park, Highline Lake, the Walker Wildlife Area, and Dupont's Lake (the latter 3 areas are in Mesa County). Brown's Park has not been inventoried since 1978. Additions since 1970 have been Highline Lake in 1970, Walker Wildlife Area in 1977, and Dupont's Lake in 1980. With the exception of some of the Brown's Park inventories, mid-winter counts have not been summarized by species (files of H. D. Funk). Statewide estimates of waterfowl harvest and number of hunters (based on surveys of small game hunters) date to the 1930's (Donoho 1980). Estimates of hunters and harvest by county and by small game management unit are available. Of the 5 northwestern Colorado counties, Mesa consistently receives the greatest amount of waterfowl hunting pressure (Donoho et al. 1981).

The Colorado Division of Wildlife banded mallards in west central Colorado from 1974 to 1981. Of 12,840 mallards banded, 7,044 were banded

in the Grand Junction area. More than 700 (724) bands were recovered through the 1979-80 hunting season (Hopper 1981).

RECOMMENDATIONS

Research

Research efforts concerning dabbling ducks in northwestern Colorado should center around the effects of different types and levels of energy development. Changes in vegetation and cover, fluctuations in water levels, increases in hunting pressure, and changes in agricultural development due to mining should be investigated. Further research on methods to mitigate detrimental effects is needed. Because of northwestern Colorado's importance as a migration corridor, investigations should not only include breeding, nesting, and wintering areas, but also those areas and times vital to migrating ducks.

Management

Because of losses of wetlands throughout the United States, it is important to preserve as much wetland habitat as possible. Changes that accompany increases in energy development, urban expansion, and/or agricultural production should be monitored. Harvest statistics will be of particular interest. Hunter surveys, breeding pair counts, and mid-winter inventories should be continued. Data should be separated by species when possible.

Grazing and holding of livestock around the shorelines of ponds and marshy areas should be discouraged. Another practice that should be discouraged is the indiscriminate burning of large, dense stands of cattails and bulrush (Boeker 1953, Grieb 1965).

DIVING DUCKS AND MERGANSERS

Order Anseriformes, Family Anatidae, Aythya affinis, A. americana, A. collaris, A. valisineria, Bucephala albeola, B. clangula, B. islandica, Lophodytes cucullatus, Mergus merganser, M. serrator, Oxyura jamaicensis.

DISTRIBUTION AND OCCURRENCE IN NORTHWESTERN COLORADO

Information on diving ducks and mergansers in northwestern Colorado is scarce. Redheads, common mergansers, and ruddy ducks regularly nest, lesser scaup nest infrequently, and all species included in this report have been observed during migration and where open water is available in winter. These species are associated primarily with streams and rivers in northwestern Colorado because that is the predominant waterfowl habitat available (Fig. 2) (Boeker 1953, Tester 1953, Frary 1954, Bailey and Niedrach 1965). Few references to historical distribution in northwestern Colorado exist. Rockwell (1908) observed redheads, canvasbacks, and lesser scaup in Mesa County during winter and spring and fall migrations. Other early 1900's reports include common mergansers during early June in Routt County (Warren 1908) and buffleheads during times of migration and winter in Rio Blanco County (Felger 1910).

TIME OF YEAR PRESENT

Only 3 species (redhead, common merganser, ruddy duck) are considered summer residents in northwestern Colorado. All 3 winter in the state, with common mergansers being most numerous. Lesser scaup and canvasbacks may occasionally nest, but generally are migrants and infrequent winter residents. Common and Barrow's goldeneyes and buffleheads are migrants and winter residents. The 3 remaining species (ring-necked

duck, hooded and red-breasted mergansers) are not numerous in Colorado and are considered uncommon migrants and winter residents (Bailey and Niedrach 1965).

Based on breeding pair counts conducted by Boeker (1953), Tester (1953), and Frary (1954), redheads, ruddy ducks, and common mergansers are the most numerous species nesting in northwestern Colorado. Boeker (1953) observed only common mergansers in the Yampa River Valley, while redheads and ruddy ducks were noted at Brown's Park (Tester 1953). Frary (1954) observed few species during the nesting season on the White River Plateau, including 1 pair each of common mergansers and lesser scaup.

Among the species most often observed in northwestern Colorado, common mergansers are the earliest to arrive in the spring, followed by lesser scaup, redheads, and ruddy ducks. Boeker (1953) reported that earliest arrival times were late March for common mergansers, mid-April for lesser scaup, and late April for redheads. Tester (1953) first noted common mergansers in early April, redheads and lesser scaup in late April, and ruddy ducks in late April to early May. Buffleheads and common goldeneyes generally begin arriving in Colorado in mid-October to November and remain as long as open water is available (Bailey and Niedrach 1965). Information on timing of fall migration for most diving ducks and mergansers in northwestern Colorado is lacking. Boeker (1953), Tester (1953), and Frary (1954) did not document fall migration.

HABITAT REQUIREMENTS

Waterfowl habitat available throughout the year in northwestern Colorado consists primarily of riverbottoms (Hopper 1968). Principal rivers are the Green, Little Snake, Yampa, White, Colorado, and Gunnison.

Nesting

In most areas of northwestern Colorado, rivers and marsh areas provide the majority of waterfowl nesting habitat (Boeker 1953, Tester 1953). Ponds and small lakes are present and used on the White River Plateau (Frary 1954) as are man-made impoundments on the Brown's Park National Wildlife Refuge.

Diving ducks are primarily over-water nesters. Examples are redheads, which prefer to nest over water in, or near, emergent vegetation, and lesser scaup which nest on floating or semi-floating mats of vegetation (Townsend 1966, Bellrose 1976). Redhead nests have also been observed on islands and in upland sites (Millar 1965, Vermeer 1970). Ruddy ducks nest in emergent vegetation that is characteristic of the area (Bellrose 1976). In contrast to redheads, lesser scaup, and ruddy ducks, common mergansers prefer to nest in hollow trees. However, when trees are lacking, they will nest on the ground, on cliffs, and in nest boxes (Griffee 1958).

Feeding

In northwestern Colorado, feeding habits for diving ducks are similar to those areas used for nesting. Frary (1954) believed that a lack of food for adults above 3,200 m on the White River Plateau may have restricted the nesting of ducks. Seeds of pondweed and sedges (Carex spp.) were not available until after nesting had begun. Diving ducks feed in a variety of bodies of water. Redheads and ruddy ducks feed on the surface more than other divers and, therefore, have more of a tendency to feed in small ponds with shallow water. In contrast, lesser scaup are

more likely to feed in relatively deep water than are most other divers (Bellrose 1976). Throughout the western United States, diving ducks prefer pondweed, bulrush, and widgeongrass (Martin et al. 1951). Mergansers consume a variety of fish (Martin et al. 1951, Bellrose 1976). Tester (1953) observed common mergansers on marshes in Brown's Park where carp (Carpio spp.) were abundant

Loafing/Resting

Although loafing/resting sites are probably adequate throughout much of northwestern Colorado, Tester (1953) stated that a lack of such sites could be responsible for fewer breeding pairs in some areas of Brown's Park.

Water

As with other waterfowl, diving ducks and mergansers are associated with water during all phases of their lives. Riverbottoms and adjacent wetlands are the most important areas for diving ducks in northwestern Colorado.

Special Requirements

Wetlands in northwestern Colorado are more valuable for migration stopover and wintering than for breeding. Immediately after the breeding season, many males and unsuccessful nesting pairs concentrate to undergo post-nuptial molt. Throughout Colorado, wetland areas smaller than those used by ducks for breeding are adequate for molting (Grieb 1965).

EFFECTS OF HABITAT ALTERATION

Wetlands throughout the United States have been subject to draining, filling, and other types of alteration. These reductions in wetland area have detrimentally affected waterfowl (including diving ducks) more than any other group (Hopper 1968).

Energy development is the principal cause of northwestern Colorado wetland alteration and destruction. In addition to loss of wetland area, other negative effects of increased development include direct mortality (from the operation of equipment and machinery and from vehicle-wildlife collisions), the presence of toxic materials and pathogens in surface water, instream flow changes, and the removal of impoundments. Accompanying an increase in human population would be a rise in hunting pressure (U.S. Dep. Inter. 1977, Horak and Olson 1980). Earlier studies conducted in northwestern Colorado discussed potential effects of agricultural production and grazing but stated that waterfowl were not detrimentally affected at that time (Boeker 1953, Tester 1953, Frary 1954).

MITIGATION

Little information is available concerning mitigation for loss of wetlands in northwestern Colorado. Potential efforts include the use of wastewater areas adjacent to mining operations and the creation of wetlands to divert waterfowl away from toxic waters. Ideas tried elsewhere in Colorado, but lacking cost-effectiveness are food plots and the creation of potholes by blasting (Hopper 1978).

DATA BASE

Data for diving ducks on a continental basis are collected 3 times during each year: breeding pair counts in May and June, brood counts in July, and mid-winter inventories.

There are several sources of data for Colorado, and more specifically, the northwestern part of the state. Investigations were conducted in the Yampa River Valley by Boeker (1953), in Brown's Park

by Tester (1953), and on the White River Plateau by Frary (1954). Breeding pair counts and mid-winter inventories are conducted in May and June, and in January, respectively while small game hunters are surveyed annually. Boeker (1953) documented arrival dates and apparent peaks in spring migration for redheads, lesser scaup, and common mergansers. Tester (1953) collected spring migration data for redheads, lesser scaup, common mergansers, ruddy ducks, and bufflehead. In addition, he conducted breeding pair counts that yielded information on redheads and ruddy ducks. During 2 years of research, Frary (1954) observed only 1 breeding pair each of lesser scaup and common mergansers. The only diving duck that is recorded consistently on statewide breeding pair counts conducted by the Colorado Division of Wildlife is the redhead. Data for northwestern Colorado consist primarily of counts conducted in Brown's Park and the Yampa River Valley (Szymczak and Steinert 1981). Principal areas of interest that are presently being inventoried, or have been in the past, in January are the Gunnison and Colorado rivers, Brown's Park, Highline Lake, the Walker Wildlife Area, and Dupont's Lake (the latter 3 areas are in Mesa County). Inventories at Brown's Park ceased in 1979. Recent additions have been Highline Lake in 1970, the Walker Wildlife Area in 1977, and Dupont's Lake in 1980. With the exception of some of the Brown's Park inventories, mid-winter counts have not been summarized by species as they are composed of 95% + mallards (files of H. D. Funk). Statewide estimates of waterfowl harvest and number of hunters (from small game hunter surveys) are available from the 1930's to the present (Donoho 1980). Estimates of hunters and harvest by county and small game

management unit are available. Of the 5 northwestern Colorado counties, Mesa consistently receives the greatest amount of waterfowl hunting pressure (Donoho et al. 1981).

RECOMMENDATIONS

Research

The effects of different types and levels of energy development on waterfowl (including diving ducks) in northwestern Colorado should be investigated. Further research is needed on methods to mitigate possible detrimental effects. In addition, changes in vegetation and cover, fluctuations in water levels, increases in hunter pressure, and changes in agricultural patterns due to energy development should be investigated.

Management

Efforts should be made to preserve as much existing wetland as possible. The effects of energy development, urban expansion, and/or agricultural production should be monitored. Hunter surveys, breeding pair counts, and mid-winter inventories should be continued. When possible, data should be summarized by species.

Grazing should be kept to a minimum and should be deferred until after the nesting season. Grazing and holding of livestock around the shorelines of ponds and marshy areas should be discouraged. Similarly, indiscriminant burning of large, dense stands of cattails and bulrush should be discouraged. These recommendations will benefit waterfowl in general, not diving ducks in particular (Boeker 1953, Grieb 1965).

CHUKAR

Order Galliformes, Family Phasianidae, Alectoris chukar.

DISTRIBUTION AND STATUS IN NORTHWESTERN COLORADO

In Colorado, chukars occur primarily in northwestern and west central counties (Fig. 3). They were introduced into all 5 northwestern counties between 1951 and 1967 and became established in Moffat, Rio Blanco, Garfield, and Mesa counties (Sandfort 1967). Populations in these counties accounted for 64% of the total chukar range in Colorado in 1964 (Sandfort 1965). Chukars did not become established in Routt County and their current status in northwestern Colorado is unknown.

Chukars have been hunted annually since the first season opened in 1958 (Sandfort 1967, Donoho et al. 1981). Harvest apparently peaked in 1967 and has declined since then. The current estimated harvest in northwestern Colorado is highest in Mesa County followed by Garfield and Moffat counties.

HABITAT REQUIREMENTS

Chukars prefer semi-desert habitats characterized by high summer temperatures, low winter snowfall, rough terrain, low-growing vegetation, abundant cheatgrass brome, and a source of free water in summer (Sandfort 1965). Ideal range is considered to be rocky, steep terrain in canyons and on sides of mesas (Sandfort 1954). Principal vegetation on slopes includes big sagebrush (Artemisia tridentata), saltbush (Atriplex spp.), broom snakeweed (Gutierrezia sarothrae), and scattered pinyon pine (Pinus edulis) and junipers (Juniperus spp.). Saskatoon serviceberry (Amelanchier

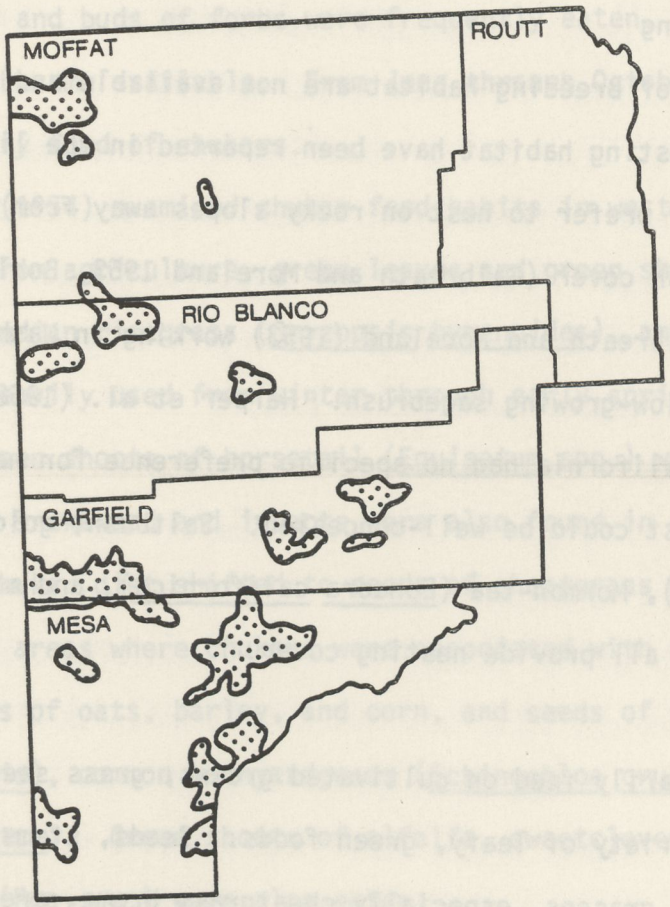

Fig. 3. Distribution of chukars, northwestern Colorado (after Sandfort 1965).

alnifolia) and antelope bitterbrush (Purshia tridentata) are common in chukar habitat in northwestern Colorado. Plants providing cover in draws and waterways include sagebrush, black greasewood (Sarcobatus vermiculatus), fragrant sumac (Rhus aromatica), rabbitbrush (Chrysothamnus spp.), willows (Salix spp.), and cottonwoods (Populus spp.). Cultivated crops are important sources of food in agricultural areas.

Breeding and Nesting

Descriptions of breeding habitat are not available and only general descriptions of nesting habitat have been reported in the literature. Chukars apparently prefer to nest on rocky slopes away from creek bottoms and heavy sagebrush cover (Galbreath and Moreland 1953, Bohl 1957, Harper et al. 1958). Galbreath and Moreland (1953) working in Washington located most nests under low-growing sagebrush. Harper et al. (1958) reported that chukars in California had no specific preference for nesting cover as long as the nest could be well-concealed. Saltbush, goldenweed (Haplopappus spp.), Mormon-tea (Ephedra californica), and mixed annual forbs and grasses all provide nesting cover.

Feeding

Chukars primarily feed on cultivated grains, grass seeds, fruits, berries, and a variety of leafy, green foods. Seeds, stems, leaves, and rootstocks of grasses, especially cheatgrass brome, are the most important year-round items in the chukar diet throughout its range (Alcorn and Richardson 1951, Galbreath and Moreland 1953, Sandfort 1954,

Bohl 1957). Harper et al. (1958) found seeds of common Russianthistle (Salsola kali) to be more heavily used than grass seeds in the summer-fall diet of chukars in California.

Christensen (1970) summarized the year-round food habits of chukars in Nevada. From November through March, leaves of grasses germinating after the fall rains made up the bulk of the diet. In April and May, leaves, stems, and buds of forbs were frequently eaten. Insects were eaten as they became available. From June through October, grass seeds were the primary food of chukars.

Sandfort (1954) examined chukar food habits in western Colorado. In areas remote from agriculture, green leaves and green shoots of cheatgrass brome, Indian ricegrass (Oryzopsis hymenoides), and other perennial grasses were heavily used from winter through early spring. During dry, hot months, green shoots of horsetail (Equisetum spp.) were often eaten. Flower buds of snakeweed and insects were also found in crop contents. In fall, the chukar diet shifted to seeds of cheatgrass brome and Indian ricegrass. In areas where chukars were associated with agriculture, they consumed grains of oats, barley, and corn, and seeds of green bristlegrass (Setaria viridis), common barnyardgrass (Echinochloa crusgalli), and wild oats (Avena fatua). Green shoots of alfalfa, sweetclover (Melilotus spp.) and bluegrass (Poa spp.) were also eaten.

Loafing/Roosting

Chukars do not usually seek heavy cover for roosting. They apparently prefer to loaf and roost in the shelter of rock outcrops on open rocky areas (Alcorn and Richardson 1951, Galbreath and Moreland 1953, Sandfort 1954, Christensen 1970). Bohl (1957) identified 3 general types of roost sites in New Mexico. These included open rocky areas, open grassy flats atop mesas, and under juniper trees.

