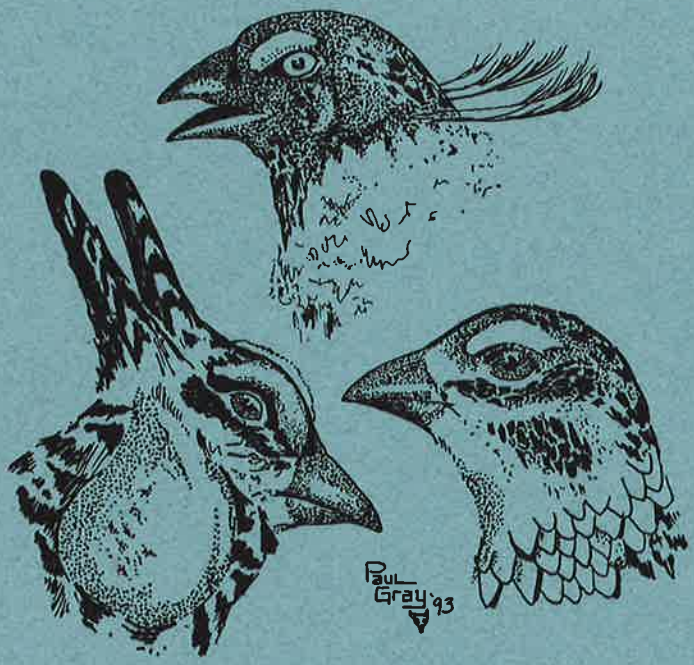
TRANSACTIONS/PROCEEDINGS

1ST JOINT MEETING

20TH PRAIRIE GROUSE TECHNICAL COUNCIL MEETING

AND

18TH WESTERN STATES SAGE/COLUMBIAN SHARP-TAILED GROUSE WORKSHOP



Clait E. Braun, Compiler

FORT COLLINS, COLORADO

26-28 JULY 1993

TABLE OF CONTENTS

AGENDA

JOINT MEETING (1ST)
PRAIRIE GROUSE TECHNICAL COUNCIL (20TH)
and
WESTERN STATES SAGE AND COLUMBIAN SHARP-TAILED GROUSE WORKSHOP (18TH)

OKLAHOMA STATE ROOM
University Park Holiday Inn - Fort Collins, Colorado
25-28 July 1993

Sunday, 25 July 1993

2:00 PM-Until ?	Ad Hoc Informal Field Trip/Alpine Grouse - Front of Holiday Inn
6:00-8:00 PM	Registration, Oklahoma State Room, University Park Holiday Inn

Monday, 26 July 1993

7:00-8:30 AM	Registration, Oklahoma State Room, University Park Holiday Inn
8:30-8:45 AM	Welcome, Bruce McCloskey, Deputy Director, Colorado Division of Wildlife, Denver
8:45-9:00 AM	Announcements, Kenneth M. Giesen, Colorado Division of Wildlife, Fort Collins
9:00 AM	**Columbian Sharp-tailed Grouse - Moderator - Michael A. Schroeder, Washington Department of Wildlife, Bridgeport**
9:00-9:15 AM	Brood-rearing Habitat Selection by Columbian Sharp-tailed Grouse in Southcentral Wyoming *Olin O. Oedekoven, Wyoming Game and Fish Department, Gillette*
9:20-9:35 AM	Winter Habitat Ecology of Columbian Sharp-tailed Grouse *Mark J. Ulliman and Kerry P. Reese, Department of Fish and Wildlife Resources, University of Idaho; John W. Connelly, Idaho Department of Fish and Game; James H. Klott, Bureau of Land Management, Twin Falls*
9:40-9:55 AM	Winter Feeding Ecology of Columbian Sharp-tailed Grouse in Southeastern Idaho *James W. Schneider and Kerry P. Reese, Department of Fish and Wildlife Resources, University of Idaho; John W. Connelly, Idaho Department of Fish and Game; James H. Klott, Bureau of Land Management, Twin Falls*
10:00-10:15 AM	Break
10:20-10:35 AM	Habitat Suitability Index Procedure for Columbian Sharp-tailed Grouse *Daryl R. Meints, John W. Connelly, Thomas P. Hemker, Idaho Department of Fish and Game; Kerry P. Reese, Department of Fish and Wildlife Resources, University of Idaho; Alan R. Sands, Bureau of Land Management, Boise*

10:40-10:55 AM — Test of a Habitat Suitability Index (HSI) Model for Reintroduced Columbian Sharp-tailed Grouse in Idaho
Scott C. Gardner, Department of Fish and Wildlife Resources, University of Idaho; John W. Connelly, Idaho Department of Fish and Game; Kerry P. Reese, Department of Fish and Wildlife Resources, University of Idaho, Moscow

11:00-11:15 AM — Preliminary Evaluation of the Reintroduction of Columbian Sharp-tailed Grouse in Oregon
Jeffrey W. Snyder and John A. Crawford, Department of Fisheries and Wildlife, Oregon State University, Corvallis

11:20-11:35 AM — Regulations and Hunting of Sharp-tailed Grouse: Is the Fit Proper?
G. D. Kobriger, North Dakota Game and Fish Department, Dickinson

11:40-11:55 AM — Effects of Radio Transmitters on Prairie Grouse Survival
John Toepher, Little Hoop Community College, Fort Totten, North Dakota

Noon — Lunch - Texas Tech Room

1:00 PM — Sage Grouse - Moderator - Clait E. Braun, Colorado Division of Wildlife, Fort Collins

1:00-1:15 PM — Diet and Nutrition of Female Sage Grouse During the Pre-laying Period in Oregon
Jenny K. Barnett, Bureau of Land Management, Vale, Oregon; John A. Crawford, Department of Fisheries and Wildlife, Oregon State University, Corvallis

1:20-1:35 PM — Sage Grouse Nesting Habitats in Southcentral Washington
Colin M. Sveum, John A. Crawford, and W. Daniel Edge, Department of Fisheries and Wildlife, Oregon State University, Corvallis; Larry L. Cadwell, Pacific Northwest Laboratory, Richland, Washington

1:40-1:55 PM — Nesting-Area Fidelity of Sage Grouse in Southeastern Idaho
Richard A. Fischer, Anthony D. Apa, Wayne L. Wakkinen, and Kerry P. Reese, Department of Fish and Wildlife Resources, University of Idaho; John W. Connelly, Idaho Department of Fish and Game, Pocatello

2:00-2:15 PM — Relationships Between Vegetative Structure and Predation Rates of Artificial Sage Grouse Nests
Anita Kang Delong and John A. Crawford, Department of Fisheries and Wildlife, Oregon State University, Corvallis

2:20-2:35 PM — Renesting by Sage Grouse in Southeastern Idaho
John W. Connelly, Idaho Department of Fish and Game, Pocatello; Richard A. Fischer and Kerry P. Reese, Department of Fish and Wildlife Resources, University of Idaho; Anthony D. Apa, Idaho Department of Fish and Game, Jerome; Wayne L. Wakkinen, Idaho Department of Fish and Game, Bonners Ferry

2:40-2:55 PM — Relationships of Herbaceous Vegetation to Reproductive Success of Sage Grouse
John A. Crawford, Department of Fisheries and Wildlife, Oregon State University, Corvallis

3:00-3:15 PM — Break

3:15 PM — Sage Grouse - Moderator - John W. Connelly, Idaho Department of Fish and Game, Pocatello

3:20-3:35 PM — Reproductive Behavior of Gunnison Sage Grouse: Do Mating Barriers Exist?
Jessica R. Young, Purdue University, West Lafayette, Indiana

3:40-3:55 PM — Sage Grouse Movement/Habitat Use Patterns in a Fragmented Landscape
Michael A. Schroeder, Washington Department of Wildlife, Bridgeport

4:00-4:10 PM — The Status of Sage Grouse: Are They Threatened, Endangered or?
Clait E. Braun, Colorado Division of Wildlife, Fort Collins

4:10-4:20 PM — Status of Sage Grouse in Oregon
Mitch Willis, Oregon Department of Fish and Wildlife, Burns

4:20-4:55 PM — Sage Grouse Biology/Habitat (What Do We Need to Know and Why)
Panel: Clait E. Braun, John W. Connelly, Mitch Willis, Gerald D. Kobriger, Alan R. Sands

5:00-5:55 PM — Business Meeting - Oklahoma State Room
Western States Sage and Columbian Sharp-tailed Grouse Technical Committee

6:00 - ? — Social/Mexican Buffet
Anheuser-Busch

uesday, 27 July 1993

7:30-8:30 AM — Business Meeting - Oklahoma State Room
Prairie Grouse Technical Council

8:35 AM — Prairie-chickens - Moderator - Kenneth M. Giesen, Colorado Division of Wildlife, Fort Collins

8:40-8:55 AM — Attwater's Prairie-chicken, A Status and Recovery Update
Stephen E. Labuda, Jr. and Michael E. Morrow, Attwater Prairie-chicken National Wildlife Refuge, Eagle Lake, Texas

9:00-9:15 AM — Relationship of Grazing, Burning, and Precipitation to Population Changes of the Attwater's Prairie-chicken
Michael E. Morrow, Robert S. Adamcik and Jenny D. Hoskins, Attwater Prairie-chicken National Wildlife Refuge, Eagle Lake, Texas; and Lloyd B. McKinney, Department of Rangeland Ecology and Management, Texas A&M University, College Station

9:20-9:35 AM — Attwater's Prairie-chicken Captive Propagation Program at Fossil Rim Wildlife Center, Glen Rose, Texas
Bob Smith, Fossil Rim Wildlife Center, Glen Rose

9:40-9:55 AM — Annual Nest Success of Greater Prairie-chickens Relative to Grassland Structure and Landscape Patterns in Southwestern Missouri
Gwyn McKee and Mark R. Ryan, School of Natural Resources, University of Missouri, Columbia; and Larry M. Mechlin, Missouri Department of Conservation, Columbia

10:00-10:15 AM	Break
10:20-10:35 AM	A Tool for Herbicide Application for Control of Woody Vegetation in Grasslands *James R. Keir, Wisconsin Department of Natural Resources, Friendship*
10:40-10:55 AM	Relationship of Range Condition to Greater Prairie-chicken Abundance and Use of Tallgrass Prairie in Eastern Kansas *Thomas A. Eddy, Division of Biological Sciences, Emporia State University, Emporia, Kansas*
11:00-11:15 AM	Trends and Predictions for Greater Prairie-chicken Populations in Kansas *Kevin E. Church, Kansas Department of Wildlife and Parks, Emporia; David A. Haukos, U. S. Fish and Wildlife Service, Texas Tech University, Lubbock*
11:20-11:35 AM	Survival, Movements, Reproduction, and Habitat Use of Greater Prairie-chickens Translocated from Minnesota to Illinois: Phase I *Ronald L. Westemeier, Center for Wildlife Ecology, Champaign, Illinois; Cory S. Rubin, University of Illinois; Terry L. Esker and Scott A. Simpson, Illinois Department of Conservation*
11:40-Noon	Reintroduction of Greater Prairie-chickens in Northeastern Colorado *Grant M. Beauprez and Jennifer A. Clarke, Department of Biological Sciences, University of Northern Colorado, Greeley; Clait E. Braun, Colorado Division of Wildlife, Fort Collins*
Noon-5:00 PM	Greater Prairie-chicken Field Trip - Barnesville
6:00-7:00 PM	Social, Ohio State Room
7:00 PM	Banquet - Texas Tech Room, University Park Holiday Inn
8:00-8:30 PM	Life with the Fuzzy-footed White Bird, *Clait E. Braun, Colorado Division of Wildlife, Fort Collins*

<u>Wednesday, 28 July 1993</u>

7:00-Noon	Sage Grouse Field Trip - North Park
Noon	Flush to the Winds

10:00-10:15 AM Break

10:20-10:35 AM A Tool for Herbicide Application for Control of Woody Vegetation in Grasslands
James R. Keir, Wisconsin Department of Natural Resources, Friendship

10:40-10:55 AM Relationship of Range Condition to Greater Prairie-chicken Abundance and Use of Tallgrass Prairie in Eastern Kansas
Thomas A. Eddy, Division of Biological Sciences, Emporia State University, Emporia, Kansas

11:00-11:15 AM Trends and Predictions for Greater Prairie-chicken Populations in Kansas
Kevin E. Church, Kansas Department of Wildlife and Parks, Emporia; David A. Haukos, U. S. Fish and Wildlife Service, Texas Tech University, Lubbock

11:20-11:35 AM Survival, Movements, Reproduction, and Habitat Use of Greater Prairie-chickens Translocated from Minnesota to Illinois: Phase I
Ronald L. Westemeier, Center for Wildlife Ecology, Champaign, Illinois; Cory S. Rubin, University of Illinois; Terry L. Esker and Scott A. Simpson, Illinois Department of Conservation

11:40-Noon Reintroduction of Greater Prairie-chickens in Northeastern Colorado
Grant M. Beauprez and Jennifer A. Clarke, Department of Biological Sciences, University of Northern Colorado, Greeley; Clait E. Braun, Colorado Division of Wildlife, Fort Collins

Noon-5:00 PM Greater Prairie-chicken Field Trip - Barnesville

6:00-7:00 PM Social, Ohio State Room

7:00 PM Banquet - Texas Tech Room, University Park Holiday Inn

8:00-8:30 PM Life with the Fuzzy-footed White Bird,
Clait E. Braun, Colorado Division of Wildlife, Fort Collins

Wednesday, 28 July 1993

7:00-Noon Sage Grouse Field Trip - North Park

Noon Flush to the Winds

ABSTRACTS

SHARP-TAILED GROUSE

BROOD-REARING HABITAT SELECTION BY COLUMBIAN SHARP-TAILED GROUSE IN SOUTHCENTRAL WYOMING

OLIN O. OEDEKOVEN, Wyoming Game and Fish Department, Gillette, WY 82717

Abstract: A Columbian sharp-tailed grouse (Tympanuchus phasianellus columbianus) population was studied from April 1983 to August 1984 within mixed shrub rangeland in southcentral Wyoming. Population distribution and seasonal habitat characteristics were investigated using radiotelemetry and ground searching. Seven females and 6 males were banded with aluminum leg bands, weighed, classified to sex and age, and fitted with a 10-g solar-powered radio transmitter. Observations of radio-marked sharptails and other females with broods were used to monitor seasonal movements, habitat use characteristics, and productivity. Nine breeding areas, 2 nest sites, 20 brood observations, 30 summer observations of males, and 30 random sites were surveyed using line intercept, point quarter, and quadrat vegetation sampling techniques and were statistically compared to describe habitat selection. Summer movements of sharptails were within a 1.0-km radius of the center of dancing activity. Comparisons between breeding habitat and adjacent areas indicated selection ($P \leq 0.05$) for habitat characterized by higher percent grass and forb cover with lower total shrub cover. The frequency of occurrence of snowberry (Symphoricarpos spp.) was higher ($P \leq 0.05$) in breeding habitat than in adjacent habitat. Breeding habitat also included less ($P \leq 0.05$) big sagebrush (Artemisia tridentata) cover. Females with broods selected microhabitats which included a high frequency of snowberry and slightly higher total shrub cover than habitat used by males.

