*Guidelines for the Management of*

# Columbian Sharp-tailed Grouse

## Populations and their Habitats

*A Product of the* **Western Agencies Sage and Columbian Sharp-tailed Grouse Technical Committee**

*Sponsored by the* **Western Association of Fish and Wildlife Agencies**

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# The Authors

RICHARD W. HOFFMAN, retired
*Colorado Parks And Wildlife*
1804 Wallenberg Drive
Fort Collins, CO 80526, USA

KATHLEEN A. GRIFFIN
*Colorado Parks and Wildlife*
711 Independent Avenue
Grand Junction, CO 81505, USA

JEFFREY M. KNETTER
*Idaho Department of Fish and Game*
P. O. Box 25
Boise, ID 83707, USA

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

ANTHONY D. APA
*Colorado Parks and Wildlife*
711 Independent Avenue
Grand Junction, CO 81505, USA

JASON D. ROBINSON
*Utah Division 0f Wildlife Resources*
1594 West North Temple, Suite 2110
Salt Lake City, UT 84114, USA

SHAWN P. ESPINOSA
*Nevada Department of Wildlife*
1100 Valley Road
Reno, NV 89512, USA

TOM J. CHRISTIANSEN
*Wyoming Game and Fish Department*
351 Astle Avenue
Green River, WY 82935, USA

RICK D. NORTHRUP
*Montana Department of Fish, Wildlife and Parks*
P. O. Box 200701
Helena, MT 59620, USA

DAVID A. BUDEAU
*Oregon Department of Fish and Wildlife*
3406 Cherry Avenue NE
Salem, OR 97303, USA

MICHAEL J. CHUTTER
*British Columbia Ministry of Forest, Lands, and Natural Resource Operations*
P. O. Box 9338
Victoria, BC V8W 9M1, Canada

**Technical Editor:**
THOMAS W. KEEGAN
*Sprig Technical Editing & Wildlife Consulting*
29 Nighthawk Lane
Salmon, ID 83467

**Design Editor:**
KELLY KENNEDY YOKOYAMA
*Idaho Department of Fish and Game*
720 Park Boulevard, P. O. Box 25
Boise, ID 83707, USA

Cover photos by Richard W. Hoffman/retired Colorado Parks and Wildlife, Jeffrey M. Knetter/ Idaho Department of Fish and Game, and Michael A. Schroeder/Washington Department of Fish and Wildlife.

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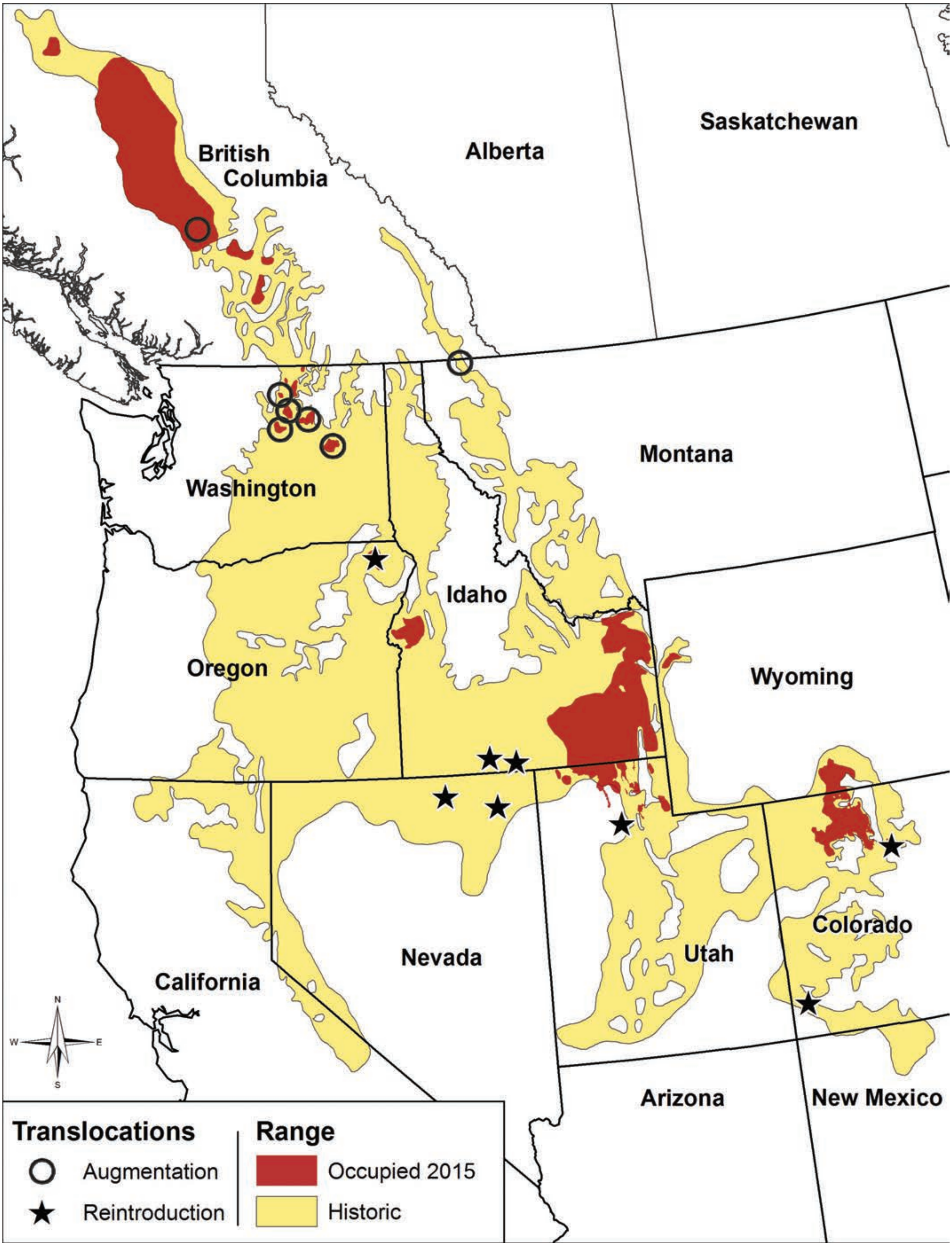


Figure 1. Historical and current distribution (includes translocation sites) of Columbian sharp-tailed grouse in western North America. Map updated and modified from Stinson and Schroeder (2012) and based on historical distribution of potential habitat, museum specimens, and published observations (Aldrich and Duvall 1955, Aldrich 1963).

# Introduction

Columbian sharp-tailed grouse (*Tympanuchus phasianellus columbianus*, hereafter CSTG) are endemic to big sagebrush (*Artemisia tridentata*), shrub-steppe, wheatgrass-fescue (*Pseudoroegneria-Festuca*), pinegrass (*Calamagrostis rubescens*), mountain shrub, and riparian shrub plant communities in western North America (Connelly et al. 1998). The historical distribution included portions of British Columbia, Washington, Oregon, California, Idaho, Montana, Utah, Nevada, Wyoming, and Colorado (Fig.1; Aldrich 1963, Miller and Graul 1980). Early accounts, although descriptive in nature, suggest CSTG were extremely abundant in portions of the range (Bendire 1892, Gabrielson and Jewett 1940, Hart et al. 1950, Yocom 1952). Populations started to decline in the late 1800s. Marshall and Jensen (1937) described the decline as one of the most striking examples of a reduction in game bird populations in the western U.S. The decline was so pronounced that between 1920 and 1970, CSTG disappeared from Oregon, California, and Nevada, and only remnant populations remained in Utah, Montana, Washington, and Wyoming (Hamerstrom and Hamerstrom 1961, Miller and Graul 1980, Hoffman and Thomas 2007). The subspecies currently occupies <10% of its historical range with >95% of remaining breeding birds found within 3 metapopulations: south-central British Columbia, northern Utah and southeastern Idaho, and northwestern Colorado and south-central Wyoming (Fig. 1; Bart 2000).

Numerous events have been implicated in the decline of CSTG populations. All are anthropogenic in origin and many are inter-related and synergistic in their impacts on CSTG. Actions and events most commonly identified in the literature include conversion of native plant communities to cropland, inappropriate grazing by domestic livestock, use of herbicides to control shrubs, alteration of natural fire regimes, invasion of exotic plants, and urban and rural expansion (Hart et al. 1950, Buss and Dziedzic 1955, Miller and Graul 1980, Marks and Marks 1987, Wood 1991, Giesen and Braun 1993, Ritcey 1995, McDonald and Reese 1998, Schroeder et al. 2000, Hoffman 2001, Utah Division of Wildlife Resources [UDWR] 2002). Primary negative consequences of these activities have been loss, degradation, and fragmentation of native habitats. In contrast to the negative effects of these anthropogenic activities, there is strong evidence that CSTG in parts of British Columbia have expanded their range in response to the availability of large openings within the forest created by clear-cutting practices (Leupin and Chutter 2007).

Giesen and Connelly (1993) initially published guidelines for managing CSTG habitats. Management issues related to populations, such as breeding and production surveys, predation, translocations, hunting, disease, and genetics, were not addressed by Giesen and Connelly (1993). Furthermore, since publication of the Giesen and Connelly (1993) guidelines, new threats have emerged and more information about population dynamics and habitat requirements of CSTG were revealed via research (reviewed by Hoffman and Thomas 2007, Stinson and Schroeder 2012). Because of the availability of new information and continued concern for CSTG, the Western Agencies Sage and Columbian Sharp-tailed Grouse Technical Committee, under the direction of the Western Association of Fish and Wildlife Agencies, requested a revision and expansion of the guidelines originally published by Giesen and Connelly (1993). This document provides a synopsis of current knowledge of CSTG ecology and presents updated guidelines for CSTG population and habitat management.

Taxonomic status of CSTG was recently reevaluated using genetic data (Spaulding et al. 2006, Warheit and Dean 2009). These studies indicate sharp-tailed grouse from western Montana and northwestern Colorado are molecularly more similar to plains sharp-tailed grouse (*Tympanuchus phasianellus jamesi*) than to CSTG. Presently, no action has been taken to officially recognize these findings or change boundaries between plains and CSTG. For this reason, and because habitats in western Montana and northwestern Colorado are similar to other occupied areas in the western U.S., issues and related guidelines presented in this document are considered applicable to these areas.

Plant names follow the U.S. Department of Agriculture (USDA) Plants Database available at http://www.plants.usda.gov. Conversion factors are provided for managers wanting to compute English system equivalents of metric data reported in this document (Table 1).

Table 1. Conversion of metric to English system measurements.

| Metric measurement | Multiply by | English system equivalent |
|---|---|---|
| Centimeter (cm) | 0.3937 | Inch (in) |
| Meter (m) | 3.281 | Foot (ft) |
| Kilometer (km) | 0.6214 | Mile (mi) |
| Square kilometer ($km^2$) | 0.3861 | Square mile ($mi^2$) |
| Hectare (ha) | 2.471 | Acre (ac) |
| Kilogram (kg) | 2.205 | Pound (lb) |
| Milligram (mg) | 0.000035 | Ounce (oz) |
| Milliliter (ml) | 0.0021 | Pint (pt) |

# Treatment of Uncertainty

When making natural resource management decisions, managers desire a high level of certainty their actions will have anticipated outcomes (Garton et al. 2005). However, natural systems have inherent complexity and stochasticity that make certainty in wildlife management decisions challenging. In an effort to ameliorate some of this uncertainty, managers use information from high-quality scientific studies to guide population and habitat management decisions (Garton et al. 2005). When their decisions cannot be supported by well-designed studies published in peer-reviewed sources, managers must rely upon non-refereed information, best professional judgment, or descriptive studies to formulate management strategies. Such is the case for CSTG. Most of the literature on CSTG originates from descriptive rather than manipulative studies (Hoffman and Thomas 2007). Even so, inferences derived from these descriptive studies have been consistent enough to improve our understanding of the ecology and habitat requirements of CSTG (metareplication, Johnson 2002).

A concerted effort was made to review all available information on CSTG. Preparation of this document also included reviewing and incorporating pertinent information on other subspecies of sharp-tailed grouse (hereafter STG) and on other species of grouse, particularly prairie grouse. Users of this document should be aware that, although there is a wealth of information on STG, there is a dearth of published literature on the Columbian subspecies. In many areas, CSTG populations were severely reduced or extirpated by the early 1900s. Consequently, opportunities for study were limited.

Due to the lack of empirical data on effects of management activities on CSTG populations, managers should view many of the guidelines as hypotheses to be tested using the scientific method under principles of adaptive management (Walters and Holling 1990). Furthermore, in light of uncertain effects of management activities, users are encouraged to take a conservative approach formulating management strategies to benefit CSTG. Equally important, users of these guidelines are encouraged to read this document in its entirety so they are aware of and take into consideration cumulative impacts of multiple issues when formulating management strategies for CSTG. Not every guideline is applicable throughout the range of CSTG. Guidelines should be modified as needed based on local and regional conditions. Managers should be aware of potential impacts on other species when actions are taken to benefit CSTG and adapt the guidelines accordingly. Ultimately, managers must assess the level of risk associated with their proposed management decisions based upon cited findings presented in this document.

# Conservation Status

The fact the CSTG is only 1 of 6 existing subspecies of STG in North America (Connelly et al. 1998) does not diminish its importance in the conservation of the species. Management of definable subspecies is essential for maintaining biological diversity and ensuring evolutionary potential within the species (Haig et al. 2006). Miller and Graul (1980) identified CSTG as the subspecies of STG most in need of conservation. Accordingly, the U.S. Forest Service (USFS) and the Bureau of Land Management (BLM) identify CSTG as a sensitive species wherever it occurs on lands under their jurisdictions. The CSTG is state-listed as threatened in Washington (Stinson and Schroeder 2012) and blue-listed (of special concern) in British Columbia (Ritcey 1995, Leupin and Chutter 2007). Most other states where CSTG still occur identify it as a bird of special concern (Hoffman and Thomas 2007). The CSTG is classified as a game species and was once hunted throughout its historical range. Currently, legal hunting seasons are only allowed in portions of Colorado, Utah, Idaho, and British Columbia (Hoffman and Thomas 2007).

Two petitions for listing CSTG under the Endangered Species Act have been filed with the U.S. Fish and Wildlife Service (USFWS). Currently, the subspecies is not protected (U.S. Department of Interior 2000, 2006). In making their ruling the subspecies did not warrant listing, the USFWS expressed concern about the status of small, isolated populations, but concluded the large metapopulations of CSTG were not at risk of extirpation. The USFWS retained the option to recognize a population segment for listing should information become available which indicates such action is appropriate and warranted (Fig. 2).

Several agencies have prepared conservation, management, or recovery plans for CSTG including British Columbia (Ritcey 1995, Leupin and Chutter 2007), Washington (Stinson and Schroeder 2012), Utah (UDWR 2002), Montana (Wood 1991), and Colorado (Braun et al. 1994, Hoffman 2001). Idaho is in the process of preparing a plan (J. M. Knetter, Idaho Department of Fish and Game, personal communication). Oregon completed a plan in 2005, but adoption was delayed because conservation of greater sage-grouse (*Centrocercus urophasianus*) garnered higher priority (D. A. Budeau, Oregon Department of Fish and Wildlife, personal communication). At regional and national levels, Hoffman and Thomas (2007) prepared a technical conservation assessment of CSTG for the Rocky Mountain Region of the USFS, and Bart (2000) prepared a range-wide status review of CSTG for the USFWS. The grassland conservation plan for prairie grouse mentions CSTG (Vodehnal and Haufler 2008), but only addresses strategies for management of plains and prairie (*Tympanuchus phasianellus campestris*) STG along with greater (*Tympanuchus cupido*) and lesser (*Tympanuchus pallidicinctus*) prairie-chickens.

Figure 2. Columbian sharp-tailed grouse are the smallest of 6 existing subspecies of sharp-tailed grouse in North America. The subspecies has twice been petitioned for protection under the Endangered Species Act. (Photos courtesy of Colorado Parks and Wildlife [CPW]).