WATER

Chukars congregate around water sources during dry, hot summer months and it is generally believed that their summer distribution is limited by availability of free water (Alcorn and Richardson 1951, Galbreath and Moreland 1953, Harper et al. 1958, Christensen 1970). Affinity to open water sources in summer has been observed in Colorado (Nicolls 1961) and Sandfort (1965) recommended construction of "gallinaceous guzzlers" to increase chukar distribution and numbers. The apparent requirement for free water during summer may be necessitated by their dry seed diet. Chukars disperse from summer range around water sources in August and September in Colorado when temperatures decrease, rainfall increases, and grasses begin to sprout again providing adequate moisture in succulent green vegetation (Nicolls 1961).

SEASONAL MOVEMENTS

Water availability during summer and snowfall during winter are determining factors in chukar distribution and movements. During the breeding season in spring, chukars are widely scattered over their range (Galbreath and Moreland 1953, Bohl 1957, Christensen 1970). During summer months, chukars congregate around water sources but after the fall rains, they disperse widely throughout suitable habitat. During periods of heavy snow cover, chukars will often seek steep, snow-free, south-facing slopes or move to lower elevations where there is less snow and more available food. Once snow cover has receded, however, chukars will return to higher elevations (Galbreath and Moreland 1953, Harper et al. 1958, Christensen 1970).

EFFECTS OF HABITAT ALTERATION

Effects of habitat alteration on chukars have not been specifically examined. However, chukars are dependent upon altered habitats since cheatgrass brome, an exotic species, is an important year-round source of food. Where cultivated grains and alfalfa are available, chukars may feed on them from summer through winter. Galbreath and Moreland (1953) reported that agricultural areas along valley floors may become important feeding areas during winters with heavy snowfall in Washington. Sandfort (1965) stated that overgrazing created no problem for the chukar as the resulting growth of cheatgrass brome provided an excellent food source. He also recommended controlled burning experiments to reduce the heavy overstory of pinyon pine and juniper in some areas to promote growth of cheatgrass brome for food and cover.

MITIGATION

No attempts to mitigate loss of chukar habitat have been reported in the literature. Kays (1962), however, reported unsuccessful attempts to introduce chukars over a 5-year period on reclaimed strip-mined land in Kentucky. Reasons for failure were poorly documented but may have been related to unsuitable climatic factors.

DATA BASE

The data base for chukars in northwestern Colorado is limited to the statewide small game harvest survey (Donoho et al. 1981). Annual harvest estimates are available for western Colorado but sample sizes have been extremely small. Accuracy of the harvest estimates and trends is unknown. Harvest may be overestimated as has been demonstrated with sage grouse (Braun 1979) and indicated by Sandfort (1965) for earlier chukar harvest estimates.

RECOMMENDATIONS

Research

1. Initiate banding and radiotelemetry studies to examine seasonal movements, identify important seasonal habitats, understand habitat selection, and obtain population and harvest information.
2. Develop and evaluate techniques to mitigate chukar habitat losses from energy development on public lands.
   a. Conduct controlled burning experiments to promote growth of cheatgrass for food and cover (Sandfort 1965).
3. Develop techniques to rehabilitate chukar habitats altered by energy development.
   a. Seed and transplant grasses, forbs, and shrubs which are important food and cover species for chukars.
   b. Fertilize and irrigate reclaimed areas to stimulate rapid revegetation.

Management

1. Initiate free permit and questionnaire system (Braun 1981) to examine harvest and hunter activity and trends by small game management units. Operate check stations and volunteer wing collection stations during the hunting season to obtain chukar harvest and population statistics.
3. Fence existing water sources to prevent trampling of cover by cattle and provide open water for chukars during summer (Sandfort 1965).
4. Develop new water sources where water is limiting summer distribution of chukars (Sandfort 1965).

RING-NECKED PHEASANT

Order Galliformes, Family Phasianidae, *Phasianus colchicus*

DISTRIBUTION AND STATUS IN NORTHWESTERN COLORADO

Ring-necked pheasants occur in all 5 northwestern Colorado counties. In 1957, occupied range was greatest in Mesa County followed by Garfield, Moffat, Rio Blanco, and Routt counties (Swope 1965) (Fig. 4). Pheasant range in these 5 counties accounted for only 3% of the total Colorado pheasant range in 1957. The highest population densities by county occurred along the Colorado and Gunnison rivers in Mesa County, the Colorado River and its tributaries in Garfield County, the White River in Rio Blanco County, and the Yampa and Green rivers in Routt and Moffat counties.

Except for Mesa County, Swope (1965) considered the Northwest Region of Colorado as generally poor pheasant habitat, too limited to be of management significance. The 1955-63 harvest from the Northwest Region except Mesa County accounted for only 0.5% of the total statewide harvest.

Little is known about current distribution and status of ring-necked pheasants in northwestern Colorado. Recent harvest estimates (Donoho et al. 1979, 1980, 1981) have been stable for Mesa County. Harvest estimates for Garfield and Moffat counties have been low. No estimates are available for Rio Blanco and Routt counties.

HABITAT REQUIREMENTS

The ring-necked pheasant occupies a variety of habitats and is primarily found throughout grain-producing agricultural areas (Hanson

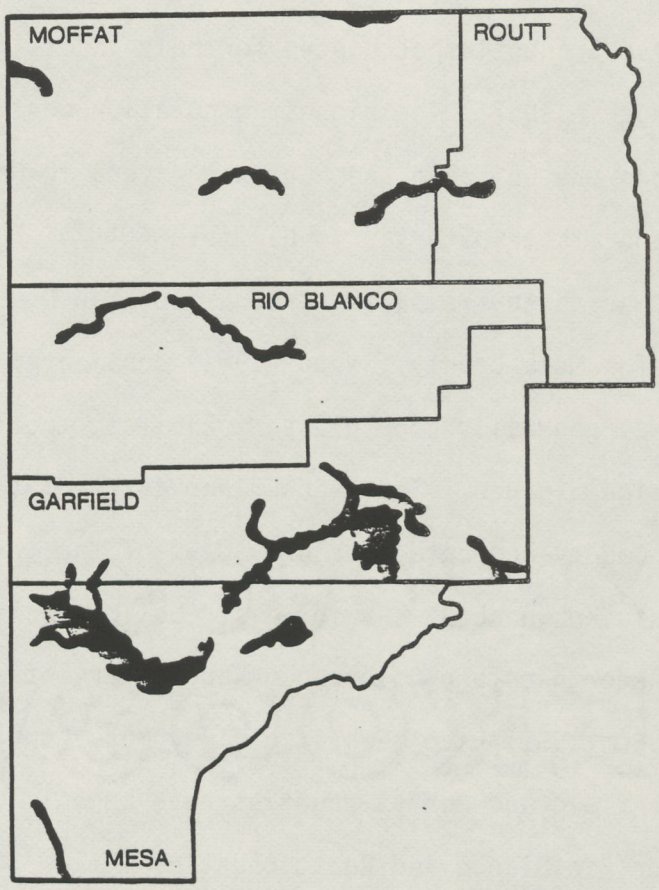

Fig. 4. Distribution of ring-necked pheasants, northwestern Colorado (after Swope 1965).

and Labisky 1964). Swope (1965) reported that fencerows, borrow pits, swales, woody plantings, and abandoned homesites provide most of the permanent cover for pheasants in eastern Colorado. Woody or brushy areas are frequently used during winter for protective cover whereas residual grasses, hayfields, and grainfields provide suitable cover during spring through fall (Hanson and Labisky 1964, Olsen 1977).

Breeding

Breeding ring-necked pheasants concentrate in areas with relatively flat, open cover interspersed with heavier tree or brush cover (Baskett 1947, Taber 1949, Burger 1966). However, heavy brush cover is not always required. Snyder (1974) reported ring-necked pheasants used wheat stubble for breeding areas in northeastern Colorado. Baskett (1947) and Burger (1966) also reported that brush and tree cover are not always a requirement on breeding territories.

Nesting

Pheasant hens generally prefer to nest in the densest and tallest cover available (Hanson 1970, Gates and Hale 1975). Most early nesting attempts in eastern Colorado are in wheat stubble and alfalfa fields due to the lack of other permanent cover (Sandfort 1963, Swope 1965). Hoffman (1973) reported that hens preferred to nest in wheatgrasses (Agropyron spp.) and alfalfa-crested wheatgrass (A. cristata) mixtures over either crested wheatgrass or alfalfa alone.

Pheasants use roadsides extensively for nesting where other cover is unavailable (Klonglon 1955, Trautman 1960, Baxter and Wolfe 1973). Snyder (1974) reported that the number of successful nests was highest

along seeded roadsides in Colorado followed by unfarmed and farmed roadsides.

Loafing/Roosting

Ring-necked pheasants seek loafing and roosting cover in relatively open vegetation such as grasses, hayfields, stubble fields, or residual cover from previous years (Hanson and Labisky 1964, Olsen 1977). During hot, dry summer months and adverse winter weather, woody plantings are important. Lyon (1954) found that heavy weed cover > 38.5 cm tall and cattails were highly preferred winter roost cover in north central Colorado. Pheasants also made limited use of riverbottoms, ditch banks, willows, and grain stubble.

Feeding

Food preferences vary on a regional or local basis and probably reflect differences in availability more than any other single factor (Olsen 1977). Although waste grains, primarily corn, constitute the major portion of the pheasants' diet throughout much of its range (Fried 1940, Hiatt 1946, Trautman 1952, Korschgen 1964), several authors have reported dependence upon other food sources where corn, wheat, barley, and oats have not been readily available. Cottam (1929) reported that weed seeds were more important than cultivated grains during winter in Utah. Dalke (1943) observed that fruits and berries were important in Michigan when ice and snow covered waste grains.

On a seasonal basis, ring-necked pheasants are heavily dependent upon waste grains during winter, spring, and fall (Hiatt 1946, Trautman 1952, Korschgen 1964). Forb and grass seeds are also important sources of food

during fall and winter. Green foliage and animal foods, primarily grasshoppers, are eaten when available from spring through fall.

Water

Although water is important to pheasant survival, open water sources have not been demonstrated to be essential in ring-necked pheasant habitat (Olsen 1977). Swope (1965) stated that some of the better pheasant areas in Colorado frequently lack open water. In the absence of open water, dew, succulent vegetation and fruits, insects, frost, and snow adequately meet water requirements.

SEASONAL MOVEMENTS

Daily and seasonal movements of ring-necked pheasants are fairly limited. Gates and Hale (1974) found that 80% of hen movements to and from wintering areas in Wisconsin were within a 3.2 km radius. Egbert (1968) reported that movements of pheasants from summer and fall ranges to winter ranges in Iowa averaged approximately 1 km. Movements within winter ranges averaged only 0.3 km and little or no movement between wintering areas was observed. Lyon (1967) reported that pheasants in Iowa moved greater distances in spring as they dispersed from winter concentration areas than at other times of the year. Spring movements averaged 1.5 km compared to 0.3 km during winter and 0.5 km during late summer and fall.

EFFECTS OF HABITAT ALTERATION

Loss of winter and nesting habitats through intensive farming practices have been considered major limiting factors for ring-necked pheasants in Colorado and throughout the intermountain region (Yeager et al. 1956, Hoffman 1973). Winter and nesting cover in Colorado have been

eliminated through burning, herbicide spraying, and cultivation of roadsides, ditchbanks, fencelines, sloughs, and waste places (Sandfort 1963, Swope 1965). Snyder (1974) reported that lack of roadside nesting cover is the primary reason pheasants have declined in Colorado. Without roadside cover, hens nest in alfalfa fields where pheasant production is low due to high nest destruction from early haying operations (Galbreath 1973, Snyder 1974, Olsen 1977).

MITIGATION

Attempts to mitigate ring-necked pheasant habitat losses from farming practices have been directed toward providing suitable nesting cover (Joselyn et al. 1968, Joselyn and Tate 1972, Snyder 1974) and establishing brushy winter cover with shrubs and herbaceous plantings (Keck 1963, Olsen 1977). Attempts to mitigate losses from energy developments have not been reported in the literature.

DATA BASE

The data base for ring-necked pheasants in northwestern Colorado is limited to call count and brood census routes in the Grand Junction area and the statewide small game harvest survey (Donoho et al. 1981). Due to small sample sizes, population trends may not be accurately depicted using these data except in Mesa County where pheasant populations have been fairly stable in recent years.

RECOMMENDATIONS

Research

1. Initiate banding and radiotelemetry studies to examine seasonal movements, identify important seasonal habitats, investigate habitat selection, and obtain population and harvest statistics.

2. Develop and evaluate techniques to mitigate ring-necked pheasant habitat impacted by energy development.
   a. Seed and transplant native and exotic forbs, grasses, and shrubs which are important food and cover species for pheasants.
   b. Plant food plots of cultivated grains to provide adequate winter food until revegetated areas become established.
   c. Fertilize and irrigate reclaimed areas to stimulate rapid revegetation.

Management

1. Conduct spring crowing counts to estimate breeding densities of pheasants.
2. Initiate free permit and questionnaire system (Braun 1981) to examine annual harvest and hunter activity and trends by small game management units in northwestern Colorado.
3. Operate check stations and volunteer wing collection stations during the hunting season to obtain pheasant harvest and population statistics.
4. Provide winter cover through planting and cultivation of grasses, legumes, and shrubs where cover is limiting pheasant distribution (Keck 1963, Swope 1965).
5. Provide nesting cover where it is limiting along roadsides in agricultural areas (Snyder 1974).
6. Encourage farmers to alter timing of spring cultivation practices to enhance pheasant nesting success.
7. Develop winter herbaceous and shrub cover where habitat will be impacted by energy development.
8. Plant food plots adjacent to winter cover used by pheasants where natural foods are lacking or disturbed by energy development.

9. Maintain or develop adequate interspersion of cover types required for breeding, nesting, brooding, and winter cover.
10. Purchase private lands within better pheasant ranges to ensure adequate habitat is available.
11. Reduce grazing pressure in pheasant habitats on lands adjacent to areas to be developed.

BLUE GROUSE

Order Galliformes, Family Phasianidae, Dendragapus obscurus.

DISTRIBUTION AND STATUS IN NORTHWESTERN COLORADO

Blue grouse are distributed throughout the mountainous areas of western Colorado at elevations ranging from approximately 1,380 to 3,870 m (Rogers 1968). Their distribution is fairly similar to the distribution of Douglas-fir (Pseudotsuga menziesii) and white fir (Abies concolor) although they are not strictly limited to these forest types (Fig. 5).

Little is known about blue grouse distribution and status in Moffat, Routt, Rio Blanco, Garfield, and Mesa counties. Data from questionnaire surveys suggested that blue grouse populations were increasing statewide from 1976 to 1979 (Donoho 1980) and that blue grouse harvest in these 5 counties has been fairly stable or slightly increasing from 1978 through 1980 (Donoho et al. 1979, 1980, 1981). Harvest data collected at check stations and from wing barrels indicate that blue grouse production in Routt County and the Piceance Basin of Rio Blanco County has been adequate to maintain populations in these areas (R. W. Hoffman, unpubl. data).

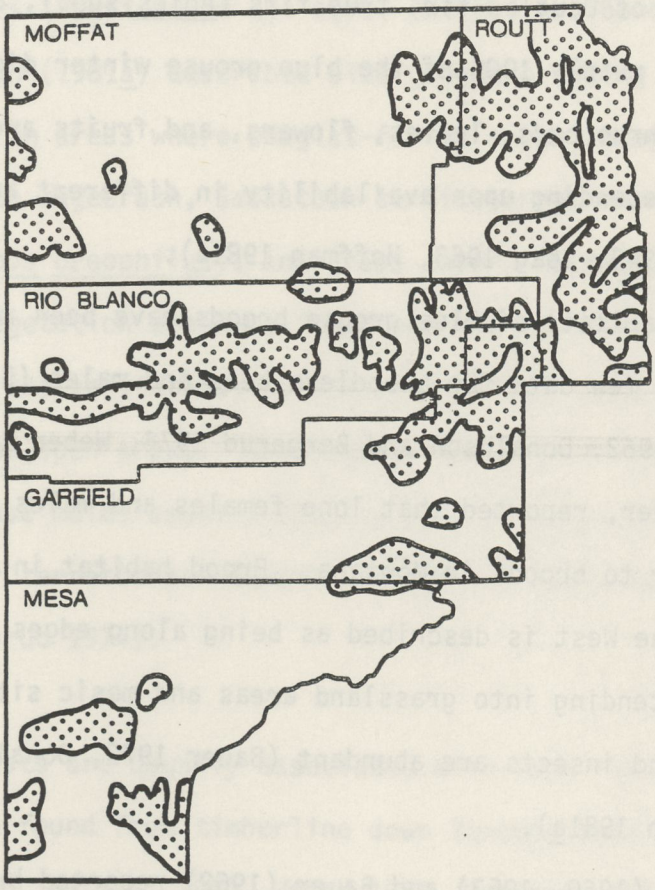

Fig. 5. Distribution of blue grouse, northwestern Colorado (after Rogers 1968).

HABITAT REQUIREMENTS

Blue grouse winter in coniferous forests in the mountains and migrate to relatively open breeding areas at lower elevations in spring (Marshall 1946, Zwickel and Bendell 1972a). Summer-early fall habitats are typically in open or semi-open areas along edges of shrub and tree cover where there is abundant herbaceous vegetation. Whereas needles, buds, and twig tips of Douglas-fir, true firs (Abies spp.), and pines (Pinus spp.) compose nearly 100% of the blue grouse winter diet, a wide variety of forb and shrub buds, leaves, flowers, and fruits are eaten during spring-fall depending upon availability in different areas and between years (Beer 1943, Boag 1963, Hoffman 1981a).

Summer habitats of blue grouse broods have been reported frequently but there are few data for broodless hens and males (Beer 1943, Mussehl 1960, Bauer 1962, Donaldson and Bergerud 1974, Weber 1975). Mussehl (1963), however, reported that lone females and males were found in cover similar to broods in Montana. Brood habitat in Colorado and throughout the West is described as being along edges of tree and shrub cover and extending into grassland areas and mesic sites where herbaceous vegetation and insects are abundant (Bauer 1972, Donaldson and Bergerud 1974, Hoffman 1981a).

Mussehl (1960, 1963) and Bauer (1962) reported broods primarily used grassland sites up to 6-7 weeks of age, after which deciduous shrub types became more important. Harju (1974) stated that the wide variety of shrub species present on brood ranges indicated that species composition was less important than structure and abundant food resources. Dominant trees and shrubs on brood ranges examined in Colorado included Douglas-fir, aspen, snowberry, and sagebrush (Rogers 1968, Hoffman 1981a).