WINTER HABITAT ECOLOGY OF COLUMBIAN SHARP-TAILED GROUSE

MARK J. ULLIMAN, Department of Fish and Wildlife Resources, University of Idaho, Moscow, ID 83843
KERRY P. REESE, Department of Fish and Wildlife Resources, University of Idaho, Moscow, ID 83843
JOHN W. CONNELLY, Idaho Department of Fish and Game, 1345 Barton Road, Pocatello, ID 83204
JAMES H. KLOTT, Bureau of Land Management, Jarbidge Resource Area, 2620 Kimberly Road, Twin Falls, ID 83301

Abstract: Winter habitat ecology of Columbian sharp-tailed grouse (Tympanuchus phasianellus columbianus) is poorly understood. We quantified characteristics of their winter habitat in southeastern Idaho and documented their movement patterns, home range size, and habitat selection during winter 1992 and 1993. During 1992, radio-marked birds inhabited lower elevations ($\bar{x}$ = 1551 m) with gentle slopes ($\bar{x}$ = 4.33°), while during 1993 they used higher elevations ($\bar{x}$ = 1770 m) on steeper slopes ($\bar{x}$ = 17.18°). During both winters sharp-tailed grouse exploited a wide variety of cover types but typically used 1 or 2 most often. During 1992, 67.6% of all telemetry locations were in Conservation Reserve Program lands, while in 1993, 58.4% were in shrub stands of mixed species composition. Distance moved from lek of capture to winter habitat was greater (P = 0.03) for females ($\bar{x}$ = 5.0 km) than miles ($\bar{x}$ = 1.9 km) in 1992 but not in 1993 (P = 0.13). This may have resulted from a small sample of males (n = 4). No significant differences were detected between male and female home range sizes.

WINTER FEEDING ECOLOGY OF COLUMBIAN SHARP-TAILED GROUSE IN SOUTHEASTERN IDAHO

JAMES W, SCHNEIDER, Department of Fish and Wildlife Resources, University of Idaho, Moscow, ID 83843
KERRY P. REESE, Department of Fish and Wildlife Resources, University of Idaho, Moscow, ID 83843
JOHN W. CONNELLY, Idaho Department of Fish and Game, 1345 Barton Road, Pocatello, ID 83204
JAMES H. KLOTT, Bureau of Land Management, Jarbidge Resources Area, 2620 Kimberly Road, Twin Falls, Id 83301

Abstract: Dependable and nutritious winter food sources are critical to the survival of all grouse, but no studies have specifically described Columbian sharp-tailed grouse (Tympanuchus phasianellus columbianus) winter feeding ecology. We studied winter food preferences, forage nutrient quality, selection or avoidance of specific elements within their chosen foods, food use differences between age and sex classes, potential winter internal morphological differences, and importance of grit during winter. Preliminary results of microhistologically analyzed fecal samples from 1992, a mild winter, indicated that in January (n = 7), forbs comprised 80%, grasses 17%, and shrubs only 3% of the sharptails diet, with alfalfa being the primary food at 35%. In February (n = 11), forbs comprised 39%, grasses 15%, and shrubs 46% of the diet. Rabbitbrush (Chrysothamnus spp.) was the major food item in February comprising 39% of the total monthly diet. These preliminary results are not consistent with what is currently known about Columbian sharp-tailed grouse winter diets.

HABITAT SUITABILITY INDEX PROCEDURE FOR COLUMBIAN SHARP-TAILED GROUSE

DARYL R. MEINTS, Idaho Department of Fish and Game, 1345 Barton Road, Pocatello, ID 83204

JOHN W. CONNELLY, Idaho Department of Fish and Game, 1345 Barton Road, Pocatello, ID 83204

THOMAS P. HEMKER, Idaho Department of Fish and Game, 1345 Barton Road, Pocatello, ID 83204

KERRY P. REESE, Department of Fish and Wildlife Resources, University of Idaho, Moscow, ID 83843

ALAN R. SANDS, Bureau of Land Management, Boise, ID 83706

Abstract: Columbian sharp-tailed grouse (Tympanuchus phasianellus columbianus) occupy <10% of their historic range. Because of recent increases in some sharp-tailed grouse populations, improved range condition, and the Conservation Reserve Program (CRP), interest in transplanting Columbian sharp-tailed grouse into historic range within Idaho and surrounding western states has increased. Unfortunately, a habitat suitability index (HSI) to systematically evaluate and rank potential release sites for Columbian sharptails is not available. After evaluating the HSI for plains sharp-tailed grouse (T.p. jamesi), we developed an index more applicable to Columbian sharptails. Four areas in southeastern Idaho were chosen to develop the procedure. The HSI is divided into 2 component, each representing a seasonal habitat of Columbian sharp-tailed grouse. Both winter food/cover habitat and nest/brood cover habitat were evaluated using the concept of percent equivalent optimum area. The equivalent optimum area concept assumes that a large area of low quality can have a habitat value equivalent to a smaller area of higher quality. Our HSI provides a systematic method to evaluate habitat quality for Columbian sharp-tailed grouse. It provides values compatible with the U.S. Fish and Wildlife Services' Habitat Evaluation Procedure (HEP). The HSI can also be used to estimate the amount of mitigation crediting a particular site may provide and be used by biologists without considerable experience in sharp-tailed grouse biology.

TEST OF A HABITAT SUITABILITY INDEX (HSI) MODEL FOR REINTRODUCED COLUMBIAN SHARP-TAILED GROUSE IN IDAHO

SCOTT C. GARDNER, Department of Fish and Wildlife Resources, University of Idaho, Moscow, ID 83843

JOHN W. CONNELLY, Idaho Department of Fish and Game, 1345 Barton Road, Pocatello, ID 83204

KERRY P. REESE, Department of Fish and Wildlife Resources, University of Idaho, Moscow, ID 83843

Abstract: A habitat suitability index (HSI) model for Columbian sharp-tailed grouse (Tympanuchus phasianellus columbianus) has recently been developed to systematically identify and rank potential release sites for reintroducing Columbian sharptails. HSI models are based on assumed relationships between a species and its habitat, but differences in habitat use between resident and reintroduced grouse may occur. Therefore, we tested the validity of these relationships with reintroduced birds. The standards of comparison used in testing the HSI model included survival, reproductive success, and habitat use. This research began with a pilot study during 1992 when 47 Columbian sharp-tailed grouse (28 males, 19 females) were trapped on leks in southeastern Idaho. Of these, 22 birds (17 females and 5 males) were fitted with radio transmitters and released at Langford Flat on the western edge of the Sawtooth National Forest. Throughout the season, 8 known mortalities were documented (5 < 1 km and 3 > 10 km from the release site). Eight birds were alive at the end of August and the other 6 were not found following release. Two radio-marked birds nested, but both were depredated early in incubation. As of 1 May 1993, an additional 20 grouse (12 males, 8 females) were fitted with radio transmitters and released < 1 km from the 1992 release site. A final release and field season is planned for 1994.

PRELIMINARY EVALUATION OF THE REINTRODUCTION OF COLUMBIAN SHARP-TAILED GROUSE IN OREGON

JEFFREY W. SNYDER, Department of Fisheries and Wildlife, Oregon State University, Corvallis, OR 97331

JOHN A. CRAWFORD, Department of Fisheries and Wildlife, Oregon State University, Corvallis, OR 97331

Abstract: Previous work on the distribution of Columbian sharp-tailed grouse (Tympanuchus columbianus phasianellus) revealed the subspecies declined to 10% of its former range and was extirpated from Oregon. Previous introduction attempts to restore them in Oregon were unsuccessful. Little or no information on habitat use, movements, and breeding behavior of translocated birds was available to assess the success of translocations. This study quantified habitat use, movements, mortality rates, breeding success, and a release technique currently advocated for upland game bird translocations. A total of 81 birds was translocated in 1991 (n = 33) and 1992 (n = 48). Preliminary results from 48 birds fitted with radio transmitters indicate wide dispersal from the release site during 1991 and 1992. A hen and a male moved 26 and 51 km, respectively. Post-release mortality rates (<3 weeks) were 33 and 32% in 1991 and 1992, respectively. No radio-marked birds were known to survive through either winter. During May 1992, a lek (12-16 birds) formed within ~100 m of the release site and remained active until the end of the month. Only 2 confirmed nesting attempts were documented. Translocated birds (n = 297 relocations) used bluebunch wheatgrass/Idaho fescue (Agropyron spicatum/Festuca idahoensis) (77%), grazed bluebunch wheatgrass/Idaho fescue (15%), and Conservation Reserve Program (CRP) land (8%), in 1991. During 1992, translocated birds (n = 259 relocations) used bluebunch wheatgrass/Idaho fescue (77%), grazed bluebunch wheatgrass/Idaho fescue (21%), and CRP land (2%). Preliminary results demonstrated wide dispersal, high mortality rates, and low breeding success among translocated birds.

CONSIDERATIONS FOR REINTRODUCTION OF SHARP-TAILED GROUSE IN COLORADO

KENNETH M. GIESEN, Colorado Division of Wildlife, Research Center, 317 W. Prospect Road, Fort Collins, CO 80526

CLAIT E. BRAUN, Colorado Division of Wildlife, Research Center, 317 W. Prospect Road, Fort Collins, CO 80526

Abstract: Two races of sharp-tailed grouse (Tympanuchus phasianellus columbianus, T. p. jamesi) are native to Colorado. Columbian sharp-tailed grouse historically occurred in suitable habitats in mountainous areas of western Colorado. Habitats of this race have become fragmented and populations greatly reduced, although it is still hunted in northwestern Colorado. Annual harvests are <2,000 birds. Plains sharp-tailed grouse occurred in eastern Colorado, primarily along the foothills of the Rocky Mountains and northeastern Colorado. The distribution of this race is greatly reduced and <100 birds are thought to still occur in 2 widely separated (>240 km) locations. It is classified as endangered in Colorado. Substantial interest exists to reintroduce both races of sharptails into suitable habitats within their historic range and a recovery plan has been prepared for the plains sharp-tailed grouse. Several potential sites for reintroduction of Columbian sharp-tailed grouse have been identified on public (U.S. Forest Service, BLM) and private lands in Dolores, Montezuma, Montrose, and Ouray counties. However, evaluation of seasonal habitat suitability on these sites has not been completed. Suitable habitats for reintroduction of the plains race are limited because of agricultural activities, urbanization, and politics associated with federal installations (Rocky Flats, Rocky Mountain Arsenal, Fort Carson), some of which are contaminated with toxins (Rocky Flats, Rocky Mountain Arsenal). Other potential reintroduction sites are privately owned (Larimer and Elbert counties) or already occupied by greater prairie-chickens (Tympanuchus cupido) (Weld and Yuma counties). Sites owned by the Colorado Division of Wildlife appear to be too small and/or require agreements with adjacent states (New Mexico). Provided agreements can be reached with land management agencies, reintroductions of plains sharp-tailed grouse could start in 1994 following procedures developed for transplanting greater prairie-chickens.

REGULATIONS AND HUNTING OF SHARP-TAILED GROUSE: IS THE FIT PROPER?

GERALD D. KOBRIGER, North Dakota Game and Fish Department, Route 1, Box 56, Dickinson, ND 58601

Abstract: Conflicting data have been reported in the literature regarding effects of length of hunting seasons on upland game populations. Most authors have used age ratio data collected throughout the hunting season to support or reject the hypothesis that length of hunting seasons can have an effect on resident upland game populations. No published reports could be located which analyzed wing data to support or reject this theory for sharp-tailed grouse (Tympanuchus phasianellus), prairie-chickens (T. cupido, T. pallidicintus) or sage grouse (Centrocercus urophasianus). Data from North Dakota indicate declining age ratios during lengthy hunting seasons for sharp-tailed grouse and ring-necked pheasants (Phasianus colchicus), but not for gray partridge (Perdix perdix). The declining age ratio for sharptails was related to spring census data to further review the effect of season length.

ABSTRACTS

SAGE GROUSE

DIET AND NUTRITION OF FEMALE SAGE GROUSE DURING THE PRE-LAYING PERIOD IN OREGON

JENNY K. BARNETT, Bureau of Land Management, 100 Oregon Street, Vale, OR 97918

JOHN A. CRAWFORD, Department of Fisheries and Wildlife, Oregon State University, Corvallis, OR 97331

Abstract: Reduced productivity was associated with decline of sage grouse (Centrocercus urophasianus) populations in Oregon since the 1940s. Reproductive success of other tetraonids has been related to diet and nutrition, but little information is available on spring diet and nutrition of female sage grouse. We studied the diet, dietary selection, and nutritional composition of foods of sage grouse hens during the pre-laying period in southeastern Oregon during 1990 and 1991. We collected 42 female sage grouse during a 5-week period preceding incubation (4 Mar-8 Apr). Sagebrush (Artemisia spp.) was the most common of 21 foods consumed but forbs composed 18 to 50% of the diet by mass. Desert parsley (Lomatium spp.), hawksbeard (Crepis spp.), long-leaf phlox (Phlox longifolia), everlasting (Antennaria spp.), mountain-dandelion (Agoseris spp.), clover (Trifolium spp.), Pursh's milk-vetch (Astragalus purshii), buckwheat (Eriogonum spp.), and obscure milk-vetch (A.obscurus) were the primary (≥1% of the diet by mass) forbs consumed. Forbs were used selectively over sagebrush in both low (A. arbuscula) and big sagebrush (A. tridentata) cover types. All forbs were higher in crude protein and phosphorus and many were higher in calcium than sagebrush. Substantially more sagebrush was present in the diet in 1991 than in 1990, which coincided with reduced sage grouse productivity on the study area. These results suggest that reproductive success may be related to diet and nutrient intake, especially forbs, of female sage grouse during the pre-laying period.