# Population Ecology

## Movements and Home Range Size

Seasonally distinct home ranges corresponding to spring-autumn (breeding, nesting, and brood-rearing) and winter periods typify CSTG use of landscapes. The exception is during mild winters when grouse may remain on spring-autumn ranges or move between spring-autumn and winter ranges depending on snow conditions (Ulliman 1995, McDonald 1998). Distances moved between spring-autumn and winter ranges may exceed 40 km, but generally average <10 km (Fig. 3; Table 2). Movements within seasonally occupied ranges are restricted to small home ranges that average <200 ha and frequently are <100 ha (Marks and Marks 1987, Ulliman 1995, Giesen 1997, Collins 2004, Boisvert et al. 2005).

Evidence of partial gender segregation in winter is inconclusive. Ulliman (1995), Schroeder (1996), and Collins (2004) documented longer movements to wintering areas by females than males (Table 2). Collins (2004) prefaced his findings by noting that some males moved long (>20 km) distances and some females wintered close (<2 km) to their lek of capture. In north-central Washington, females moved farther than males to wintering areas on 1 study area, whereas the opposite was documented on another study area (McDonald 1998). Boisvert et al. (2005) found males and females moved similar distances to wintering areas and wintered in the same geographic area (Table 2). Boisvert et al. (2005) suggested males and females using the same general area may segregate on a finer scale than studies have documented to date.

Data obtained throughout the range of CSTG indicate most (>80%) females nest and raise broods within 2.0 km of their lek of capture (Table 3). Collins (2004) found the median distance between nest sites in successive years was 0.3 km ($n$ = 28, range = 0.02–5.7 km), indicating females exhibit an affinity for previously used nesting areas. Average movements from nest sites to brood-rearing areas were reported by Meints (1991), Boisvert et al. (2005), and Collins (2004) as 0.6, 0.4, and 0.8 km, respectively. Collins (2004) found some females in his study made unusually long movements (>3.5 km) to brood-rearing sites, possibly due to drought conditions. Excluding those movements, findings of Collins (2004) were nearly identical to those of Meints (1991) and Boisvert et al. (2005). These findings suggest females select nest sites within or immediately adjacent to suitable brood-rearing areas.

Figure 3. Movements of Columbian sharp-tailed grouse between breeding (spring-autumn) and winter ranges vary from <1 km to >40 km based on multiple studies of radiomarked birds. These studies further indicate that most (80%) females nest and raise broods within 2 km of the lek where they were captured. (Photo of female with necklace-mounted radio by R. W. Hoffman/retired CPW).

**Table 2. Distances (km) moved by Columbian sharp-tailed grouse from their lek of capture to wintering areas.**

| Gender | *n* | Median | Mean | Range | Reference | Location |
|---|---|---|---|---|---|---|
| Male | 13 | 21.5 | 20.0 | 4.2–36.5 | Boisvert et al. 2005 | CO |
| Female | 17 | 21.4 | 22.1 | 3.1–41.5 | Boisvert et al. 2005 | CO |
| | | | | | | |
| Male | 47 | 5.4 | 6.5 | 0.5–28.6 | Collins 2004 | CO |
| Female | 71 | 7.5 | 10.4 | 0.5–48.9 | Collins 2004 | CO |
| | | | | | | |
| Male | 41 | 2.2 | 2.8 | 0.2–7.1 | Schroeder 1996 | WA |
| Female | 28 | 3.8 | 4.4 | 0.4–11.4 | Schroeder 1996 | WA |
| | | | | | | |
| Male | 9 | | 2.8 | 0.8–9.7 | McDonald 1998[1] | WA |
| Female | 4 | | 2.3 | 1.1–4.3 | McDonald 1998 | WA |
| | | | | | | |
| Male | 2 | | 1.0 | 0.2–2.6 | McDonald 1998 | WA |
| Female | 6 | | 5.5 | 0.5–11.5 | McDonald 1998 | WA |
| | | | | | | |
| Male | 6 | 0.6 | | 0.5–2.2 | Ulliman 1995[2] | ID |
| Female | 6 | 3.2 | | 1.1–9.9 | Ulliman 1995 | ID |
| | | | | | | |
| Male | 4 | 2.0 | | 1.2–3.7 | Ulliman 1995 | ID |
| Female | 9 | 3.4 | | 0.8–9.2 | Ulliman 1995 | ID |

[1] Distances reported separately by study areas.

[2] Distances reported separately by years of study.

**Table 3. Distances (km) moved by female Columbian sharp-tailed grouse from their lek of capture to initial nest sites.**

| *n* | Median | Mean | Range | Reference | Location |
|---|---|---|---|---|---|
| 58 | 0.6 | 1.3 | 0.1–11.3 | Boisvert et al. 2005 | CO |
| 130 | 1.0 | 1.5 | 0.1–21.7 | Collins 2004 | CO |
| 42 | 0.8 | 1.6 | 0.1–7.0 | Schroeder 1996 | WA |
| 41 | 1.4 | 2.0 | 0.2–12.7 | Apa 1998 | ID |
| 16 | | 1.2 | | Meints 1991 | ID |

## Survival

There are a paucity of longevity data for CSTG because no long-term (≥4 years) studies have been conducted. Longevity data for other subspecies of STG suggest few birds live past 3 years (Hamerstrom and Hamerstrom 1951, Ammann 1957, Robel et al. 1972, Sisson 1976). Annual survival estimates reported for CSTG range from 20% to 57% (Table 4). Most studies have reported no differences (Schroeder 1996, McDonald 1998, and Collins 2004) or only marginal differences (Boisvert 2002) in annual survival by gender.

Summarizing data from several studies of STG, Bergerud and Gratson (1988) estimated only 4% of females are killed on the nest. Studies of CSTG support this conclusion (McDonald 1998, Boisvert 2002, Collins 2004, Gillette 2014). McDonald (1998) found survival of nesting females (89%) was no different than survival of non-nesting females (96%). However, for the 21-day period following hatching, survival of females with broods (81%) was significantly lower than that of females without broods (97%). Gillette (2014) detected no consistent trends in survival of yearling (62%) and adult (58%) female CSTG during the reproductive period (Apr-Sept). Survival of female plains STG during the reproductive period (1 May–13 Aug) was 53% (95% CI: 44–63%) over 3 years in southeastern Alberta (Manzer and Hannon 2007).

Survival of CSTG chicks until 45–50 days was 12% in north-central Washington (McDonald 1998), and 20% (Collins 2004) and 48% (Boisvert 2002) in northwestern Colorado based on flush counts of radiomarked brood hens (Fig. 4). Survival of chicks in broods of adult females was higher than for chicks in broods of yearling females (Collins 2004). In southeastern Alberta, survival of radiomarked plains STG chicks to 30 days was 47% over 2 years (95% CI: 29–64%) with 81% of mortalities occurring during the first 15 days (Manzer and Hannon 2007). Survival of plains STG to 35 days in British Columbia was 37±7%; distance moved from the nest and inclement weather during the first 7 days post-hatch significantly reduced the survival rate of chicks to 14 days (Goddard and Dawson 2009).

## Reproduction

Most (>90%) females attempt to nest, lay large clutches (10–12 eggs; Fig. 5), and often renest if the first nest is abandoned or depredated (Table 4). Adult females renested at a higher rate than yearling females in Colorado (Collins 2004), but not in Idaho (Gillette 2014). Some females will attempt to renest more than once within a single nesting season (Schroeder 1996, Apa 1998, McDonald 1998, Boisvert 2002, Gillette 2014). Only rarely will a female renest after losing her brood (Apa 1998). Clutch sizes of initial nests are larger than those of renests (Table 4). Estimates of nesting success throughout the range of CSTG vary from 37% to 72% (Table 4). No differences in nest success have been detected between initial nests and renests (McDonald 1998, Boisvert 2002), or between adult and yearling females (Apa 1998, Collins 2004, Gillette 2014).

Approximately 63% of females that successfully nested in northwestern Colorado still possessed ≥1 chick by mid-August (Boisvert 2002, Collins 2004). This equated to 3.7 chicks/successful female or 1.4 chicks/female alive at the onset of nesting. In north-central Washington, Schroeder (1996) and McDonald (1998) reported averages of 3.4 and 2.5 chicks/successful female at 45–50 days post-hatch. At approximately 1 month (28–31 days) post-hatch, average brood size was 4.6 chicks/successful female in northern Utah (Hart et al. 1950) and 4.1 chicks/successful female in eastern Idaho (Meints 1991).

Figure 4. Although Columbian sharp-tailed grouse chicks are precocial, they require brooding during the first 2–3 weeks of life because they cannot thermoregulate. Consequently, prolonged inclement weather during this time can have a pronounced influence on chick survival. (Photo of chicks <1 week old by R. W. Hoffman/retired CPW).

Figure 5. Columbian sharp-tailed grouse have naturally high reproductive rates to compensate for their high mortality rates. (Photo of successful nest by K. F. Stonehouse/Washington State University).

**Table 4. Annual survival and reproductive parameters of Columbian sharp-tailed grouse in Colorado (Giesen 1987, Boisvert 2002, Collins 2004), Utah (Hart et al. 1950), Idaho (Meints 1991, Apa 1998, Gillette 2014), and Washington (Schroeder 1996, McDonald 1998).**

| Source | Annual survival | | Nesting effort[1] | | Renesting effort[2] | | Hen success[3] | | Nest success[4] | | Clutch size, initial nest | | Clutch size, renest | | Hatching success[6] | | Brood success[7] | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | % | *n* | % | *n* | % | *n* | % | *n* | % | *n* | mean | *n* | mean | *n* | % | *n* | % | *n* |
| Giesen 1987 | | | | | | | | | 62 | 13 | 10.8 | 10 | | | | | | |
| Boisvert 2002 | 20 | 61 | 98 | 62 | 24 | 33 | 47 | 62 | 42 | 67 | 10.2 | 39 | 7.8 | 5 | 91 | 367 | 76 | 28 |
| Collins 2004 | 39 | 196 | 98 | 121 | 47 | 38 | 71 | 121 | 63 | 137 | 10.4 | 71 | 8.5 | 11 | 94 | 835 | 58 | 79 |
| Hart et al. 1950 | | | | | | | | | 37 | 110 | 11.0[5] | 127 | | | | | | |
| Meints 1991 | | | 100 | 20 | 80 | 5 | 86 | 20 | 72 | 25 | 11.9 | 19 | 10.0 | 4 | 91 | 196 | | |
| Apa 1998 | | | | | | | 58 | 38 | 51 | 47 | | | | | | | | |
| Gillette 2014 | 42 | 129 | 100 | 108 | 56 | 63 | | | 33 | 143 | 11.1 | 71 | 8.7 | 27 | | | 38 | 48 |
| Schroeder 1996 | 57 | 102 | 100 | 42 | 89 | 27 | 65 | 42 | 43 | 67 | 11.5 | 28 | 8.9 | 13 | 92 | 244 | 43 | 21 |
| McDonald 1998 | 55 | 38 | 91 | 44 | 73 | 22 | 49 | 45 | 41 | 54 | 12.2 | 17 | 9.5 | 10 | 95 | 183 | 50 | 22 |

[1] Proportion of females alive at the onset of nesting that attempted to nest.

[2] Proportion of females that survived their initial nest failure and attempted to lay a second clutch.

[3] Proportion of females that hatched ≥1egg.

[4] Proportion of nests in which ≥1egg hatched (includes initial nests and renests).

[5] Combined clutch size for initial and renest attempts.

[6] Proportion of eggs in successful nests that hatched.

[7] Proportion of females that successfully nested and still possessed ≥1chick at 35–50 days post-hatch.

# Habitat Requirements


Figure 6. Columbian sharp-tailed grouse use artificially-created habitats, such as Conservation Reserve Program (CRP) lands (left). However, large tracts of relatively undisturbed native habitats (right) are essential for maintaining healthy populations. (Photo of CRP field by R. W. Hoffman/retired CPW; photo of native shrub-steppe by J. M. Knetter/IDFG).

## General

Sharp-tailed grouse can tolerate a moderate degree of habitat disturbance, and will use and benefit from artificially-created habitats (Connelly et al. 1998, Hoffman and Thomas 2007, Stinson and Schroeder 2012). For example, CSTG have adapted to using agricultural fields, Conservation Reserve Program (CRP) stands, mine reclamation lands, and large-scale clear-cuts, and can exist in simple or complex vegetation types as long as they provide adequate food and cover (Hart et al. 1950, Meints 1991, Sirotnak et al. 1991, Apa 1998, McDonald 1998, Boisvert 2002, UDWR 2002, Collins 2004, Leupin and Chutter 2007, Stonehouse 2013, Gillette 2014). Even so, managers must understand CSTG cannot persist in artificially-created habitat alone, nor can they persist on small, isolated tracts of native habitat (Fig. 6). Besides requiring a full suite of seasonal habitats, space is as critical to survival of STG as cover (Bergerud 1988*a*). Maintaining healthy populations requires extensive, relatively undisturbed, native landscapes exposed to natural disturbance regimes (Bergerud 1988*a*, Johnsgard 2002).

## Food Habits

Plant materials comprise most of the diet of CSTG (Marshall and Jensen 1937, Hart et al. 1950, Jones 1966, Parker 1970, Marks and Marks 1987, Schneider 1994). The diet often differs between winter and other seasons due to changing snow depths (Marshall and Jensen 1937, Hart et al. 1950). During winter, diets primarily consist of buds and persistent fruits of deciduous trees and shrubs that protrude above snow (Fig. 7), particularly serviceberry (*Amelanchier* spp.), chokecherry (*Prunus virginiana*), water birch (*Betula occidentalis)*, hawthorn (*Crataegus* spp.), quaking aspen

Figure 7. Buds, catkins, and persistent fruits of deciduous shrubs and trees provide critical foods for Columbian sharp-tailed grouse during winter. (Photo of female eating water birch catkins by G. Thompson/Seattle, WA).

(*Populus tremuloides*), Woods' rose (*Rosa woodsii*), snowberry (*Symphoricarpos* spp.), willow (*Salix* spp.), and juniper (*Juniperus* spp.). Other items that have been identified as winter foods include Russian olive (*Elaeagnus angustifolia*) berries and midge galls (*Rhoplomyia* spp.) from sagebrush (Schneider 1994). During mild winters, CSTG may supplement their normal diet of buds and persistent fruits with grains, forbs, and grasses (Schneider 1994).

Diets gradually shift to forbs and grasses in spring as snow melts. Forbs continue to be the main item in diets throughout summer, along with insects, fruits, and seeds as they become available. Forbs, insects, seeds, fruits, and cultivated grains may be consumed during autumn. Grasshoppers (Orthoptera), ants (Hymenoptera), and beetles (Coleoptera) are critically important in diets of chicks (Connelly et al. 1998). Insects comprised 92–100% of the diet of 2–3 week old STG in Nebraska and North Dakota and gradually declined to 12–26% at 11–12 weeks of age (Kobriger 1965, Bernhoft 1969). Adults also consume insects, although Jones (1966) reported adult STG tend to consume fewer insects than other species of prairie grouse.

Green plant material represented 96% of the total volume of foods eaten by CSTG in north-central Washington during spring and summer, with Sandberg bluegrass (*Poa secunda*), early buttercup (*Ranunculus glaberrimus*), and common dandelion (*Taraxacum officinale*) the most frequently identified food items (Jones 1966). More than 50 items were identified in summer and autumn diets of CSTG in southeastern Idaho, but only a few items comprised >80% of foods consumed (Parker 1970). These included insects, creeping barberry (*Mahonia repens*), yellow salsify (*Tragopogon dubius*), prickly lettuce (*Lactuca serriola*), Douglas knotweed (*Polygonum douglasii*), buckwheat (*Eriogonum* spp.), wheat (*Triticum aestivum*), and common dandelion. Spring through autumn foods consumed in Utah were primarily obtained from agricultural lands and included insects, wheat, alfalfa (*Medicago sativa*), sunflowers (*Helianthus* spp.), and knotweed (Marshall and Jenkins 1937, Hart et al. 1950).