Breeding

Much of the research on blue grouse habitat selection has been directed toward breeding habitats (Bendell and Elliot 1966, Redfield et al. 1970, Martinka 1972, Donaldson and Bergerud 1974). Blue grouse breed in a wide variety of forest and shrub types from the foothills to the alpine. High breeding densities may be found in cover ranging from open to 50% conifers (Redfield et al. 1970, Zwickel and Bendell 1972a). In Colorado, Hoffman (1981a) described blue grouse breeding territories as being primarily in areas where Douglas-fir or aspen integrade into more open areas with sagebrush, Saskatoon serviceberry, mountain snowberry (Symphoricarpos oreophilus), and grass cover. Structural characteristics of the vegetation are more important than species composition. Common elements of the vegetation include some form of tree cover, shrub thickets, edges, and open areas. Openings in the tree or shrub canopy are important because males usually display from elevated positions in open areas on their territories (Bendell and Elliot 1966, Rogers 1968, Donaldson and Bergerud 1974).

Nesting

Blue grouse nests are usually associated with some form of shrub cover and have been found from timberline down through open sagebrush plains (Heebner 1956, Mussehl 1960, Weber 1975, Hoffman 1981a). Weber (1975) suggested that hens may nest on territories of males which bred them. However, only half of the nests found by Hoffman (1981a) were within the boundaries of a territory.

Hoffman (1981a) described nest sites in Colorado as being in generally open or semi-open shrub cover. All but 1 of 12 nests were associated with big sagebrush cover. Slope at nest sites varied from 6 to 25% and average height of cover above the nest was 98 cm. Weber (1975) also found the majority (14 of 16) of blue grouse nest sites in Utah under big sagebrush.

Feeding

Winter.--Blue grouse area associated with coniferous forests during winter but are not restricted to specific plant associations (Zwickel and Bendell 1972a). They feed on buds, twig-tips, needles, and cones of a variety of species including Douglas-fir, true firs, pine, and mountain hemlock (Tsuga mertensiana) (Beer 1943, Stewart 1944, Hoffmann 1961, King 1973).

Little research has been done involving winter nutrition and cover preferences. Hoffmann (1961) suggested that blue grouse may be selectively feeding on needles with high protein content. Peterson and Stauffer (1980) reported that blue grouse in Idaho selected larger trees for feeding and those with more conifer cover within 40 m than trees not used for feeding.

Spring.--Blue grouse feed on conifer buds and needles in early spring but will rapidly shift to a diet of green leaf material and flowers as they become available on breeding areas (Mussehl and Finley 1967, King 1968). Hoffman (1981a) reported that shrub thickets are important for blue grouse feeding and resting cover on breeding territories in Colorado.

Blue grouse may continue to feed on conifer needles to some extent throughout the breeding season. Zwickel and Bendell (1972b) observed a preference for Douglas-fir by nesting hens in British Columbia but salal (Gaultheria shallon) and willows were acceptable alternates where Douglas-fir was not available.

Summer.--Food habits of blue grouse broods follow a similar pattern as for other species of grouse. Insects, especially grasshoppers, are the most important component of the diet for chicks early in life (Beer 1943, Mussehl and Finley 1967, King 1968). Weber (1975) reported that insects provided the bulk of the chick diet from June through August in Utah. Buds, leaves, flowers, and fruits of plants, however, are more important for adults during summer and become increasingly important for chicks throughout summer.

Fall.--The transition from summer to winter diet for blue grouse begins in late September and early October and depends upon the availability of herbaceous vegetation, seeds, and fruits. Whereas conifer needles were found most frequently in several fall food habits studies throughout the West (Beer 1943, Boag 1963, Harju 1974), Hoffman (1981a) found that blueberry (Vaccinium spp.) was the most common item in the fall diet of Colorado blue grouse. Juvenile grouse continued to eat more insects than adults.

Loafing/Roosting

Few studies have commented specifically on resting and roosting cover for blue grouse. Winter roosts are in conifer trees associated with feeding sites. Hoffman (1981a) reported that conifer or aspen

trees are used in spring for escape and roost cover and that broods often used aspen or shrub thickets of serviceberry or common chokecherry (Prunus virginiana) during summer. Harju (1974) observed hens and chicks roosting in dense cover associated with quaking aspen (Populus tremuloides) and narrowleaf cottonwood (P. angustifolia) or at the edges of aspen groves.

Water

There is no indication that blue grouse need open water (Rogers 1968, Hoffman 1981a) and water requirements have received little attention. Blue grouse are often observed near streams and other mesic sites during summer but this appears to be due to the abundant herbaceous vegetation and insects available in these areas.

SEASONAL MOVEMENTS

Most blue grouse migrate from fairly dense coniferous winter cover to more open breeding and summer habitats at lower elevations (Marshall 1946, Wing 1947, Bendell 1955). In some areas, blue grouse may winter and breed on the same ranges (Hoffmann 1956) or move upward to breeding areas at or near timberline (Bailey 1928). Distances between winter and breeding habitats have not been widely documented. Zwickel et al. (1968) observed that 50% of the fall band recoveries of blue grouse in north central Washington were beyond 8 km from summer ranges. Their data suggest that long-distance movements between summer and winter ranges may be fairly common.

Brood movements within summer range are limited (Bendell 1955, Mussehl 1960). Mussehl (1960) reported that brood movements were restricted to 0.8 km or less on summer range in Montana.

Movements to and from summer ranges are believed to be influenced largely by weather patterns and range conditions (Marshall 1946, Bendell 1955, Rogers 1968) but this has been disputed (Bauer 1962, King 1968). Migration downslope to breeding areas in Colorado usually occurs in early April (Hoffman 1981a) but is probably determined to some extent by snow conditions on breeding range (Weber 1975). Rogers (1968) reported that males tend to concentrate at higher elevations during summer than broods. Mussehl (1960) reported that males and broodless hens disperse from summer range earlier than brood hens and that brood break-up in late August and early September was concurrent with dispersal to winter ranges.

EFFECTS OF HABITAT ALTERATION

Natural and artificial alteration of blue grouse habitat may be beneficial or detrimental to blue grouse populations. Fires and logging in mature coniferous forests have been demonstrated to increase breeding densities of blue grouse in British Columbia (Redfield et al. 1970). Martinka (1972) also stated that logging may be beneficial on blue grouse breeding ranges to open the canopy and allow regeneration of scattered conifer thickets preferred as breeding cover in Montana. Fires and logging in winter habitats, however, would be detrimental to blue grouse since they require mature conifer forests for winter food and cover.

Grazing on summer ranges may be detrimental to blue grouse. Harju (1974) observed a large reduction in the number of brood sightings between years when blue grouse summer habitat in Wyoming was grazed or not. Mussehl (1963) related lack of brood activity in grazed areas to reduction in effective cover. Zwickel (1972) stated that the proportion of successful breeding hens may have been lower on grazed areas in Washington.

Ash et al. (1977) observed the effects of fertilization with urea nitrogen on blue grouse breeding range in British Columaia. Although no increases in breeding densities or reproductive success were observed after 2 years, there was increased use of the fertilized areas by yearling grouse.

MITIGATION

No attempts to mitigate losses of blue grouse habitat have been reported in Colorado or throughout blue grouse range in western North America.

DATA BASE

Data bases for blue grouse in northwestern Colorado include the statewide small game harvest survey (Donoho et al. 1981) and harvest data obtained from hunter check stations and volunteer wing collection stations (Hoffman 1981b). Harvest estimates for northwestern Colorado from the small game harvest survey may accurately indicate population trends. However, estimates of total harvest are probably over-estimated as has been found for sage grouse (Braun 1979). Blue grouse population and harvest data are available from hunter check stations and wing barrels for 1977-81 in Routt County and 1978-81 in the Piceance Basin of Rio Blanco County (R. W. Hoffman, unpubl. data).

RECOMMENDATIONS

Research

1. Initiate radiotelemetry studies to identify important seasonal habitats and understand components of habitat selection.
2. Develop and evaluate techniques to mitigate impacts of energy development on blue grouse habitat.

3. Develop and evaluate blue grouse habitat rehabilitation techniques for lands disturbed by energy development.
   a. Seed and transplant native forbs, grasses, shrubs, and trees on reclaimed land.
   b. Fertilize reclaimed areas to encourage rapid revegetation of seedlings and transplants.
4. Examine aspen silvicultural practices that would improve blue grouse breeding and brood-rearing habitats (Hoffman 1981c).

Management

1. Continue and expand operation of hunter check stations and volunteer wing collection stations during the hunting season in Routt County and the Piceance Basin area of Rio Blanco County to obtain blue grouse population and harvest data.
2. Initiate check station and wing barrel operations in areas to be impacted by energy development to monitor blue grouse population and harvest trends prior to, during, and after development.
3. Initiate free permit and questionnaire system (Braun 1981) to examine harvest and hunter activity and trends by small game management units in northwestern Colorado.
4. Limit disturbance of important seasonal habitats from road construction, off-road vehicles, overburden piles, and urban development.
5. Reduce grazing pressure on breeding and summer ranges where it limits blue grouse abundance.

SAGE GROUSE

Order Galliformes, Family Phasianidae, Centrocercus urophasianus.

DISTRIBUTION AND STATUS IN NORTHWESTERN COLORADO

Sage grouse are widely distributed throughout western North American rangelands dominated by sagebrush (Aldrich 1963). Early records of sage grouse distribution in Colorado, compiled by Rogers (1964) and Bailey and Niedrach (1965), indicated that sage grouse occurred in nearly all counties west of the continental divide and several eastern slope counties. Sage grouse were reported from all 5 northwestern counties (Moffat, Routt, Rio Blanco, Garfield, Mesa) with highest densities in Moffat and Routt counties.

Current distribution of sage grouse in Colorado includes all 5 northwestern counties (Fig. 6). Reproductively heatlhy populations occur in Moffat and western Routt counties (Braun 1981) and the Piceance Basin of Rio Blanco County (C. E. Braun, unpubl. data). Little is known about the status of populations in Garfield and Mesa counties. Lek count data for the northwest region from 1962 through 1979 fluctuate widely (Donoho 1980).

Sage grouse are annually hunted in all 5 counties. Harvest statistics from the statewide small game harvest survey in 1980 indicated that over 12,000 sage grouse were harvested in the 5 northwestern counties (Donoho et al. 1981). Harvest was highest in Moffat County followed by Routt, Garfield, Mesa, and Rio Blanco counties. Braun (1981) reported a 7-11% harvest rate during 1978-81 in Moffat County. Although harvest rate data are not available for other northwestern counties, it is

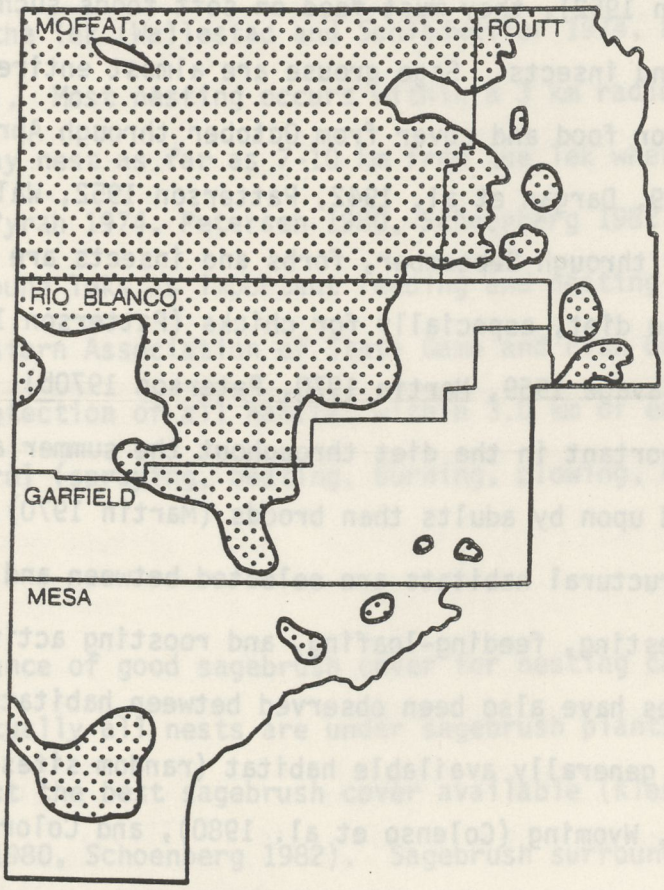

Fig. 6. Distribution of sage grouse, northwestern Colorado (C. E. Braun, unpubl. data).

unlikely that hunting is removing more than 10% of the fall population of sage grouse (Braun 1979).

HABITAT REQUIREMENTS

Sage grouse are probably the most narrowly adapted member of the Tetraoninae as they are dependent upon sagebrush for food and cover throughout the year. Because they lack a muscular gizzard containing stones (Patterson 1952), they must feed on soft foods such as sagebrush leaves, forbs, and insects. Sage grouse are almost entirely dependent upon sagebrush for food and cover from October through April (Girard 1937, Griner 1939, Dargan et al. 1942, Patterson 1952, Wallestad et al. 1975). From May through September, forbs and insects are important components of the diet, especially for chicks (Patterson 1952, Klebenow and Gray 1968, Savage 1969, Martin 1970, Peterson 1970b). Sagebrush becomes more important in the diet throughout the summer and is usually more heavily fed upon by adults than broods (Martin 1970).

Diverse structural habitats are selected between and within seasons for breeding, nesting, feeding-loafing, and roosting activities. Distinct differences have also been observed between habitats selected by sage grouse and generally available habitat (random sites) in Idaho (Klebenow 1969), Wyoming (Colenso et al. 1980), and Colorado (Schoenberg 1981).

Breeding

Leks are typically on sparsely vegetated flat areas in sagebrush draws and on benches and ridges (Patterson 1952, Rogers 1964, Rothenmaier 1979, Dingman 1980). Man-made openings such as abandoned homesteads, gravel pits, roads, and airstrips are also used occasionally. Average sagebrush canopy cover and height at leks in North Park, Colorado varied from 6 to 11% and 5 to 10 cm, respectively (Emmons 1980,

Petersen 1980, Schoenberg 1982). Total vegetative cover on 11 leks in North Park averaged 10-25% (Dingman 1980).

Leks are not only important as breeding sites but also serve to identify important feeding, nesting, and brood-rearing habitats. Leks may be the center of year-round activity in some areas (Eng and Schladweiler 1972, Wallestad and Pyrah 1974, Wallestad and Schladweiler 1974). Practically all feeding sites of males during the breeding season are within 2 km of the lek (Wallestad and Schladweiler 1974, Emmons 1980, Schoenberg 1982). Most nesting occurs within a 3 km radius of the lek although hens may nest as far as 7-10 km from the lek where they breed (Wallestad and Pyrah 1974, Petersen 1980, Schoenberg 1982). Recognition of the areas around leks as important feeding and nesting habitat prompted the Western Association of State Game and Fish Commissioners to recommend protection of all habitat within 3.0 km of each lek from vegetation control (spraying, beating, burning, plowing, etc.) (Braun et al. 1977).

Nesting

The importance of good sagebrush cover for nesting cannot be overestimated. Virtually all nests are under sagebrush plants and nesting hens often select the best sagebrush cover available (Klebenow 1969, Colenso et al. 1980, Schoenberg 1982). Sagebrush surrounding nest sites ranges between 18 and 44% average canopy cover and 28-35 cm average height (Klebenow 1969, Wallestad and Pyrah 1974, Petersen 1980, Schoenberg 1982). Hens typically select plants under which to nest which are taller (35-52 cm) than the surrounding vegetation.

Feeding/Loafing

Sage grouse generally select relatively flat terrain for feeding/loafing (FL) throughout the year. During winter, however, sage grouse often use windswept ridges where sagebrush is available (Dalke et al. 1963, Eng and Schladweiler 1972, Beck 1977). In more severe winters, the flat expanses of sagebrush are often snow-covered and sage grouse frequently use draws where tall stands of sagebrush are exposed despite deep snow (Ihli et al. 1973, Schoenberg 1982).

Preferred feeding/loafing cover during the breeding season for hens prior to incubation and males is usually in sagebrush with 28-35% average canopy cover and 24-30 cm average height (Wallestad and Schladweiler 1974, Emmons 1980, Petersen 1980, Schoenberg 1982). Hens select slightly lower ranges of sagebrush canopy cover and height than males. Preferred ranges are fairly broad: 10-50% canopy cover and 10-40 cm tall.

Canopy cover and height of sagebrush selected by broods on summer range are usually lower than other feeding sites due to the preference for forbs and insects in the summer diet. Sagebrush on summer brood ranges in Idaho and Montana averaged from 6 to 19% canopy cover and 18-41 cm tall (Klebenow 1969, Martin 1970, Peterson 1970b, Wallestad 1971). The most common insects in the diet are Orthoptera (grasshoppers), Hymenoptera (ants), and Coleoptera (beetles). Preferred forbs include common dandelion (Taraxacum officinale), clover, salsify (Tragopogon spp.), yarrow (Achillea spp.), fringed sagebrush (Artemisia frigida), and prickly lettuce (Lactuca serriola) (Klebenow and Gray 1968, Martin 1970, Wallestad et al. 1975).

Average sagebrush canopy cover and height at winter feeding/loafing sites may be similar to breeding season feeding/loafing sites if snow cover is not excessive. In Montana, Eng and Schladweiler (1972) reported similar mean sagebrush canopy cover at female winter FL sites (28%) as reported at male spring FL sites (32%) by Wallestad and Schladweiler (1974) in the same area. However, average canopy cover and height at winter FL sites in Colorado were almost twice as great (51% and 41 cm) during a severe winter with deep snow cover (Schoenberg 1982).

Few studies have examined roosting sites of sage grouse. Emmons (1980) reported that approximately 81% of breeding season roosting sites of males were on leks. Average canopy cover was 8.7% for all roost locations and 22.4% for off-lek roost sites. Petersen (1980) examined roost sites of hens during the breeding season and reported height data only. Average height was 7.6 cm and all roost sites were in sagebrush < 20 cm tall. Sagebrush height at roost sites was considerably lower than at feeding and loafing sites. Average canopy cover at winter roost sites of hens in Montana was 25.7% (Eng and Schladweiler 1972) and was not markedly different from feeding/loafing sites (27.7%).