SAGE GROUSE NESTING HABITATS IN SOUTHCENTRAL WASHINGTON

COLIN M. SVEUM, Department of Fisheries and Wildlife, Oregon State University, Corvallis, OR 97331
JOHN A. CRAWFORD, Department of Fisheries and Wildlife, Oregon State University, Corvallis, OR 97331
W. DANIEL EDGE, Department of Fisheries and Wildlife, Oregon State University, Corvallis, OR 97331
LARRY L. CADWELL, Department of Environmental Sciences, Pacific Northwest Laboratory, Richland, WA 99352

Abstract: Sage grouse (Centrocercus urophasianus) populations in western states have declined because of habitat change and land use practices. The largest remaining contiguous habitat in Washington that still supports sage grouse is on the Yakima Training Center, a U.S. Department of the Army installation. This study was initiated in spring 1992 to identify use and selection of cover types for nesting, to learn if habitat characteristics at nests differed from random sites within the same cover types, and whether differences existed between successful and unsuccessful nests of sage grouse. We measured vegetation characteristics at nest sites and random locations within cover types grouse used for nesting. Nesting success was 30% in 1992 and 45% in 1993. Hen success was 41% in 1992 and 58% in 1993. Vegetation was measured at 33 nests in 1992 and 50 nests in 1993. The cover types where most nests were found were Wyoming big sagebrush/bluebunch wheatgrass (Artemisia tridentata wyomingensis/Agropyron spicatum) and degraded (areas subject to mechanical disturbance or fire in the past 5 years) Wyoming big sagebrush/bluebunch wheatgrass. Preliminary data evaluation indicated that hens selected nest sites with greater medium (40-80 cm) or tall (80 cm) shrub cover or dead standing cover than available at random locations. Comparisons between successful and unsuccessful nests from 1992 indicated successful nests tended to have greater forb cover, tall grass (≥18 cm), medium shrub, and dead standing cover. Only dead standing cover however, was significantly greater at successful nests.

NESTING-AREA FIDELITY OF SAGE GROUSE IN SOUTHEASTERN IDAHO

RICHARD A. FISCHER, Department of Fish and Wildlife Resources, University of Idaho, Moscow, ID 83843
ANTHONY D. APA, Department of Fish and Wildlife Resources, University of Idaho, Moscow, ID 83843
WAYNE L. WAKKINEN, Department of Fish and Wildlife Resources, University of Idaho, Moscow, ID 83843
KERRY P. REESE, Department of Fish and Wildlife Resources, University of Idaho, Moscow, ID 83843
JOHN W. CONNELLY, Idaho Department of Fish and Game, 1345 Barton Road, Pocatello, ID 83204

Abstract: From 1986 to 1992, we used radiotelemetry to study fidelity of nesting sage grouse (Centrocerus urophasianus) from 2 migratory populations in southeastern Idaho. We monitored 242 female sage grouse during 7 consecutive nesting seasons. Eighteen hens were located on nests (n = 40) in consecutive years. Sage grouse hens showed strong fidelity, relative to their annual range, to specific nesting areas surrounding the lek closest to the nest. No differences (U = 73, P = 0.35) were detected in distances moved by successful vs. unsuccessful females between nest sites in consecutive years (726 ± 170 m [$\bar{x}$ ± S.E.], n = 13 vs. 1026 ± 248 m, n = 9). Nest locations in consecutive years may reflect a strategy to remain within a familiar nesting area, while avoiding previous nests and areas where predators may be more likely to search.

INFLUENCE OF GRASS COVER ON FATE OF ARTIFICIAL SAGE GROUSE NESTS

ANITA KANG DELONG, Department of Fisheries and Wildlife, Oregon State University, Corvallis, OR 97331

JOHN A. CRAWFORD, Department of Fisheries and Wildlife, Oregon State University, Corvallis, OR 97331

Abstract: We experimentally tested the hypothesis that grass cover influences that fate of sage grouse (Centrocerus urophasianus) nests. We placed 330 artificial nests on Hart Mountain National Antelope Refuge in southeastern Oregon, from April through June 1991 and 1992. Nests were apportioned into tall (nest shrub >40 cm, primarily Artemisia tridentata vaseyana) and short shrub cover types (nest shrub ≤40 cm, primarily A. arbuscula) in areas used by sage grouse for nesting. Within each shrub height class, nests were placed in sparse or dense tall (≥15 cm) grass cover. Sparse grass averaged 3% in both shrub cover types. Dense grass averaged 31% cover for nests in tall shrubs and 22% for nests in short shrubs. For nests placed under tall shrubs, tall grass cover was associated with nest fate. Proportionally fewer (P = 0.006) nests in dense grass cover were depredated than in sparse grass cover, 56 and 74%, respectively. In short shrub cover, no difference (P = 0.5) in nest predation was detected between nests placed in sparse and dense grass cover, 71 and 80%, respectively. These results provide supportive evidence for the hypothesis that availability of tall, dense grass cover at nest sites in tall shrub cover reduced the likelihood that sage grouse nests would be depredated.

RENESTING BY SAGE GROUSE IN SOUTHEASTERN IDAHO

JOHN W. CONNELLY, Idaho Department of Fish and Game, 1345 Barton Road, Pocatello, ID 83221

RICHARD A. FISCHER, Department of Fish and Wildlife Resources, University of Idaho, Moscow, ID 83843

KERRY P. REESE, Department of Fish and Wildlife Resources, University of Idaho, Moscow, ID 83843

ANTHONY D. APA, Idaho Department of Fish and Game, 868 East Main Street, Jerome, ID 83338

WAYNE L. WAKKINEN, Idaho Department of Fish and Game, HCR 85, Box 323J, Bonners Ferry, ID 83805

Abstract: We documented renesting rates of sage grouse (Centrocercus urophasianus) in southeastern Idaho and compared nesting and renesting rates between yearling and adult age classes. Overall, 69% of the hens (n = 242) initiated nests. Nesting effort by adults was greater (P = 0.001) than that of yearlings. Nest success between age classes was similar (P = 0.95) and we could not detect a difference (P = 0.65) in renesting rates between age classes. Our findings suggest that a relatively large number of female sage grouse either fail to nest or terminate their nesting effort early in the nesting period. Contrary to some previous work, we also documented a low renesting rate (≤ 15%) for this species. We suggest that low renesting rates may be a function of this species' relatively xeric environment and the relatively limited time in which suitable food is available for broods.

RELATIONSHIP OF HERBACEOUS VEGETATION TO REPRODUCTIVE SUCCESS OF SAGE GROUSE

JOHN A. CRAWFORD, Department of Fisheries and Wildlife, Oregon State University, Corvallis, OR 97331

Abstract: Sage grouse (Centrocerus urophasianus) and sagebrush (Artemisia spp.), which is used to varying extents throughout the year for food and cover, are so closely associated that the value of other habitat components to the reproductive success of these birds has received little attention. Early work provided anecdotal information about use of herbaceous cover in conjunction with sagebrush for nesting and established the importance of forbs in the summer diet of sage grouse, especially chicks. Recent work in several western states, including Idaho, Oregon, and Washington has revealed a wider role of herbaceous vegetation during the reproductive period than previously appreciated. Forbs, especially milkvetch (Astragalus spp.), hawksbeard (Crepis spp.), desert parsley (Lomatium spp.), and clover (Trifolium spp.) provide a diet rich in protein and minerals for hens during pre-laying, influence habitat use by hens, and are consumed by chicks during the 3-month period after hatching. Availability of forbs may influence nesting success and recruitment of chicks into the fall population. Several studies revealed the importance of tall (> 18 cm), residual herbaceous cover in concert with sagebrush to nesting success of sage grouse. Most herbaceous cover is composed of bunchgrasses, such as fescue (Festuca spp.), wheatgrass (Agropyron spp.), and wildrye (Elymus spp.). These research efforts elucidated the contribution of herbaceous vegetation for food and cover from pre-laying through late brood rearing. In some areas of the western portion of sage grouse range, shrub densities impede the production of herbaceous vegetation and land-use practices preclude development of mid to late seral grasses and forbs and residual herbaceous cover. In many instances, sagebrush availability likely is not limiting the productivity, abundance, or distribution of sage grouse; rather, it is the availability of herbaceous food and cover in these sagebrush stands that most influence sage grouse. Research is needed to develop means of rehabilitating degraded sagebrush stands to achieve a more favorable balance of grass, forb, and shrub components.

REPRODUCTIVE BEHAVIOR OF GUNNISON SAGE GROUSE: DO MATING BARRIERS EXIST?

JESSICA R. YOUNG, Department of Biological Sciences, Purdue University, West Lafayette, IN 47907

Abstract: Reproductive behaviors of male sage grouse (Centrocerus urophasianus) in an isolated montane basin near Gunnison, Colorado are strikingly different from those reported from northern and northwestern populations. Male sage grouse in the Gunnison Basin have an unique vocalization which they give at a slower rate. Feather morphology and use of those feathers also differs. Previous studies of sage grouse in other populations indicate that both rapid display rate and some acoustical aspects of the mating display influence male mating success. Recent studies suggest that sexual selection may underlie divergence of secondary sexual characteristics and lead to speciation. To determine whether divergence in Gunnison male mating displays constitutes a mating barrier among populations, I conducted playback experiments in Gunnison County during spring 1992 and Moffat County, Colorado during spring 1993. Mating vocalizations from northern and Gunnison males were broadcast to identify the effect of both vocalization types on female and male behavior. Initial results suggest that behavioral mating barriers do exist between the Gunnison and north/northwestern populations.

MOVEMENT AND HABITAT USE OF SAGE GROUSE IN A FRAGMENTED LANDSCAPE

MICHAEL A. SCHROEDER, Washington Department of Wildlife, P.O. Box 1077, Bridgeport, WA 98813

Abstract: Sage grouse (Centrocerus urophasianus) were historically found throughout most of the sagebrush (Artemisia spp.)/grassland habitat of central, southern, and eastern Washington. However, large-scale degradation and removal of habitat by a variety of agricultural practices has resulted in the statewide reduction of sage grouse. Remaining populations appear to be restricted to relatively small and isolated patches of habitat, primarily in Kittitas, Yakima, and Douglas counties. In 1992 and 1993 radio transmitters were fitted to 14 male and 39 female sage grouse captured on leks near Mansfield in Douglas County, Washington. Radiotelemetry was used to examine patterns of movement and habitat use from February 1992 through July 1993. Females nested an average of 6.2 km from the lek where they were captured. Most nests (81%) were in relatively thick sagebrush/grass cover, often in remnant areas of shrub-steppe habitat bordered by wheat or Conservation Reserve Program (CRP) grasslands. Leks were either in wheat (67%) or CRP (22%). Males typically moved to remnant areas of shrub-steppe habitat following the breeding season. Distances between breeding and wintering locations averaged 16.7 km for females and 11.0 km for males. Although breeding locations frequently were dominated by either threetip sagebrush (Artemisia tripartita) or big sagebrush (A. tridentata), virtually all wintering locations were in areas dominated by big sagebrush. In the future, Geographical Information Systems will be used to evaluate the relationships between sage grouse and habitat.

THE STATUS OF SAGE GROUSE: ARE THEY ENDANGERED, THREATENED, OR?

CLAIT E. BRAUN, Colorado Division of Wildlife, Research Center, 317 W. Prospect Road, Fort Collins, CO 80526

Abstract: Sage grouse (Centrocercus urophasianus) historically occurred in at least 14 states and 3 provinces in western North America. Populations currently exist in 11 states and 2 provinces and have been extirpated from Arizona (?), British Columbia, Kansas (?), Nebraska, New Mexico, and Oklahoma. Populations elsewhere have been greatly reduced and those remaining in Alberta, North Dakota, Saskatchewan, and South Dakota are probably marginal. The same may be true for populations in California, Colorado, Utah, and Washington. Secure populations (statewide) occur in Idaho, Montana, Nevada, Oregon, and Wyoming although extinction of small populations within these states has undoubtedly occurred. Further complicating population management is the unknown taxonomic status of the species. Two subspecies (C. u. phaios, C. u. urophasianus) have been described and a 3rd (C. u. gunnisoni) is proposed. The latter subspecies is known from southern Colorado and Utah. It is hypothesized to have also occurred into Arizona (?), Kansas (?), New Mexico, and Oklahoma. While taxonomic and behavioral studies of sage grouse are urgently needed before other populations become extirpated, prompt consideration should be given to providing this species and its habitats further protection throughout its range.

IS NESTING SUCCESS OF SAGE GROUSE RELATED TO CHARACTERISTICS OF HABITAT IN NORTHCENTRAL WASHINGTON?

MICHAEL A. SCHROEDER, Washington Department of Wildlife, P.O. Box 1077, Bridgeport, WA 98813

LESLIE A. ROBB, P.O. Box 1077, Bridgeport, WA 98813

Abstract: Sage grouse (Centrocerus urophasianus) were studied in 1992 and 1993 in northcentral Washington. The study area was dominated by 4 basic habitats; big sagebrush (Artemisia tridentata), threetip sagebrush (A. tripartita), Conservation Reserve Program (CRP), and wheat. Walk-in traps were used to capture sage grouse on leks near Mansfield in Douglas County. Nest locations were determined with the aid of radio transmitters fitted to 39 females. Habitat type and specific habitat variables were examined at all known nest sites. Most nests (81%) were in areas dominated by threetip or big sagebrush, despite the prevalence of CRP and wheat on the study area. Although previous research on nesting habitat has supported the importance of sagebrush, the relationship between nesting success and habitat was difficult to characterize in this study.

SAGE GROUSE NEST SITE CHARACTERISTICS AND MICROCLIMATES ON GRAZED LANDS IN WYOMING.