## Spring-Summer Habitats (Breeding)

### *Lekking*

Visibility on leks is important for ritualized displays of male grouse, to attract female grouse to the lek, and to detect predators (Ward 1984, Bergerud and Gratson 1988). For these reasons, leks are typically positioned on elevated sites (e.g., knolls and ridgetops) in open areas where slope generally averages <3% (Fig. 8; Hart et al. 1950, Rogers 1969, Parker 1970, Ward 1984, Boisvert 2002). Vegetation on leks is usually short and sparse, and primarily comprised of grasses (Boisvert 2002). However, CSTG will use sites with moderate (<15%) shrub cover (Ward 1984, Klott and Lindzey 1989). Suitable escape cover in the form of dense shrub patches or tall herbaceous cover usually occurs in close (<400 m) proximity to leks (Fig. 9; Boisvert 2002). Compared to random sites, leks sites tend to have less shrub and herbaceous cover, lower shrub height, more bare ground, lower visual obstruction readings (VOR), and lower plant species richness (Ward 1984, Boisvert 2002). Cover type at lek sites is less important than vegetative structure. Lek sites have been found in native sagebrush, shrub-steppe, grassland, and mountain-shrub communities as well as non-native or artificially-created cover types, such as CRP

**Figure 8. Columbian sharp-tailed grouse leks are typically located on elevated sites, such as knolls or ridgetops, where vegetation is short and sparse, and slope averages <3%. (Photo of active lek by R. W. Hoffman/retired CPW).**

**Figure 9. Escape and loafing cover in the form of tall herbaceous vegetation or shrub patches usually occurs in close proximity (<400 m) to leks. (Photo of active lek in foreground and nearby escape cover in background by R. W. Hoffman/retired CPW).**

lands, mine reclamation lands, clear-cuts, alfalfa and wheat fields, pastures, and grass-hay meadows (Hart et al. 1950, Rogers 1969, Hoffman 2001, Leupin and Chutter 2007, Gillette 2014). The single most important factor affecting lek location in eastern Idaho was proximity to suitable nesting and brood-rearing cover (Meints et al. 1992).

There is no evidence to suggest suitable lek sites are limiting. Males will adjust where they display in response to changing habitat conditions (Ward 1984, Hoffman 2001, Boisvert 2002). They may use several different sites within the same general area over a period of years, forming what are known as lek complexes (Stinson and Schroeder 2012). Males can even transform and improve an otherwise marginal site for lekking by trampling vegetation when performing their breeding rituals.

### *Nesting*

With regard to nesting habitat, CSTG are generalists (Apa 1998). They may nest in grasslands, alfalfa fields, seeded rangelands, CRP fields, or mine reclamation lands with few or no shrubs in the plant community, or in sagebrush, shrub-steppe, or mountain-shrub communities with ≤40% shrub cover (Table 5). Regardless of vegetation type used for nesting, CSTG consistently select sites with greater cover than randomly available across the landscape (Fig. 10). Investigators have reported some combination of the following cover-related measurements as being greater at nest sites than random sites: grass height, percent grass cover, VOR, percent litter cover, percent shrub cover, cover board readings, and percent residual cover (Meints 1991,

**Figure 10. Columbian sharp-tailed grouse nest beneath herbaceous and shrub cover, with females consistently selecting nest sites with denser cover than randomly available across the landscape. (Photo of successful nest in herbaceous cover by M. A. Schroeder/Washington Department of Fish and Wildlife [WDFW]; photo of female on nest beneath sagebrush plant by R. W. Hoffman/retired CPW).**

**Table 5. Mean habitat characteristics associated with Columbian sharp-tailed grouse nest sites.**

| State[1] | *n* | VOR[2] | %Grass | Grass ht (cm) | %Forb | Forb ht (cm) | %Shrub | Shrub ht (cm) | Species richness | %Bare ground | %Litter |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CO (1) | 36 | 55 | 41, 45[3] | 57 | 17, 26[3] | | 2 | 36, 41[3] | 15, 19[3] | 5, 8[3] | 88 |
| CO (2) | 71 | 68 | 15, 19[3] | 16, 22[3] | 17 | | 40 | 60 | 23, 27[3] | 9, 11[3] | 70, 86[3] |
| CO (3) | 61 | 43, 58[3] | 33 | 68, 93[3] | 23 | 32, 44[3] | 10, 24[3] | 30, 50[3] | 13, 16[3] | 6, 11[3] | 79 |
| WA (4) | 44 | 20 | 48 | | 13 | | <1 | | 13 | 10 | 76 |
| WA (5) | 26 | | 61 | 38 | 14 | | 1 | | >15 | | 58 |
| ID (6) | 51 | 90 | 20 | 36 | 7 | 20 | 10 | 59 | 13 | | 37 |
| ID (7) | 23 | | | 18, 27[4] | | | >35 | | | 15 | |
| ID (8) | 9 | | 19 | | 28 | | 16 | | | | |

[1]References for measurements: 1 Collins (2004) mine reclamation sites, 2 Collins (2004) shrub-steppe sites, 3 Boisvert (2002), 4 McDonald (1998), 5 Stonehouse (2013) predominantly grassland (Conservation Reserve Program) sites, 6 Apa (1998), 7 Meints (1991), 8 Marks and Marks (1987).

[2]Visual Obstruction Reading.

[3]Data reported separately by year.

[4]Grass height reported separately for unsuccessful (18 cm) and successful nests (27 cm).

Schroeder 1996, Apa 1998, McDonald 1998, Boisvert 2002, Collins 2004, Stonehouse 2013). Further, some of these same measurements (e.g., percent residual grass, percent litter cover, and VOR) have been found to decrease at increasing distances from nest bowls, indicating micro-selection within suitable nesting cover (McDonald 1998, Boisvert 2002, Collins 2004). Measurements indicative of greater cover tend to be higher at successful than unsuccessful nest sites, whereas bare ground tends to be lower (Table 6). Percent bare ground also tends to be less at nest sites than random sites (Meints 1991, Schroeder 1996, McDonald 1998) and increases at increasing distances from nest bowls (McDonald 1998, Collins 2004).

Optimum nest sites in Washington had a VOR of 27.9 cm, 54.2% grass cover, 82.8% litter cover, 5.6% bare ground, and 84% overhead canopy cover (McDonald 1998). Nest sites in northwestern Colorado had greater residual vegetation (≥8.5%), grass (≥31.9%), VOR (≥48.8 cm), and overstory cover (≥62.8%) than random sites (Boisvert 2002). Collins (2004) recommended nesting areas in shrub-steppe should have grass cover ≥22%, grass height ≥22 cm, bare ground ≤3.4%, and VOR ≥48 cm. The Habitat Suitability Index Procedure for CSTG in Idaho revealed optimum nest/brood habitat occurred where VOR of residual vegetation was ≥25 cm and when the equivalent optimum area providing nest/brood habitat within 2 km of leks was ≥50% (Meints et al. 1992). Nesting cover with mean herbaceous height >20 cm may be suitable, as long as numerous sites with taller (≥30 cm) cover are present.

### *Brood-rearing*

Brood habitats must be structured so chicks can easily move through vegetation, support suitable cover for protection from predators and adverse weather, and provide adequate food to meet nutritional requirements of females and chicks (Bergerud and Gratson 1988). Because broods have limited mobility at an early age, it is important that brood habitat be interspersed or occur in close proximity to nesting habitat. The primary features of suitable brood habitat are an abundance of forbs, high interspersion of cover types, and high species richness of grasses and forbs (Fig. 11; Table 7). Whereas these characteristics may be found in native cover types, evidence suggests artificially-created cover types used by CSTG broods may not provide the same characteristics. For example, CSTG broods have been documented using CRP fields where >95% of the vegetation consists of only 2–5 species of grasses and forbs in relatively homogeneous stands (Sirotnak et al. 1991, Apa 1998, McDonald 1998, Boisvert 2002, UDWR 2002, Rodgers and Hoffman 2005, Gillette 2014).

In northwestern Colorado, Boisvert (2002) reported females with broods used areas with VOR ≥50 cm, >20% forb cover,

**Table 6. Mean habitat characteristics that differed between successful and unsuccessful Columbian sharp-tailed grouse nest sites.**

| Habitat characteristic | Successful | Unsuccessful | Study |
|---|---|---|---|
| Grass height 0 (cm)[1] | 26.8 | 18.4 | Meints 1991 |
| Grass height 0 (cm)[1] | 20.8, 21.5[2] | 16.8, 17.0[2] | Collins 2004[3] |
| Grass height 1 (cm)[4] | 62.1, 37.5[2] | 38.8, 20.9[2] | Collins 2004[5] |
| % Grass | 54.2 | 45.0 | McDonald 1998 |
| % Litter | 82.8 | 71.5 | McDonald 1998 |
| % Bare ground | 5.6 | 10.7 | McDonald 1998 |
| Canopy cover[6] | 13.4 | 7.1 | McDonald 1998 |
| VOR 2.5 (cm)[7] | 46.2 | 31.1 | Collins 2004[3] |
| VOR 10 (cm)[7] | 59.1 | 40.9 | Collins 2004[5] |
| VOR 1 (cm)[7] | 38 | 30 | Boisvert 2002[3] |
| VOR 1 (cm)[7] | 38 | 23 | Boisvert 2002[5] |

[1]Grass height at the nest bowl.
[2]Data reported separately by year of study.
[3]Nests located in shrub-steppe.
[4]Grass height 1 m from the nest bowl.
[5]Nests located in mine reclamation.
[6]Measured using a cover board (16-3X3 cm squares) read from a position directly above the nest bowl with all squares ≥50% covered by vegetation counted.
[7]Visual Obstruction Reading at 2.5, 10, and 1 m from the nest bowl.

Figure 11. Examples of Columbian sharp-tailed grouse brood-rearing habitat showing an interface between vigorous herbaceous and shrub communities (left) and high interspersion of shrub and herbaceous cover (right). These sites support abundant and diverse populations of insects, which are critically important in diets of chicks. (Photos by R. W. Hoffman/retired CPW).

and ≥70% canopy cover, mainly in the form of grasses and forbs and secondarily by shrubs. Unlike nest sites, brood-site characteristics were more uniform across larger areas and reflected the need of broods to move to obtain adequate resources (Boisvert 2002). Broods in mine reclamation areas and native shrub-steppe consistently used sites with greater forb cover and taller forbs than randomly available within these cover types (Collins 2004). Brood-rearing habitats in Idaho also had greater forb cover than independent sites, but were similar to nesting areas, except with higher cover values (Apa 1998). Females with broods in south-central Wyoming used sites within shrub-steppe and mountain shrub communities where shrub cover and height were less than average for the cover type (Klott and Lindzey 1990). During a severe drought year in Colorado, females that successfully nested in shrub-steppe moved their broods to higher elevations and used mountain shrub sites dominated by serviceberry and Gambel oak (Collins 2004).

Minor differences have been documented in habitat use patterns between females with broods and males and females without broods (Meints 1991, Boisvert 2002). Availability of free water does not appear to be a requirement for CSTG during summer (Parker 1970, Klott 1987, Saab and Marks 1992), although they will use water sources when available.

## Autumn-Winter Habitats

Columbian sharp-tailed grouse continue to use spring-summer habitats into autumn (Giesen 1997, Boisvert 2002). In late summer and early autumn, males may reappear on leks during early morning (Moyles and Boag 1981, Kermott 1982, Hoffman and Thomas 2007). However, not all leks active in spring are active in autumn. In addition, attendance at leks during autumn is less consistent compared to the spring lekking period (Moyles and Boag 1981). Females occasionally visit leks in autumn, but not nearly as often as

Table 7. Mean habitat characteristics associated with Columbian sharp-tailed grouse brood sites.

| State | *n* | % Grass | Grass ht (cm) | % Forb | Forb ht (cm) | % Shrub | Shrub ht (cm) | % Bare ground | Species richness | % Litter |
|---|---|---|---|---|---|---|---|---|---|---|
| CO(1)[1] | 30 | 28 | 38 | 24, 27[2] | 23 | 2 | 35, 45[2] | 10, 15[2] | 17, 26[2] | 85 |
| CO (2) | 46 | 17 | 25 | 11, 15[2] | 13 | 28, 60[2] | 69, 118[2] | 14, 18[2] | 19, 26[2] | 77 |
| CO (3) | 99 | 26, 36[2] | 65, 85[2] | 22, 33[2] | 45, 58[2] | 4, 17[2] | 93 | 7, 12[2] | 11 | 78 |
| ID (4) | 51 | 17 | 32 | 8 | 25 | 19 | 90 | | 10 | 44 |
| ID (5) | 20 | 28, 33[2] | | 28 | | 14, 18[2] | | | | |
| ID (6) | 23 | | 44 | >20 | | 23 | 57 | 7 | | |
| WY(7) | 33 | 33 | | 29 | | 28 | | 10 | | 28 |

[1]References for measurements: 1 Collins (2004) mine reclamation sites, 2 Collins (2004) shrub-steppe sites, 3 Boisvert (2002), 4 Apa (1998), 5 Marks and Marks (1987), 6 Meints (1991), 7 Klott and Lindzey (1990).
[2]Data reported separately by year of study.

males (Hoffman and Thomas 2007). Because of their greater attraction to leks, males tend to stay on summer range longer into autumn than females (Boisvert 2002).

Onset of winter generally causes a marked shift in habitat use patterns of CSTG. As snow accumulates, CSTG abandon cover types associated with summer range in favor of mountain shrub and riparian areas that support tall (>1 m) deciduous shrubs and trees that protrude above the snow (Fig. 12; Hart et al. 1950, Marks and Marks 1988, Ulliman 1995, McDonald 1998, Boisvert 2002). Winter habitats typically include some combination of the following shrub species: serviceberry, chokecherry, hawthorn, willow, and water birch. Some authors reported use of wheat fields during winter (Meints 1991, McDonald 1998). Columbian sharp-tailed grouse commonly roost beneath the snow surface during winter when snow depths permit (Marks and Marks 1988, McDonald 1998). In portions of the range, CSTG may continue to use summer habitats during mild winters or move between winter and summer habitats depending on snow conditions (Ulliman 1995, McDonald 1998). Despite this behavior, Giesen and Connelly (1993) considered mountain shrub and riparian shrub communities essential for long-term persistence of CSTG.

Figure 12. Mountain-shrub and riparian-shrub communities provide critical winter habitats for Columbian sharp-tailed grouse throughout the subspecies' range. Important shrub species within these habitats include serviceberry and water birch. (Upper photo of mountain-shrub community by R. W. Hoffman/retired CPW; lower photo of riparian-shrub community by M. A. Schroeder/WDFW).

# Population Management and Related Guidelines

Figure 13. When access permits, the most efficient way to count leks is from a vehicle. However, flushing birds off leks is frequently the only way to obtain accurate counts. Males usually return to a lek within 10–15 minutes after an observer leaves. (Photo on left courtesy of H. Richardson/The Denver Post. Photo on right courtesy of CPW).

## Population Monitoring

Most wildlife agencies use lek counts to monitor CSTG populations, but survey methods and effort vary among agencies. Lek counts are expressed as total number of birds counted on leks and average number of birds counted/lek. Distinguishing between males and females is difficult because of morphological similarities between genders. Large numbers of females are seldom present on a lek at the same time. Therefore, attempting to count them separately from males does not add greatly to accuracy of counts. The most efficient way to count leks is from a vehicle (Fig. 13). However, some leks may not be accessible by vehicle due to lack of roads or road conditions. Obtaining an accurate count may be confounded if birds are obscured by vegetation or by lack of an adequate vantage point to view the lek. In such cases, flushing birds off a lek may be the only way to obtain an accurate count (Fig. 13; Hoffman and Thomas 2007, Gillette 2014). Flush counts are an acceptable method for counting grouse as males generally return to leks within 10–15 minutes of being flushed (Baydack and Hein 1987). Managers who want to count males and females separately on leks should review Hoffman and Thomas (2007:91).

Because leks are easy to locate and observe, lek counts have become an integral part of prairie grouse management programs (Johnsgard 2002). Lek counts are useful to detect presence-absence and annual and long-term population trends, and for tracking population distribution (Applegate 2000). Until methods are developed to estimate the total number of leks and until lek counts can be calibrated to actual population parameters by estimating detection probability, they cannot be used to reliably estimate population size (Beck and Braun 1980, Robel 1980, Applegate 2000, Anderson 2001, Walsh et al. 2004, Clifton and Krementz 2006).