Water

Although it is unclear whether sage grouse require free water, they often drink water when it is available (Patterson 1952, Dalke et al. 1963). Summer distribution of sage grouse is dependent on water since sage grouse concentrate in meadows and other mesic areas where forbs and insects are abundant. Girard (1937) reported that sage grouse drink from 1-3 times daily and that they obtain necessary moisture from snow during winter.

Special Requirements

Sage grouse feed on several species of sagebrush including big, black (Artemisia nova), silver (A. cana), and fringed sagebrush (Patterson 1952, Dalke et al. 1963, Rogers 1964). Recent work by Remington (1981), however, has indicated that sage grouse prefer Wyoming big sagebrush (A. t. wyomingensis) over mountain big sagebrush (A. t. vaseyana). Preferred use of a single subspecies may limit total available habitat more than previously recognized. Schoenberg (1982) reported that perhaps as little as 30% of the available habitat was suitable for sage grouse in North Park, Colorado based on habitat structure alone.

SEASONAL MOVEMENTS

Seasonal movements or local migrations are commonly observed among sage grouse and depend upon vegetative preferences and weather patterns. Migrations from breeding to summer ranges occur in response to the dietary shift from sagebrush to forbs and insects. Timing of movements to meadows and other mesic sites is dependent upon spring moisture and subsequent availability of forbs on more xeric breeding ranges (Patterson 1952, Klebenow 1969, Peterson 1970b, Wallestad 1971). Migrations to winter range are common when heavy snowfall limits availability of sagebrush on breeding and summer ranges. Sage grouse may migrate as far as 80.5 km to winter range (Dalke et al. 1963). They are locally migratory to some extent throughout most of their range (Patterson 1952, Eng and Schladweiler 1972, Schoenberg 1982). Beck (1977) reported that sage grouse may be restricted to only 7% of the total sagebrush range during winter.

RESPONSES TO HABITAT ALTERATION

Alterations of sage grouse habitats have usually been detrimental to sage grouse populations. Adverse effects of sagebrush control practices on sage grouse habitats have been documented during all seasons. Substantial declines in the number of males and total abandonment of leks have occurred in areas disturbed by 2,4-D spraying and mechanical treatment of sagebrush adjacent to leks (Rogers 1964, Higby 1969, Peterson 1970a, Braun and Beck 1976). Wallestad (1975) reported 63% decline in males counted on leks 2 years after a 31% loss of suitable habitat adjacent to a lek in Montana. Klebenow (1970) reported that spraying with 2,4-D caused hens to cease nesting in the treated area for up to 7 years following treatment. He also observed reduced carrying capacity of brood habitat treated with 2,4-D. Martin (1970) found that only 4% of all brood observations were in sprayed strips even though 90% of his study area had been treated. Carr and Glover (1970) reported that brood movements were impeded by sprayed areas.

Reductions in winter use of sprayed and mechanically-treated areas of sagebrush by sage grouse were reported by Pyrah (1972) in Montana. Higby (1969) observed total abandonment of a winter use area in Wyoming 5 years after treatment that eradicated 80-90% of the sagebrush cover.

Alteration of sage grouse habitats may be beneficial in areas where brood habitat is limiting. Klebenow (1970) felt that controlled burns might be useful to reduce shrub cover and increase forb production on Idaho brood ranges. Autenrieth (1981) suggested that prescribed spot burns, strip spraying with 2,4-D, and chaining might be considered to remove sagebrush and improve brood habitat in Idaho. He also recommended seeding forbs to enhance brood habitat on severely abused ranges that had suitable soils and precipitation.

MITIGATION

Two attempts to mitigate habitat loss to sage grouse have concentrated on establishing new leks for birds displaced by destruction of their traditional leks (Eng et al. 1979, Tate et al. 1979). Decoys and tape-recorded sounds of sage grouse on an active lek were used to attract grouse to the new lek in both studies. Eng et al. (1979) achieved good success recruiting yearling males to a new lek 3.2 km from the traditional lek. They felt that establishment of the new lek within preferred winter, nesting, and brood habitat was the most critical factor accounting for their success. Tate et al. (1979) were not successful in attracting birds to a new lek 1.5 km from the traditional lek. They did observe a shift to a satellite lek after disturbance of the traditional lek. Long-term success of both attempts is unknown.

DATA BASE

The data base for sage grouse in northwestern Colorado includes lek counts, banding studies, hunter check stations, wing collection barrels (Hoffman and Braun 1975), and the statewide small game harvest survey. Counts of sage grouse on known leks have been made each year from 1969 through 1981 in Moffat County and from 1978 through 1981 in western Routt County (Braun 1981). Lek count data are incomplete or unavailable for Rio Blanco, Garfield, and Mesa counties. Due to large fluctuations in lek counts throughout the breeding season, their usefulness may be limited as indicators of population size and trend. Counts of males on leks may better serve to identify important habitat areas (Beck and Braun 1980).

Banding studies were conducted in Moffat County from 1978 through 1981 (Braun 1981). Capture efforts were concentrated primarily on brood ranges with Spring banding of adults during 1979 and 1980. No banding studies have been conducted in the other 4 counties. Banding studies

combined with hunter check stations in Moffat County have provided data on sage grouse movements, survival rate, harvest rate (direct recovery, rate), and vulnerability to hunting by sex and age class of sage grouse.

Harvest statistics, hunter information, and sage grouse population data have been collected at check stations and volunteer wing collection stations from 1978 through 1981. Check stations and wing barrels have primarily sampled the Moffat and Routt county areas but have also provided limited data for the Piceance Basin in Rio Blanco County.

Population data obtained from check stations and wing barrels include estimates of sex and age ratios, ovulation rates, nesting success, hatching dates, annual production, and survival and turnover rates (Braun 1981). Hunter and harvest data include origin of hunters, hunter success, timing of harvest, and distribution of hunter and harvest pressure by small game units and harvest zones.

From 1978 through 1980, Moffat County sage grouse hunters were required to obtain a free permit (Braun 1981). Questionnaires were sent to permittees to obtain additional information on sage grouse harvest and hunter activity by small game units and harvest zones.

The statewide small game harvest survey (Donoho et al. 1981) provides harvest estimates for all 5 counties on an annual basis. However, the reliability of these data is questionable. Estimates are based on relatively small sample sizes, vary widely from year-to-year, and tend to overestimate total hunter numbers and harvest (Braun 1979).

RECOMMENDATIONS

Research

1. Initiate banding studies as human populations increase to evaluate trends in harvest rates and hunting pressure by small game units and harvest zones (Braun 1981).

2. Initiate radiotelemetry studies in areas to be impacted by energy development to identify important breeding, nesting, brood-rearing and winter habitats.
3. Continue monitoring populations with radiotelemetry to document impacts of energy development on sage grouse distribution, seasonal movements, and habitat selection.
4. Develop and evaluate mitigation techniques to maintain sage grouse habitats:
   a. Establish new leks (Eng et al. 1979).
   b. Examine fertilization techniques to enhance sagebrush nutrition and structural development.
5. Develop and evaluate habitat rehabilitation techniques.
   a. Seed and transplant native forbs, grasses and preferred sagebrush species and subspecies.
   b. Develop structural diversity in sage grouse habitats. Preferred cover requirements vary by season and by function (breeding, nesting, etc.) (Colenso et al. 1980, Schoenberg 1982).
   c. Fertilize and irrigate reclaimed habitat to encourage rapid revegetation of sage grouse habitats.

Management.

1. Visit leks annually to document presence or absence of sage grouse and conduct searches for new leks to identify important habitat areas (Beck and Braun 1980).
2. Operate check stations and volunteer wing collection stations annually during the hunting season to monitor sage grouse population, harvest, and hunter trends (Braun 1981).

3. Initiate free permit and questionnaire system (Braun 1981) to examine harvest and hunter activity and trends by small game management units and harvest zones.
4. Limit disturbance in preferred habitats where possible (e.g., road construction, overburden piles, urban development, and off-road vehicles).
5. Reduce or eliminate grazing pressure where it reduces available habitat. Autenrieth (1981) suggested fencing stream meadow habitats to protect limited brood ranges in Idaho.

SHARP-TAILED GROUSE

Order Galliformes, Family Phasianidae, Tympanuchus phasianellus columbianus.

DISTRIBUTION AND STATUS IN NORTHWESTERN COLORADO

Columbian sharp-tailed grouse in northwestern Colorado occur primarily in Routt and eastern Moffat counties (Giesen and Hoffman 1981). Current known distribution also extends into Rio Blanco County (Fig. 7). Columbian sharptails have been reported from Mesa and Garfield counties (Rogers 1969) but current status of these populations is unknown.

Columbian sharp-tailed grouse have been annually hunted in western Colorado since 1953 (Rogers 1969, Giesen and Hoffman 1981). Most of the harvest is from Routt and eastern Moffat counties although "sharptails" have been reported to have been harvested in Rio Blanco, Garfield, and Mesa counties in recent years (Donoho et al. 1979, 1980).

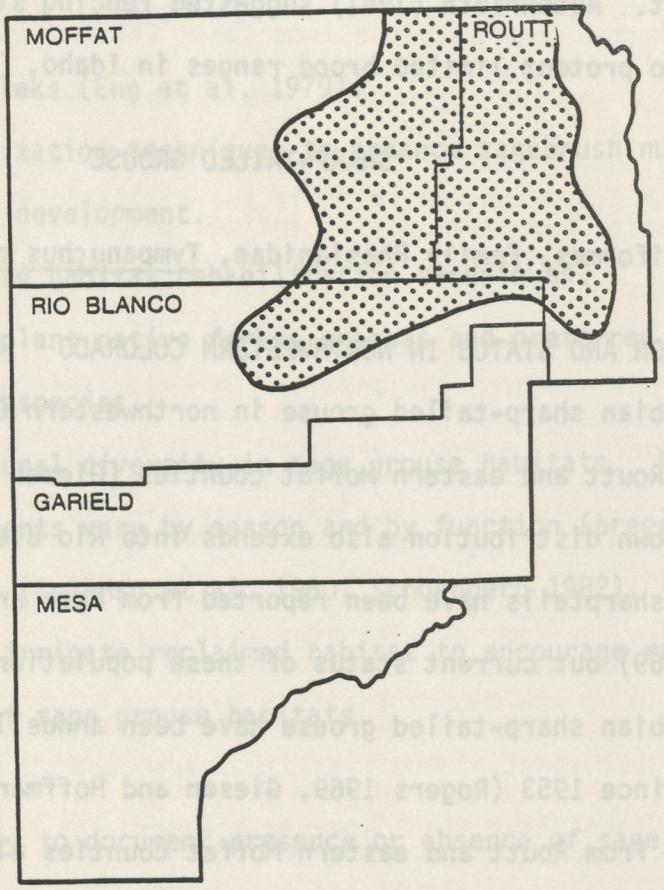

Fig. 7. Known distribution of sharp-tailed grouse, northwestern Colorado (after Giesen and Hoffman 1981).

HABITAT REQUIREMENTS

Rogers (1969) described Columbian sharp-tailed grouse ranges in northwestern Colorado as being dominated by mid- and tall grasses with a wide variety of forbs and lightly interspersed with shrubs or aspen. Shrubs included Utah serviceberry (Amelanchier utahensis), big sagebrush, chokecherry (Prunus melanocarpa), Gambel's oak (Quercus gambelii), mountain snowberry, and willows. Common genera of grasses were Agropyron, Bromus, Elymus, Festuca, Koeleria, Poa, and Stipa.

Seasonal habitat use is related to preferred cover types and available food resources (Marshall and Jensen 1937, Hart et al. 1950). Columbian sharptails feed on a variety of grasses and forbs during spring through early fall. Insects are important in the summer diet of chicks. Shrub species provide food and cover during winter. Cultivated grains such as wheat are often used but are not believed to be essential to sharptails in northwestern Colorado (Rogers 1969).

Breeding

Although sharptail dancing grounds are generally on elevated or level areas with sparse ground cover (Marshall and Jensen 1937, Ammann 1957, Kobriger 1965, Pepper 1972, Sisson 1976), Rogers (1969) reported that vegetation on Columbian sharptail leks in western Colorado was more varied, taller, and denser than that found on plains sharptail (T. p. jamesi) leks in eastern Colorado. Most grounds were on knolls, followed by ridges, benches, and valleys. Dominant shrubs on leks were big sagebrush, oak, serviceberry, and snowberry. Visibility of sharptails on dancing grounds was extremely limited.

Nesting

Studies of nesting habitat of Columbian sharp-tailed grouse are limited and descriptive. Hart et al. (1950) reported sharptails nesting in native grass-shrub, alfalfa fields, and grain stubble. Rogers (1969) observed Columbian sharptails nesting in green winter wheat if it was tall and rank enough to provide good cover.

Structural characteristics of nesting cover have been examined for prairie (T. p. campestris) and plains sharptails. Most nests located were under shrubs in dense native grass-shrub cover (Ammann 1957, Pepper 1972, Caldwell 1976, Sisson 1976). Pepper (1972) observed that nest placement was more dependent on physiognomy of cover than vegetative species composition for plains sharptails in Saskatchewan. Cover at nest sites was greater than that found 3-4 m from the nest but not significantly different from random plots. Ammann (1957) observed canopy cover up to 75% and Caldwell (1976) reported 89.1% average cover at prairie sharptail nest sites in Michigan and Manitoba, respectively.

Feeding

General habitat use and food habits of Columbian sharptails have been examined during all seasons. However, data on habitat selection relative to available habitat is lacking. Dargan et al. (1942) examined fall and winter habitats of sharptails in northwestern Colorado. Sharptails were most frequently found on north-facing slopes where taller shrub cover and preferred food plants were available. Buds and seeds of chokecherry and serviceberry provided almost 100% of their winter (Dec-Feb) diet. Marshall and Jensen (1937) also observed heavy use of chokecherry and bigtooth maple (Acer grandidentatum) buds during periods of heavy snow cover from late December through early February in Utah.

The Columbian sharp-tailed grouse diet shifts toward forbs and grasses as they become available in spring. Marshall and Jensen (1937) noted extensive use of alfalfa, grass blades, and waste wheat in early spring in Utah. Jones (1966) observed that grass leaves, especially Sandberg bluegrass (Poa sandbergii), composed one-half of the spring diet and three-fourth's of the summer diet of Columbian sharptails in eastern Washington. Common dandelion and sagebrush buttercup (Ranunculus glaberrimus) were preferred over grass where forbs and grasses were available, and composed one-fourth of the spring and summer diets.

Late spring through early fall diets of Columbian sharptails include a variety of insects, especially grasshoppers, beetles, and ants (Marshall and Jensen 1937, Jones 1966). Insects are the major component of plains sharp-tailed grouse chick diets during the first several weeks of life (Kobriger 1965, Pepper 1972).

Sharp-tailed grouse shift to a predominantly granivorous diet in the fall although dandelion, grasses, and insects are eaten when available. Dargan et al. (1942) observed heavy use of short grass areas adjacent to wheat fields in northwestern Colorado where sharptails fed upon waste wheat. Marshall and Jensen (1937) reported that wheat was the most frequently used fall food in Utah followed by common sunflower (Helianthus annuus) and grass seeds. Jones (1966) examined 14 Columbian sharptail crops collected during October in eastern Washington and found that dandelion seeds and grass leaves composed the greatest percent of the volume of plant foods in the diet.

Loafing/Roosting

Typical resting and roosting cover for Columbian sharp-tailed grouse are fairly open upland forb and grass areas (Marshall and Jensen 1937, Hart et al. 1950). Shrub cover may be used throughout the year (Hart et al. 1950) but is used most frequently during winter when snow is crusted. Shrubs providing winter cover in northwestern Colorado include chokecherry, big sagebrush, snowberry, and serviceberry (Dargan et al. 1942). Snow roosts in soft snow are used when conditions are favorable (Marshall and Jensen 1937, Dargan et al. 1942).

Water

Columbian sharp-tailed grouse drink water when it is available but it has not been established that they are dependent on open water sources (Marshall and Jensen 1937, Dargan et al. 1942, Rogers 1969). Sharptails may often be found in areas where open water is available due to the associated lush vegetation and increased plant and animal food (Kobriger 1965, Stearns 1968).

SEASONAL MOVEMENTS

Sharp-tailed grouse are generally non-migratory but may travel long distances in search of food (Evans 1968). Seasonal movements of sharptails are a function of seasonal food and cover preferences relative to available cover types, elevation, and winter snow depths (Marshall and Jensen 1937, Dargan et al. 1942, Hamerstrom and Hamerstrom 1951, Rogers 1969). Winter habitats may be lower or higher in elevation than breeding, summer, and fall habitats. Most authors agree that winter ranges of sharp-tailed grouse are generally within 4-5 km of spring-fall ranges (Marshall and Jensen 1937, Hart et al. 1950, Kobriger 1965, Hillman and Jackson 1973).

Movements from dancing grounds to feeding and nesting sites are apparently short. However, available movement data are limited. Marshall and Jensen (1937) found that 90% of breeding season observations of Columbian sharptails were within 0.8 km of dancing grounds in Utah. Hart et al. (1950) stated that breeding season movements in Utah were limited to 1.6 km daily. Hamerstrom and Hamerstrom (1951) reported that most lek-to-nest movements of prairie sharptails in Wisconsin were < 1.6 km of dancing grounds. Hillman and Jackson (1973) observed that plains sharptail nests in South Dakota were usually within 0.8 km of a dancing ground.

EFFECTS OF HABITAT ALTERATION

The Columbian sharp-tailed grouse has probably undergone the most severe range reductions of any sharptail subspecies and occupies only 10-50% of its former Colorado range (Miller and Graul 1980). Intensive grazing and conversion of rangeland to cropland have been the primary adverse factors affecting Columbian sharptail habitats. Hart et al. (1950) identified heavy grazing as the most important factor limiting populations of Columbian sharptails in Utah. Ziegler (1979) observed that heavy grazing of sharptail habitats in Washington removed nesting and brooding cover and contributed to the destruction of deciduous trees and shrubs essential for sharptail winter habitat. Yocom (1952) and Buss and Dziedzic (1955) attributed severe reductions and extirpation of Columbian sharptails from eastern Washington to intensive and extensive cultivation of former sharptail habitat.

Some habitat alteration practices have been suggested to improve Columbian sharptail habitats. Hart et al. (1950) suggested that controlled burning may benefit Columbian sharptails in Utah by opening up dense, extensive sagebrush stands to create an interspersion of brush and grassy cover. Rogers (1969) also stated that dense sagebrush cover may be limiting Columbian sharptail distribution in western Colorado. McArdle (1977), however, reported that fires may be detrimental on sharptail ranges in southeastern Idaho if they are too hot and destroy all shrub cover. He recommended chaining sagebrush rather than using fire or herbicides to better control the amount of brush removed, shape of treated areas, and time of treatment.