D. R. WEBB, Department of Zoology and Physiology, University of Wyoming, Laramie, WY 82071

Abstract: I studied 15 nests of sage grouse (Centrocercus urophasianus) at 2 sites in Wyoming to learn whether hens select for particular nesting habitat characteristics. I evaluated visual cover from aerial and ground predators, shelter from wind and solar radiation as well as habitat variables such as height and density of sagebrush (Artemisia spp.) bushes. I also developed new methods of vegetation assessment which should prove less time consuming that previous methods. Wind speeds differed little between nest and non-nest bushes which may reflect the lack of any bushes with wind sheltering in this grazed habitat. Nesting grouse selected for shading from solar radiation, particularly during the hottest parts of the day. Overhanging sagebrush limbs and leaves provided shade from strong solar radiation present in these habitats. Grouse selected for nest sites with high amounts of cover from both aerial and ground predators. The sagebrush bush provided visual concealment from aerial predators. Selection for aerial cover may be independent from selection for radiative shading. Visual concealment from ground predators was affected by forbs and grasses in the vicinity of the nest bush and differed strongly between nest and non-nest sites. Removal of understory forbs and grasses by cattle grazing affects visual concealment from ground predators and sheltering from wind.

ABSTRACTS

ATTWATER'S PRAIRIE-CHICKEN

ATTWATER'S PRAIRIE-CHICKEN - A STATUS AND RECOVERY UPDATE

STEPHEN E. LABUDA, JR., Attwater Prairie Chicken National Wildlife Refuge, P.O. Box 519, Eagle Lake, TX 77434

MICHAEL E. MORROW, Attwater Prairie Chicken National Wildlife Refuge, P.O. box 519, Eagle Lake, TX 77434

Abstract: Population estimates of Attwater's prairie-chicken (Tympanuchus cupido attwateri) declined from a rangewide total of 1,620 to 444 in 1984 and 1993, respectively. Individuals are currently distributed among 3 widely separated populations. This rapid decline reflects extreme meteorological conditions ranging from drought to flood conditions, and continued loss and fragmentation of remaining prairie habitats. These factors are potentially impacting populations indirectly through inbreeding, disease, predation, and demographic anomalies. Research currently underway will elucidate the relative importance of these indirect factors. Recovery efforts are focused on 5 major strategies: (1) habitat management, (2) public outreach, (3) coordination, (4) population management, and (5) research. Limited progress has been made in habitat management, primarily through private lands work of the Texas Parks and Wildlife Department. Public outreach efforts have increased due to activities of the newly created Gulf Coastal Prairies Foundation and others. Coordination, which amounts to a concerted effort to increase communication among recovery participants, has identified obstacles to long-term recovery efforts. Potential solutions to these obstacles, most involving the political arena, have been proposed by various groups. Significant progress has been made in population management, particularly with the captive propagation program. Research underway is focused on analysis of limiting factors, genetics, disease, and rangewide habitat assessment. Much progress has been made in developing a recovery infrastructure, but much remains to be done. Impediments to removing Attwater's prairie-chicken from the brink of extinction include its extremely low numbers, lack of remaining habitat, time, and lack of recognition and prioritization by agencies, environmentalists, and the public.

ABSTRACTS

GREATER PRAIRIE-CHICKEN

ANNUAL NEST SUCCESS OF GREATER-PRAIRIE CHICKENS RELATIVE TO GRASSLAND STRUCTURE AND LANDSCAPE PATTERNS IN SOUTHWESTERN MISSOURI.

GWYN MCKEE, School of Natural Resources, 112 Stephens Hall, University of Missouri, Columbia, MO 65211

MARK R. RYAN, School of Natural Resources, 112 Stephens Hall, University of Missouri, Columbia, MO 65211

LARRY M. MECHLIN, Missouri Department of Conservation, 1110 S. College Avenue, Columbia, MO 65201

Abstract: Greater prairie-chicken (Tympanuchus cupido) populations have declined in Missouri as a result of large-scale changes in the landscape and consequent loss of native prairies. The Missouri Department of Conservation's Species Management Plan focuses on greater prairie-chicken restoration through intensive management of grasslands. Yet, the specific grassland management techniques best suited to stabilize and increase prairie-chicken populations in Missouri have not been identified. A major component of population dynamics is reproduction. One objective of our 3-year study was to quantify reproductive success of greater prairie-chickens as it relates to habitat characteristics that result from a management rotation system consisting of burning, grazing, haying, and resting on 2 Missouri prairies. Chi-square and Z-test analyses showed differences ($P = 0.05$) in nest success for 1990 and 1991 within one area and between both study areas. Nest success did not differ ($P = 0.05$) between 1991 and 1992 within or between either study area. These data will be compared to different vegetative and landscape parameters to identify possible correlations between nest success and habitat features resulting from different prairie management strategies.

A TOOL FOR HERBICIDE APPLICATION FOR CONTROL OF WOODY VEGETATION IN GRASSLANDS

JAMES R. KEIR, Wisconsin Department of Natural Resources, P.O. Box 100, Friendship, WI 53934

Abstract: Control of woody plant invasion into grasslands has been a management priority since inception of the effort to maintain suitable habitat for Wisconsin's remnant greater prairie-chicken (Tympanuchus cupido pinnatus) population. Previously, large areas have been treated with broadleaf herbicides, both aerially and by ground application. In summer 1991 and 1992, and in March 1993, a tractor-mounted wick applicator was used to apply herbicide for control of aspen (Populus tremuloides) and willow (Salix spp.) within grasslands. The height of application was adjusted to target vegetation by raising or lowering the wick during application. Grasses and forbs below the woody vegetation were avoided. Results from summer treatments (with Roundup) have been positive and evaluation is pending for the dormant season (Mar) application (with Garlon 4). This tool provides a method for spot treatment of woody vegetation to prevent the development of larger proble areas requiring broad scale herbicide application. Non-selecti herbicides, such as Roundup, can be applied selectively to targ vegetation.

RELATIONSHIP OF RANGE CONDITION TO GREATER PRAIRIE-CHICKEN ABUNDANCE AND USE OF TALLGRASS PRAIRIE IN EASTERN KANSAS

THOMAS A. EDDY, Division of Biological Sciences, Emporia State University, Emporia, KS 66801

Abstract: Range condition may have a major role in habitat selection by greater prairie-chicken (Tympanuchus cupido) and, thus, be a determining factor in their abundance and distribution. Between 1 September 1991 and 1 June 1993, prairies in 5 counties in the Flint Hills region of east-central Kansas were searched using a section-grid. Sixty-three observations of greater prairie-chicken activity were documented on 31 sites. Vegetation condition and soil stability condition were determined on each site by the Wilk step-loop scorecard method. All fall and spring lek sites were rated in poor range condition. Eighty percent of nesting sites and 85% of loafing and roosting sites were rated in fair condition. Ninety-two percent of brood rearing sites were rated in good condition while 70% of winter and summer feeding sites were rated in good condition. Agricultural cropland and domestic grass pastures were not evaluated. Range management practices and variation in range sites in the study area have produced an interspersion of range conditions that support the essential habitat needs of the greater prairie-chicken.

TRENDS AND PREDICTIONS FOR GREATER PRAIRIE-CHICKEN POPULATIONS I KANSAS

KEVIN E. CHURCH, Kansas Department of Wildlife and Parks, Wildlife Research Office, P.O. Box 1525, Emporia, KS 66801
DAVID A. HAUKOS, U.S. Fish and Wildlife Service, Department of Range and Wildlife Management, Texas Tech University, Lubbock, TX 79409

Abstract: In North America, 10-year cycles are most pronounced in northern populations of territorial species of grouse occupying large continuous blocks of habitat. In contrast, data are lacking which convincingly demonstrate cyclic tendencies among lekking species of grouse in fragmented habitats at southern latitudes. We used time-series analyses of lek count data to examine population trends (1963-92) and predict relative abundance for 4 subpopulations of greater prairie-chicken (Tympanuchus cupido) in Kansas. Results indicated a short-memor (i.e., no obvious long-term trends) and a weak 16-year cycle in subpopulations and the rangewide population. Using data from 1963 to 1990, we successfully predicted the observed size of all subpopulations and the rangewide population for 1991 (X^2 = 0.83, P = 0.94) and 1992 (X^2 = 0.33, P = 0.99). However, each estimate required a different model for prediction. Although our data ar for a relatively long period (30 years), they are nonetheless minimal for time-series analysis of a 16-year cycle. Therefore, additional observations (years) are needed to learn if our conclusions are valid. Likewise, we recommend predicting only 1 year ahead for the most reliable forecast.

SURVIVAL, MOVEMENTS, HABITAT USE, AND REPRODUCTION OF GREATER PRAIRIE-CHICKENS TRANSLOCATED FROM MINNESOTA TO ILLINOIS: PHASE I

RONALD L. WESTEMEIER, Illinois Natural History Survey, Effingham, IL 62401
CORY S. RUBIN, University of Illinois, Champaign, IL 61820
TERRY L. ESKER, Illinois Department of Conservation, Effingham, IL 62401
SCOTT A. SIMPSON, Illinois Department of Conservation, Yale, IL 62481

Abstract: Some evidence suggests that inbreeding depression may be suppressing recovery of greater prairie-chickens (Tympanuchus cupido) in Jasper County, Illinois. About 50 individuals in 3 populations (cock count = 28) remained in 3 counties in spring 1993. Translocation is a common practice in wildlife management to bolster declining populations. Thus, in mid-August 1992, 15 radio-marked female prairie-chickens were translocated via air-conditioned vehicles 1,440 km from Minnesota and released in sanctuary grasslands in Illinois. This preliminary evaluation of over 2,100 locations (still growing) documents survival, movements, habitat use, and reproduction. Survival for the first 7 months from release through winter was high (67%). Only 2 of the 15 Minnesota hens were known to have moved more than 3.2 km from release through winter; mixing with Illinois birds was frequently observed. However, a mass exodus from the sanctuary area occurred in late March apparently involving all Minnesota hens; 3 hens were found alive 10-61 km from the release site. By 16 April, 4 hens returned and eventually nested in sanctuary grasslands. During the 40-day orientation period following release, habitat use involved wheat stubble double cropped with soybeans 60-64% of night and day locations, respectively. Use of agricultural habitats peaked in winter with 90% of daytime locations, 71% of which involved corn stubble. Sanctuary grasslands were used about 60% of the time for night roosting from release through winter. As expected, all 4 nesting hens increasingly focused on sanctuary grasslands day and night during their prelaying, egg laying, incubation, and early brooding periods. Three clutches contained 16, 17, and 18 eggs; fertility of 33 eggs was 97%; and in 1 successful nest all 17 eggs hatched. Only 2 chicks were observed with the successful hen 2 weeks after hatching. The tendency to disperse enmasse in late March may be the greatest obstacle to genetic and demographic enhancement of greater prairie-chickens in Illinois via translocations. Other factors such as brood survival and inadequate sanctuary habitat should also be considered.

REINTRODUCTION OF GREATER PRAIRIE-CHICKENS IN NORTHEASTERN COLORADO

GRANT M. BEAUPREZ, Department of Biological Sciences, University of Northern Colorado, Greeley, CO 80639
JENNIFER A. CLARKE, Department of Biological Sciences, University of Northern Colorado, Greeley, Co 80639
CLAIT E. BRAUN, Colorado Division of Wildlife, Research Center, 317 W. Prospect Road, Fort Collins, CO 80526

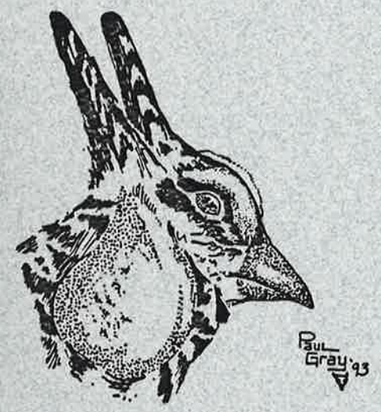
Abstract: Greater prairie-chickens (Tympanuchus cupido) ranged over much of northeastern Colorado in the early 1900's, however, with intensified farming, overgrazing, and drought, their distribution markedly decreased. They were classified as endangered by the Colorado Division of Wildlife in 1973. The goals of this study were to: (1) successfully transplant greater prairie-chickens to 2 sites in northeastern Colorado, (2) evaluate their success in establishing breeding populations, and (3) improve guidelines for introduction of greater prairie-chickens into new or previously occupied habitats. In 1991, 43 birds (23 females, 20 males) were released near Pinneo in Washington County, and 50 (23 females, 27 males) were released near Barnesville in Weld County. In 1992, 41 birds (22 females, 19 males) were released near Pinneo, and 50 (27 females, 23 males) were released near Barnesville. Six males and 6 females were radiomarked at each site in each year and were relocated using radiotelemetry 1-2 times per week for approximately 12 months. Prairie-chickens at Pinneo established 9 leks and 6 hens had successful nests while birds at Barnesville established 5 leks and 2 hens had successful nests. Recruitment of juveniles was documented at Pinneo while no recruitment was documented at Barnesville. Mortality was 38% at Pinneo and 44% at Barnesville, and mean dispersal distance of birds was 6.6 km at Pinneo and 15.0 km at Barnesville. Preliminary data indicate the Pinneo releases were more successful in establishing a population of greater prairie-chickens than the releases near Barnesville. Our observations indicate that (a) the difference between the birds' native habitat and habitat at the transplant site, and (b) length of time that birds are held in captivity prior to release may be the primary factors influencing success of these reintroductions. If the transplants are successful in establishing self-sustaining populations, greater prairie-chickens may be delisted from endangered status in Colorado.

GENETIC VARIATION AMONG POPULATIONS OF GREATER PRAIRIE-CHICKENS IN KANSAS

DARIN R. PORTER, Emporia State University, RR 3, Box 354, Independence, KS 67301
DWIGHT MOORE, Emporia State University, Emporia, KS 66801
KEVIN CHURCH, Kansas Department of Wildlife and Parks, Box 1525, Emporia, KS 66801

Abstract: In Kansas, greater prairie-chickens (Tympanuchus cupido), are most abundant in the Flint Hills of east-central Kansas, with smaller populations in the southeastern corner of the state. Populations from these 2 areas are now relatively isolated from each other due to destruction of intervening suitable habitat. This study examined the extent of genetic divergence within and among populations of greater prairie-chickens from these 2 regions. Starch-gel electrophoresis was used to examine genetic variation at 22 presumptive loci. Mean levels of heterozygosity ranged from 0.008 to 0.045. A phenetic summary of the genetic similarity values among populations indicated that those close geographically were most similar genetically. However, all populations clustered above 0.98 similarity which indicated that all were similar genetically. F statistics indicated that 95% of the total genetic diversity was attributable to differences among individual birds. Based on these analyses, none of the populations exhibited significant divergence between the 2 areas in Kansas. Management of greater prairie-chickens in Kansas should not be concerned with genetic resources, unless population numbers were to decline drastically.