No studies have estimated lek attendance rates (probability a bird is on a lek when the counts are conducted) and lek fidelity (likelihood a bird only attends one lek) for CSTG. Boisvert (2002) documented inter-lek movements for female CSTG, but this behavior has not been documented for males. Rippin and Boag (1974) reported some male plains STG (primarily yearlings) did not attend leks. In Michigan, the lek attendance rate of male prairie STG approached 90% from mid-April to early May and 95% of all radio-marked males attended only one lek (Drummer et al. 2011). Attendance was constant from sunrise to 3 hours post-sunrise. Females exhibited a lower lek attendance rate (60%) and lek fidelity (81%) than males. The lek attendance rate for females peaked shortly after sunrise and decreased rapidly thereafter. Also, the period when females exhibited a high lek attendance rate was shorter than for males. The lek attendance rate decreased as wind speed increased for both genders.

A recent evaluation using fixed-winged aircraft equipped with aerial infrared technology to count CSTG leks in Idaho indicated this approach may be an effective and efficient method to count leks compared to ground-based counts (Gillette 2014). No differences were detected in ground (mean = 11.2) and aerial infrared counts (mean = 10.8) conducted simultaneously on 19 leks after censoring 6 ground counts that were considered inaccurate (Gillette 2014). The air infrared method of circular flight around the lek at low altitude (150-190 m) did not cause the birds to flush from the lek. The cost to conduct the aerial counts ($177/lek) was over twice that of ground counts ($71/lek), but the air counts surveyed more leks in less time (88 leks in 4 days) compared to ground counts (required 29 days to count the same 88 leks).

Collection and analysis of wings from hunter-harvested birds is a common method used to derive an index of production (i.e., juvenile:adult; Fig. 14). The rigor of this index depends on the assumption that harvest rates of different age groups remain stable throughout a hunting season. This assumption has not been tested on harvested samples of CSTG. However, Flanders-Wanner et al. (2004*a*) found no difference in age ratio of harvested birds over time in 4 populations of plains STG in Nebraska. For CSTG, collection of wing-based production data is not possible for most populations because they are not hunted, or too few are harvested to obtain adequate samples. Hagen and Loughin (2008) reported a sample of ≥300 wings is necessary to generate reasonably precise estimates of productivity. Currently, only Idaho collects >300 wings/year (J. M. Knetter, Idaho Department of Fish and Game, personal communication, Gillette 2014). Giesen (1999) made a concerted effort to collect wings from hunter-harvested CSTG in northwestern Colorado from 1980 to 1997. During this time, collections averaged only 104 wings/year (range = 26–224), with >100 wings collected in only 8 of 18 years. Attempts to collect sufficient samples of wings in Utah have been unsuccessful due to low harvest levels and reluctance of hunters to give up a wing (they view CSTG as “trophy” game, J. D. Robinson, Utah Division of Wildlife Resources, personal communication).

Figure 14. Wing collection kiosk at Tex Creek Wildlife Management Area, Idaho. (Photo by J. M. Knetter/IDFG).


Figure 15. A group of volunteers conducting a flush survey of Columbian sharp-tailed grouse in northeastern Oregon. (Photo by M. A. Schroeder/WDFW).

Whereas wings can be used to determine age composition of the harvest, they cannot be used to assess sex ratios because males cannot be distinguished from females based on wing characteristics (Ammann 1944, Giesen 1999). Managers must collect head and/or tail feathers in addition to wings to ascertain sex composition of the harvest (Henderson et al. 1967).

Brood counts conducted along established routes are an alternative method to assess production where collection of wing-based production data is not possible. Routes are established through known brood-rearing and summer use areas and generally surveyed by vehicle in early morning and evening at speeds of 10–20 km/hr. Brood surveys are usually conducted in late July and early August when chicks are old enough to fly, but small enough to be distinguished from adults. Extended sampling periods may create bias due to changes in behavior and distribution of birds. In most encounters, observers must exit the vehicle and flush birds to obtain an accurate count. Number of broods encountered, number of chicks counted/brood, and number of other birds (males or females unaccompanied by chicks) observed are recorded for each route. If sufficient numbers of grouse are observed, brood routes can provide birds observed/km, broods observed/km, average brood size, and chicks observed/adult (includes yearlings). Unless an adult grouse is accompanied by chicks, one can seldom ascertain if a bird is a male or female due to plumage similarities. Thus, brood routes for CSTG cannot be used to estimate ratios of successful to unsuccessful females.

Collins (2004) found use of a trained hunting dog, after completion of a traditional flush count of CSTG broods without the dog, resulted in 16% more chicks being flushed. Traditional flush counts of greater sage-grouse broods only detected 72% of marked chicks, whereas flush counts using trained pointing dogs detected 96% (Dahlgren et al. 2010). Hoffman and Thomas (2007) suggested shorter routes that can be intensively searched on foot or horseback using trained hunting dogs may be a better approach to conducting brood counts than surveys conducted from vehicles along established roads (Fig. 15). Even this approach may not produce sufficient observations. Over 2 summers of searching for broods with a dog, Klott (1987) only encountered 28 individual CSTG broods in south-central Wyoming.

By applying statistical population reconstruction techniques to synthesize hunter harvest, lek count, and radio-telemetry data, Gillette (2014) was able to estimate fall population abundance of a hunted population of CSTG in Idaho from 2000-2013. The total estimated abundance was stable at around 37,000 (range =32,411-45,190) and was positively correlated with the annual lek count index (Gillette 2014). The stable trend in abundance was consistent with the findings of a separate study using 11 demographic variables to estimate the intrinsic rate of population change (λ) of CSTG occupying CRP and shrub-steppe landscapes (Gillette 2014). The results of this separate study indicated populations were relatively stable in both habitat types from 2011-2013. The ability to use this approach to estimate abundance emphasizes the value of collecting long-term data sets and the need to increase precision of the auxiliary information incorporated into the model because more precise auxiliary data will lead to greater precision in the statistical population reconstruction estimates (Clawson et al. 2013, Gillette 2014).

*Guidelines:*

1. Conduct studies to better understand lek attendance patterns of CSTG with the goal of developing detection probabilities that can be used to derive a more rigorous index of population change. This approach will require developing methods to capture males when they are not attending leks. Also, developing a means to estimate the number of unknown leks in an area is essential for relating lek counts to population size and trends (Walsh et al. 2004).

2. Continue to conduct lek counts annually until a more rigorous technique is developed and tested. Managers should be aware of limitations of lek counts and use caution in interpreting data.

3. Minimize sources of error in lek counts by standardization of protocols and effort, and by using experienced observers to conduct counts.

4. Attempt to count all known leks. Flush counts should be conducted when there is no other way to accurately count all birds on the lek.

5. Conduct lek counts from ½ hour before sunrise to 2 hours after sunrise on mornings with wind <16 km/hr and no precipitation.

6. Attempt to count each lek 2 times.

7. Counting all leks and obtaining 2 counts/lek may be unrealistic in areas with large numbers of leks. If so, obtain 1 reliable count or select a sample of leks to count each year. Consider a combination of ground and aerial infrared counts to survey all known leks.

8. Consistency from year to year is important. Count individual leks at about the same time each year. Timing of counts may need to be adjusted slightly from year to year depending on snow cover and weather patterns. If only a sample of leks is surveyed, then count the same leks each year for comparative purposes and consistency.

9. Efforts should be made to locate new leks in conjunction with counting known leks. Search suitable habitats within a 1-km radius of sites that were previously occupied to ascertain whether a lek has moved. Mitigate the effects of potential inter-lek movements by counting all known sites within a lek complex and all known leks within the same general area on the same morning.

10. Maintain lek count data in a centralized database. The template for this database should be the same among agencies. Retain locations of unoccupied sites in the database for future reference. Classify sites unoccupied for ≥5 consecutive years as inactive. Check inactive sites periodically (every 3–5 years) for occupancy unless there is an obvious reason why sites were abandoned (e.g., habitat conversion) and there is no likelihood of future occupancy.

11. Use color infrared aerial photography to develop interpretation criteria for identifying lek sites based on known leks, and test feasibility of using this information to identify potential new lek sites (Grensten 1987).

12. For hunted populations, collect and analyze wings from hunter-harvested birds to estimate the proportion of juveniles in the harvest in relation to yearlings and adults. Attempt to collect a minimum sample of 300 wings,

13. Collect head and/or tail feathers in addition to wings to estimate sex ratio in the harvest.

14. Compare sex and age ratios derived from harvest samples collected over the course of the season to detect possible differential harvest rates and changes over time.

15. Because brood surveys conducted from a vehicle are labor-intensive and seldom result in adequate sample sizes, they are not recommended as a means of assessing production of CSTG. However, surveys conducted on foot or horseback along established transects using trained hunting dogs may provide useful information for localized areas.

16. Collect hunter harvest, lek count, and radio-telemetry and/or banding data, and use this information in a statistical population reconstruction model to obtain annual abundance estimates for hunted populations of CSTG (Broms et al. 2010, Gillette 2014). Media campaigns should be directed at increasing hunter participation in wing collection programs and harvest surveys in an effort to increase the precision of the abundance estimates.

## Hunting

The general approach to harvest management of upland game birds was developed in the 1930s and 1940s (reviewed by Reese and Connelly 2011, Connelly et al. 2012). During that period, concepts of compensatory mortality and diminishing returns were introduced and incorporated into harvest strategies. The basic premise was that a large portion of a population could be harvested each autumn because, if not taken by hunters, they would die of natural causes. These concepts have since been characterized as dogma because they have not been critically evaluated and tested for many species (Romesburg 1981). Most upland bird populations, especially prairie grouse, currently exist under vastly different conditions (i.e., fragmented landscapes with multiple anthropogenic features) than during the mid-20th century. Consequently, concepts of compensatory mortality and diminishing returns may have little application to present day harvest management programs.

Indeed, there are a growing number of studies that indicate hunting of tetraonids is often not compensatory (Bergerud 1988*a*, Ellison 1991, Small et al. 1991, Steen and Erikstad 1996, Smith and Willebrand 1999, Connelly et al. 2003). The argument that additive hunting mortality would be manifested in declines of subsequent breeding populations may not be valid. Immigration from lightly hunted or non-hunted areas may sustain densities on some heavily hunted areas (Small et al. 1991, Smith and Willebrand 1999). As a result, negative effects of hunting may go undetected or hunting may be interpreted as having no impact because breeding populations remain stable.

Although unregulated hunting in the late 1800s may have contributed to the decline of CSTG populations in some areas (Hart et al. 1950, Yocom 1952, Olson 1976), impacts of modern, regulated hunting on CSTG populations are mostly unknown. The average harvest rate of CSTG in Idaho over a 14 year period was 6.4%; harvest rates between 5 and 16% were considered acceptable if the goal was to maintain a stable population (Gillette 2014). Appropriate harvest rates have not been determined for other populations that are still hunted, nor is it known whether current harvest levels are compensatory or additive to natural mortality. This uncertainty is due to the absence of empirical research on effects of exploitation on CSTG populations. As a consequence, hunting seasons for CSTG have been developed primarily by trial and error.

Marks and Marks (1987) and Ritcey (1995) cautioned against allowing hunting of small, isolated populations of

CSTG. Hunting was a leading source of mortality for CSTG on 2 public Wildlife Management Areas in eastern Idaho (Meints 1991). Hoffman (2001) expressed concern about the potential for over-harvest of CSTG on public lands, but believed hunting of CSTG in Colorado was self-regulating because >70% of the population occurred on private lands where little or no grouse hunting was allowed. The lack of population responses to season closures has been cited as evidence that other factors besides hunting were primarily responsible for the decline of CSTG throughout its range (Connelly et al. 1998). For example, CSTG populations in Utah continued to decline despite a closed season for 25 years (Hart et al. 1950). Also, in Oregon, cessation of hunting in 1929 failed to prevent extirpation of CSTG in the state nearly 40 years later (Olson 1976).

Small populations of CSTG in Washington, Wyoming, and western Idaho are no longer hunted. In addition, areas where CSTG have been reintroduced in Colorado, Idaho, Nevada, and Oregon are closed to hunting. Areas open to hunting include portions of British Columbia, Idaho, Utah, and Colorado (Fig. 16). Approximately 60% of the occupied range in British Columbia is open to hunting, 95% in Idaho, 70% in Utah, and 65% in Colorado. In general, hunting seasons, daily bag limits, and possession limits for CSTG have become more conservative in response to changing population levels and increasing threats from other sources. Currently, British Columbia has the most liberal season (length = 82 days, daily and possession limit = 5 and 10) and Utah has the most conservative season (23 days, with a 2-bird/season limit). Seasons in Colorado vary from 16 to 21 days in length with a 2-bird daily bag and 4-bird possession limit. Idaho has a 31-day season, 2-bird daily bag, and 6-bird possession limit. Opening dates range from 1 September to 1 October. Utah has a limited-entry hunt, whereas hunter numbers are not restricted in British Columbia, Colorado, or Idaho. Idaho requires hunters to obtain a permit, but permits numbers are not limited. Average range-wide harvest of CSTG in western North America from 2000 to 2013 was 6,683 birds/year (Table 8).

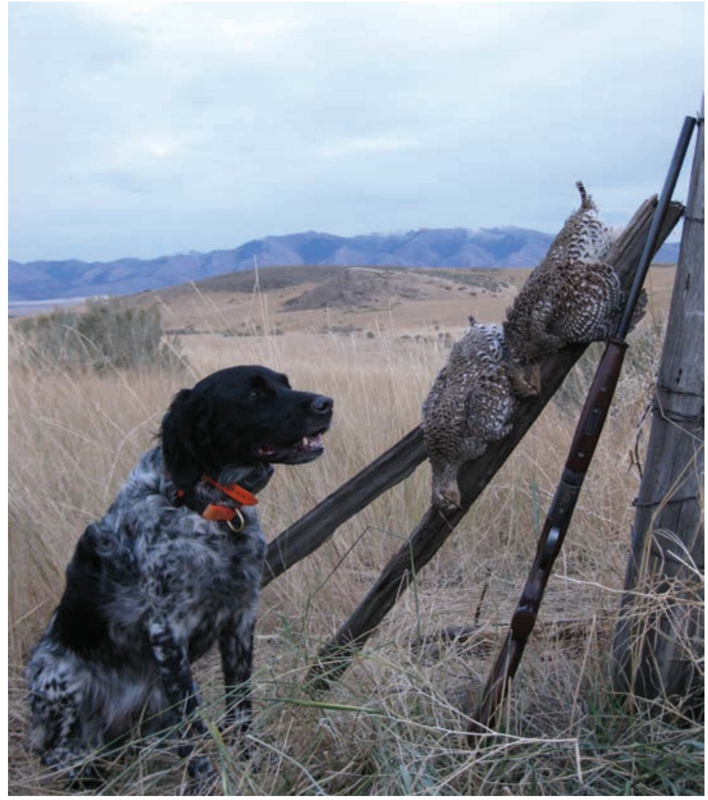

**Figure 16. Columbian sharp-tailed grouse are legally hunted in British Columbia, Idaho, Utah, and Colorado. (Photo by J. M. Knetter/IDFG).**

*Guidelines:*

1. Some level of hunting may be acceptable. However, wildlife agencies must be sensitive to public apprehension about allowing hunting for species of special concern.

2. Continue to take a conservative approach to developing harvest strategies for CSTG in the absence of reliable estimates of population size and harvest rates, and uncertainty about dynamics of small populations living in altered landscapes.

3. Implement banding studies to estimate population size and harvest rates.

**Table 8. Average hunters, harvest, and birds/hunter for Columbian sharp-tailed grouse in western North America, 2000–2013.**

| Location | Hunters | | Harvest | | Birds/hunter | |
|---|---|---|---|---|---|---|
| | Average | Range | Average | Range | Average | Range |
| BC | 619 | 345–939 | 1,294 | 549–1,823 | 2.1 | 1.3–3.2 |
| CO | 231 | 85–576 | 395 | 148–1,096 | 1.7 | 1.2–3.1 |
| ID | 2,200 | 1,700–3,000 | 4,826 | 2,900–6,900 | 2.2 | 1.4-3.4 |
| UT | 203 | 71–364 | 167 | 46–279 | 0.8 | 0.6–1.2 |
| Range-wide | 3,253 | 2,549–4,125 | 6,683 | 3,927–8,955 | 2.1 | 1.4–2.8 |

4. Consider adjusting season dates and legal hunting hours to minimize harvest of males on leks during the autumn lek-attendance period and of females with broods.