MITIGATION

No mitigation attempts have been reported to date to compensate for past Columbian sharptail habitat losses (Kessler and Bosch 1982). Apparently, some state agencies are developing guidelines to minimize future development impacts on sharptails including protection of riparian areas, mechanical or chemical sagebrush control, and implementation of deferred or moderate intensity grazing systems.

DATA BASE

Data bases for Columbian sharp-tailed grouse in northwestern Colorado are limited to eastern Moffat and Routt counties and include dancing ground counts, collection of harvest data from hunter check stations and volunteer wing collection barrels, and the statewide small game harvest survey (Donoho et al. 1981). Banding and radiotelemetry studies have recently begun in Moffat and Routt counties (K. M. Giesen, pers. commun.).

Dancing ground counts have been conducted annually since 1977 in eastern Moffat and Routt counties. Average number of males per active lek increased in 1981 due to increased field efforts to locate new dancing grounds. However, perhaps as few as 10% of the active leks have been located in these 2 counties (K. M. Giesen, unpubl. data). There are few or no current data available on dancing ground locations in Rio Blanco, Garfield, and Mesa counties.

Sharptail harvest data from hunter check stations and volunteer wing collection barrels are available from 1976 through 1981 for eastern Moffat and Routt counties. These data are not available for Rio Blanco, Garfield, and Mesa counties. Although samples have been fairly low in some years, harvest data indicate that sharptail populations in Moffat and Routt counties are reproductively healthy. Chick production has varied from good to excellent with percent chicks in the fall population averaging 46.9 from 1976 through 1981 (K. M. Giesen and C. E. Braun, unpubl. data).

The statewide small game harvest survey provides annual estimates of sharp-tailed grouse harvest in all 5 northwestern counties (Donoho et al. 1981). However, the reliability of this survey is questionable because other grouse may be reported as "sharptails", the harvest estimates are based on small samples, vary greatly from year-to-year, and probably tend to overestimate the actual harvest as has been demonstrated for sage grouse (Braun 1979).

RECOMMENDATIONS

Research

1. Continue banding study in Moffat and Routt counties to obtain sharptail population, movement, and harvest data.
2. Continue radiotelemetry study in Moffat and Routt counties to identify important seasonal habitat areas and understand Columbian sharptail habitat selection.
3. Initiate studies to examine energetic and nutrient requirements of sharptails and nutrient and energetic content of foods to understand consequences of habitat manipulations and develop mitigation techniques (Robel 1980).
4. Examine mitigation techniques to compensate for habitat losses from energy developments on public lands.
   a. Evaluate grazing management systems and their impacts on sharptail habitats.
   b. Evaluate habitat alteration techniques that will improve seasonal habitats for sharptails (McArdle 1977).
   c. Evaluate lek relocation attempts as has been done with sage grouse (Eng et al. 1979, Tate et al. 1979).
5. Develop and evaluate rehabilitation techniques for sharp-tailed grouse habitat on disturbed and reclaimed lands.
   a. Seed and transplant native grasses, forbs, and shrubs on reclaimed areas.
   b. Fertilize and irrigate reclaimed areas to promote rapid revegetation.

Management

1. Continue monitoring dancing grounds for presence of grouse and search for new leks throughout northwestern Colorado to identify important habitat areas.

2. Continue hunter check stations and volunteer wing collection stations during the hunting season in Moffat and Routt counties to obtain population and harvest data.
3. Initiate free permit and questionnaire system (Braun 1981) to examine harvest and hunter activity and trends by small game management unit in northwestern Colorado.
4. Limit disturbance on preferred or essential seasonal habitats.

WILD TURKEY

Order Galliformes, Family Phasianidae, Meleagris gallopavo merriami.

DISTRIBUTION AND STATUS IN NORTHWESTERN COLORADO

In 1962, Merriam's wild turkeys occurred in 14 western slope counties including Rio Blanco, Routt, Garfield, and Mesa (Hoffman 1965). Their distribution in these counties accounted for approximately 30% of the western slope wild turkey range (Fig. 8). Myers (1973) reported peak numbers and harvests of wild turkeys on the Uncompahgre Plateau, including southern Mesa county, in the early 1960's. The turkey population in that area apparently declined through 1967. The current distribution and status of wild turkeys in northwestern Colorado are unknown. Recent harvests have been too low to accurately assess population sizes or trends (Donoho et al. 1981).

HABITAT REQUIREMENTS

Merriam's wild turkeys inhabit ponderosa pine (Pinus ponderosa) and quaking aspen forests with scattered oakbrush (Quercus spp.) and grassland openings. Myers (1973) described turkey habitat on the Uncompahgre Plateau in southwestern Colorado. Aspen, primarily pole stage, covered 47.8% of the vegetative community. Oakbrush and ponderosa pine

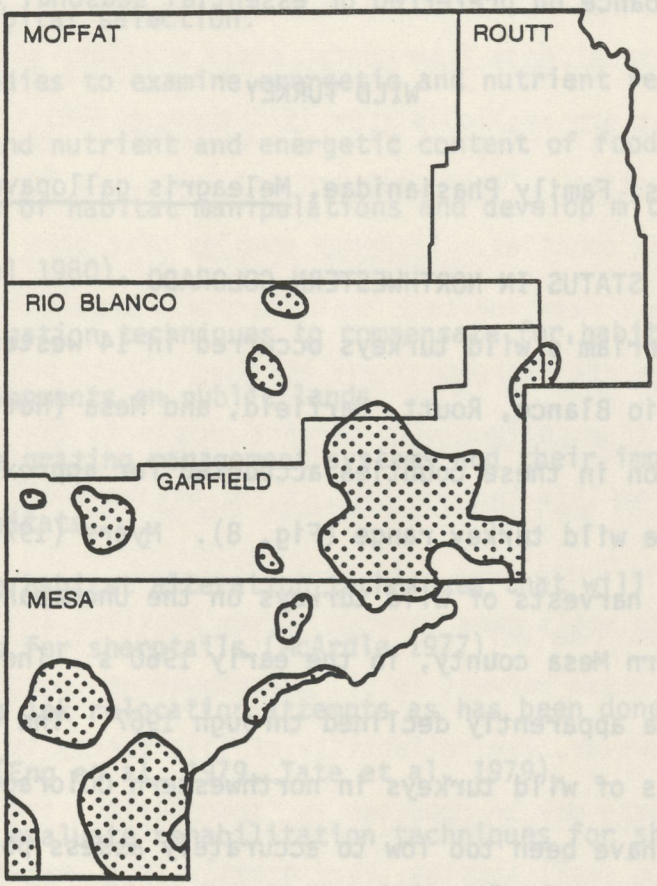

Fig. 8. Distribution of wild turkey, northwestern Colorado (after Hoffman 1965).

comprised 18 and 13.8%, respectively. Pinyon pine-juniper composed 9% of the habitat and was the dominant type used during winter. The understory composition consisted of 6.6% shrubs, 14.7% forbs, and 10.7% grasses. The most common shrubs were western snowberry (Symphoricarpos occidentalis) and oakbrush. The most common forb and grass genera included yarrow, fleabane (Erigeron), bluegrass, and needlegrasses (Stipa).

Jonas (1966) examined seasonal habitat relationships of Merriam's wild turkeys in southeastern Montana. Grasslands provided 36% of the year-round cover and were used primarily for feeding during spring through fall. Snowberry shrubs provided brood cover from spring through fall. The ponderosa pine community, primarily pole stage type, provided food and cover during fall and winter. Deciduous tree-brush habitats along drainageways provided good cover and berry-producing shrubs during fall and winter.

Breeding and Nesting

Merriam's wild turkey breeding habitat has not been well described. Jonas (1966) observed most courtship groups in open grassland areas in southeastern Montana. Nesting cover has been described frequently but only in general terms. Most nests found in Colorado have been in dense thickets of oakbrush (Burget 1957, Hoffman 1962, Bailey and Niedrach 1965). Jonas (1966) located 3 nests in Montana in brushy cover. Petersen and Richardson (1975) reported that cut-over pine slash was the most common type of nesting cover used by Merriam's turkeys in South Dakota. Hoffman (1962) also observed use of pine slash by nesting

turkeys in southern Colorado. Occasionally, alfalfa fields may be used for nesting (Burger 1954, Hoffman 1962, Jonas 1966).

Loafing/Roosting

Merriam's wild turkeys prefer to roost in tall, mature, overmature, and dead ponderosa pines (Jonas 1966, Hoffman 1968, Boeker and Scott 1969). Old-growth Douglas-fir, white fir, narrowleaf cottonwood, and Engelmann spruce (Picea engelmannii) may be used occasionally (Hoffman 1968, Myers 1973). Most roost trees are on east-to-southeast slopes. Trees with relatively open crowns and large horizontal branches receive the heaviest use. Moreover, individual trees and groups of trees receive consistent use, especially during winter.

Hoffman (1968) described ponderosa pine roost trees used by Merriam's turkeys in southern Colorado. Roost trees were usually in unlogged tracts of old-growth timber adjacent to natural clearings or on open ridges. Ponderosa pine composed 81 and 84% of the roost trees used in winter and summer, respectively. Turkeys usually selected the tallest and largest trees available at each site. Roost trees averaged 163 years old. Ponderosa pine trees used for winter roosts were similar to summer roost trees and averaged 55 cm (dbh) and 21.3 m tall. Slope at roost sites averaged 18 and 19% during winter and summer, respectively.

Merriam's wild turkeys select loafing and escape cover in areas with denser cover than roost sites. Hoffman (1962) described loafing and escape cover as being dense thickets of oakbrush and ponderosa pine, often near feeding and watering sites. Jonas (1966) reported 71% of turkey loafing observations in the ponderosa pine type were primarily in pole stage stands.

Feeding

Merriam's wild turkeys are omnivorous, feeding on a variety of grasses, forbs, insects, pine seeds, acorns, and cultivated grains. Use of foods depends upon availability between seasons and from year-to-year. Hoffman (1962) reported that the grass family provided most of the year-round diet of wild turkeys in southern Colorado furnishing green leaves, matured seeds, and cultivated grains in agricultural areas. Wild turkeys do not require cultivated grains where other foods are plentiful but when in the vicinity of grain fields, oats, corn, and barley may become major parts of the diet (Hoffman 1962, Jonas 1966, Myers 1973, Petersen and Richardson 1975).

During winter, Merriam's wild turkeys are dependent upon acorns, pine seeds, juniper berries, cultivated grains, and grass leaves and seeds (Ligon 1946, Hoffman 1962, Petersen and Richardson 1975). Hoffman (1962) reported that during the early part of the winter in southern Colorado, pine seeds, cultivated oats, insects, grass seeds, acorns, and persistent fruits of hawthorn (Crataegus spp.), snowberry, and wild rose (Rosa spp.) were heavily used. As grass leaves began sprouting in mid-February, however, they became the main food in the turkey's late winter diet. Myers (1973) reported that pinyon nuts and juniper berries may provide the primary winter turkey food on the Uncompahgre Plateau but that grass sprouts were heavily used beginning in February in snow-free areas with warm exposures. Spicer (1959) observed that grass leaves and stems were the most frequently used food during winter and early spring in New Mexico.

During spring and summer, forb leaves and flowers and grass leaves are the major foods of wild turkeys (Hoffman 1962, Petersen and Richardson 1975). Grasshoppers are the most important animal food in the diet, especially for young polts, and are eaten whenever available from spring through fall.

During late summer and fall, a wide variety of food is available and eaten by turkeys. Grass and forb leaves and seeds, pine seeds, acorns, fruits and berries, and cultivated grains are all included in the wild turkey's diet (Hoffman 1962, Jones 1962, Jonas 1966).

Water

Wild turkeys may drink water daily, especially during warmer months of the year (Ligon 1946, Burget 1957, Hoffman 1962). Snow apparently satisfies water requirements during winter. Distribution of water may influence summer turkey distribution. Both Spicer (1959) and Hoffman (1962) observed that turkeys shifted ranges to include permanent water when water became scarce on summer ranges.

SEASONAL MOVEMENTS

Merriam's wild turkeys generally move to lower elevations during winter and return to breeding and summer ranges at higher elevations (Spicer 1959, Hoffman 1962, Jonas 1966, Petersen and Richardson 1975). During mild winters, however, turkeys may not migrate at all. On the Uncompahgre Plateau in southwestern Colorado, wild turkeys are usually on winter ranges by mid-January and return to breeding and summer ranges sometime in April (Myers 1973). Movements between winter trap sites and summer ranges on the Uncompahgre Plateau averaged 19.4 km and varied from 8.1 to 50 km.

Movements within summer and winter ranges are more restricted. Jonas (1966) reported that summer ranges were between 10.4 and 15.5 km^2 in size for gobbler flocks vs. 6.5 to 9.1 km^2 for brood flocks in southeastern Montana. Winter ranges were between 2.6 and 5.2 km^2 in size.

EFFECTS OF HABITAT ALTERATION

Effects of grazing pressure and brush control on wild turkeys have been reported in the literature. Most authors consider overgrazing detrimental to wild turkeys (Dalke et al. 1946, Ligon 1946, Stoddard 1963). Hoffman (1965) reported that winter ranges statewide in Colorado were in poor condition due to heavy grazing pressure by livestock and big game. Since the grass family and mast are major winter food sources for wild turkeys, overgrazing may exacerbate winter food shortages brought on by drought.

Quinton et al. (1980) reported that Rio Grande wild turkeys (M. g. intermedia) avoided extensive areas of sprayed, chained, and grubbed brushland in Texas. Although abundant food was available on these areas, turkeys avoided large treated blocks due to lack of nearby escape cover. Moderate brush control practices that left escape cover nearby apparently did not diminish turkey use of treated areas.

MITIGATION

No attempts to mitigate losses of Merriam's wild turkey habitat have been reported in the literature.

DATA BASE

The data base for wild turkeys in northwestern Colorado is limited to the statewide small game harvest survey (Donoho et al. 1981). Annual harvest estimates for northwestern Colorado are available only for Mesa County. The sample size has been too small to accurately assess current population size or trend.

RECOMMENDATIONS

Research

1. Refine or develop census techniques (Hoffman 1965).
2. Initiate banding and radiotelemetry studies to examine seasonal movements, identify important seasonal habitats, investigate habitat selection, and obtain population and harvest statistics.
3. Develop and evaluate techniques to mitigate wild turkey habitat losses from energy development.
4. Develop and evaluate techniques to rehabilitate wild turkey habitats lost from energy development.
   a. Seed and transplant native forbs, grasses, shrubs, and trees which are important food and cover species for wild turkeys.
   b. Fertilize and irrigate reclaimed areas to stimulate rapid revegetation.

Management

1. Conduct annual winter censuses using selected, isolated food plots (Myers 1973) in known winter concentration areas in northwestern Colorado.
2. Sample all turkey license holders in northwest Colorado to examine annual harvest and hunter activity and trends by small game management units.
3. Use wing collection envelopes to obtain wild turkey harvest and population statistics.
4. Reduce grazing pressure by domestic livestock on turkey habitats adjacent to developed areas.
5. Provide winter food plots in developed areas where natural winter food sources have been eliminated or reduced (Hoffman 1962, Myers 1973).

6. Purchase private lands within wild turkey habitats to ensure adequate habitat is available, especially on critical winter ranges (Hoffman 1965).
7. Maintain adequate interspersion of habitat types required seasonally by wild turkeys. These include old-growth pines, pole stage pine and aspen, oakbrush, pinyon-juniper, and grassland types.

GAMBEL'S QUAIL

Order Galliformes, Family Phasianidae, Callipepla gambelii.

DISTRIBUTION AND STATUS IN NORTHWESTERN COLORADO

Gambel's quail occur principally along the Colorado, Gunnison, and Uncompahgre river valleys in west central Colorado and along the McElmo Creek Valley in Montezuma County. Sandfort (1965) identified approximately 4,480 km^2 of Gambel's quail range in 6 counties including Garfield, Mesa, Delta, Montrose, Ouray, and Montezuma (Fig. 9). Populations may also occur in the lower portions of the Animas River drainage in La Plata County. Population densities are generally low throughout the more intensively farmed areas and increase where brushy arroyos, sides of mesas, and creek and river bottoms provide better cover (Sandfort 1965).

Gambel's quail are hunted annually throughout western Colorado (Sandfort 1965, Donoho et al. 1981). Most quail are harvested in west central Colorado in Mesa, Delta, and Montrose counties. Harvest statistics are currently unavailable for populations in southwestern Colorado. Sandfort (1965) reported low densities and declining distribution of Gambel's

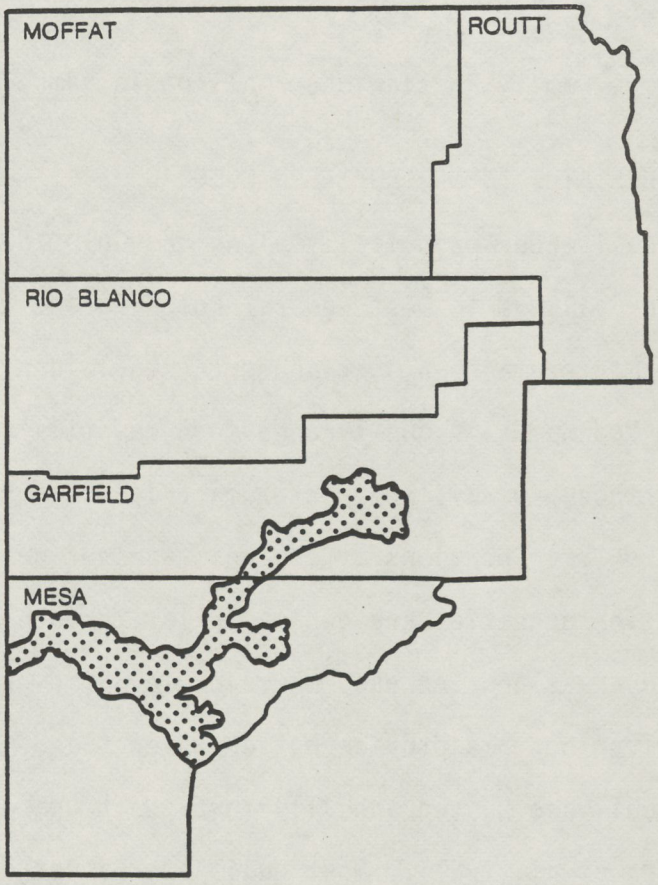

Fig. 9. Distribution of Gambel's quail, northwestern Colorado (after Sandfort 1965).

quail in Montezuma County. The number of hunters and quail harvest in west central Colorado have been declining since 1969 (Donoho et al. 1981). However, the number of birds per hunter has remained fairly stable. Current distribution and densities of Gambel's quail in western Colorado are unknown. No systematic census data have been collected since 1952 (Sandfort 1965).