GREATER PRAIRIE-CHICKEN REINTRODUCTION SITE FIELD TRIP



1ST JOINT MEETING

18TH WESTERN STATES
SAGE AND COLUMBIAN SHARP-TAILED GROUSE WORKSHOP

AND

20TH PRAIRIE GROUSE
TECHNICAL COUNCIL CONFERENCE

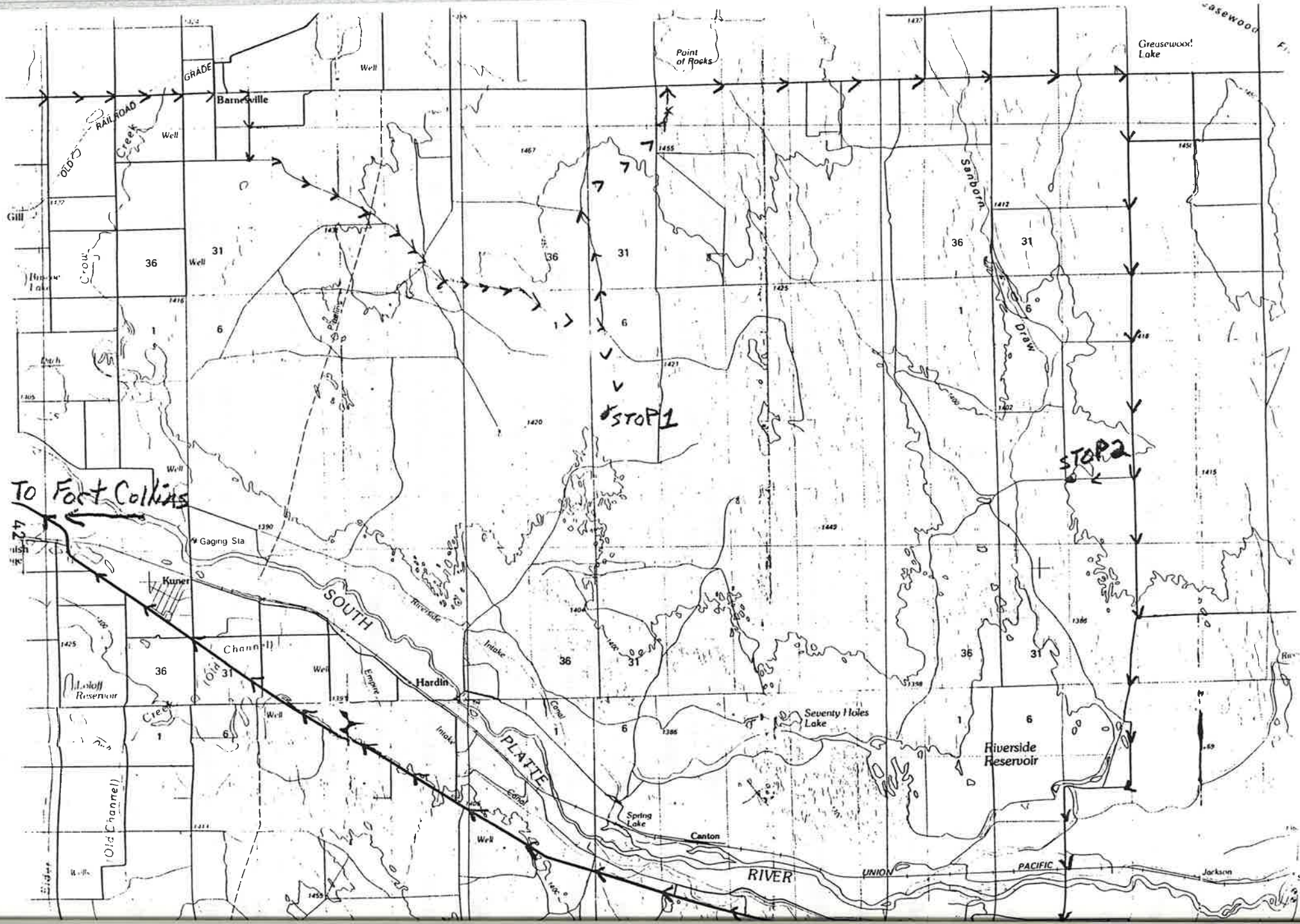
Fort Collins, Colorado
26-28 July 1993

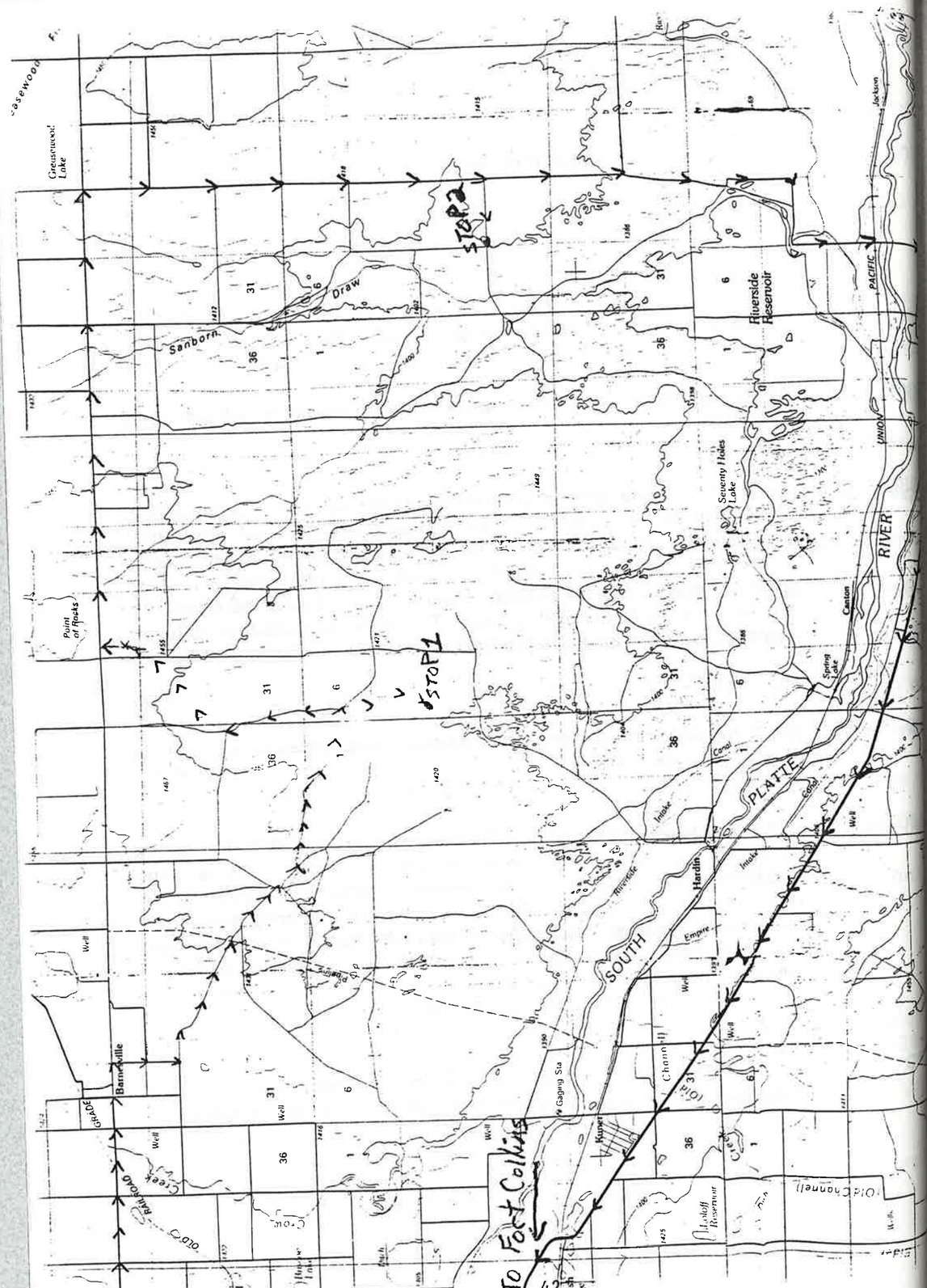
HISTORY OF GREATER PRAIRIE-CHICKENS IN COLORADO

Greater prairie-chickens (Tympanuchus cupido) historically did not occur in Colorado. With settlement and grain farming, they moved into Colorado in the late 1890's and ranged over much of northeastern Colorado in the early 1900's. However, with intensified farming, overgrazing, and drought, their distribution markedly decreased. They were classified as endangered by the Colorado Division of Wildlife in 1973. The most current published population estimates (1981-1983) indicate that at least 3000 and possibly 6000 birds were present in Yuma, Washington, and Phillips counties (VanSant and Braun 1990).

The Colorado Division of Wildlife's greater prairie-chicken recovery plan (Pusateri 1990) calls for the removal of the greater prairie-chicken from the state's endangered and threatened list by 1995. Attainment of this goal involves increasing the greater prairie-chicken's distribution in the state by means of transplanting birds into previously occupied and unoccupied range. A transplant was conducted in 1984-85 at the Tamarack State Wildlife Area northeast of Sterling, Colorado. Leks were established (15 between 1984 and 1991) and reproduction and recruitment were documented (Hoffman et al. 1992).

In 1991, 50 (23 females, 27 males) birds were released near Barnesville, Colorado, and in 1992 another 50 (27 females, 23 males) were released. In 1993 a supplemental transplant of 21 females and 20 males was conducted approximately 11.5 km southeast of the original release area near Masters, Colorado.


To Fort Collins
STOP 1
STOP 2
Barnesville
Point of Rocks
Greasewood Lake
Gill
Crow Creek
OLD RAILROAD GRADE
Sanborn Draw
Gaging Sta
Kuner
SOUTH PLATTE RIVER
Old Channel
Hardin
Empire Canal
Intake
Riverside Canal
Loloff Reservoir
Seventy Holes Lake
Riverside Reservoir
Spring Lake
Canton
UNION PACIFIC
Jackson
Well
36
31
1
6



NORTH PARK

SAGE GROUSE TOUR

1st JOINT MEETING
18TH WESTERN STATES SAGE AND COLUMBIAN SHARP-TAILED GROUSE WORKSHOP
AND
20TH PRAIRIE GROUSE TECHNICAL COUNCIL MEETING

28 July 1993

NORTH PARK SAGE GROUSE TOUR ITINERARY

Wednesday, 28 July 1993

0700	Meet at University Park Holiday Inn (east side) to load bus and vans for North Park sage grouse tour.
0715-0930	Travel to North Park via Laramie, Wyoming.
0930-1120	Tour of North Park sage grouse study areas.
1120-1200	LUNCH (provided).
1200-1430	Return trip to Fort Collins.

OVERVIEW: North Park in Jackson County is a high elevation basin (2,370-2,750 m) surrounded on all sides by mountains up to 3,660 m. About 2,100 km^2 of sagebrush rangeland and hay meadows are used seasonally by sage grouse. The average frost free season is 65 days. Annual precipitation in Walden averages 25 cm and increases to >100 cm at higher elevations in the surrounding mountains. Approximately 70% of the precipitation falls as snow, with Walden receiving an average of 135 cm/year.

Before settlement by white man, the Ute Indians summered in North Park, calling it Bull Pen or Cow Lodge because of its geographical features and the great number of bison found there. Fur trappers began exploring the area in the 1820's and named it New Park to distinguish it from Middle Park to the south. In the 1870's the area experienced a short-lived gold and silver rush. During this time cattlemen from Wyoming also began using the area as summer range for livestock, but abandoned the area during winter because of harsh winters and lack of forage above snow. In the 1880's ranchers began settling in North Park and wintering livestock there. After a severe winter in 1887, ranchers began cutting hay for winter livestock food and began clearing sagebrush and digging irrigation ditches to water hay meadows. Ultimately, nearly 20% of the Park floor was cleared of sagebrush and brought under irrigation. Much of North Park is underlaid with fossil fuels and coal mining for local use began in the late 1800's. In 1926 oil drilling began and North Park now has 3 producing oil fields and 1 natural gas field. The other major industry in Jackson County is lumbering, with much of the timber being shipped out of the area. Because of the extensive wildlife resources in the area, hunting, fishing, camping, and other recreation have a significant impact on the local economy of Jackson County.

The population of Jackson County exceeded 2,000 during the late 1880's silver boom. The population has since declined and about 1,600 people now live in Jackson County, with about half residing in Walden.

The Colorado Game, Fish, and Parks Department began surveys of sage grouse in North Park in 1939. Intensive studies of sage grouse biology, habitat, and populations began in 1963, initially in response to proposed herbicide spraying of sagebrush, and were conducted in cooperation with a series of graduate students. Winter ecology, lek attendance patterns, nutrition and energetics, population demography, and the effects of hunting have been investigated. A total of 612 males was counted on 26 strutting grounds in 1993.