5. Consider implementing walk-in programs and leasing state trust lands for public access where hunting opportunities are limited due to the preponderance of private lands.

6. Use educational information and increased law enforcement where needed to reduce accidental harvest of CSTG during legal hunting of other upland bird species.

7. Implement a permit system for hunting CSTG (already implemented in Idaho and Utah) in order to obtain more precise estimates of hunter effort and harvest. Permit numbers can be unlimited or limited depending on the need to manage hunter participation. Harvest surveys should be conducted by phone, mail, or online immediately following close of the season. Mail surveys should include ≥2 non-response surveys to minimize non-response bias (Braun et al. 1994, Hoffman 2001).

## Predation

Predation is a fact of life for grouse, accounting for over 85% of all causes of mortality and 79% of all nest failures (Fig. 17; Bergerud 1988*b*). However, identifying cause-specific (e.g., mammalian or avian) mortality in grouse is difficult (Lariviere 1999, Bumann and Stauffer 2002). Identifying a specific predator is even more challenging, especially for prey such as CSTG that have a large suite of predators, none of which specialize on CSTG as their primary food source (Connelly et al. 1998, Hoffman and Thomas 2007). Hart et al. (1950) attributed 93% of CSTG mortalities in Utah for which cause of death was ascertained to mammalian predators. Avian predators were responsible for 86% of CSTG mortalities in western Idaho (Marks and Marks 1987). Avian predation also was the major (33%) source of mortality for radiomarked CSTG in eastern Idaho; hunting and unknown causes each accounted for 29% of documented mortalities and mammalian predation accounted for 9% (Meints 1991). Coates (2001) found mammalian predation (51%) was the primary cause of mortality of translocated CSTG in northern Nevada, followed by avian predation (28%) and unknown causes (21%). Cause of death for 224 mortalities documented in northwestern Colorado was 35% mammalian, 26% avian, 7% other (included hunting), and 32% unknown (Boisvert 2002, Collins 2004). Known and suspected predators of CSTG mentioned in these studies included northern goshawk (*Accipiter gentilis*), golden eagle (*Aquila chrysaetos*), great horned owl (*Bubo virginianus*), prairie falcon (*Falco mexicanus*), red-tailed hawk (*Buteo jamaicensis*), Cooper's hawk (*Accipiter cooperii*), northern harrier (*Circus cyaneus*), Swainson's hawk (*Buteo swainsoni*), ferruginous hawk (*Buteo regalis*), common raven (*Corvus corax*), gulls (*Larus* spp.), bobcat (*Felis rufus*), red fox (*Vulpes vulpes*), coyote (*Canis latrans*), American badger (*Taxidea taxus*), weasel (*Mustela* spp.), rattlesnake (*Crotalus* spp.), and gopher snake (*Pituophis catenifer*). While some of these predators take grouse year-round, others only take grouse at certain times of the year, and still others may only prey on chicks or partially-grown juveniles.

Based on data collected across the West (Table 4), approximately 51% of all CSTG nests fail (Fig. 17). The same mammalian predators that prey upon CSTG also are known to consume their eggs (Hart et al. 1950, McDonald 1998, Collins 2004). Additional mammalian nest predators include striped skunk (*Mephitis mephitis*) and common raccoon (*Procyon lotor*). Black-billed magpie (*Pica hudsonia*), common raven, American crow (*Corvus brachyrhynchos*), and gulls are known avian predators of CSTG nests (Connelly et al. 1998, Schroeder and Baydack 2001, Hoffman and Thomas 2007). McDonald (1998) concluded coyotes and common ravens destroyed the majority of CSTG nests in eastern Washington. Collins (2004) attributed 56% of CSTG nest depredations in northwestern Colorado to mammals, 6% to avian predators, and 38% to unknown predators. Predators were responsible for 91% of all nest failures in southeastern Idaho; of 30 documented nest predation events recorded by video-monitoring, 16 were caused by American badgers, 8 by coyotes, 2 by common ravens, and one each by a striped skunk, long-tailed weasel (*Mustela frenata*), black-billed magpie, and cow (Gillette 2014). Although olfactory predators were responsible for 75% of the nest predation events, CSTG did not select nest sites with characteristics (i.e., higher wind velocity and turbulence) that matched the olfactory concealment theory (Gillette 2014).

Ground squirrels (*Spermophilus* spp.) have been identified as egg predators of STG nests (Connelly et al. 1998, Schroeder and Baydack 2001). Using video-monitoring and still photography, other investigators demonstrated that although ground squirrels frequently visited grouse nests, they did not take undamaged eggs (Holloran and Anderson 2003, Coates et al. 2008). However, ground squirrels were recorded scavenging egg shells and membranes from successful nests

Figure 17. Predation is the leading cause of mortality and nest failures of Columbian sharp-tailed grouse. Predator management is best addressed by protecting and enhancing existing habitats, restoring previously occupied habitats, increasing connectivity between suitable habitats, and reducing or modifying factors that facilitate predation. Predator control is only recommended under extenuating circumstances and should not be viewed as a long-term solution to predation issues. (Photo of depredated nest by A. D. Goddard/British Columbia Ministry of Environment; photo of resting coyotes by M. A. Parchman/Craig, CO; and photo of mortality by R. W. Hoffman/retired CPW).

or nests that were destroyed by other predators. Coates et al. (2008) cautioned that sign left at scavenged nests may result in incorrectly attributing predation events to ground squirrels. Michener (2005) found Richardson's ground squirrels (*Spermophilus richardsonii*) were incapable of puncturing or carrying off undamaged greater sage-grouse eggs because their functional gape-width was smaller than the average width of sage-grouse eggs. This same argument applies to CSTG eggs. The maximum (26 mm) and functional (17 mm) gape-width of Richardson's ground squirrels reported by Michener (2005) are substantially smaller than the average width of CSTG eggs (30–34 mm, Connelly et al. 1998). Gillette (2014) monitored 64 CSTG nests using videography and recorded only one unidentified rodent visiting a nest. The rodent made no attempt to remove any eggs.

The role of snakes in predation of CSTG nests has not been well documented. Egg predation by snakes in grassland and shrub habitats may be more frequent than previously considered (Davison and Bollinger 2000). Gopher snakes accounted for 19% of 161 nest depredations of lesser prairie-chickens in southwestern Kansas (Pitman et al. 2006). Collins (2004) suspected gopher snakes were responsible for the disappearance of 6 entire clutches of CSTG eggs in northwestern Colorado. However, other common predators may have been responsible for the losses. Similar to snakes, badgers and ravens sometimes remove or consume entire clutches, leaving no eggs or shell fragments behind (Coates et al. 2008, Gillette 2014). No snakes were recorded visiting 64 CSTG nests under video surveillance in Idaho (Gillette 2014).

Grouse have evolved with predators and developed strategies to compensate for high predation rates. Thus, predation is generally not a factor limiting grouse populations, provided large tracts of suitable habitat are available (Bergerud 1988*a*, Schroeder and Baydack 2001, Hagen 2011). However, large tracts of undisturbed habitat are seldom available because human activities have drastically altered landscapes within the range of CSTG. This situation may have disrupted the balance between predators and prey in ways that favor certain predators. The extent to which human activities have influenced predation on CSTG has yet to be determined, but it is likely human-related factors have contributed to increases in some predator populations, allowed other predators to expand their range, and improved hunting efficiency of other predators (Bergerud 1988*a*). For example, higher densities of corvids and a concomitant increase in predation rates of STG nests were associated with human-induced changes in landscapes in southeastern Alberta (Manzer and Hannon 2005). In southern Idaho and Oregon, raptors and common ravens began nesting on towers along a 596-km transmission line within 1 year of construction. Ten years after construction, 133 pairs of raptors and ravens were nesting along the line (Steenhof et al. 1993).

As prairie grouse populations become smaller in size and more threatened in status, managers will probably need to consider additional options for management of prairie grouse-predator relationships, including direct control of predator numbers (Schroeder and Baydack 2001, Hagen 2011). The question remains whether such action will be effective in obtaining conservation goals (Hagen 2011). Following a meta-analysis of 20 published predator-removal studies, 12 of which involved game birds, Côté and Sutherland (1997) concluded that although predator removal fulfilled goals of increasing harvestable post-breeding populations, such management was much less consistent in achieving conservation goals to increase breeding populations. Development of effective predator management programs to increase CSTG breeding populations will require a better understanding of predator communities as they relate to habitat variables and demographic rates of CSTG. Even with this information, predator removal programs designed to increase breeding populations may be plagued with technical problems (Côté and Sutherland 1997).

*Guidelines:*

1. Predator management for CSTG is best addressed by protecting, restoring, and enhancing habitats, and reducing or modifying factors that facilitate predation (Jiménez and Conover 2001, Schroeder and Baydack 2001).

2. Improvement of existing habitats alone will not ensure CSTG can cope with current predator communities. The most effective predator management strategy for CSTG is to increase availability of, and connectivity between, suitable habitats.

3. Creating small patches of suitable nesting and brood-rearing cover within otherwise marginal or unsuitable habitats may only serve to concentrate predators. Females must be provided opportunities to select from an expansive area of potential nest and brood-rearing sites to effectively evade predators (Bergerud 1988*a*).

4. Predator control is only recommended under extenuating circumstances because of high cost, questionable long-term benefits, protected status of many predators, possibility of predator exchange, and negative public attitudes towards broad-based predator control programs (Parker 1984, Côté and Sutherland 1997, Messmer et al. 1999, Schroeder and Baydack 2001, Hagen 2011).

5. Examples of situations that might justify predator control include protecting small, isolated populations until habitats are restored, protecting newly translocated grouse until they can become established, and removing an exotic predator that has become established in native habitat and is negatively affecting a local population. Control programs frequently must target a broad suite of predators over large (>40 km$^2$) areas to be effective (Frey et al. 2003). Once a control program is terminated, predator numbers will likely return to pre-control levels (Chesness et al. 1968, Duebbert and Kantrud 1974, Frey et al. 2003).

6. Control programs that target nest predators have the best chance for success.

7. Where feasible, remove from CSTG habitats unused structures and abandoned equipment that facilitate predation by providing denning, nesting, and perching sites for predators (e.g., buildings, grain bins, farm implements, utility poles, and fence posts).

8. Where possible, remove trees planted at abandoned homesteads, unless they provide a potential winter food source.

9. Where feasible, reduce or eliminate human-related food sources from CSTG habitats that may attract predators (e.g., unauthorized garbage dumps, bird feeding stations, livestock and roadkill carcasses, and free-ranging domestic poultry).

10. New power lines and utility lines should be located in existing corridors, buried (preferred alternative), or placed in locations that minimize risk of predation to CSTG.

11. Consider installing perch deterrent devices on new power lines and utility lines and retro-fitting existing lines on a case-by-case basis (Fig. 18; Slater

and Smith 2010). Deterrent devices will be most effective in areas with few alternative tall perch sites (both natural and human-supplied) or to reduce use of specific poles (e.g., those in close proximity to a lek). Managers must be aware that perch deterrent devices reduce, but do not completely prevent raptor and corvid perching, especially in open, perch-limited habitats (Slater and Smith 2010). Design perch deterrents to withstand weather extremes and to fit all parts of a pole where perching may occur, including insulators (Prather and Messmer 2010).

**Figure 18. Managers should be aware perch-deterrent devices discourage, but do not always eliminate perching by raptors and corvids, especially in areas where natural perches are limited. Perch-deterrent devices need only be installed on problem structures, such as those located immediately adjacent to a lek or within key nesting and brood-rearing habitats. (Photo by M. A. Schroeder/WDFW).**

## Disease and Parasites

Presence of parasites and disease-causing agents in grouse is normal and, in most cases, does not cause significant alteration in survival or reproductive performance of host species (Herman 1963). For STG, cases of disease and parasite infections and their subsequent effects on populations are poorly understood. Most of what is documented comes from studies on subspecies other than CSTG (Connelly et al. 1998, Peterson 2004). At least 11 species of protozoan and 20 species of helminth parasites have been found in STG (Braun and Willers 1967). Hillman and Jackson (1973) reported consistent and heavy parasite loads in plains STG from South Dakota (<2% of 800 birds examined were free of parasites). Approximately 125 CSTG trapped in northwestern Colorado and relocated to other areas of the state were tested for avian influenza, *Salmonella pullorum*, *Mycoplasma gallisepticum, M. synoviae,* and *M. meleagridis*. No clinical signs of disease were apparent in any of the birds examined and all samples tested negative (Gorman and Hoffman 2010). West Nile virus has been confirmed in numerous species of birds, including 3 species of grouse (CDC 2011). Mortality associated with West Nile virus reduced survival of female greater sage-grouse by 25% across 4 populations (Naugle et al. 2005). Greater sage-grouse challenged by subcutaneous injection of West Nile virus died within 6 days (Clark et al. 2006). Positive tests for West Nile virus have not been reported for STG, possibly due to the lack of intensive monitoring of STG populations since West Nile virus has spread westward. There is no reason to expect CSTG would not be susceptible to West Nile virus.

Ring-necked pheasants (*Phasianus colchicus*) are found in many areas inhabited by CSTG. Some are wild birds and others are game-farm birds released on shooting preserves or by private landowners. Pheasants are carriers of *Heterakis gallinarum* (Lund and Chute 1972), a cecal worm that can be infected with the protozoan that causes histomoniasis or blackhead disease. Pheasants are relatively resistant to histomoniasis, but can shed infected cecal worm eggs into the environment where other less resistant birds, such as grouse, may be exposed to the disease. Because histomoniasis has potential to cause significant (75%) mortality in native game birds, Peterson (2004) questioned the wisdom of perpetuating ring-necked pheasants in areas with at-risk populations of prairie grouse. Futhermore, avian influenza was detected in game farm pheasants in Washington during 2015 (M. A. Schroeder, Washington Department of Fish and Wildlife, personal communication).

Although no substantial mortality due to disease or parasitic infections has been documented in STG, potential for population impacts should not be dismissed (Peterson 2004). Emergence of new infectious diseases in grouse, such as West Nile virus, coupled with continued loss, fragmentation, and degradation of habitats, suggests diseases and parasites deserve greater attention from research and management perspectives (Peterson 2004, Christiansen and Tate 2011). Small, isolated populations are likely at greatest risk of being impacted by disease or parasitic infections (Christiansen and Tate 2011, Walker and Naugle 2011). Infections could lead to increased vulnerability of such populations to other stressors that could cause extirpation.

*Guidelines:*

1. Add disease surveillance protocols to CSTG research and management programs that involve trapping and handling wild birds by collecting, processing, and analyzing fecal and blood samples. Develop a process for centralizing information and archiving samples for future use.

2. Collect all remaining body parts from birds that died of unknown causes and promptly deliver or overnight-mail them to a health laboratory for disease testing. Keep carcasses refrigerated or on ice if possible. If a carcass cannot be delivered or mailed within 1 or 2 days, it should be frozen and delivered as soon as practical. Fresh carcasses provide the best samples and should be delivered for testing with minimal delay.

3. Collect any birds that exhibit unusual behavior (i.e., unable to fly or weak flight, drooping head or wings) or clinical signs of disease and submit carcasses for testing immediately.

4. Encourage landowners to keep domestic fowl in pens and not allow them to roam freely.

5. In order to mitigate potential impacts of West Nile virus on CSTG populations, take actions to reduce, eliminate, or modify human-made sources of water that serve as breeding sites for mosquitoes (*Culex* spp.) in CSTG habitats as recommended by Zou et al. (2006), Doherty (2007), and Walker and Naugle (2011).

6. To effectively detect presence of West Nile virus in CSTG populations, studies involving radiomarked birds should intensify monitoring efforts during peak West Nile virus season (1 Jul–31 Aug, Walker et al. 2004). Locate radiomarked birds once every 2–3 days and visually confirm them dead or alive every 3–4 days.

7. Conduct studies to better understand potential for disease transmission between exotic game birds, especially ring-necked pheasants, and CSTG in areas where their ranges overlap.

8. Wildlife agencies should consider risks when issuing licenses for private shooting preserves and discourage the release of ring-necked pheasants and other exotic game birds within the range of CSTG.