HABITAT REQUIREMENTS

Gambel's quail habitat in Colorado is characterized by shrub thickets, brushy mesas, and irrigated farmlands bordering river or creek valleys (Sandfort 1965). Shrub associations are the key to suitable habitat. Gambel's quail require ample brushy cover of species such as black greasewood, tamarisk (Tamarix spp.), and fragrant sumac. Gullion (1960) noted that these and other shrub species including rubber rabbitbrush (Chrysothamnus nauseosus), saltbush, and big sagebrush are almost universally present in the range of the subspecies (C. g. sanus) in Colorado, Utah, and northwestern New Mexico.

Goodwin and Hungerford (1977) working in southern Arizona quantified habitat requirements of Gambel's quail. Canopy cover of shrub associations used by quail was usually between 50 and 75%. Sixty to 80% of the shrubs were taller than 2 m. Dense understory, however, did not appear to be an important habitat requirement. Grass cover varied from 0 to 50% in grazed vs. ungrazed areas supporting high quail densities.

Breeding and Nesting

Detailed descriptions of breeding and nesting habitats are not available for Gambel's quail. Bailey and Niedrach (1965) reported that Gambel's quail in Colorado nest on the ground under shrubs or flowering plants on dry hillsides in well-hidden locations. Goodwin and Hungerford (1977) located 3 nests in southern Arizona. Nests were found under datura (Datura spp.) and acacia (Acacia spp.) shrubs adjacent to dense shrub associations which provided cover for all life functions of Gambel's quail.

Feeding

Food habits of Gambel's quail have been examined in southeastern Arizona (Hungerford 1962) and along the Rio Grande River in New Mexico (Campbell 1957) but have not been reported for Colorado. Although species composition of the diet may be distinct between Colorado and these areas, general food habit patterns are probably similar.

Gambel's quail are primarily granivorous. Hungerford (1962) found that seeds of forbs, grasses, and shrubs composed 60.7% of the annual diet. Seeds, leaves, and flowers of low-growing annual and perennial forbs were most important year-round. The volume ratio of dry:succulent foods was lower during the spring (50:50) and summer (58:42) when flowers, fruits, and leaf material were available than during fall (69:29) and winter (67:33). Several genera of forbs were preferred in spring due to their high moisture content including Erodium, Lotus, Lupinus, Descurania, and Dalea. Insects, principally ants, were important in summer. Gullion (1960) reported that insects were important for chick survival during spring in Nevada.

Campbell (1957) found seeds to be a more important component of the fall diet of Gambel's quail in New Mexico than Hungerford (1962) found in Arizona. Approximately 92% of the volume of the fall diet was composed of seeds and fruits, especially seeds. Green leaf material and insects, composed only 6.5 and 1.6% of the volume of the diet, respectively. Seeds of chenopods, legumes, grasses, and composites were especially well represented in the diet.

Loafing/Roosting

Gambel's quail prefer to roost above ground in dense cover to avoid potential avian and mammalian predators (Sandfort 1965, Goodwin and Hungerford 1977). Shrubs and trees with dense foliage and extensive branching provide ideal roost sites. Sandfort (1965) described loafing cover as open, shady areas beneath a good overstory of cover. Goodwin and Hungerford (1977) found 75 of 87 roosts 2-5 m above the ground in trees. They felt that the availability of good roosts may limit Gambel's quail distribution in southern Arizona.

Water

Gambel's quail often drink water and are frequently found near water sources. For this reason, early quail management efforts were directed toward providing permanent water sources using some form of "gallinaceous guzzler" (Glading 1947, MacGregor 1953). The need for free water, however, has been disputed over the years. Early researchers (Grinnell 1927, McLean 1930) believed that a need for daily watering was an important factor limiting the distribution of the species. Vohries (1928) and Gorsuch (1934), however, did not agree. More recent evidence indicates that Gambel's quail do not require surface water to survive. Sufficient moisture can usually be obtained from succulent green plants and insects

(Lowe 1955, Hungerford 1960). Gullion and Gullion (1964) observed quail thriving without free water when living in desert areas where succulent vegetation was readily available. Campbell (1960) concluded that "gallinaceous guzzlers" were ineffective and impractical for quail management in New Mexico. Although they provided a permanent water source, use by quail was not great enough to justify the high costs of construction and maintenance.

SEASONAL MOVEMENTS

Movements of Gambel's quail coveys are generally restricted to relatively small areas between seasons and between years. Gullion (1962) observed high fidelity to covey ranges in 2 successive years in Nevada. He reported an average movement of only 340 m for periods ranging from 7 to 13 months. Although coveys did not always remain confined to definite areas, winter (Dec-early Feb) home ranges averaged only 14 ha. Goodwin and Hungerford (1977) reported that Gambel's quail in southern Arizona maintained well-defined home ranges within preferred habitats from September through December. However, when nightly temperatures dropped near freezing in late December through early February, quail began moving from higher areas to the foothills. Covey home ranges in March were between 4 and 16 ha in size.

Both Gullion (1962) and Goodwin and Hungerford (1977) reported prenesting dispersal or shuffle in late March and early April when coveys began seeking suitable nesting areas. Daily movements in Nevada doubled from 34 to 69 m/day (Gullion 1962). By early to mid-April, however, coveys became sedentary as nesting commenced.

EFFECTS OF HABITAT ALTERATION

There are no well-documented reports of beneficial or detrimental effects of habitat alteration on Gambel's quail populations. Campbell (1957) reported that flexibility in food habits explained the success of Gambel's quail populations in some areas of New Mexico. Where farming and overgrazing had reduced native foods and allowed invasion of exotic species, Gambel's quail altered their diet to include exotics such as common Russianthistle, sorghum, and alfalfa. Goodwin and Hungerford (1977) reported no apparent change in quail density after an area supporting high quail densities was grazed. Sandfort (1965), however, stated that clearing of brushy areas for farmland, grazing of river bottoms by livestock, and lack of cover growth because of drought all have contributed to reduction of quail populations in Colorado.

MITIGATION

No attempts to mitigate losses of Gambel's quail habitat have been reported for Colorado or other western states with quail populations.

DATA BASE

The data base for Gambel's quail in northwestern Colorado is extremely limited. Annual harvest estimates are available for Mesa, Delta, and Montrose counties from the small game harvest survey (Donoho et al. 1981). Harvest trends provided by this survey may be fairly reliable but accuracy of total harvest estimates has not been established.

RECOMMENDATIONS

Research

1. Initiate banding and radiotelemetry studies to examine seasonal movements, identify important seasonal habitats, investigate habitat selection, and obtain population and harvest information.

2. Develop and evaluate techniques to mitigate Gambel's quail habitat losses from energy development.
3. Develop and evaluate techniques to rehabilitate Gambel's quail habitats lost from energy development.
   a. Seed and transplant native forbs, grasses, and shrubs which are important food and cover species for Gambel's quail.
   b. Provide brushy cover in form of brush piles until revegetation of reclaimed areas is sufficient to provide cover needs of quail (Sandfort 1965).
   c. Fertilize and irrigate reclaimed areas to stimulate rapid revegetation.

Management

1. Initiate free permit and questionnaire system (Braun 1981) to examine harvest and hunter activity and trends by small game management units and harvest zones.
2. Operate check stations and volunteer wing collection stations during the hunting seasons to obtain quail harvest and population data.
3. Develop and maintain brush thickets and brush piles that provide cover for Gambel's quail (Sandfort 1965).
4. Encourage production of annual forbs and other succulent and seed-producing plants through cultivation or scarification of soils (Sandfort 1965).
5. Protect important feeding and cover habitats from overgrazing and development.

WETLAND GROUP

Order Gruiformes, Family Rallidae, Rallus limicola, Porzana carolina, Fulica americana.

Order Charadriiformes, Family Scolopacidae, Gallinago gallinago.

DISTRIBUTION AND OCCURRENCE IN NORTHWESTERN COLORADO

The Virginia rail, sora, American coot, and common snipe are associated with wetlands. In northwestern Colorado, coots breed mainly in Brown's Park in Moffat County. In northwestern Colorado, the distribution of coots follows the distribution of river drainages and wetlands (Fig. 2). Previous reports list the coot as a common resident in spring and summer throughout northwestern Colorado and include observations of nesting activities at lakes in Rio Blanco, Garfield, and Moffat counties (Warren 1908, Felger 1910, Hendee 1929).

In Colorado, soras nest in marsh habitat to 3,140 m elevation while Virginia rails nest at elevations to 2,730 m (Bailey and Niedrach 1965, Griese 1977). Griese (1977) reported that April temperatures (a function of topography) rather than the distribution of cattail marshes determined the distribution of rails in Colorado. Soras are more abundant than Virginia rails when April temperatures are 5.6 C or below. The occurrence of both species in northwestern Colorado parallels the major drainage systems (Colorado, Yampa, Little Snake, and Green rivers), water storage impoundments, and associated irrigation districts at lower elevations (Bailey and Niedrach 1965, Griese et al. 1980). Boeker (1954)

believed that rails in the Yampa River Valley of northwestern Colorado primarily bred between 1,830 and 2,440 m. Several investigators have reported observations of rails in northwestern Colorado and the collection of specimens in Rio Blanco County (Felger 1910, Bailey and Niedrach 1965).

In northwestern Colorado, common snipe nest wherever suitable moist habitat occurs. They are most numerous during migration and often winter at lower elevations (Bailey and Niedrach 1965). Earlier observations in northwestern Colorado include numerous sightings in Rio Blanco County (Felger 1910) and winter sightings at Sweetwater Lake, Garfield County (Cooke 1897) and in the Plateau Valley, Mesa County (Rockwell 1908).

TIME OF YEAR PRESENT

Gorenzel et al. (1981a) reported that coots arrived at Hog Lake in Brown's Park National Wildlife Refuge (Moffat County) in late February and reached peak numbers during the 2nd week of April. Numbers decreased to resident levels by the 2nd to 4th week of May. Compared to the spring migration, southward movements in fall were slower with peak numbers occurring from late August to mid-October. A few winter but most are gone by late October (Jones 1940, Bailey and Niedrach 1965).

Bailey and Niedrach (1965) observed rails in northwestern Colorado during late April, while Griese (1977) first observed rails during the 2nd week in April. He reported that peak spring concentrations of rails occur in late April-early May, with the peak of soras being 1-2 weeks before that of Virginia rails. Similar to coots, the fall migration

of rails occurs over a greater period than the spring migration. Although Griese (1977) noted highest numbers of rails from mid-August to mid-September, local movements may have masked the actual timing of migration.

Although most rails migrate in the fall, they are occasionally flushed by hunters in early winter (Bailey and Niedrach 1965). Virginia rails have been observed during Christmas bird counts at Grand Junction, Mesa County. Generally, wintering rails are restricted primarily to warm water sloughs with ample emergent vegetation.

Snipe are common summer residents in northwestern Colorado and nest in suitable moist habitat. Nesting snipe have been observed in Routt and Moffat counties (Boeker 1954, Bailey and Niedrach 1965, Martin et al. 1974). Spring migrants arrive in northwestern Colorado in mid-April, with males preceding females by about 10 days (Boeker 1954, Martin et al. 1974, Johnson 1975). Numbers are generally high through May and stabilize at lower levels after late May. Fall migration is in progress throughout the state by early September, peaks later that month, and is nearly complete by mid-October (Johnson and Ryder 1977). Juveniles may begin their southward movement earlier than adults (Tuck 1972, Johnson 1975). Scattered populations winter in the vicinity of unfrozen marshes and sloughs.

HABITAT REQUIREMENTS

Coots breed primarily on freshwater wetlands and winter in brackish and fresh water. Natural wetlands (both coastal and inland) are important during winter. During migration, coots may concentrate on rivers, lakes, reservoirs, and sewage ponds (Fredrickson 1977). In Colorado, coots are found during the breeding season in most marshy areas to 3,000 m (Bailey and Niedrach 1965).

Rails generally use marshes. Although freshwater marshes are preferred, brackish and saltwater marshes are also used, especially during migration (Holliman 1977). In Colorado (above 2,600 m), rails use wet meadows and irrigated hayfields in place of marshes. Both species use deep-standing emergents, primarily cattails during spring migration. Soras are found in short emergents during fall migration while Virginia rails use tall, dense vegetation (Griese et al. 1980). Boeker (1954) noted the presence of rails in the Yampa River Valley in small marshy areas vegetated with cattails and bulrushes.

Snipe use bogs, meadows, pastures, and marsh and stream habitats throughout the year (Johnson 1975, Fogarty and Arnold 1977). Areas of suitable habitat in Colorado contain shallow, stable, discontinuous water levels and moist to saturated soils (Johnson and Ryder 1977). In the Yampa River Valley, snipe most often occur in flooded meadows and cattail and sedge marshes (Boeker 1954, Martin et al. 1974). During migration and winter, snipe often use wet pastures and agricultural lands close to human habitation (Tuck 1972). Those wintering in Colorado concentrate in snow- and ice-free areas (Johnson 1975).

Nesting

The preferred nesting habitat of coots consists of wetlands dominated by cattails and/or bulrush (Gullion 1954, Ryder 1961, Fredrickson 1977). Ryder (1961) noted an increase in coot nesting density as the proportion of open water to available nesting cover increased. Weller and Fredrickson (1973) reported highest breeding populations in cattail marshes within 50% open water and 50% emergent cover. Preferred nesting habitat in Colorado is also composed of bulrush and cattails (Rockwell 1912, Bailey and Niedrach 1965, Gorenzel 1979). At Hog Lake in Brown's

Park, 95.1% of all nests located by Gorenzel (1979) were in bulrush. He stated that factors influencing nest site selection were presence of vegetation to serve as a nest foundation, water depth, and presence of other territorial coots.

Throughout much of their breeding range, rails prefer to nest in sedge and cattail borders of freshwater marshes (Pospichal and Marshall 1954, Holliman 1977, Lowther 1977). Although most nests are in cattails, bulrush is an important component of nesting cover in Colorado (Glahn 1974, Griese 1977). At higher elevations, nesting occurs in sedges where they are dominant or where high water makes cattails unavailable. Rails prefer not to swim and select water depths that are less than the length of their legs (7-8 cm). If the vegetation present is sufficient to support their weight, rails will nest where water depth reaches 15 cm. Water level fluctuations of more than 20 cm will adversely affect rail nesting activities. Preferred brooding habitat in Colorado consists of cattail marshes (Griese 1977).

In North America, snipe nest in areas of organic soils, primarily peatlands in northern forest regions. Along the southern limits of the breeding range, snipe nest along ponds, meandering streams and rivers, and similar marshy areas with organic soil and sparse vegetation (Tuck 1972). Stewart and Kantrud (1968) reported that snipe often nest in areas that are grazed by livestock. In Colorado, snipe breeding densities vary with habitat factors, primarily water depths and coverage, vegetation heights and densities, and soil conditions. Nest sites are typically in grasses or sedges 20-40 cm high, on moist, but unflooded, ground that is near water (Johnson 1975).

Feeding

Adult coots feed mostly on vegetative matter during most of the year. Principal food plants include pondweeds, sedges, bulrush, cattail, filamentous algae (Cladaphora spp.), and muskgrass (Echinochloa spp.) (Jones 1940, Ryder 1958). Animal matter in the diet is minor, consumed only in late spring-early summer, primarily Insecta and Mullusca (Jones 1940, Martin et al. 1951). Coots use the same areas for nesting and feeding during the breeding season. Young coots feed on animal material during the first few weeks after hatching. During winter, coots often graze on pastures, golf courses, lawns, and forage crops (Fredrickson 1977). In northwestern Colorado, the Colorado River drainage contains important feeding sites used during migration (Moore et al. 1977).

Animal foods, especially Coleoptera, Dytiscidae, and larval Diptera, constitute the majority of the Virginia rail's diet. Duckweed (Lemna spp.) and seeds of bulrush, sedges, and spikerush are consumed in limited quantities. Soras feed primarily on small mollusks and insects, but also use seeds of bulrush, sedges, and smartweed (Martin et al. 1951, Pospichal and Marshall 1954, Holliman 1977). Rails feed in areas quite similar to those used for nesting. Glahn (1974) observed rails feeding on mudflats and in areas of bulrush, spikerush, and saltgrass.

With a few exceptions, investigators have stated that snipe feed mostly on animal material (Erickson 1941, Martin et al. 1951, Neely 1959, Fritzell et al. 1979). Fogarty and Arnold (1977) concluded that food used on wintering and breeding areas is approximately 80% animal material, primarily insects, earthworms (Annelida), crustaceans (Crustacea), arachnids (Arachnida), and mollusks. Plant matter, seeds, and fibers have also been identified in snipe food habits studies. Some researchers

have classified plant matter as snipe food (Erickson 1941, Martin et al. 1951); others have disregarded those items (White and Harris 1966, Fogarty and Arnold 1977, Fritzell et al. 1979). Because snipe probe for food, they prefer to feed in soft, organic soils (Tuck 1972, Johnson 1975). Seasonal and temporary wetlands are often used during the summer (Fritzell et al. 1979). A substantial portion of winter feeding habitat is man-made, such as wet pastures (Tuck 1972).

Loafing/Resting

Wetlands with cover provided by adequate emergent vegetation are the key for these 4 species. During migration, coots use areas with more open water (such as large lakes and reservoirs) than do rails and snipe. In spring and fall, river drainage systems are heavily used, especially by coots. The Colorado River drainage is of primary importance in northwestern Colorado (Moore et al. 1977).

Water

Coots, rails, and snipe are intimately linked to water throughout the year. Reservoirs, ponds, river drainages, wetlands, and wet fields are used during the breeding season, migration, and winter.