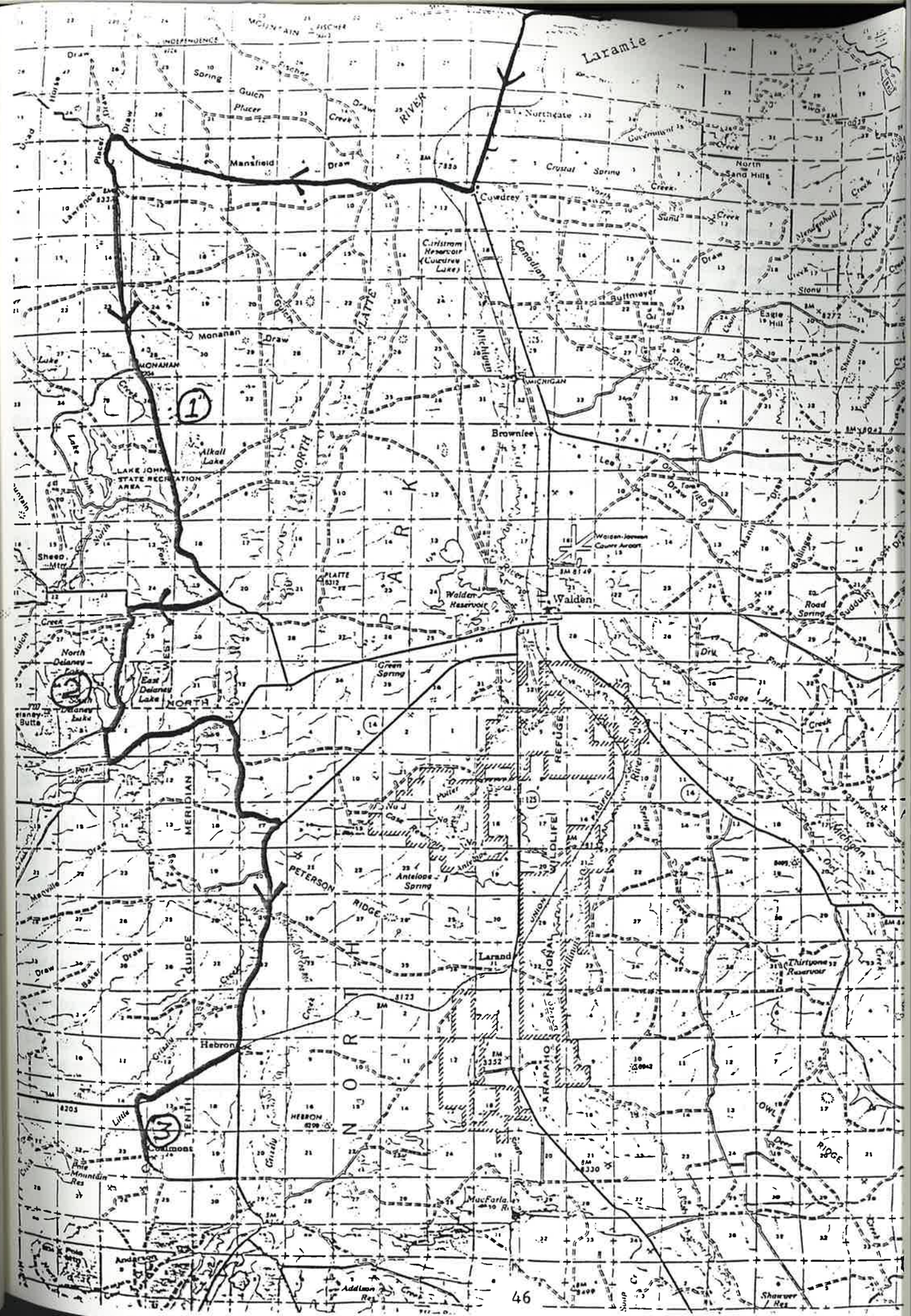
NORTH PARK SAGE GROUSE TOUR

Stop 1. 0930-1000 — The Lake John - Boetcher Junction area. Sagebrush in this area was modified by aerial application of 2,4-D herbicide in the 1960's and much of the area was planted to crested wheatgrass. While much of the sagebrush has recovered, many of the impacts to the sagebrush habitat are still visible after 30 years. Reservoir development (Lake John) in 1962 also flooded sagebrush habitats. Clait Braun will discuss the cumulative impacts on sagebrush and sage grouse populations in the area.

Stop 2. 1015-1045 — Delaney Butte Strutting Ground. Ken Giesen will discuss his proposed study concerning sage grouse nesting and residual cover. In 1993 we captured and radio-marked 20 hens on this strutting ground to identify nesting habitats in this area.

Stop 3. 1100-1120 — Coalmont Public Viewing Lek. Clait Braun will discuss the Watchable Wildlife Program for sage grouse and the potential effects of disturbance on breeding sage grouse.

1120-1200 — LUNCH (on the Coalmont Strutting Ground).



Business Meeting Minutes
18th Western States Sage/Columbian Sharp-tailed Grouse Workshop
26 July 1993
Fort Collins, Colorado

Chairman Clait E. Braun (Colorado) called the meeting to order at 1700 hours with a roll call of member states/provinces. Present were California, Colorado, Idaho, North Dakota, Oregon, South Dakota, Utah, Washington, and Wyoming. Proceedings, including the minutes of the business meeting of the 17th workshop were distributed to those present who had not received a copy. The minutes were adopted by voice vote.

David Dobkin of the High Desert Ecology Research Institute was introduced. He reported that a meeting to discuss a comprehensive assessment of the ecological requirements of sage grouse, funded by the Bureau of Land Management in Oregon, was being planned.

Ken Giesen (Colorado) reported that the Columbian sharp-tailed grouse habitat guidelines had been accepted for publication by The Wildlife Society Bulletin. Publication should be in late 1993 or early 1994..

Jack Connelly (Idaho) discussed revision of the sage grouse habitat guidelines. He will take the lead with assistance from Clait Braun (Colorado). Others expressing interest in this endeavor were Mike Schroeder (Washington) and Alan Sands (BLM, Idaho). Consensus was reached to pursue the revision with a draft to be produced in 1994, reviews in 1995, with publication in 1996/1997.

Consistency in use of techniques recommended for sage grouse and Columbian sharp-tailed grouse data collection was discussed. The consensus was to poll the states to learn which techniques were being used in comparison with those promoted in the 1981 guidelines (Autenrieth et al.). Further, consensus was reached that standardized guidelines would be desirable. Jerry Kobriger (North Dakota) agreed to chair the effort for sage grouse with assistance from Olin Oedekoven (Wyoming) and Sam Blankenship (California). Techniques used for Columbian Sharp-tailed grouse studies will be reviewed by Ken Giesen (Colorado), Jack Connelly (Idaho), and Dave Larson (Utah).

Considerable discussion was generated about the taxonomic status of sage grouse throughout the west. Oregon, Washington, Utah, and Colorado expressed interest in this topic as the states need credibility in discussing populations within their boundaries. The topic of landscape/ecosystem management was also discussed with no resolution.

Consensus was reached that the Prairie Grouse Technical Council and the Western States Sage and Columbian Sharp-tailed Grouse Workshop should meet in alternate years. The latter group should meet in 1994 and again in 1996. Nevada was suggested as the possible host state in 1994 with Wyoming possibly hosting the meeting in 1996.

The meeting adjourned at 1800 hours.

(Minutes summarized by Clait E. Braun)

Business Meeting Minutes
20th Prairie Grouse Technical Council
27 July 1993
Fort Collins, Colorado

Chairman Ken Giesen (CO) called the meeting to order at 0730 and asked for the approval of the 1991 minutes of the Billings, Montana meeting. Moved by Nova Silvy (TX) and seconded by Ron Westemeier (IL). Approved.

Financial Report: Giesen reported that he received $251.81 from former PGTC chair, Bruce Waage (MT), and $875.05 from the Western States Sage and Columbian Sharp-tailed Grouse Committee. The balance after expenses of the current meeting will be distributed to the two groups in proportion to these contributions. Registrants at this joint meeting numbered 114.

Awards Committee Report: Dan Svedarsky (MN) reported that the PGTC awards program has been successfully launched as approved at the Billings meeting. Ten award plaques were prepared with expenses covered by Western Energy Company of Montana (coordinated by Bruce Waage) and the Minnesota Prairie Chicken Society. Svedarsky will coordinate getting plaques engraved and delivered to future PGTC meetings. Svedarsky presented the first Hamerstrom Award to Fran Hamerstrom at the annual meeting of the Society of Tympanuchus Cupido Pinnatus held in Milwaukee, Wisconsin on 1 December 1992.

Awards for 1993 will be presented at the banquet.

Prairie Grouse Book: Book coordinator, Nova Silvy, reported that all prairie chicken chapters are in and he proposed that a book on prairie chickens be printed with a sharptail book to come later, since there are some key parts of the sharptail range that are not covered. Nova suggested that all chapters be updated and incorporate 1993 census data. Good, 3 X 5, black and white photographs of typical habitat of states and provinces are needed to round out the book. Nova will have 4 people review the entire manuscript by 1 June 1994 so he can deliver it to Richard McCabe of the Wildlife Management Institute by early summer. The Institute will be a co-sponsor of the book.

PGTC Archives: Ron Westemeier received the archives from Bruce Waage following the Billings meeting. Ron was looking into the Illinois Natural History Survey being a repository of the archives. More recently, Don Christisen (MO) contacted Ron and other PGTC executive board members about the University of Missouri's "Western Historical Manuscript Collection" perhaps being a more appropriate repository. The archives would be more accessible to researchers if housed at a University library because that's what they do. The library is wiling to provide this service at no charge to the PGTC. Nova Silvy spoke in favor of accepting their offer. Val Lehmann has deposited his writings and papers at the University of Texas library and it has worked out very well. Action moved by Silvy and seconded by Larry Fredrickson (SD). Passed. Ron Westemeier will check on how to proceed with making slides and photographs available for inclusion in the archives.

Prairie Grouse Promotion Committee: Mike Gratson (ID) reported for the committee chair, John Toepfer (ND), on promotion efforts. The "Grand Slam of Prairie Grouse" concept presented at the Billings meeting has been replaced with the concept of approaching the U.S. Postal Service to issue a series of prairie grouse stamps. Perhaps an art competition could be promoted in this effort as well.

Toepfer responded to an article published in the National Wildlife magazine ("The Pleasant Pheasant") which asserted that pheasants caused no ill

effects to native birds. Toepfer pointed out the disruptive effects of pheasants on prairie grouse booming grounds and nest parasitism, particularly in Illinois.

Toepfer also raised the question of what should the role of the PGTC be in "listing" prairie grouse species or subspecies as threatened or endangered? This issue was not resolved but could be resolved in the future. Also, what should be the role of the PGTC in delineating the relationship between prairie grouse and the CRP program? Arnie Kruse (ND) has developed CRP management guidelines for North Dakota and a similar effort might be undertaken or at least endorsed by the PGTC. Prairie grouse might be proposed as an indicator of grassland habitat quality.

New Business: A possible affiliation with the Midwest Association of Fish and Wildlife Agencies was discussed. Would the PGTC have more "clout" with such an affiliation? The PGTC was organized under the wing of the National Wildlife Federation but they let the group "leave the nest" when it fledged. Over the years, the PGTC has functioned reasonably well as a communication vehicle between prairie grouse workers. Clait Braun (CO) suggested that a letter could be directed to member agencies of the Association to see if the group would accept the PGTC. Kevin Church (KS) questioned how well the geographic boundaries of prairie grouse (and hence PGTC) fit with the Midwest Association. Silvy noted that "working groups" are presently being organized within The Wildlife Society, but it's possible that the PGTC could get swept in with more urban orientations. Silvy also spoke to the value of the PGTC meeting in various states to view a variety of conditions and programs. Randy Rodgers (KS) spoke in favor of maintaining the status quo. Jerry Kobriger (ND) noted that the Midwest Pheasant Council, which had been a useful working group to researchers and managers, disappeared because of an affiliation with an umbrella group. Kobriger favored continuing the current organizational framework of the PGTC. No formal action was taken but the consensus appeared to be, "things are working well so leave it (PGTC) as it is."

Kobriger noted that he missed not receiving regular newsletters that contain status reports for states. Giesen indicated that he neglected to request status information from states and provinces.

Next Meeting: Bids to host the next meeting were entertained by chairman Giesen. Kobriger suggested North Dakota. Jim Keir (WI) and Larry Gregg (WI) suggested Wisconsin, with a focus on sharp-tailed grouse in the northern part of the state. Illinois was suggested but funding could be a problem. Texas was mentioned but Silvy indicated that "the book" will take up any spare time he has. North Dakota was accepted as the 1995 meeting site with a location to be chosen in the western part of the state. The North Dakota grouse hunting season opens 15 September so Kobriger favored having the meeting in late September to afford hunting opportunities as well as lessen his schedule demands during the opening of the season.

"Fish and Wildlife 2000": Kobriger noted the availability of this planning document recently published by the Bureau of Land Management. One section deals with upland game bird management which, according to Alan Sands (ID) of the BLM, might seem to be a bit counter with the new ecosystem approach of federal agencies but it really is quite compatible. Copies of the publication were available for distribution. The PGTC executive board was requested to send a letter of commendation to the director of the BLM for this planning effort.

Meeting adjourned at 0830.