9. Restoring and enhancing native habitats of CSTG may minimize their use of cover types frequented by ring-necked pheasants and reduce risks of disease transmission.

## Collisions

Grouse as a group appear highly susceptible to collision with anthropogenic structures (Bevanger 1995, Baines and Andrew 2003, Wolfe et al. 2007, Stevens 2011), which may be related to their large body weight and high wing loading (Bevanger 1995, Janss 2000). Collisions with fences, power lines, and automobiles accounted for 93 (36%) of 260 mortalities of radiomarked lesser prairie-chickens in Oklahoma and New Mexico for which cause of death could be assigned (Wolfe et al. 2007). Collision mortality was second only to predation in causes of mortality. Of the 93 collision mortalities, 86 (92%) involved collisions with fences. In southern Idaho, greater sage-grouse fence collision rates averaged 0.70–0.75 strikes/km of fence (corrected for detection bias) over 2 breeding seasons (Stevens 2011). Collision rates differed regionally and were influenced by topography, population density, distance to nearest active lek, fence density, type of fence post, and distance between fence posts (Stevens et al 2012*a*). In another Idaho study, Beck et al. (2006) attributed 33% of all mortality of radiomarked juvenile greater sage-grouse to collisions with power lines. Fence and power line collisions by grouse in Europe have been well documented (Bevanger 1995, Baines and Andrew 2003, Moss 2001), and may be contributing to population declines in some areas (Moss 2001).

Sharp-tailed grouse are sometimes killed when colliding with fences, overhead lines, moving vehicles, and wind turbines (Fig. 19; Aldous 1943, Hart et al. 1950, Buss 1984, Johnson and Holloran 2010, Stevens 2011). It is unknown whether CSTG are as susceptible to collisions as documented for other prairie grouse. Boisvert (2002) and Collins (2004) recovered 224 carcasses of radiomarked CSTG captured on leks in northwestern Colorado. No mortalities were attributed to collisions. However, cause of death could not be ascertained for 32% of recovered carcasses. Lee (1936) cited an interview with an early pioneer of the Cache Valley in northern Utah who claimed "scores" of CSTG were killed in 1872–73 by flying into a newly constructed telegraph line. In northeastern Oregon, preliminary findings indicated 4 (12%) of 34 mortalities of radiomarked translocated CSTG may have been caused by collisions with power lines (M. C. Hansen, ODFW, unpublished data). Another 18 (53%) mortalities were recovered within 100 m of fences, suggesting fences may be a hazard to translocated CSTG either directly from collisions or indirectly from raptors using fence posts as hunting perches. Translocated grouse may be more susceptible to collisions because they are naïve to hazards in their new environment. Stonehouse (2013) found strong avoidance of distribution lines by CSTG in eastern

**Figure 19. Fences and power lines not only serve as perches for raptors and corvids, but also present a potential collision risk for grouse. (Photos by R. W. Hoffman/retired CPW).**

Washington, but was uncertain whether this behavior was in response to the collision and/or predation risk the lines posed to the birds. All the lines were associated with roads, so the avoidance also could have been due in part to the noise and disturbance associated with roads (Stonehouse 2013).

*Guidelines:*

1. Remove unnecessary fences and overhead lines in areas occupied by CSTG.

2. Where feasible, conduct surveys to identify problematic fences and overhead lines. Surveys should target high use areas near leks and within foraging areas and travel corridors. Conduct surveys at ≤2-week intervals to reduce influence of sign survival bias (i.e., longevity of evidence at collision sites) on collision rate estimates (Stevens et al. 2011).

3. Mitigate collisions with problem fences and overhead lines by marking them or, if possible, moving them to areas with lower risks of collision (Fig. 20). Although marking fences and overhead lines reduces collision rates, risk will remain (Stevens et al. 2012*b*). Removal is the only option if any level of collision risk is deemed unacceptable.

4. Although several types of markers have been developed for power lines (Morkill and Anderson 1991, Brown and Drewien 1995) and fences (Summers and Dugan 2001, Wolfe et al. 2009, Stevens et al. 2012*b*), continued research is needed to develop effective markers that are highly conspicuous to grouse, inexpensive to manufacture, easy to install, and have a long life expectancy.

5. Because construction of new fences and overhead lines in areas occupied by CSTG may present a greater collision risk than features already in place, route new fences and overhead lines through areas of marginal or non-habitat whenever possible. Otherwise, mark all new fences and overhead lines that traverse occupied habitats.

6. If possible, place new overhead lines in established corridors, provided existing lines within corridors have not been identified as problematic collision sites.

7. Whenever feasible, bury power or utility lines that must cross critical habitats.

8. Periodically clear away vegetation growing next to fences that may interfere with the ability of a grouse in flight to detect the fence.

9. Use wooden posts with perch deterrents when constructing fences and reduce the length of exposed wire between successive posts to increase visibility of the fence line. Stevens et al. (2012*a*) recommended reducing width of fence segments between posts to <4 m to reduce collision rates of greater sage-grouse.

10. Height of cross fences used to establish rotational grazing systems should be as low as possible. Wolfe et al. (2007) recommended lowering cross fences by ≥10% compared to perimeter fences.

11. Encourage landowners to apply for cost share programs such as Environmental Quality Incentives Program (EQIP) through the Natural Resource Conservation Service (NRCS) to modify existing fences, remove unused fences, or construct new fences with grouse in mind.

Figure 20. Comparative photos depicting visibility of a fence before and after marking. Marking fences will reduce collision rates, but not eliminate collisions. Not all fences present a collision risk. Managers should identify problem fences and mark or remove them, if possible. (Top and bottom photos by M. A. Schroeder/WDFW; center photo by T. J. Christiansen/Wyoming Game and Fish Department).

## Interspecific Competition

Seasonal ranges of CSTG may overlap ranges of other native galliforms including Gunnison sage-grouse (*Centrocercus minimus*), greater sage-grouse (Fig. 21), dusky grouse (*Dendragapus obscurus*), wild turkey (*Meleagris gallopavo*), and California quail (*Callipepla californica*); and with non-native game birds including ring-necked pheasant, chukar (*Alectoris chukar*), and gray partridge (*Perdix perdix*). Whether any of these species directly or indirectly compete with CSTG for resources is unknown. Ring-necked pheasants have been documented parasitizing and contributing to failure of greater prairie-chicken nests (Westemeier et al. 1998*b*). No instances of nest parasitism have been reported for CSTG in states where they are sympatric with pheasants (Hart et al. 1950, Meints 1991, Schroeder 1996, Apa 1998, McDonald 1998, Leupin and Chutter 2007, Gillette 2014). Where CSTG share habitats with other native galliforms, the likelihood of significant competition should be low because these species evolved together and should partition habitats to minimize competition (Fig. 22). For example, Apa (1998) found greater sage-grouse and CSTG in southeastern Idaho partitioned nesting habitat and, to a lesser extent, brood-rearing habitat. Niche partitioning between greater sage-grouse and CSTG broods also was documented in south-central Wyoming (Klott and Lindzey 1990). In Washington, areas of highest probability of use by translocated greater sage-grouse and CSTG overlapped by 72% during the spring-summer reproductive period (Stonehouse 2013). However, within these areas, greater sage-grouse and CSTG selected sites with different vegetation characteristics for nesting, resulting in minimal (20%) overlap (Stonehouse 2013).

### *Guidelines:*

1. Guidelines for managing sage-grouse habitats should take precedence where CSTG coexist with greater or Gunnison sage-grouse. This recommendation is based on the assumption that managing for sage-grouse will benefit, or at least not harm, CSTG populations.

2. Conduct studies to better understand habitat use patterns, interactions, and degree of niche overlap between CSTG and non-native galliforms in areas where they coexist.

3. Maintain and conserve large blocks of native habitat and connectivity between blocks as a strategy to minimize niche overlap with ring-necked pheasants (Hagen et al. 2007).

Figure 21. Current range of Columbian sharp-tailed grouse frequently overlaps the range of greater sage-grouse. Columbian sharp-tailed grouse also historically occurred within the range of Gunnison sage-grouse, and have been recently reintroduced into portions of this range in southwestern Colorado. (Photo courtesy of CPW).

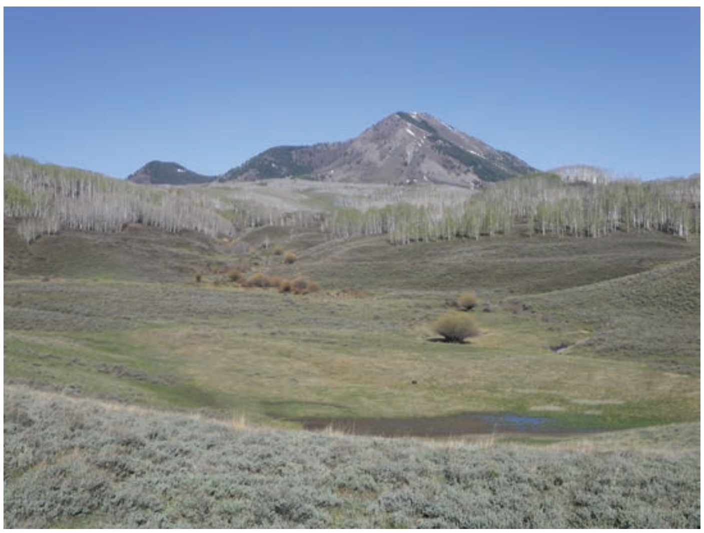

Figure 22. Breeding (spring-autumn) habitat used by Columbian sharp-tailed grouse, greater sage-grouse, and dusky grouse in northwestern Colorado. (Photo by R. W. Hoffman/retired CPW).

## Genetics

Spaulding et al. (2006) provided evidence populations of CSTG in British Columbia, Washington, Idaho, and Utah are genetically distinct from other subspecies of STG and should be managed as a distinct entity. Analysis of samples from presumed CSTG in northwestern Colorado indicated a closer alliance with plains STG. While Spaulding et al. (2006) did not propose the STG in northwestern Colorado are not of the Columbian subspecies, they did report the Colorado birds are genetically different from the other populations of CSTG they sampled. Samples from the extirpated population of presumed CSTG in western Montana also were found to be molecularly more similar to plains STG than CSTG (Warheit and Dean 2009). The Continental Divide in Montana did not appear to be a barrier to historical gene flow in STG, as proposed by Spaulding et al. (2006). These findings indicate the monophyly of the Columbian subspecies needs to be further examined. Hoffman and Thomas (2007) argued the STG in northwestern Colorado are more similar to *T. p. columbianus* in terms of habitat, size, and plumage than to *T. p. jamesi*, which are found at lower elevations in eastern Colorado.

Broad-scale habitat loss and fragmentation throughout the range of CSTG have isolated remaining populations to the extent there is little or no possibility of natural gene flow among populations. Preliminary evidence presented by Warheit and Schroeder (2001) indicated populations in Washington are already experiencing reduced genetic variability due to inbreeding. Studies of greater prairie-chickens in Illinois illustrate potential consequences (i.e., lower reproductive performance) when populations decline and become increasingly more isolated (Bouzat et al. 1998, Westemeier et al. 1998*a*).

Hybridization between STG and greater prairie-chickens is common where the ranges overlap, with $F_1$ hybrids and backcrosses being fertile (Sparling 1980). Greater prairie-chickens do not occur within the range of CSTG. One case of a dusky grouse x STG hybrid is recorded in the literature (Brooks 1907) and several cases of hybridization with greater sage-grouse have been documented (Eng 1971, Kohn and Kobriger 1986, Aldridge et al. 2001). All cases of hybridization with sage-grouse involved the plains subspecies until 2002 when 3 greater sage-grouse x CSTG hybrids were observed on a sage-grouse lek in northwestern Colorado (Fig. 23; Hoffman and Thomas 2007).

*Guidelines:*

1. Add genetic sampling protocols (i.e., collection of blood or feathers) to CSTG research and management programs that involve trapping and handling of wild birds. Develop a process for centralizing genetics information and archiving samples for future use.

2. Additional genetic surveys are needed throughout the range of STG to resolve discrepancies, refine taxonomic definitions, and identify potential genetic bottlenecks.

3. Develop a conservation genetics plan for management and recovery of CSTG in western North America.

4. Using genetic data alone for taxonomic classifications is not advised (Oyler-McCance and Leberg 2005). Taxonomic delineations also must take into consideration behavioral and morphological attributes.

5. Because the STG population in south-central Wyoming is contiguous with the population in northwestern Colorado of questionable genetic status, any future genetic studies need to include samples from Wyoming.

6. Genetic data should be used to decide when small, isolated populations of CSTG may require augmentation to persist (Stinson and Schroeder 2012). Follow-up surveys should be conducted to determine whether augmentation was successful in enhancing genetic diversity.

7. Despite uncertain genetic status of STG in western Colorado and Montana, guidelines presented in this document should apply to these areas.

**Figure 23. Male Columbian sharp-tailed grouse x greater sage-grouse hybrid on a greater sage-grouse lek in northwestern Colorado. (Photos courtesy of CPW).**

## Translocations

A translocation is the intentional release of animals into the wild to establish, reestablish, or augment a population. Translocations have become an increasingly important conservation tool for restoring wildlife populations that are severely diminishing in distribution and abundance (Griffith et al. 1989), and for enhancing genetic diversity in isolated populations no longer functionally connected to other populations (Westemeier et al. 1998*a*, Stinson and Schroeder 2012). Availability of quality habitat is the ultimate factor determining success of any translocation (Griffith et al. 1989, Toepfer et al. 1990). Recent changes in land use practices have allowed some habitats within the historical range of CSTG to recover (Coates 2001, Gorman and Hoffman 2010). In addition, implementation of the CRP has created new habitats for CSTG (Rodgers and Hoffman 2005). These changes in the landscape have prompted a growing interest among wildlife managers in translocating CSTG to portions of their former range.

Snyder et al. (1999) reviewed past translocation projects involving STG or prairie-chickens in North America. They concluded common features of successful releases were 1) >100 grouse were released, 2) grouse were released over several years, 3) grouse were released in spring, and 4) grouse were released from remotely-opened settling boxes. One of the main problems associated with translocation efforts involving prairie grouse has been the tendency of released birds to disperse long distances (Toepfer et al. 1990). Several approaches have been recommended to address this problem: 1) releasing grouse in spring (Hoffman et al. 1992), 2) using various soft-release methods (Rodgers 1992, Gardner 1997, Coates 2001), 3) using movement patterns from initial releases to guide future release-site selection (Coates et al. 2006), 4) capturing and releasing females late in the breeding season (Coates and Delehanty 2006), and 5) releasing males in autumn followed by a spring release of females (Gorman and Hoffman 2010).

The minimum area required to support a self-sustaining population of CSTG is unknown. Bart (2000) reported that no existing populations of CSTG persist on areas <50 km$^2$. Connelly et al. (1998) recommended 30 km$^2$ as the minimum area necessary for a reintroduction attempt provided ≥33% of the landscape consisted of undisturbed grass-shrub cover. Toepfer et al. (1990) recommended release areas should contain sufficient habitat to support ≥200 breeding birds, which they estimated required >1,000 ha of undisturbed grass-shrub cover within a 3.1-km radius of a release site. A population viability analysis of prairie STG in Wisconsin indicated a spring population of 280 birds on 4,000 ha would be the minimum necessary to ensure population persistence for ≥50 years (Temple 1992). These recommendations all appear to underestimate effective habitat size. Larger areas of unfragmented habitat are desirable, especially within more xeric portions of historical range.

Merker (1996) proposed using captive-reared CSTG to supplement translocations of wild-trapped birds, which may be in short supply. Captive-rearing is labor-intensive and costly, but most importantly, grouse raised in captivity rarely survive and reproduce when released into the wild (reviewed by Storch 2000, Hoffman and Thomas 2007). Establishment of captive populations as a long-term conservation strategy to reduce risk of extinction is only recommended when a taxon has declined to <1,000 individuals in the wild (IUCN 1987). Wild CSTG are in no immediate danger of reaching this critically low level. Adequate numbers (>5,000 breeding birds/population) remain in British Columbia, Idaho, Utah, and Colorado to support reintroduction and augmentation programs using wild-trapped birds of appropriate genetic stock (Bart 2000, Hoffman and Thomas 2007).