Special Requirements

Each of the 4 species prefers special conditions within its nesting habitat. Coots exhibit an increase in nesting density as the proportion of open water to available nesting cover increases (Ryder 1961, Weller and Fredrickson 1973). Soras are more abundant in Colorado than are Virginia rails when mean April temperatures are 5.6 C or below (Griese 1977). Snipe prefer areas with sparse vegetation (Neely 1959, Stewart and Kantrud 1968, Tuck 1972). In addition, display arenas (characterized by a lack of obstacles and high vegetation) are essential to snipe pair formation and precopulatory activities (Tuck 1972).

EFFECTS OF HABITAT ALTERATION

The loss of wetlands (through drainage and reclamation projects) has been detrimental to coots, rails, and snipe. Fogarty and Arnold (1977) believed all wetland species could be in peril unless efforts are made to secure additional wetland habitat. Other reported alterations have varied effects. Ditching for mosquito control and trampling of nesting habitat by cattle have adversely affected rails (Holliman 1977, Lowther 1977) and snipe wintering range has been lost to urbanization (Fogarty and Arnold 1977). However, grazing has improved snipe habitat in some areas (Erickson 1941, White and Harris 1966). Gorenzel et al. (1981b) observed a better aquatic food supply at Beebe Draw (Weld County) in north central Colorado following efforts to control emergents.

Information on the effects of habitat alteration on these species in northwestern Colorado is scarce. Direct effects due to energy development would include increased human presence (primarily more hunting and disturbance) and toxic water caused by tailing ponds (Moore et al. 1977). Any changes that further reduce or alter wetlands would severely affect these species.

MITIGATION

Little information exists concerning attempts to mitigate the effects of habitat alteration on wetland species. Some possible mitigation methods exist. Waste water areas associated with energy development could be managed to the benefit of these species. Neely (1959) has outlined the steps involved in managing areas for snipe. Because coots occur in close association with waterfowl, they have benefitted from private and public

programs designed to benefit ducks and geese (Fredrickson 1977). Any acquisition of wetland habitat would positively affect at least 1 of the 4 wetland species.

DATA BASE

Nationwide data bases for coots are breeding-ground surveys (in conjunction with waterfowl breeding-ground surveys) and annual surveys of waterfowl hunters (Fredrickson 1977, Martin 1979). The reliability of the breeding-ground surveys is uncertain because coot habits are different from those of dabbling and diving ducks, and because the data collectors' interest in ducks may be greater than their interest in coots.

Data for Colorado are limited to annual mail surveys (Donoho et al. 1979, 1980, 1981) and those collected by Gorenzel (1979). Gorenzel (1979) collected data on nesting and migration at Hog Lake, Brown's Park National Wildlife Refuge (Moffat County) during 1977 and 1978.

Data bases for rails are even more restricted. As with coots, waterfowl hunters are surveyed annually. Because rails are generally harvested incidentally to other species, the total harvest is low.

Data for Colorado are limited to censuses conducted by Boeker (1954), Glahn (1974), and Griese (1977). Rails are no longer included in mail surveys conducted by the Colorado Division of Wildlife. The response in previous years had been so small that survey results were not usable for comparative purposes to establish statewide trends (Donoho et al. 1979).

Snipe data bases are similar to those for rails although (Boeker (1954) and Johnson (1975) both had study areas in the Yampa Valley where they censused snipe.

Colorado Division of Wildlife mail surveys no longer include snipe due to low response rates in previous years (Donoho et al. 1979).

RECOMMENDATIONS

The major recommendation for all species is the preservation of wetland habitat.

American Coot

Research

1. Evaluate waterfowl breeding ground survey data to estimate coot breeding populations (Fredrickson 1977).
2. Evaluate harvest inventory data (Fredrickson 1977).
3. Evaluate effects of land use practices on habitat quantity and quality (Fredrickson 1977).
4. Investigate the timing of fall migration and the hunting season. Hunting seasons could be set to coincide with the peak of migration (Gorenzel 1979).

Management

1. Design and conduct improved inventories. Late summer counts of coots 30 days of age or older could be undertaken as an index to productivity (Fredrickson 1977, Gorenzel 1979).
2. Collect improved harvest information (Fredrickson 1977).
3. Collect information on available habitat and habitat use (Fredrickson 1977).
4. Increase hunter interest in coots (Ryder 1961, Fredrickson 1977, Gorenzel 1979).

5. Marshes managed for coots should contain primarily persistent emergent vegetation (such as tule bulrush, S. acutus and/or cattails) with a cover: water ratio within the emergent zone of approximately 50:50. Water levels 30 cm or greater and sufficient to flood emergents should be maintained during spring migration and the breeding season. Growth of aquatic food species should be encouraged (Gorenzel 1979).

Rails

Research

1. Develop reliable census techniques (Holliman 1977).
2. Determine effects of drainage, agriculture, and other changes in land use practices on rails (Holliman 1977).
3. Develop reliable field techniques for classifying sex and age of rails during all seasons (Griese 1977).
4. Delineate migrational routes (Griese 1977).
5. Estimate recovery and survival rates through banding programs (Griese 1977).

Management

1. Measure harvest rates and hunting pressure (Holliman 1977).
2. Survey productivity (Holliman 1977).
3. Assist the public in species identification and inform them of rails' value as game birds (Holliman 1977).
4. Inventory habitat and restore that in poor condition (Holliman 1977).
5. Marshes managed for breeding rails should contain primarily (> 60%) robust vegetation (such as Typha spp.) interspersed with small openings containing short, thin emergents (such as American bulrush, S. americanus) or mud flats. Water levels should be maintained at 15 cm during spring migration. Gradual decreases in water levels

may be allowed through the summer, but levels should be increased in late summer (Griese 1977).

Common Snipe

Research

1. Determine breeding and wintering population densities by using winnowing counts on the breeding range, strip flush counts on wintering areas, and banding programs (Fogarty and Arnold 1977).
2. Determine harvest, evaluate habitat types, and measure hunter distribution and crippling loss (Fogarty and Arnold 1977).
3. Conduct further research on the relationship between snipe numbers and their use of soils of varying productivity (Johnson 1975).

Management

1. Obtain an annual population estimate (Fogarty and Arnold 1977).
2. Assess snipe habitat (Fogarty and Arnold 1977).
3. Include species on statewide survey to obtain an approximate annual harvest (Fogarty and Arnold 1977).
4. Initiate a wing-collection program to obtain information on the age ratio in the harvest (Fogarty and Arnold 1977).
5. Areas managed for snipe should have shallow, discontinuous water levels that should not exceed 50-60 mm. Vegetation should be manipulated by grazing, burning, and/or mowing to maintain low cover (< 200 mm) (Johnson 1975).

BAND-TAILED PIGEON

Order Columbiformes, Family Columbidae, Columba fasciata.

DISTRIBUTION AND OCCURRENCE IN NORTHWESTERN COLORADO

In Colorado, band-tailed pigeons are found throughout the forested mountains, especially where pine and oak occur. Exceptions are South Park, the Gunnison Basin, the northern San Luis Valley, and much of northwestern Colorado (Braun 1973). The present distribution in northwestern Colorado includes extreme southern and southwestern areas of Routt County, extreme southeastern Moffat County, the eastern one-fourth of Rio Blanco County, the eastern two-thirds of Garfield County, and the eastern three-fourths of Mesa County (Fig. 10) (Braun 1973). Pigeons are found in close association with ponderosa pine and Gambel oak and with areas dominated by sedimentary and volcanic materials. This latter association could be a function of climatic conditions and soil fertility that allows growth of Gambel oak (Braun 1973, Braun et al. 1975). A comparison of pigeon (Braun 1973) and ponderosa pine (Currie 1975) distribution maps illustrates the association of pigeons with pines. Because much of northwestern Colorado lacks ponderosa pine, pigeons are also absent or occur in extremely low densities.

Little is known about pigeon distribution in Colorado prior to the 1940's as only scattered references before 1946 exist (Bailey and Niedrach 1965). Accounts of distribution in the 1940's (Neff 1947, Neff and Culbreath 1947) differ somewhat from Braun's (1973) distribution. Earlier accounts placed pigeons in South Park and the Gunnison

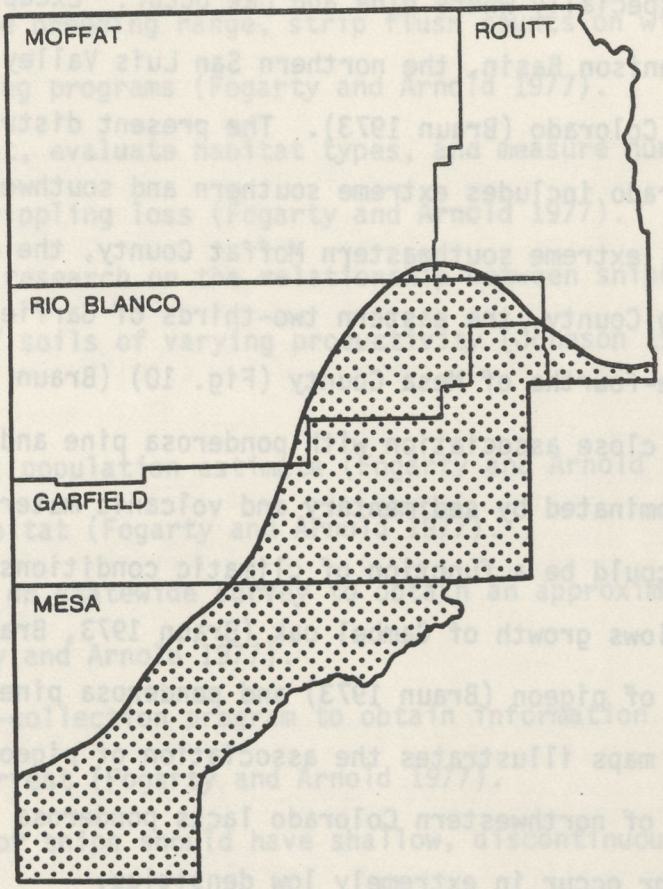

Fig. 10. Distribution of band-tailed pigeons, northwestern Colorado (after Braun 1973).

Basin (where they are now absent) and excluded them from areas north of the Cache la Poudre River, Moffat County, Routt County, and parts of Rio Blanco, Garfield, and Mesa counties where they presently occur. These changes could reflect a lack of access and/or observers in the 1940's. It is probable that there have been no real changes in pigeon distribution statewide since 1946.

TIME OF YEAR PRESENT

Band-tailed pigeons are summer residents of most pine-oak forests in Colorado, including those areas in northwestern Colorado described in Fig. 10. Pigeons begin a relatively rapid northward migration into Colorado in April. The peak of spring migration is from late April to mid-May. In mid- to late August a more gradual southward migration begins. The number of birds migrating substantially increases from late August until mid-September. Band-tailed pigeons are virtually absent from all areas of Colorado after mid-October. Most migrate through extreme southwestern New Mexico and southeastern Arizona to wintering areas in Mexico.

HABITAT REQUIREMENTS

Band-tailed pigeons prefer forests dominated by ponderosa pine and Gambel oak between 1,550 and 2,790 m. They are uncommon above treeline (approximately 3,600 m) and absent from sagebrush-pinyon-juniper areas of northwestern Colorado (Braun 1973).

Nesting

Band-tailed pigeons are believed to nest in conifers and broad-leaved trees on moderate to steep slopes. Nesting habitats vary, but most are outside of feeding areas in the higher limits of ponderosa pine forests through spruce-fir-aspen forests into areas dominated by lodgepole and limber pine (Pinus contorta and P. flexilis). Cottonwood and other

riparian deciduous forest communities adjacent to grain fields are often of major importance during the breeding season (Braun et al. 1975). Few nests have been observed in Colorado. Two active and 6 unused or deserted nests located by Neff and Niedrach (1946) were at 2,600 m in lodgepole pine.

Feeding

Depending upon season of year and food availability, pigeons feed on a variety of foods. Native foods are primarily acorns from Gambel oak and wavy leaf oak (Q. undulata) and berries, such as those from common chokecherry and elderberry (Sambucus spp.). Because acorn crops are unreliable and berry-producing shrubs and trees are scarce in forested areas of Colorado, pigeons rely heavily on cultivated grains and livestock feeding areas. Principal grains used for food are barley and wheat. To a lesser degree, oats and peas are used. Preferred foods at livestock feeding areas and home bird feeders are corn and milo. Pigeons often follow stream courses from nesting areas to feeding sites (Braun 1976). Other areas where pigeons periodically feed are orchards, pinyon-juniper woodlands, and mixed sclerophyll communities of Great Basin chaparral (Braun et al. 1975).

Loafing/Resting

A considerable amount of time is spent loafing in trees adjacent to feeding areas during feeding periods (Kautz 1977, Curtis 1981).

Water

Presence of water is important to feeding flocks in Colorado, but it is usually not a limiting factor due to the great mobility of pigeons (Braun 1973).

Special Requirements

Use of mineral springs is uncommon in Colorado compared to the Coastal subspecies. This lack of use could be related to a difference in grit availability.

EFFECTS OF HABITAT ALTERATION

There is no literature about the effects of habitat alteration on pigeons in northwestern Colorado. Considering the limited distribution of pigeons in this area and the types of habitats in which they occur, effects from most types (such as energy development and water projects) would be nonexistent. An increase in agricultural production would be beneficial in terms of increased food availability. Urban development and/or expansion in forested areas would destroy small areas of nesting habitat, but would possibly result in an increase in food supply at home bird feeders. Greater hunting pressure and harvest could occur, but due to the pigeon's limited appeal as a game bird, any increases would be small.

MITIGATION

No attempts to mitigate effects of habitat alteration on band-tailed pigeons have occurred.

DATA BASE

In Colorado, no census method has been successful in providing an accurate population or density estimate. Several methods have been attempted on the west coast, including call counts in Oregon that have shown promise as an index of abundance (Keppie et al. 1971). However, call counts were unsuccessful in Colorado (Kautz 1977).

Earlier population estimates in Colorado were based on season-long surveys (in the form of reports from field personnel) and ranged from 12,000 in 1941 to 2,221 in 1952. Similar reports in the late 1960's and early 1970's resulted in approximately the same range (Braun 1973).

From 1969 through 1975, 24,068 band-tailed pigeons were banded in Colorado. Included in that total were 1,368 banded in northwestern Colorado: 340 at Carbondale, Garfield County; 69 at Collbran, 69 at Molina, and 570 at Unaweep Canyon in Mesa County; and 149 at Buford and 171 at Little Beaver Creek in Rio Blanco County. To obtain sufficient band recovery data so that harvest levels could be estimated, an experimental hunting season was opened in 1970; band-tailed pigeons had not been legally harvested in Colorado since 1944. Hunters were required to obtain free permits which provided a mailing list for distribution of questionnaires about harvest and hunting activity (Braun 1976).

No population estimates are available for northwestern Colorado, few permits have been issued to people hunting in that region, and reported harvests have been extremely low (0 in 1978, 0 in 1979, 17 in 1980).

Considering the difficulties associated with census techniques for Interior population pigeons, it is probable that banding and harvest trends will continue to provide the best data for estimating numbers (Jeffrey 1977).

RECOMMENDATIONS

Research

1. A population census or monitoring technique must be developed (Braun et al. 1975).

2. Further research is needed on counts at artificial bait sites to draw definitive conclusions about their potential as a census technique (Curtis 1981).
3. Additional research is needed to relate crop gland development to nesting phenology, reproductive success, migration, and hunting (Braun et al. 1975).
4. Survival rates of band-tailed pigeons, especially immatures, must be more thoroughly investigated (Braun et al. 1975).

Management

1. Band-tailed pigeons in Colorado can be managed as specific subpopulations, including those found in the northwestern part of the state, through manipulation of food supplies at state-owned or state-controlled properties and through the monitoring of hunter numbers, pressure, and harvest (Braun 1972, 1976).
2. When a population census is developed, it should be conducted annually.
3. The hunting season should be continued (Braun et al. 1975).
4. The permit system should be retained and hunter surveys continued (Braun et al. 1975).
5. Periodic banding of subpopulations should continue, including opportunistic banding of at least 100 pigeons every 3 to 5 years at the following northwestern Colorado sites: Carbondale, Garfield County; Unaweep Canyon and the Collbran-Molina area, Mesa County; and the Meeker-Buford area, Rio Blanco County (Braun 1976). Capture-recapture methods can be used to calculate an index of population size, but care must be used in selection of trap sites and interpretation of population data (Kautz 1977).

MOURNING DOVE

Order Columbiformes, Family Columbidae, Zenaida macroura.

DISTRIBUTION AND OCCURRENCE IN NORTHWESTERN COLORADO

In Colorado, mourning doves occur throughout the state, primarily below 2,635 m (Bailey and Niedrach 1965). They have been observed from above timberline to river bottoms, prairies, and sagebrush semi-deserts during spring and fall migrations (Braun 1976). Sedgwick (1981) observed doves during summer in the Piceance Basin, Rio Blanco County. The present distribution in northwestern Colorado includes most areas in Moffat, Routt, Rio Blanco, Garfield, and Mesa counties below 2,635 m (Fig. 11). Highest densities are present along stream courses and in orchards and scattered woodlands, including towns and homesteads.

References to the historical distribution of mourning doves in northwestern Colorado are not specific. Bailey and Niedrach (1965) reviewed reports dating to 1908. The mourning dove was listed as a summer resident of Mesa County and as a commonly observed species in Garfield, Rio Blanco, and Moffat counties (Rockwell 1908, Felger 1910, Hendee 1929). Nesting was documented in Moffat County by Warren (1908) and Hendee (1929). Sandfort (1953) studied mourning dove nesting and productivity in Mesa County orchards. Although distribution in Routt County was not mentioned, doves probably occurred there historically as well.