(Minutes summarized by Dan Svedarsky)

WESTERN SAGE AND COLUMBIAN SHARP-TAILED GROUSE COMMITTEE

ALBERTA ENVIRONMENTAL PROTECTION, FISH AND WILDLIFE SERVICES, WILDLIFE MANAGEMENT DIVISION
Ken J. Lungle, 9945 108th Street, North Tower, Petroleum Plaza, Main Floor, Edmonton, Alberta, Canada T5K 2G6
Robert Andrews, Director of Wildlife, 9945 108th Street, North Tower, Petroleum Plaza, Main Floor, Edmonton, Alberta, Canada T5K 2G6

BRITISH COLUMBIA MINISTRY OF ENVIRONMENT, WILDLIFE BRANCH
W.T. (Bill) Munro, 780 Blanshard Street, Victoria, B.C., Canada V8V 1X4
Michael J. Chutter, 780 Blanshard Street, Victoria, B.C., Canada V8V 1X4

CALIFORNIA DEPARTMENT OF FISH AND GAME
Dan Connelly, 1416 Ninth Street, Sacramento, California 95814
Boyd Gibbons, 1416 Ninth Street, Sacramento, California 95814

COLORADO DIVISION OF WILDLIFE
Clait Braun, 317 West Prospect Road, Fort Collins, Colorado 80523
Len Carpenter, 6060 Broadway, Denver, Colorado 80216

IDAHO DEPARTMENT OF FISH AND GAME
Jack Connelly, 1345 Barton Road, Pocatello, Idaho 83204
Jerry M. Conley, 600 South Walnut, Box 24, Boise, Idaho 83707

MONTANA DEPARTMENT OF FISH, WILDLIFE, AND PARKS
Tom Hinz, 1420 East Sixth Avenue, P.O. Box 200701, Helena, Montana 59620-0701
Pat Graham, 1420 East Sixth Avenue, P.O. Box 200701, Helena, Montana 59620-0701

NEVADA DIVISION OF WILDLIFE
San Stiver, P.O. Box 10678, 100 Valley Road, Reno, Nevada 89520-0022
William A. Molini, Box 10678, Reno, Nevada 89520

NEW MEXICO GAME AND FISH DEPARTMENT
Dan Sutcliffe, Division of Wildlife, P.O. Box 25112, Santa Fe, New Mexico 87504
Bill Montoya, P.O. Box 25112, Santa Fe, New Mexico 87504

NORTH DAKOTA GAME AND FISH DEPARTMENT
Gerald Kobriger, Route 1, Box 56, Dickinson, North Dakota 58601
K.L. Cool, 100 North Bismark Expressway, Bismark, North Dakota 58501

OREGON DEPARTMENT OF FISH AND WILDLIFE
Ken Durbin, 2501 S.W. 1st Avenue, Portland, Oregon 97201
Director, 2501 S.W. 1st Avenue, Portland, Oregon 97201

SASKATCHEWAN DEPARTMENT OF ENVIRONMENT AND RESOURCE MANAGEMENT, WILDLIFE BRANCH
Dennis Sherratt, 3211 Albert Street, Room 436, Regina, Saskatchewan, Canada S4S 5W6
Ray Longmuir, 3211 Albert Street, Room 436, Regina, Saskatchewan, Canada S4S 5W6

SOUTH DAKOTA DEPARTMENT OF GAME, FISH AND PARKS
Bob Hauk, 3305 West South Street, Rapid City, South Dakota 57702
Doug Hansen, Director of Wildlife, 445 East Capitol, Pierre, South Dakota 57501-3185

UTAH DIVISION OF WILDIFE RESOURCES
Dave Larson, Small Game Manager, 1596 W. North Temple, Salt Lake City, Utah 84116
Director, 1596 W. North Temple, Salt Lake City, Utah 84116

WASHINGTON DEPARTMENT OF WILDLIFE
Dave Ware, 600 North Capitol Way, Olympia, Washington 98504
Curt Smitch, 600 N. Capitol Way, Olympia, Washington 98504

WYOMING GAME AND FISH DEPARTMENT
H.J. Harju, Game Division, 5400 Bishop Boulevard, Cheyenne, Wyoming 82006
Frances Petera, Game Division, 5400 Bishop Boulevard, Cheyenne, Wyoming 82002

PRAIRIE GROUSE TECHNICAL COUNCIL CONFERENCES

1st	Grand Island, Nebraska	26-27 September 1957
2nd	Emporia, Kansas	16-18 March 1959
3rd	Stevens Point, Wisconsin	8-10 September 1960
4th	Pierre, South Dakota	21-22 September 1961
5th	Nevada, Missouri	18-20 September 1963
6th	Warroad, Minnesota	14-16 September 1965
7th	Effingham, Illinois	12-14 September 1967
8th	Woodward, Oklahoma	9-11 September 1969
9th	Dickinson, North Dakota	14-16 September 1971
10th	Lamar, Colorado	5-7 September 1973
11th	Victoria, Texas	9-11 September 1975
12th	Pierre, South Dakota	13-15 September 1977
13th	Wisconsin Rapids, Wisconsin	26-28 September 1979
14th	Halsey, Nebraska	23-25 September 1981
15th	Emporia, Kansas	20-22 September 1983
16th	Sedalia, Missouri	24-26 September 1985
17th	Crookston, Minnesota	15-19 September 1987
18th	Escanaba, Michigan	13-15 September 1989
19th	Billings, Montana	25-27 September 1991
20th	Fort Collins, Colorado	26-28 July 1993

WESTERN STATES SAGE AND COLUMBIAN SHARP-TAILED GROUSE WORKSHOP LOCATIONS

1st	1959	Farson, Wyoming
2nd	1961	Elko, Nevada
3rd	1963	Lima, Montana
4th	1965	Walden, Colorado
5th	1967	Boise, Idaho
6th	1969	Rock Springs, Wyoming
7th	1971	Salt Lake City, Utah
8th	1973	Lewistown, Montana
9th	1975	Reno, Nevada
10th	1977	Grand Junction, Colorado
11th	1979	Twin Falls, Idaho
12th	1981	Bowman, North Dakota
13th	1983	Ontario, Oregon
14th	1985	Alturas, California
15th	1987	Midway, Utah
16th	1989	Moses Lake, Washington
17th	1991	Pocatello, Idaho
18th	1993	Fort Collins, Colorado

REGISTRATION

1ST JOINT MEETING

PRAIRIE GROUSE TECHNICAL COUNCIL

AND

WESTERN STATES SAGE/COLUMBIAN SHARP-TAILED

GROUSE WORKSHOP

Jeff Abegglen
U.S. Forest Service
Pine Ridge, HC75, Box 13A9
Chadron, NE 69337

Jim Aragon
Colorado Division of Wildlife
1019 Arizona Avenue
Trinidad, CO 81082

Sam Blankenship
California Fish and Game
1416 9th. St. Rm. 1280
Sacramento, CA 95814

Joe Capodice
BLM
216 N. Colorado
Gunnison, CO

Harold D. Carr
200,5920-1A St. SW
Calgary, Alberta
CANADA T2H 0G3

Steve Clubine
Montana Dept. of Conservation
P.O. Box 250
Clinton, MO 65360

Michelle Commons
Colorado Division of Wildlife
7592 Red Fox Dr.
Evergreen, CO 80439

Bill Andree
Colorado Division of Wildlife
P.O. Box 633
Minturn, CO 81645

Jenny K. Barnett
Bureau of Land Management
100 Oregon St.
Vale, OR 47918

Clait E. Braun
Colorado Division of Wildlife
317 W. Prospect Rd.
Fort Collins, CO 80526

Ruth Lewis Carlson
Colorado Division of Wildlife
151 E. 16th St.
Durango, CO 81301

Art Carter
South Dakota Dept. of Game, Fish & Parks
3305 West South Street
Rapid City, SD 57702

Victor L. Coggins
Oregon Department of Fish and Wildlife
Route 1, Box 278
Enterprise, OR 97828

Jack Connelly
Idaho Dept. Fish & Game
1345 Barton Road
Pocatello, ID 83240

Anthony D. Apa
Idaho Dept. of Fish & Game
868 E. Main
Jerome, ID 83338

Grant Beauprez
University of Northern Colorado
2404 11th Avenue
Greeley, CO 80631

Larry L. Cadwell
Pacific Highway Laboratory
MSP 7-54, P.O. Box 999
Richland, WA

Len Carpenter
Colorado Division of Wildlife
6060 Broadway
Denver, CO 80216

Kevin Church
Kansas Department of Wildlife
P O Box 1525
Emporia, KS 66801

Leonard Coleman
Bureau of Land Management
50629 Highway 6 & 24, P.O. Box
Glenwood Springs, CO 81602

Barth Crouch
Pheasants Forever
1037 Co. Rd. 110A
Cheyenne, WY

Davies
olorado Division of Wildlife
26 N. Weber
olorado Springs, CO 80907

Delong
S. Fish & Wildlife Service
O. Box 111
eview, OR 97630

id S. Dobkin
h Desert Ecological Research Inst.
S.W. Colorado Ave., Suite 300
d, Oregon 97702

s Eddy
poria State
3 County Rd. N.
poria, KS 66801

a Fitzner
shington Department of Wildlife
e 1, Box 1070
on City, WA 99320

eth M. Giesen
ado Division of Wildlife
West Prospect
t Collins, CO 80526

hael Gratson
o Fish & Game
0 Warner Avenue
ston, ID 83501

a Guenzel
oming Game & Fish Dept.
N. 18th
ie, WY 82070

a Harper
ado Division of Wildlife
Box 268
Creek, CO 81324

Henker
Department of Fish and Game
Box 25
, ID 83707

Tim Davis
Colorado Division of Wildlife
13791 Beal Rd.
Sterling, CO 80751

Bill deVergie
Colorado Division of Wildlife
P.O. Box 40
Dinosaur, CO 81610

Hilary Donoghue
Bureau of Land Management
701 Comino del Rio
Durango, CO 81301

Tom Eddy
Emporia State University
1883 County Rd. N.
Emporia, KS 66801

Larry Fredrickson
South Dakota Dept. Game, Fish & Parks
715 N. Main
Chamberlain, SD 57325

Daniel P. Golner
Univ. of Wisconsin, Stev. Pt.
College of Natural Resources
Stevens Point, WI 54481

Larry Gregg
Wisconsin Dept. Natural Resources
Box 220
Park Falls, WI 54552

Tony Gurzick
Colorado Division of Wildlife
4025 Westmeadow Drive, #1116
Colorado Springs, CO 80906

Brian Heath
Wyoming Game & Fish
124 S. Taylor St. A.
Laramie, WY 82070

Greg Hiatt
Wyoming Game and Fish Department
Box 186
Sinclair, WY 82334

Anita Kang Delong
Oregon State University
104 Nash Hall
Corvallis, OR 97331

James R. Dennis
Colorado Division of Wildlife
317 W. Prospect
Fort Collins, CO 80526

Ken Durbin
Oregon Department of Fish and Wildlife
P.O. Box 59
Portland, OR 97207

Terry L. Esicer
Illinois Dept. of Conservation
RR #3 Box 74
Newton, IL 62448

Scott C. Gardner
University of Idaho
Dept. of Fish & Wildlife
Moscow, ID 83843

Sharron Gough
Montana Dept. of Conservation
Rt. 3 Box 291
Stockton, MO 65785

Mike Gregg
U.S. Fish & Wildlife
516 Smith St. South
Vale, OR 97918

Jan Hanf
BLM
185 E. 4th St.
Prineville, OR

Bill Heicher
Colorado Division of Wildlife
P.O. Box 401
Eagle, CO 81631

Laura Higgins
Purdue University
Lilly Hall of Life Sciences
West Lafayette, IN 47907

Rick Hoffman
Colorado Division of Wildlife
317 West Prospect
Fort Collins, CO 80526

Lynn Jahnke
Wyoming Game & Fish
Box 87
Savery, WY 82332

Don Kemner
Idaho Dept. of Fish & Game
1515 Lincoln Road
Idaho Falls, ID 83401

Stephen E. Labuda Jr.
U.S. Fish & Wildlife Service
P.O. Box 519
Eagle Lake, TX 77434

Leonard L. McDaniel
U.S. Fish and Wildlife Service
HC37 Box 37
Valentine, NE 69201

Brian Meiers
South Dakota Dept. of Fish & Game
Box 14
Buffalo, SD 57720

Mike Morrow
U.S. Fish & Wildlife Service
P.O. Box 519, Attwater Prairie Chicken NWR
Eagle Lake, TX 77434

Ed Neilson
USDA, Soil Cons. Service
764 Horizon Drive, Room 129
Grand Junction, CO 81506-8720

Tom Remington
Colorado Division of Wildlife
317 W. Prospect
Fort Collins, CO 80526

Randy Rodgers
Kansas Dept. of Wildlife & Parks
U.S. Highway 138 Bypass - P.O. Box 338
Hayes, KS 67601

Russ Horton
Oklahoma Dept. of Wildlife
1801 North Lincoln
Oklahoma City, OK 73105

Kris Johnson
University of Wyoming
Range Science Dept., Box 3354, University Station
Laramie, WY 82071

Jerry Kobriger
North Dakota Game and Fish
Route 1 Box 56
Dickinson, ND 58601

Dave Larson
Utah Division of Wildlife Resources
1596 W. N. Temple
Salt Lake City, UT 84116

Gwyn McKee
University of Missouri
112 Stephens Hall
Columbia, MO 65211

Daryl R. Meints
Idaho Department of Fish and Game
1345 Barton Road
Pocatello, ID 83201

Beverly Motz
Colorado Division of Wildlife
151 E. 16th St.
Durango, CO 81301

Olin O. Oedekoven
Wyoming Game and Fish Department
Box 3571
Gillete, WY 82717

Kerry Reese
University of Idaho
College of Forestry
Moscow, ID 83843

Larry Rogstad
Colorado Division of Wildlife
1528 28th Ave Ct.
Greeley, CO 80631

Tom Howard
Colorado Division of Wildlife
18466 W. 59th Dr.
Golden, CO 80403

Jim Keir
Wisconsin Dept. of Natural Re
Ranger Station, Box 100
Friendship, WI 53934

Paul Kooiker
Wisconsin Div. of Wildlife
Box 367
Grantsburg, WI 54840

Daryl Lutz
Wyoming Game & Fish
179 Olson Road
Wheatland, WY 82201

Larry Mechlin
Missouri Dept. Conservation
1110 College Avenue
Columbia, MO 65201

Bob Moore
Iowa Division of Natural Reso
RR #1 Box 11
Griswald, ID 51535

Sue Moyer
BLM
2815 H Rd.
Grand Junction, CO 81506

William H. Pyle
U.S. Fish & Game
Box 111
Lakeview, OR 97630

Mark Robertson
BLM, White River
P.O. Box 928
Meeker, CO 81641

Mark Rumble
USFS Rocky Mtn. Station
501 E. St. Joe
Rapid City, SD 57701

Ronald Ruthstrom
Kansas Wildlife & Parks
Box 162-A
Glen Elder, KS 67446

James Schneider
University of Idaho
Department of Fish & Wildlife
Moscow, ID 83843

Scott Simpson
Illinois Natural History Survey
R.R. 3, Box 74
Newton, IL 62448

Brady Smith
Idaho Dept. of Fish & Game
P.O. Box 428
Nampa, ID 83338

Clifford Steinhauer
Route 2 Box 141-A
Red River Falls, MN 56701

John Swearingen
University of Wyoming
Range Science Dept., Box 3354, University Station
Laramie, WY 82701

Dan Taylor
Nebraska Game & Parks
2200 N. 33rd St., P.O. Box 30370
Lincoln, NE 68503

Jim Vodehnal
Nebraska Game and Parks Commission
P.O. Box 508
Ansley, NE 68714

Craig Washob
University of Wyoming
Laramie, Wyoming

Dale Willis
Idaho Department of Fish and Wildlife
600 W. Court St.
Boise, OR 97720

Dave Ziegeweid
Colorado Sharp-Tailed Grouse Soc.
1000 E. Wellington Dr.
Fort Collins, Wisconsin