Since 1987, 2,406 wild-trapped CSTG have been translocated to 16 different sites in western North America (Table 9). Numerous other sites have been identified for future translocations (Fig. 24). Most translocation programs for CSTG have involved release of birds into formerly occupied habitats (i.e., reintroductions). Long-term prospects for success appear promising for reintroductions in northern Nevada (Coates 2001), southern Idaho (Gardner 1997), and north-central and southwestern Colorado (Gorman and Hoffman 2010), whereas success of efforts to re-establish CSTG in northeastern Oregon (D. A. Budeau, Oregon Department of Fish and Wildlife, personal communication), on Antelope Island in northern Utah (J. D. Robinson, Utah Division of Wildlife Resources, personal communication), and in Bull Run Basin in northern Nevada (S.P. Espinosa, Nevada Department of Wildlife, personal communication) remains uncertain. Washington has succeeded in augmenting 2 small, isolated populations and predicts a high probability of success in augmenting 2 additional populations (Schroeder et al. 2010, Stinson and Schroeder 2012). In contrast, efforts to augment a remnant population of CSTG in northwestern Montana failed due to lack of suitable habitat (Cope 1992, Deeble 1996).

The following guidelines primarily pertain to reintroductions and are based on experiences of agency biologists in translocating CSTG and review of literature on theory and practices for translocating other species of prairie grouse. Managers are encouraged to take a more conservative approach when conducting augmentations, especially those intended to enhance genetic diversity. Genetic augmentations

Figure 24. Recent translocation site for Columbian sharp-tailed grouse at Bull Run Basin in Elko County, Nevada. (Photo by S. P. Espinosa/Nevada Department of Wildlife).

Table 9. Summary of translocation efforts for Columbian sharp-tailed grouse in western North America, 1987–2014.

| Release type, location | | Number released M | F | Total | Dates and status | Probability of success[1] |
|---|---|---|---|---|---|---|
| Reintroduction | | | | | | |
| ID | Shoshone Basin | 210 | 149 | 359 | 1992–99, Complete | Moderate |
| | House Creek | 160 | 87 | 247 | 2003–09, Complete | Moderate |
| OR | Wallowa County | 221 | 168 | 389 | 1991–97, 2001–02, 2006–08, Ongoing | Uncertain |
| CO | Dolores Rim | 63 | 103 | 166 | 2004–07, Complete | High |
| | Middle Park | 102 | 114 | 216 | 2006–09, 2014[2], Ongoing | Uncertain |
| NV | Snake Mountains | 145 | 82 | 227 | 1999–2004, Complete | Uncertain |
| | Bull Run Basin | 28 | 64 | 92 | 2014, Ongoing | Uncertain |
| UT | Antelope Island | 53 | 29 | 82 | 2009–13, Complete | Uncertain |
| | Summit County | 21 | 13 | 34 | 1993, Suspended | Failed |
| Total | | 1,003 | 809 | 1,812 | | |
| Augmentation | | | | | | |
| MT | Tobacco Plains | 103 | 46 | 149 | 1987–91, 1996–97, Complete | Failed |
| BC | Fraser Plateau | 5 | 4 | 9 | 2005, Complete | Moderate |
| WA | Scotch Creek | 33 | 31 | 64 | 1998–2000, Complete | High |
| | Dyer Hill | 35 | 29 | 64 | 1999, 2005–08, Complete | High |
| | Swanson Lakes | 113 | 92 | 205 | 2005–13, Ongoing | High |
| | Nespelem | 44 | 27 | 71 | 2005–09, Ongoing | High |
| | Greenaway Road | 25 | 7 | 32 | 2012, Ongoing | Uncertain |
| Total | | 358 | 236 | 594 | | |
| Grand total | | 1,361 | 1,045 | 2,406 | | |

[1] Based on professional opinion of appropriate agency personnel.

[2]A final release of 40 females is planned for spring 2015.

run the risk of compromising genetic integrity (i.e., genetic variation unique to a population) of the target population in an attempt to increase allelic diversity. Genetic simulations that take into account effective population size and anticipated survival and reproductive success of translocated birds should be conducted to ascertain how many individuals of each gender need to be released annually and over time to maximize biological benefits of augmentation. The goal should be to gradually introduce new genetic material into a population with the understanding additional translocation is always an option, but removing genetic diversity is nearly impossible once introduced.

*Guidelines:*

1. Initial evaluation of areas proposed for translocations should be conducted by biologists with comprehensive knowledge of CSTG life history requirements.

2. Prioritize areas identified for translocations based on potential for success and overall importance to conservation of CSTG regardless of jurisdictional boundaries.

3. Areas where there is potential to connect a translocated population with another population should take priority over areas with no opportunity for interchange between populations.

4. Only release CSTG where they were present historically, where factors responsible for their extirpation have been identified and remedied, and where habitat is available in sufficient quantity (≥50 $km^2$ and preferably more), quality, and configuration to support a year-round population of ≥200 breeding birds. Ideally, opportunities for habitat restoration and enhancement should exist within and adjacent to release areas.

5. Carefully consider potential consequences before reintroducing CSTG into areas occupied by ring-necked pheasants or into areas where exotic game birds (especially pen-reared birds) are released.

6. Areas dominated by native cover should receive higher priority for translocations than areas dominated by CRP lands unless some provisions are in place to ensure long-term persistence of CRP lands or similar cover types on the landscape.

7. Consult with key stakeholders who may be interested in or affected by a proposed translocation project. Stakeholders within a release area should be supportive or, at the very least, not opposed to the translocation.

8. When translocations are approved, funding should include costs for personnel and equipment to conduct translocations, as well as evaluate success or failure. Post-release monitoring of radiomarked birds to evaluate survival, breeding success, and movements should be considered a necessary part of the evaluation process and funded accordingly. If possible, similar data should be collected from the nearest established population for control purposes.

9. Only release wild-trapped CSTG (Fig. 25). Donor populations should be large enough as to not be adversely affected by removal of birds. The most effective way to capture wild birds is on leks using walk-in traps (Schroeder and Braun 1991), although night-lighting may be an effective capture method in some situations. Several leks can be trapped simultaneously during the same morning provided an observer is present at each site. Traps should be adjusted (block entrance or lift back end of the trap) to prevent capture of birds when no observer is present.

**Figure 25. Male Columbian sharp-tailed grouse captured on a lek in northwestern Colorado using a walk-in trap. Only wild-trapped grouse should be used for translocations. (Photo by R. W. Hoffman/retired CPW).**

10. Leks selected for trapping should support >10 males/lek and occur within cover types structurally similar to the release area. No more than 5–8 females and 30% of males should be removed from any single lek. If possible, only remove males captured on the periphery of a lek. Males captured near the center of a lek should be released on site to avoid disrupting hierarchy of dominant males.

11. The first release should consist of 40–50 males trapped on leks in autumn followed by 3 consecutive years of spring releases. Spring releases should consist of 40–50 females/year for the first 2 years and 15–20 females the third year. This approach reduces risk of releasing females during a year when conditions for nesting and brood-rearing may be poor. Additional (5–10) males can be captured and released each spring, but only after the desired number of females have been released. The combined female:male sex ratio of autumn and spring releases should approximate 2:1.

12. Equip ≥50% of autumn-captured males with radio transmitters to facilitate tracking through the subsequent breeding season. Use sites where surviving autumn-released males are located the following spring as the focal point for releasing females. Presence of males, especially if they

have formed a lek, should minimize dispersal of females and maximize likelihood they will breed (if not bred before release), nest, and produce young the same year they are released; thus limiting any founder effects. This approach avoids the need to establish artificial leks sites using decoys and playback of tape-recorded calls (Rodgers 1992). Autumn release also avoids the need to move males at a time when they may be most susceptible to stress of capture, handling, radiotagging, and relocation. Because few females attend leks in autumn and none are receptive to breeding (Hoffman and Thomas 2007), males are not as active and presumably under less physiological stress compared to spring. Autumn release of males may reduce dispersal and enhance survival versus releasing males in spring when they are sexually active and have a strong affinity to the lek.

13. If autumn trapping is not possible, translocations should be conducted over ≥3 consecutive springs, consist of 50–60 birds each year, and approximate a 1:1 sex ratio. Released grouse should be closely monitored during the initial year of translocation and their movement patterns used to fine-tune the location of subsequent release sites (Coates et al. 2006).

14. Suitable winter habitat should occur in close (≤2 km) proximity to release sites, particularly for autumn releases because autumn-released grouse may have little time to fully orient themselves to their new environment before they must move to wintering areas.

15. Commence trapping ≤5 days after females regularly start attending leks. Coates and Delehanty (2006) found translocated females captured later in breeding season nested with greater frequency than females captured early because they were already inseminated. Coates and Delehanty (2006) recommended initiating spring trapping approximately 8 days following the start of female lek visitations. The drawback of this approach is that trapping success frequently declines as the breeding season progresses. Consequently, capturing the desired number of females may be more difficult.

16. Process birds as soon after capture as possible. In some cases, disease testing may be a requirement for transportation across state or international boundaries. Mark all translocated birds with serially-numbered, aluminum leg bands.

17. Captured grouse should be transported in specially-built boxes with individual compartments designed to house birds separately and constrain their movements (Fig. 26). There should be no need to handle birds again once they are placed in a transport box. Line the bottom of each compartment with unscented, clay cat litter to reduce contact between feces and the bird's feet. Boxes should be designed so they can be remotely opened from a distance, allowing birds to walk or fly away without being frightened by the immediate presence of humans. Position the box so released birds have a clear flight path to escape cover (i.e., shrub thickets or tall grass) without any obstacles such as fences or overhead lines. Scan the surrounding area for raptors before releasing birds.

18. Select release sites with a low density of fences and overhead lines. Consider marking fences and overhead lines in the release area.

19. Birds can be released the day of capture provided they have ≥3 hours of daylight to adjust to their new environment. Otherwise, hold birds overnight and release them at sunrise the following morning. If possible, do not hold captured grouse in captivity >24 hours (Gardner 1997).

## Recreational Activities

Habitats occupied by CSTG are subjected to many forms of recreation including hiking, camping, off-road vehicles (including snow machines), fishing, hunting, cross-country skiing, mountain biking, horseback riding, nature viewing, and photography. Activities of greatest concern are those that disturb grouse when aggregated on leks or on critical wintering areas (Hoffman 2001, Stinson and Schroeder 2012). The most serious problems are persistent, disturbing activities that cause birds to flush or alter their behavior for substantial lengths of time. Baydack and Hein (1987) conducted experimental disturbances at lek sites in southwestern Manitoba involving parked vehicles, propane

Figure 26. Front (top) and rear (bottom) view of box used to transport and release Columbian sharp-tailed grouse in Colorado. Birds can be loaded individually from the back and released all at the same time from the front. (Photos courtesy of CPW).

exploders, scarecrows, leashed dogs, snow-fencing, and human presence. Males were temporarily displaced from disturbed leks, but usually returned quickly despite ongoing disturbance, unless disturbance involved presence of humans on leks. In comparison, females avoided disturbed leks at all times and made no effort to return until the disturbance was removed. Baydack and Hein (1987) concluded leks subject to continual disturbance may become reproductively inactive due to absence of females.

Viewing CSTG on leks and at critical wintering sites is a form of recreation that may cause disturbance (Fig. 27). Like most other forms of recreation, no experimental research has been conducted on this subject, and evidence to support this possibility is limited to observational accounts (Hoffman 2001). Based on counts of an individual lek in Colorado exposed to intensive viewing and trapping activities over many years, Hoffman and Thomas (2007) concluded there was minimal impact. Counts varied from 10 to 25 males, but the long-term trend (mean = 17.7±4.8, median = 18 males) indicated stable attendance. Hoffman and Thomas (2007) concluded viewing alone does not appear to be a threat to CSTG, but may be an issue where viewing is additive to other types of disturbance.

Response of CSTG to trapping activities has been cited as further evidence they will tolerate a moderate amount of disturbance at leks (Hoffman and Thomas 2007, Stinson and Schroeder 2012). Traps and blinds placed on leks and repeatedly flushing birds to remove birds from traps does not appear to deter males or females from attending leks. When flushed, males return within 10–15 minutes and often sooner. Observations of banded and radiomarked females flushed from leks indicated they did not return to the lek on the same morning, but frequently returned on subsequent mornings. Flushing CSTG from leks did not preclude females that were not on a lek at the time it was flushed from visiting the lek once males returned (Hoffman and Thomas 2007).

Recreational use of off-road vehicles is one of the fastest growing outdoor activities, especially in the western U.S., where >27% of the population uses off-road vehicles for recreation (Cordell et al. 2005). Wildlife harassment, displacement, and habitat degradation are a few of many environmental impacts of off-road vehicles (Ouren et al. 2007). Snow machines, perhaps more than any other off-road vehicle, may present the greatest threat because they allow increased mobility to humans at a time when CSTG may be exceptionally vulnerable to disturbance (Hoffman and Thomas 2007). Repeated disturbance of birds in winter may cause them to expend excessive amounts of energy and displace them from critical feeding and roosting sites. Conflicts between recreationists and CSTG will likely escalate as more people move into or near areas occupied by CSTG. Any one activity may have minimal impact, but combined effects may cause significant disturbance. Management of off-road vehicles will certainly be an issue that needs to be addressed for successful restoration of previously occupied habitats, especially on public lands.

*Guidelines:*

1. Disturbance and damage caused by recreational activities are usually site specific and more pronounced on public than private lands. Managers must identify areas where conflicts may exist and work with the appropriate recreational groups to develop mutually acceptable restrictions to minimize disturbance of CSTG and damage to important

Figure 27. Public viewing of Columbian sharp-tailed grouse on leks is an acceptable form of recreation provided viewers follow certain guidelines. For instance, leave pets at home, arrive >½ hour before sunrise, stay in the blind or vehicle until birds depart, then leave as quickly as possible. (Photo by R. W. Hoffman/retired CPW).

habitats. Tools available to managers include total closure, timing restrictions, re-routing trails away from critical habitats, greater enforcement of regulations where conflicts have been identified, increased fines for violations, implementing leash laws, and limiting numbers of users (e.g., by requiring access permits).

2. Implement a consistent set of rules that limit off-road vehicle use to designated trails.

3. Assist law enforcement officials and concerned citizens in identifying violators by requiring registration decals with highly visible registration numbers that allow easy identification in the field.

4. Encourage private landowners to minimize human activities around leks and wintering areas on their property.

5. Treat lek locations as sensitive information to discourage trespass on private lands and minimize disturbance at leks on public lands.

6. Regardless of cause, eliminate or minimize repeated disturbance near leks from 0500–0900 during the breeding season (Mar–May).

7. Develop protocols for lek viewing and educate the public about ethical viewing practices.

8. Designate public viewing leks. Alternate viewing opportunities among several leks so viewers are not present at individual leks for several consecutive mornings. Clearly sign where viewers must park. Require viewers to make reservations and instruct them to arrive ≥½ hour before sunrise and remained parked and in their vehicles until birds depart. If a site lacks a suitable parking area for viewing, provide a blind or viewing trailer. Viewers should not be allowed to set up their own blind or bring pets.

## Weather

Weather and vegetation production are important factors influencing production of prairie grouse (Shelford and Yeatter 1955, Yeatter 1963, Kirsch et al. 1978, Flanders-Wanner et al. 2004*b*). Of these 2 factors, weather has the single most pronounced influence because it also affects vegetation production. Adverse weather can affect grouse production in 3 primary ways: reducing nest success and chick survival due to sparse cover, decreasing availability of forbs and insects, and increasing direct mortality of chicks due to chilling or heat stress. Effects of weather are multifaceted, which is why attempts to show a relationship between a single weather variable and production indices often fail (Flanders-Wanner et al. 2004*b*).