It is believed that some changes in statewide distribution have occurred. However, the changes have been primarily in eastern Colorado where planting of shelterbelts and small grains benefitted mourning doves and resulted in higher densities. The distribution in northwestern

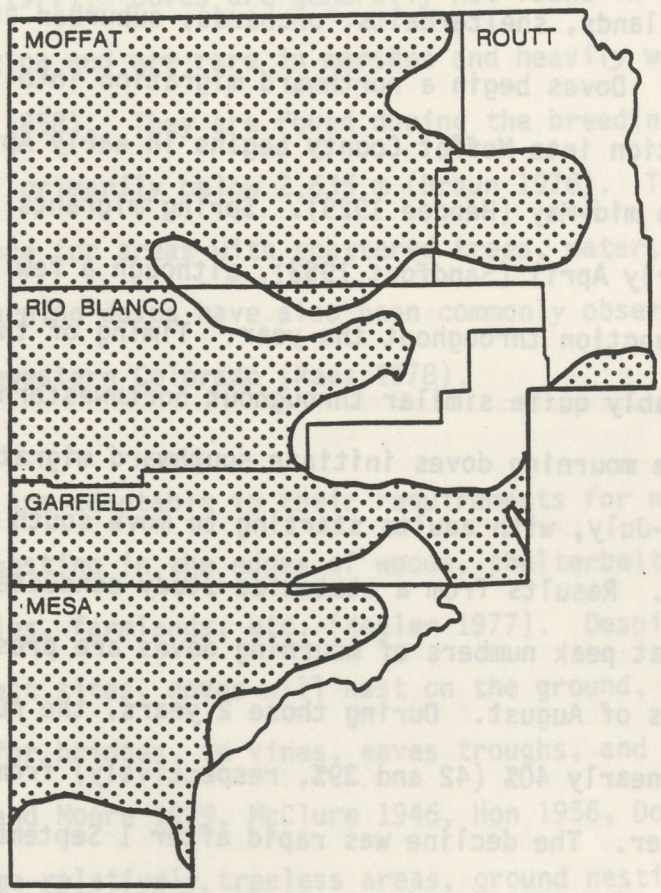

Fig. 11. Distribution of mourning doves, northwestern Colorado (after Donoho 1980).

Colorado has probably remained relatively constant with some increases in densities due to production of small grains and planting of orchards and trees.

TIME OF YEAR PRESENT

Mourning doves are common summer residents throughout much of Colorado, particularly in areas that include water, scattered woodlands (natural woodlands, shelterbelts, orchards, suburban areas), and cultivated grains. Doves begin a northward migration into Colorado in March. Spring migration into Moffat County begins in early April, and peaks from late April to mid-May (Hendee 1929). Spring migrants first arrive in Mesa County in early April (Sandfort 1953), although a few doves are present near Grand Junction throughout the year. Timing of the northward migration is probably quite similar throughout northwestern Colorado.

Juvenile mourning doves initiate southward migration throughout the state in mid-July, with adults starting to move south in late August (Olson 1980). Results from a statewide study conducted in 1962 and 1963 indicated that peak numbers of mourning doves are present during the first 3 weeks of August. During those 2 years, the number of doves declined by nearly 40% (42 and 39%, respectively) from the peak number by 1 September. The decline was rapid after 1 September (Funk 1965). By 1 October, few mourning doves remain in Colorado with those remaining occurring in sheltered areas along stream courses and near feedlots (Bailey and Niedrach 1965).

From analyses of return and recovery data, Braun (1979) felt that the Continental Divide impeded the eastward movement of doves banded west of the main mountain cordillera. Doves banded west of the Continental Divide in Colorado had a tendency to migrate west and south in the fall.

Wintering areas to which mourning doves from northwestern Colorado migrate are Arizona, New Mexico, and the Mexican states of Jalisco, Michoacan, and Guanajuato (Braun 1979).

HABITAT REQUIREMENTS

Mourning dove habitat is difficult to describe because the species is found throughout much of North America and adapts to numerous ecological types (Keeler 1977). Doves are generally not found in the boreal region of North America and are rare in marshes and heavily wooded areas (Aldrich and Duvall 1958). They are found during the breeding season throughout Colorado, primarily below 2,635 m (Braun 1976). There exists an apparent preference for areas with scattered trees, water, and cropland nearby, but mourning doves have also been commonly observed in sagebrush areas of northwestern Colorado (Rees 1978).

Nesting

Mourning doves are adaptable in their requirements for nesting. They have been observed nesting in the edges of woods, shelterbelts, church and cemetary sites, cities, farmlands, etc. (Keeler 1977). Despite a preference for trees as nest sites, doves will nest on the ground, stumps, supporting girders for bridges, in vines, eaves troughs, and abandoned buildings (Pearson and Moore 1939, McClure 1946, Hon 1956, Downing 1959, Olson 1980). In some relatively treeless areas, ground nesting contributes substantially to overall production. Cowan (1952) and Downing (1959) estimated that at least 70% of all mourning dove nesting attempts were on the ground in southeastern California and northwestern Oklahoma, respectively. Hanson and Kossack (1963) thought ground nesting by doves

in Illinois was uncommon, but not rare. Several investigators in eastern Colorado have observed considerable numbers of ground nests (Strong 1971, Ryder 1972, Olson 1980). Apparently, doves show no preference for any specific type of ground nesting habitat. Giezentanner (1970) and Olson (1980) found no preference for dense or sparse vegetation. There was no basis for relating the distribution of nearby trees to the distribution of ground nests in Oklahoma (Downing 1957).

Previous researchers have disagreed about preference, if any, shown by doves in selecting trees as nest sites. Moore and Pearson (1942), Hanson and Kossack (1963), and Caldwell (1964) believed that mourning doves preferred to nest in evergreen trees. Others have suggested that evergreens were selectively chosen only early in the breeding season (McClure 1943, Carter 1957, Klataske 1966). Several workers have stated that species of trees are chosen as nest sites according to their availability (Randall 1955, Harris et al. 1963, Davis and Sintz 1973, Olson 1980).

Three investigators have reported doves nesting in sagebrush areas. Fichter (1959) observed nests in sagebrush areas in Idaho. Ziegler (1977) located nests in sagebrush-bitterbrush (Purshia spp.) habitat, and in trees and shrubs along riparian habitat in Washington. Rees (1978) observed 7 ground nests under the canopy of big sagebrush near Lay, Moffat County, Colorado. The 7 nests were in a localized area approximately 3.2 km from dryland wheat and 0.8 km from pinyon-juniper woodland. He concluded that nesting on the ground in those instances occurred because the sagebrush offered shelter from sun and wind, and protection from predators.

Feeding

Seeds and grains compose virtually all of the mourning dove's diet. Important foods reported have ranged from sunflowers (Helianthus spp.) and hemp (Cannabis sativa) to cultivated grains, primarily corn and wheat (Moore and Pearson 1942, McClure 1943, Martin et al. 1951). Ward (1964) examined the contents of 247 crops from mourning doves collected in agricultural areas of eastern Colorado. The most important grasses and grass-like plants used for food were wheat, switchgrass (Panicum spp.), corn, bristlegrass (Setaria spp.), sorghum, and Indian ricegrass. Principal seed-producing forbs were sunflower, doveweed (Croton texensis), pigweed (Amaranthus spp.), spiderflower (Cleome spp.), and spurges (Euphorbia spp.). Sunflower seeds were the most important food item and composed nearly one-half (47.9%) of the food items eaten by doves from May to October. In August, sunflower seeds constituted 63.6% of the total volume of food.

Due to the value of cultivated grains as food for doves, fields of wheat, corn, and sorghum are important feeding sites. Areas with disturbed soil, such as roadside ditches, are likely sites for sunflowers, which in turn, make them important feeding sites. Zeigler (1977) observed doves in Washington feeding in wheat stubble fields, brush fields, weed patches, gravel bars, and orchards. He listed wheat as the primary food item. Other areas where mourning doves feed are livestock feeding areas and home bird feeders.

Loafing/Resting

Large groups of juvenile doves are often observed loafing in trees and on wires during late summer and early fall (Olson 1980).

Water

Daily access to water is required. However, it is rarely a limiting factor due to the great mobility of mourning doves.

Special Requirements

Mourning doves require grit which is usually acquired from roadsides in the form of small stones.

EFFECTS OF HABITAT ALTERATION

Most changes that have affected mourning doves throughout North America have been caused by shifts in farming practices. Early alterations, such as the clearing of large areas of deciduous forests in the 1800's and later, the planting of shelterbelts in the Great Plains, were beneficial to doves (Keeler 1977). Moore and Pearson (1942) noted mourning doves' use of waste grain. Keeler (1952) concurred and stated that the shift from cotton to grains in southeastern states during the 1920's was advantageous to doves. More recent alterations have been detrimental to doves. Examples of these changes have been the decline of small grain farming in New York, the clearing of riparian brush in the southwest, and the removal of shelterbelts in the Great Plains (Lehner 1965, Keeler 1977).

Information concerning the effects of habitat alteration on mourning doves in northwestern Colorado is limited. Because doves are quite adaptable in their nesting and feeding requirements, effects from most types of changes would be minimal. Sedgwick (1981) determined that chaining of vegetation in the Piceance Basin had a negative effect on mourning dove abundance. Doves fed in chained areas (probably because of improved

access to grass and forb seeds), but did not nest there. Sedgwick (1981) reviewed 5 modifications to chaining: leaving snags near the edge, creating an irregular edge, lighter chaining at the perimeter, chainings that were less than 200 m wide, and leaving slash piles on the chained area. None of the modifications improved the chained habitat for doves. Unless placed in an agricultural area, energy developments and/or water projects should not detrimentally affect doves. An increase in agricultural production with an accompanying rise in waste grain would be beneficial. Griffing et al. (1977) compared weights of doves from an uncultivated area with those from an irrigated, cultivated area. Those from the latter area were heavier. Urban development and/or expansion should also be beneficial, because of increased food at livestock feeding sites and home bird feeders, and nest sites in the form of trees and shrubs landscaped at new home sites. An increase in human population in northwestern Colorado would result in increases in hunting pressure and harvest.

MITIGATION

Calhoun (1948) found that mourning doves would use artificial nest structures. Nelson (1976) determined that nesting success increased when artificial cone-shaped structures were provided. Such structures would probably be of limited value in most instances, such as the removal of a high proportion of trees in a localized area. No other efforts at mitigation have been made.

DATA BASE

Data are collected in Colorado on an annual basis from 3 sources: mourning dove call counts, breeding bird surveys, and annual surveys

of small game hunters. One nesting study has been conducted in Mesa County (Sandfort 1953), part of a migration study was conducted in Moffat County (Funk 1965), and Sedgwick (1981) investigated the abundance of doves in chained and unchained areas of the Piceance Basin in Rio Blanco County. An intensive banding program took place from 1964 to 1975 in Colorado (Braun 1976). Included among the banding sites were 3 in northwestern Colorado: the Craig area (including Lay and Hayden) in Moffat County, Meeker (including Buford) in Rio Blanco County, and Unaweep Canyon in Mesa County.

The call count has been the principal means for nationwide monitoring of mourning doves since 1953. The U.S. Fish and Wildlife Service coordinates and compiles data obtained from cooperators who conduct the survey (Dolton 1981).

Four call count routes are in northwestern Colorado, in, or near, the following areas: Meeker in Rio Blanco County, Craig and Elk Springs in Moffat County, and Unaweep Canyon in Mesa County (data from the files of the Colo. Div. Wildl.). The Meeker route has been censused from 1970 through 1981. The Craig route has been censused annually from 1968 through 1981. A complete data set exists for the route near Elk Springs for 1968 through 1981. The Unaweep Canyon route was the most recently established route in northwestern Colorado; the first year of censusing was 1976.

Breeding bird survey routes are located throughout North America and are censused annually, usually in June or early July (Robbins and

Van Velzen 1974). Five routes are in northwestern Colorado: Maybell and Great Divide in Moffat County, Yampa in Routt County, Buford in Rio Blanco County, and Douglas Pass in Garfield County. No data are available for Douglas Pass (data from the files of R. A. Ryder). Similar to the mourning dove call counts, censusing of the breeding bird survey routes began in different years depending upon the individual route. Each route has had more than 1 observer since its inception. The Maybell route was censused from 1970 to 1976 and in 1978. Annual surveys of the Great Divide route were conducted from 1974 through 1980. Breeding bird survey routes at Yampa (1969-73, 1975-76) and Buford (1970-76, 1978, 1980) have been censused sporadically.

Hunter surveys in Colorado date from 1940 (Donoho 1980). Estimated harvest in northwestern Colorado during the last 3 years for which data were reported (1978-80) increased from 18,920 to 31,400. During that same time period, estimated harvest increased in Garfield (1,798 to 2,986), Mesa (6,960 to 16,015) and Moffat (6,397 to 10,724) counties, and decreased in Rio Blanco (2,684 to 630) and Routt (1,081 to 1,045) counties.

From 1964 through 1974, 31,523 mourning doves were banded in Colorado. Of that total, 871 were banded near Craig, including 522 at Lay in Moffat County and 101 at Hayden in Routt County; 733 near Meeker, including 2 at Buford, in Rio Blanco County; and 358 at Unaweep Canyon in Mesa County.

RECOMMENDATIONS

Research

1. Establish a better method of population appraisal (Keeler 1977). The call count system currently used is hampered by differential cooing rates for mated and unmated males and lack of information

on the stability of the ratio of mated to unmated males (Stone 1963, Baskett et al. 1978).

2. In lieu of the above recommendation, develop a sampling frame to test the correlation of call count results with total harvest estimates and documented age ratios (Baskett et al. 1978).
3. Establish the ratio of calling doves to breeding pairs and production in various habitats (Keeler 1977).
4. Develop and evaluate a production index (Keeler 1977).
5. Measure the sex composition of populations in the spring and fall (Keeler 1977).
6. Study production in habitat types representative of northwestern Colorado.

Management

1. Continue annual mourning dove call counts between 20 May and 10 June to ascertain long term trends in dove numbers. Results should not be used to estimate the number of breeding pairs, active nests, or productivity in a localized area (Olson 1980).
2. Implement an annual population appraisal method, if one is developed (Keeler 1977).
3. Continue harvest appraisal (Keeler 1977).

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APPENDICES

GLOSSARY

*Brood - Young hatched from 1 clutch of eggs.

*Canopy Cover - Top most level within a vegetative spectrum.

*Carrying Capacity - Number of heatlhy animals that can be maintained by the habitat on a given unit of land.

*Census - A complete count of animals over a specific area at a specified point in time.

*Chaining - Consists of dragging a heavy chain through vegetation to break off or uproot plants.

*Clutch Initiation - The onset of egg laying by 1 female.

*Clutch Size - The complete number of eggs laid by 1 female that are brooded simultaneously.

*Counts:

Brood - Number of chicks per hen.

Call - Census method based on bird vocalizations.

Christmas Bird - Type of bird count done each year during the Christmas period which emphasizes both species diversity and abundance.

Coo - Census method based on mourning dove vocalizations.

*Covey - Term used for a similarly sized flock of partridge or grouse.

*Crippling Loss - Amount of birds injured by hunters and not able to survive.

*Crop - A thin-walled, sac-like elaboration of the esophagus, whose main function is food storage.

*Dabbling Ducks - Group of ducks that primarily feed on the water surface by tipping.

*Diving Ducks - Group of ducks that primarily feed by diving.

*Double-brooding - Female duck caring for two different broods of young at the same time.

*Drake - Male duck possessing a bright plumage during the mating season.

*Exotic Species - Species that have been introduced into an area in which they are not native.

*Fidelity - The degree to which animals return or remain in a given area.

*Fledge - Term applied to a young bird acquiring its first complete set of true feathers.

*Flush - Sudden emergence of a bird to flight.

*Forb - Non-woody plant that is not a grass.

*Gallinaceous Guzzler - Permanent, self-filling water catchment used by wildlife in semi-arid areas.

*Gizzard - Oval muscular structure joining with the proventriculus to form the stomach.

*Gobbler Flock - Assemblage of male turkeys.

*Gosling - Term for a young goose.

*Granivorous - Subsisting on grain-like food matter.

*Grit - Particles of stone of varying coarseness eaten by birds to grind their food to pulp through the action of the powerful muscles in the gizzard.

*Habitat - The part of the physical environment in which a plant or animal lives.

Bogs - Plant communities that develop and grow with permanently water-logged peat substrates.

Boreal Forest - Forest comprising the climate and biotic communities between the Arctic and Transcontinental zones.

Brood - The area where young animals live.

Cover - The percentage of ground surface cover by a plant or litter.

Emergent Vegetation - Vegetation rooted in shallow water and having most of its vegetative growth above water.

Impoundments - Man-made water areas usually created by construction of a dam.

Loafing - A resting type behavior.

Peat Lands - Soils containing a large amount of peat, i.e., rich in humus (decomposed vegetation).

Pole Stage - Vegetative community containing young trees of medium height.

Riparian - Area or vegetation along a stream.

Shelterbelt - A planted barrier of trees used to reduce erosion and provide shelter from wind and storms.

Sloughs - A water area usually formed from river or stream meanders.

Swale - Low lying, depressed and often wet area.

*Harvest Trend - The variation in harvest levels over a period of time.

*Home Range - Total area that an organism habitually occupies.

*Incubation Period - The time from laying the last egg of a clutch to hatching of that egg.

*Juvenile - An individual too young to breed and still distinguishable from breeding adults by external characteristics.

*Lek - Counts of birds present on communal display areas.

Dancing Ground - Courtship display area for sharp-tailed grouse.

Satellite Lek - Courtship display area periodically used when numbers of grouse are high or when disturbed on the primary lek.

Strutting ground - Courtship display area for sage grouse.

*Mail Survey - Method of gathering information from the public by using the postal service. Survey through the mail.

*Mesic Site - Area characterized by, relating to, or requiring a moderate amount of moisture.

*Molt - Periodic shedding and renewal of plumage and pelage.

*Mortality - The proportion of deaths in a population.

*Natal Area - General surrounding of an organism's birthplace.

*Nesting:

Cover - That portion of vegetation cover that provides nesting support or protection

Overwater Nesting - Nests supported by floating vegetation over water.

Phenology - Timing of nesting events.

Success - Proportion of nests that produce broods.

*Omnivorous - Subsidizing on both animal and vegetative matter.

*Ovulation - Process by which the ovary releases an ovum into the oviduct.

*Physiognomy - The art of discovering character from outward appearance.

*Post-nuptial Molt - Complete loss of breeding feathers.

*Radiotelemetry - Equipping an organism with a miniaturized radio transmitter and monitoring its movements with a receiver.

*Roost - Term covering both the sleeping and resting behavior of birds.

*Slash - Vegetative debris.

*Small Game - Arbitrary classification of game animals based on size. Usually refers to birds and smaller mammals.

*Transients - Term used for a species or subspecies that appears on migration in the area under reference, but neither breeds nor winters there.

*Wing Barrel - Barrel-type structure used to gather bird wings, by having hunters voluntarily put wings in the container.

*Winnowing - Sound made in aerial breeding displays by common snipe.

*Yearling - An individual about 8-16 months of age.

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