Alan Sands
Bureau of Land Management
3380 Americana Terrace
Boise, ID 83706-2544

Michael Schroeder
Washington Department of Wildlife
P.O. Box 1077
Bridgeport, WA 98813-1077

Terri Skadeland
Soil Conservation Service
655 Parfet, Room E200C
Lakewood, CO 80215

Jeff Snyder
Oregon State University
Department of Fish and Wildlife, Nash 104
Corvallis, OR 97331

Dan Svedarsky
University of Minnesota
Northwest Experiment Station
Crookston, MN 56716

Margaret Taafe-Pounds
U.S. Army
1016 So. 33rd Ave.
Yakima, WA 98902

Mark J. Ulliman
University of Idaho
Dept. of Fisheries & Wildlife
Moscow, ID 83843

Paul Vohs
U.S. FWS
2631 Durmire Ct.
Fort Collins, CO 80526

David Ware
Washington Department of Wildlife
600 Capital Way N.
Olympia, WA 98501

George Wilson
Utah Division of Wildlife Resources
515 E. 5300 S.
Ogden, Utah 84405

Paul Schmidt
BLM
185 E. 4th St.
Prineville, OR

Nova Silvy
Texas A&M University
14703 I-GN Rd.
College Station, TX 77843

Bob Smith
Fossil Rim Wildlife Center
Rte #1 Box 210
Glen Rose, TX 76043

Fred Stabler
BLM, Washington Office
8533 Gwynedd Way
Springfield, VA

Colin M. Sveum
Oregon State University, Battelle
Dept. of Fish & Wildlife
Nash Hall 104
Corvallis, OR 97331

John Tonko
Colorado Division of Wildlife
600 Reservoir Rd.
Pueblo, CO 81005

Lee Upham
Bureau of Land Management
2850 Youngfield Street
Lakewood, CO 80215-7076

Bruce Waage
Western Energy
P.O. Box 99
Colstrip, MT 59323

Ronald L. Westemeier
Illinois Natural History Survey
304 Poplar Drive
Effingham, IL 62401

Jessica R. Young
Purdue University
Lilly Hall of Life Sciences
West Lafayette, IN 47907

APPENDIX

WESTERN STATES SAGE

AND

COLUMBIAN SHARP-TAILED GROUSE

Questionnaire Survey

1991-92

Compiled By

Clait E. Braun
Colorado Division of Wildlife
317 West Prospect
Fort Collins, CO 80526

SAGE GROUSE REPORT
1991-92

Provinces/States with historic or present range responding: Alberta, British Columbia, California, Colorado, Idaho, Montana, Nevada, North Dakota, Oregon, Saskatchewan, South Dakota, Utah, Washington, Wyoming.

1. Hunting was closed in British Columbia and Saskatchewan, and in South Dakota and Washington. Sage grouse hunting in California and Oregon was by permit only.

2. Season length and bag/possession limits, 1991-92.

State/Province	Length (days)	Bag/possession
Alberta	6	2/2/season
California	2	1 or 2/day, 1 or 2/season
Colorado	30-34	3/6, 3/9
Idaho	30	3/6
Montana	63-105	3/12, 4/16
Nevada	2-23	2/2, 2/4
North Dakota	3	1/1
Oregon	2	2/2
Utah	9	2/4, 3/6
Wyoming	10-31	3/9

3. Harvest characteristics, 1991-92.

State/Province	% Yg	Yg/hen	n wings
Alberta	No Data	No Data	No Data
California	0-67	0.7	34-85/area
Colorado	34-68	0.9-2.5	1595-2202
Idaho	42	1.1-1.2	3040-4889
Montana	Not Available		
Nevada	No Data	0.6-3.8	No Data
North Dakota	36-50	1.1-2.7	16-22
Oregon	31	0.0-5.0	295-407
Utah	39-56	1.1-1.9	292-943/area
Wyoming	No Data	No Data	No Data

4. Lek data, 1991-92.

State/Province	n leks	$\bar{x}$ males/lek
Alberta	Not Available	Not Available
California	3-19/area	16-23/area
Colorado	5-25/area	21-49/area
Idaho	70-85	19-20
Montana	5-55/area	9-55/area
Nevada	1-59/area	6-45/area
North Dakota	17	14-15
Oregon	2-23/area	1-42/area
Saskatchewan	No Data	No Data
South Dakota	1-10/area	6-16/area
Utah	71-125	14-18
Washington	7-9/area	20-31/area
Wyoming	No Data	No Data

5. The major issues/problems related to maintaining sage grouse and their habitats were:

a. Extirpated (British Columbia).

b. Overgrazing (Alberta, California, Colorado, Idaho, Nevada, Oregon, Saskatchewan, South Dakota, Utah, Washington, Wyoming).

c. Consistent inventories (California).

d. Drought (Alberta, California, Colorado, Idaho, Nevada, North Dakota, Utah, Wyoming).

e. Habitat fragmentation (Colorado, Washington).

f. Management of small populations (Colorado).

g. Wildlife and controlled burns (Colorado, Idaho, Nevada, Oregon).

h. Pesticide use (Idaho, Wyoming).

i. Habitat loss (Montana, Saskatchewan).

j. Competition with wild horses (Nevada).

k. Type conversion (Oregon, South Dakota, Washington, Wyoming).

l. Public opinion about hunting small populations (South Dakota).

m. Use of federal funds to treat sagebrush (Utah).

n. Disturbance on leks during breeding season (Washington).

o. Lack of uneven age stands of sagebrush (Wyoming).

p. Predator-habitat-prey relationships (Wyoming).

6. Active projects/studies are underway in:

California	-	Intensive monitoring of leks.
Colorado	-	Intensive lek surveys and harvest data collection on selected areas.
	-	Behavior and nesting of Gunnison sage grouse.
	-	Description of a new race of sage grouse.
	-	Habitat use by fragmented populations.
	-	Management plan preparation.
Idaho	-	Effects of fire.
	-	Effects of land management practices.
Nevada	-	Inventory of leks on major and island populations.
Oregon	-	Relationship between vegetation structure and predation rates of artificial sage grouse nests.
South Dakota	-	Factors limiting distribution, condition, and growth of big sagebrush communities.
Utah	-	Relationships of insect biomass to sagebrush understory composition.
Washington	-	Radiotelemetry studies of sage grouse at Hanford.
	-	Productivity and habitat use.
Wyoming	-	Factors affecting sage grouse productivity and survival.

7. Publications available:

Barber, H.A. 1991. Strutting behavior, distribution, and habitat selection of sage grouse in Utah. M.S. thesis, Brigham Young Univ., Provo. 52 pp.

Benson, L.A., C.E. Braun, and W.C. Leininger. 1991. Sage grouse response to burning in the big sagebrush type. Proc. Issues and Technology in the Management of Impacted Western Wildlife. Thorne Ecol. Inst. 5:97-104.

Connelly, J.W., and L.J. Blus. 1991. Effects of pesticides on upland game: a review of herbicides and organophosphate and carbamate insecticides. Pp. 92-97 in M. Marsh, ed. Proc. Pesticides in Natural Systems - how can their effects be monitored? U.S. Environ. Protection Agency. Seattle, WA.

_____, W.L. Wakkinen, A.D. Apa, and K.P. Reese. 1991. Sage grouse use of nest sites in southeastern Idaho. J. Wildl. Manage. 55:521-524.

Drut, M.S. 1992. Status of sage grouse in North America with emphasis on populations in British Columbia, Washington, and Oregon. Natl. Audubon Soc. Portland.

Eberhardt, L.E., and L.A. Hofmann. 1991. Sage grouse on the Yakima Training Center: a summary of studies conducted during 1989 and 1990. U.S. Army and Dep. Energy, Richland, WA.

Gibson, R.M. 1992. Lek formation in sage grouse: the effect of female choice on male territory settlement. Anim. Behav. 43:443-450.

_____, and G.C. Bachman. 1992. The costs of female choice in a lekking bird. Behav. Ecol. 3:300-309.

_____, J.W. Bradbury, and S.L. Vehrencamp. 1991. Mate choice in lekking sage grouse revisited: the roles of vocal display, female site fidelity, and copying. Behav. Ecol. 2:165-180.

Homer, C.G., T.C. Edwards, Jr., R.D. Ramsey, and, K.P. Price. 1993. Use of remote sensing methods in modeling sage grouse winter habitat. J. Wildl. Manage. 57:78-84.

Hupp, J.W., and C.E. Braun. 1991. Geographic variation among sage grouse in Colorado. Wilson Bull. 103:255-261.

Myers, O.B. 1992. Sage grouse habitat enhancement: effects of sagebrush fertilization. Ph.D. thesis, Colorado State Univ., Fort Collins. 97pp.

Remington, T.E., and C.E. Braun. 1991. How surface coal mining affects sage grouse, North Park, Colorado. Proc. Issues and Technology in the Management of Impacted Western Wildlife. Thorne Ecol. Inst. 5:128-132.

Robertson, M.D. 1991. Winter ecology of migratory sage grouse and associated effects of prescribed fire in southeastern Idaho. M.S. thesis, Univ. Idaho, Moscow. 88pp.

Sherfy, M.H. 1992. The influence of season, temperature, and wind speed on sage grouse metabolism. M.S. thesis, Univ. New Hampshire. Durham. 65pp.

Sime, C.A. 1991. Sage grouse use of burned, non-burned, and seeded vegetation communities on the Idaho National Engineering Laboratory, Idaho. M.S. thesis, Montana State Univ., Bozeman. 72pp.

Wakkinen, W.L., K.P. Reese, and J.W. Connelly. 1992. Sage grouse nest locations in relation to leks. J. Wildl. Manage. 56:381-383.

_____, _____, _____, and R.A. Fischer. 1992. An improved spotlighting technique for capturing sage grouse. Wildl. Soc. Bull. 20:425-426.

Welch, B.L., F.J. Wagstaff, and J.A. Roberson. 1991. Preference of wintering sage grouse for big sagebrush. J. Range Manage. 44:462-465.

Willis, M.J., and G.P. Keister, Jr. 1993. Status of sage grouse in Oregon. Oregon Dep. Fish and Wildl. Portland. 3pp.

_____, _____, D.A. Immell, D.M. Jones, R.M. Powell, K.R. Durbin. 1993. Sage grouse in Oregon. Oregon Dep. Fish and Wildl. Wildl. Res. Rep. 15. 56pp.

COLUMBIAN SHARP-TAILED GROUSE REPORT
1991-92

Provinces/States with historic or present range responding: British Columbia, California, Colorado, Idaho, Montana, Nevada, Oregon, Utah, Washington, and Wyoming (All!).

1. Hunting was allowed in British Columbia, Colorado, Idaho, and Wyoming. States with unhunted populations were Montana, Utah, and Washington. Oregon and Montana were involved with reintroduction/augmentation programs while this race of sharptails has been extirpated in California and Nevada.

2. Season length varied from 16-30 (Idaho), 30-34 (Colorado), 65-82 (British Columbia) to 75-120 days (Wyoming) with bag/possession limits of 2/4 (Idaho), 3/6 or 3/9 (Colorado), 4/12 (Wyoming) to 3/9, 8/16, or 10/30 (British Columbia).

3. Based on harvest samples (wings), young in the harvest ranged from 47-67% (n = 80 to 134 wings) in Colorado to 44-52% (n = 188 to 509 wings) in Idaho.

4. Number of leks reported counted ranged from 0 in Colorado, Idaho, and Wyoming, 2 in Montana, 12-13 in British Columbia, 22 in Utah to 24-32 in Washington. Birds/lek varied from 11-12 in British Columbia, 11 in Montana, 13 in Utah, to 4-8 in Washington.

5. The major issues/problems related to maintaining Columbian sharp-tailed grouse and their habitats were:

   a. Overgrazing (British Columbia, Colorado, Idaho, Washington, Wyoming).

   b. Lack of inventory (British Columbia, Colorado).

   c. Habitat fragmentation (Colorado, Idaho, Washington, Wyoming).

   d. Extinction of small populations (Colorado).

   e. Herbicide spraying (Colorado, Washington).

   f. Continuation of the Conservation Reserve Program (Idaho, Utah).

   g. Habitat loss (Montana, Washington).

   h. Lek disturbance during breeding season (Washington).

   i. Removal of winter food sources (trees, shrubs) (Washington).

   j. Drought (Wyoming).

   k. Advanced succession (Wyoming).

6. Active projects/studies are underway in:

British Columbia	-	Status Report has been contracted.
Idaho	-	Effects of land management practices.
	-	Translocation.
	-	Winter distribution and habitat use.
	-	Winter feeding ecology.
Montana	-	Reintroductions.
Oregon	-	Reintroductions.
Utah	-	Identification of reintroduction sites.
	-	Reintroduction into Weber County.
Washington	-	Captive breeding program.
	-	Productivity and habitat use.
	-	Identification of reintroduction sites.

7. Publications available:

Cope, M. 1992. Distribution, habitat selection, and survival of transplanted Columbian sharp-tailed grouse (Tympanuchus phasianellus columbianus) in the Tobacco Valley, Montana. M.S. thesis, Montana State Univ., Bozeman. 60pp.

Giesen, K.M. 1992. Body mass of Columbian sharp-tailed grouse in Colorado. Prairie Nat. 24:191-196.

Meints, D.R. 1991. Seasonal movements, habitat use and productivity of Columbian sharp-tailed grouse in southeastern Idaho. M.S. thesis, Univ. Idaho, Moscow. 74pp.

_____, J.W. Connelly, K.P. Reese, A.R. Sands, and T.P. Hemker. 1992. Habitat suitability index procedure for Columbian sharp-tailed grouse. Univ. Idaho, College For., Wildl., and Range Exp. Sta. Bull. 55. 27 pp.

Saab, V.A., and J.S. Marks. 1992. Summer habitat use by Columbian sharp-tailed grouse in western Idaho. Great Basin Nat. 52:166-173.

Van Rossom, G. 1991. Habitat of the Columbian sharp-tailed grouse in the southern Interior of British Columbia. B.C. Wildl. Branch, Kamloops.

Weddell, B.J., S. Johnston, and J. Martin. 1991. Sharp-tailed grouse winter habitat inventory in Douglas, Lincoln, and Okanogan counties, Washington, 1990-91. The Nature Conservancy and Charlotte Martin Foundation.