Sharp-tailed grouse production in North and South Dakota was positively correlated with a 23-month soil moisture index (Bergerud 1988*b*). After predation (72% of losses), exposure (14% of losses) was the next leading cause of mortality of STG chicks from 1 to 30 days of age in southeastern Alberta (Manzer and Hannon 2007). Inclement weather during the first 7 days post-hatch was negatively correlated with survival of STG chicks in British Columbia (Goddard and Dawson 2009). In north-central Nebraska, May average temperature, June average temperature, and cumulative precipitation from 1 January to 31 July were positively correlated with STG production, whereas June number of heat stress days and June number of days of precipitation >2.54 mm were negatively correlated with production (Flanders-Wanner et al. 2004*b*). Severe drought conditions in 2002 contributed to low nest success and poor survival of CSTG chicks in northwestern Colorado (Collins 2004). Effects of drought were most evident in native shrub-steppe where 4 of 10 radiomarked hens with broods moved >3.5 km in search of suitable brood-rearing sites (Collins 2004). Longer movements from nests to brood-rearing sites significantly reduced survival of STG chicks in British Columbia (Goddard and Dawson 2009).

Impacts of weather on CSTG populations are, for the most part, beyond management control. Naturally-occurring weather extremes are to be expected and generally have temporary negative impacts on grouse populations. Given adequate habitat and robust populations, species such as STG, with high reproductive rates, can quickly recover from extreme weather events. However, for small populations living in marginal habitats, effects of extreme weather events may be more catastrophic and long-lasting (Stinson and Schroeder 2012).

*Guidelines:*

1. Cover management is the best approach to mediate impacts of weather on grouse production (Flanders-Wanner et al. 2004*b*). An ample plant canopy will partially insulate chicks from heavy rainfall and intense solar radiation.

2. Reduce or eliminate vegetation disturbances such as grazing and haying during drought years to maximize cover available to grouse for nesting and brood-rearing.

3. Areas used during extreme winter weather conditions should be identified, protected, and expanded upon where feasible.

# Habitat Management and Related Guidelines

## General Habitat Attributes

Growing conditions differ across the range of CSTG depending on precipitation, elevation, soils, and past disturbance. These variations, coupled with use of native, non-native, and artificially-created habitats dominated by shrubs, grasses, or varying combinations of shrubs and grasses preclude development of a single set of guidelines for managing CSTG habitats (Fig. 28). Therefore, managers must identify local and regional habitat characteristics of productive CSTG habitats that can be reasonably achieved based on site conditions. In general, spring-autumn ranges should support an interspersion of shrub and herbaceous dominated communities comprised of 5–40% shrub cover, 25–60% grass cover, 10–25% forb cover, 5–15% residual herbaceous cover, and 3–10% bare ground. The herbaceous community should consist of desirable forbs and perennial grasses that provide food and cover, and attract insects. Combined overhead cover of shrub and herbaceous vegetation should exceed 60%. Average height of herbaceous vegetation should exceed 25 cm and vary across the landscape from ≥15 to ≤70 cm. Grass cover should consist primarily (>70%) of bunchgrasses. Mountain shrub and riparian shrub communities dominated by shrubs ≥1 m in height should comprise 15–20% of the landscape and occur within 2-6 km of suitable spring-autumn habitats.

## Dependence on CRP Lands

Currently, CSTG occupy approximately 38,000 km$^2$ of suitable habitats in the western U.S., of which nearly 70% is privately owned and 11% is enrolled in CRP (Table 10). Lands enrolled in CRP provide critical habitats for reintroduced populations of CSTG in northeastern Oregon and southwestern Colorado, for augmented populations in north-central Washington, and for larger populations in northern Utah, northwestern Colorado, and southeastern and eastern Idaho (Sirotnak et al. 1991, Hoffman 2001, UDWR 2002, Gorman and Hoffman 2010, Stinson and Schroeder 2012, Stonehouse 2013, Gillette 2014). Possible loss of CRP lands is unequivocally the most important immediate threat to CSTG throughout the subspecies' range (Hoffman and Thomas 2007). No decisions will impact CSTG more than those affecting continuation of the CRP in subsequent Farm Bills. Approximately 41% of active CRP lands within the range of CSTG will expire by 2020 (Table 10; Farm Service Agency 2014). Most of the expiring CRP lands will be eligible for re-enrollment, but based on the 2014 Farm Bill, the overall CRP acreage will likely continue to decrease due to the step down in allotted acres. Although the CRP is not the preferred solution to address problems of declining native habitat, the program has tremendous potential to provide food and cover for CSTG and connect

**Table 10. Land status and coverage of Conservation Reserve Program (CRP) lands within the current range of Columbian sharp-tailed grouse (CSTG) in the western United States as of December 2014 (includes areas occupied by translocated populations)[1,2]. Amount of CRP lands that will expire by 2020 is shown in parentheses.**

| State | Private (%) | CRP lands (ha) | Importance of CRP lands to CSTG |
|---|---|---|---|
| CO | 72 | 20,872 (8,103) | Moderately High |
| ID | 54 | 209,109 (82,969) | High |
| NV | 22 | 0 (0) | None |
| OR | 73 | 8,437 (4,003) | High |
| UT | 91 | 37,184 (25,530) | Very High |
| WA | 56 | 139,040 (53,408) | High |
| WY | 39 | 33 (33) | Very Low |
| Total | 67 | 414,675 (170,046) | Moderately High |

[1]There is no CRP or equivalent program in British Columbia.
[2]Data obtained from CRP monthly contracts report (Farm Service Agency 2014).

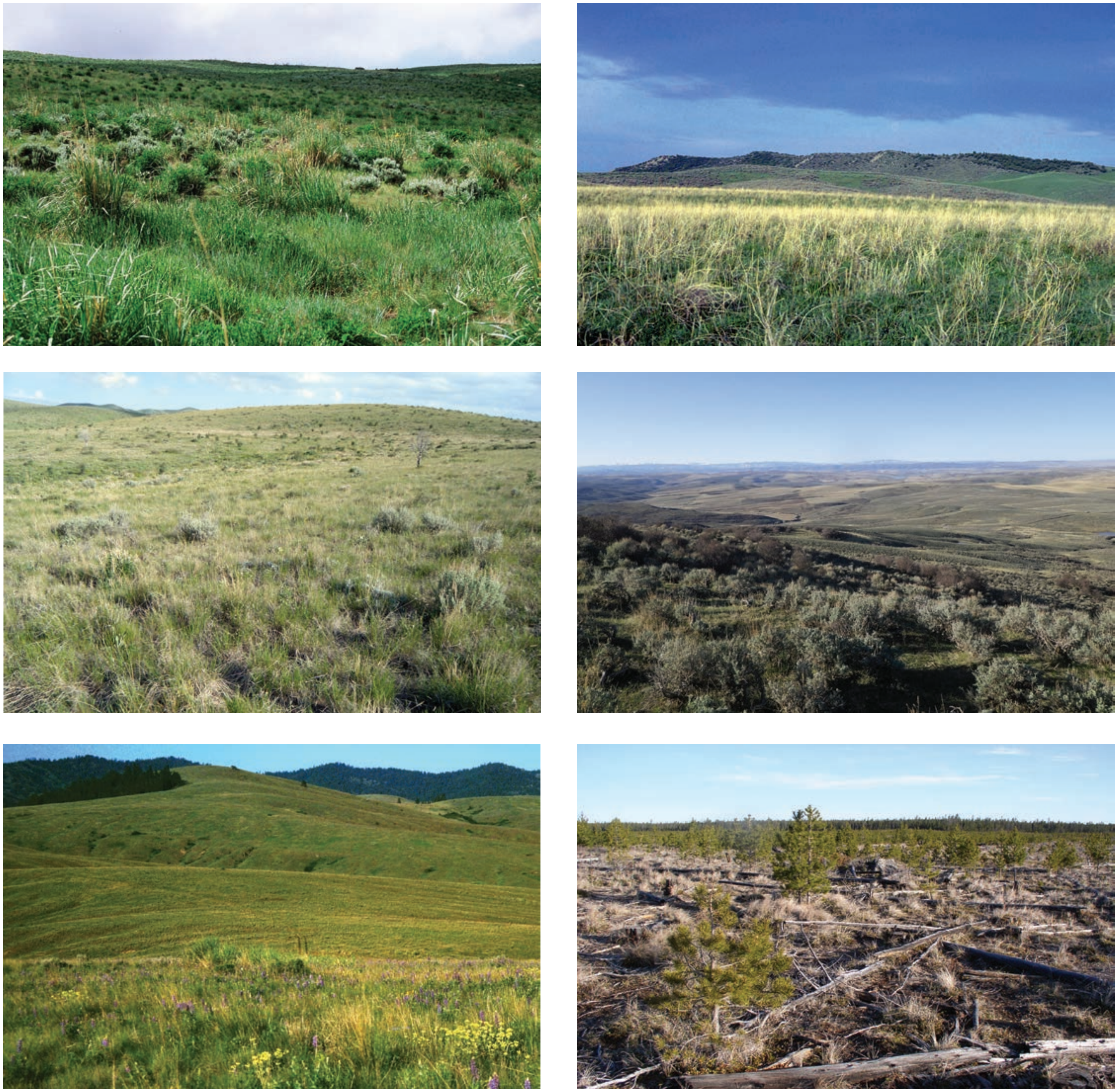

**Figure 28. Several examples of the range of habitat types used by Columbian sharp-tailed grouse from spring through autumn, including mine reclamation lands (top left), Conservation Reserve Program field (top right), early successional post-fire shrub-steppe (middle left), mixed mountain shrub and shrub-steppe (middle right), native bunchgrass prairie (bottom left), and lodgepole pine (*Pinus contorta*) clear-cut (bottom right). (Top photos and middle right photo by R. W. Hoffman/retired CPW; middle left photo by G. L. Gillette/University of Idaho [UI]; bottom photos by M. A. Schroeder/WDFW).**

isolated patches of native habitat, which create larger, more continuous patches of suitable habitat.

Many wildlife agencies view the CRP as an integral part of CSTG conservation (Rodgers and Hoffman 2005). Nonetheless, a paradox exists about the true value of the program to CSTG. Some studies have shown lower demographic rates for CSTG when using CRP. For instance, in northwestern Colorado, CSTG using monotypic CRP stands comprised of non-native, sod-forming grasses (primarily smooth brome, *Bromus inermis*) were 11 times more likely to die than grouse using mine reclamation lands (Boisvert 2002). In this same study, only 10% of the radio-marked hens (n=62) captured on leks in CRP stands actually nested in CRP and only 14% of those nested successfully. Although female CSTG in north-central Washington

**Figure 29. Conservation Reserve Program stands provide breeding, nesting, and brood-rearing habitats for Columbian sharp-tailed grouse throughout the subspecies' range, with the exception of British Columbia. Parcels enrolled in Conservation Reserve Program that occur in close proximity to native cover types (left) and support a diverse mixture of native forbs and grasses (right) provide the most suitable habitats for Columbian sharp-tailed grouse. (Left photo by R. W. Hoffman/retired CPW; right photo by M. A. Schroeder/WDFW).**

selected CRP stands dominated by monocultures of crested wheatgrass (*Agropyron cristatum*) or intermediate wheatgrass (*Thinopyrum intermedium*) for nesting, nesting success within these stands was only 18% (McDonald 1998). In southeastern Idaho, Gillette (2014) documented CSTG successfully breeding, nesting, and rearing young in CRP fields, albeit at lower rates (λ=0.77±0.284SE), compared to grouse occupying shrub-steppe (λ=1.08±0.663SE). Despite these findings, managers unanimously agree CRP lands are better than tilled agriculture and with improved seed mixes have the potential to provide quality habitat for CSTG (Table 11; McDonald 1998, Boisvert 2002, Rodgers and Hoffman 2005, Gillette 2014).

Sharp-tailed grouse, and in particular the Columbian subspecies, appear to have benefited more from CRP than any other prairie grouse (Table 10; Rodgers and Hoffman 2005). In northwestern Colorado, 26% of 133 active leks were located in CRP stands (Hoffman 2001). Over 80% of 172 new leks located in Idaho between 1995 and 1998 were in CRP stands (Rodgers and Hoffman 2005). The CRP was responsible for a 400% increase in distribution of CSTG in northern Utah (UDWR 2002). Many augmentation and reintroduction projects conducted in recent years were made possible because of increases in populations in other areas due to the CRP.

Benefits of CRP stands to CSTG are directly linked to species composition and structural diversity within stands and proximity of stands to native cover types (Fig. 29; Meints 1991, Sirotnak et al. 1991, Apa 1998, McDonald 1998, Boisvert 2002). Stands that provide the greatest benefits to prairie grouse are those that occur adjacent to native habitats, consist primarily of bunchgrasses ranging in height from 30 to 75 cm, and include a substantial (>20%) forb component (Rodgers and Hoffman 2005). Monotypic stands of mature, exotic grasses provide little benefit to CSTG and may serve as ecological traps for grouse (Fig. 30; McDonald 1998, Boisvert 2002, Rodgers and Hoffman 2005).

The CRP is dependent on congressional renewal. Furthermore, participation is voluntary and affected by market prices. Thus, long-term (>10 years) status of most CRP lands within the range of CSTG is uncertain. Large federal deficits compound the problem and raise doubts about whether the program will be funded indefinitely. The USFWS failed to acknowledge the precarious nature of the CRP when they did not list the CSTG in 2000. They partially justified not listing CSTG because several states provided evidence populations were stable or increasing due to the CRP (U.S. Department of Interior 2000). Even though USFWS staff acknowledged loss of CRP lands would likely increase risk of extirpation for small populations, they did not believe the larger metapopulations would be adversely affected. Whereas large metapopulations should persist without CRP lands, available data suggest they will experience drastic declines (Hoffman 2001, UDWR 2002, Rodgers and Hoffman 2005, Stinson and Schroeder 2012, Gillette 2014). Any major reduction in CRP lands within the range of CSTG will likely result in the need to reevaluate the status of CSTG in the western U.S. The fact that CSTG are highly dependent on CRP lands in many areas emphasizes the need to protect, enhance, and restore native habitats to ensure long-term persistence of CSTG.

*Guidelines:*

1. Inform federal, state, and local agencies, politicians and the public about the importance of the CRP to CSTG in the western U.S. Convey the potential consequences if the program is discontinued or priorities are shifted to other areas.

Figure 30. Conservation Reserve Program stand consisting of a monoculture of crested wheatgrass. This stand has marginal value for Columbian sharp-tailed grouse. (Photo by G. L. Gillette/UI).

Figure 31. Former wheat field enrolled in the Conservation Reserve Program and initially planted to smooth brome, then subsequently restored to a mixture of native bunchgrasses and forbs. (Photo by M. A. Schroeder/WDFW).

2. Review and provide comment during the rule making process at the national level to ensure Farm Bill Programs continue to benefit STG.

3. Encourage county committees, county commissioners, producers, and agricultural businesses to support the CRP. In return, rules and incentives for participating in the program should be practical and attractive to landowners.

4. Where enrollment in CRP is decreasing, efforts should focus on increasing the quality of remaining fields.

5. State and federal wildlife agencies and conservation organizations should work closely with the Farm Service Agency (FSA) to optimize benefits of the CRP for grouse and provide whatever assistance the FSA needs to develop, implement, and expand new CRP practices that benefit grouse, such as the State Acres For wildlife Enhancement initiative.

6. Seed mixtures designed to benefit CSTG should consist of ≥10 species and include at least 5 grasses, 4 forbs, and 1 shrub (Table 11; Monsen 2005, Benson et al. 2011). Avoid aggressive species that can crowd out other components of mixtures and weak-stemmed species that flatten easily under heavy snow. Include only native grasses in seed mixtures. Bunchgrasses should be favored over sod-forming grasses. The forb component should include legumes. Appropriate introduced species of forbs are acceptable and can be especially valuable additions to the seed mixture (Rodgers and Hoffman 2005).

7. At maturity, height of herbaceous vegetation should range from 25-75 cm and vary across the stand. This can be accomplished by planting different seed mixtures in different parts of a field.

8. The recommended shrub species for most CRP plantings is big sagebrush, because the vast majority of croplands within the range of CSTG were formerly dominated by this species. Managers should recognize the importance of planting the correct subspecies of big sagebrush depending on local conditions (Winward 2004, Monsen 2005).

9. Other shrub species of importance to CSTG, such as serviceberry, chokecherry, snowberry, and rose, can be included in seed mixtures, but managers should be aware not all these shrubs can be effectively restored across the wide range of sites they once occupied (Monsen 2005). Only plant shrubs that were known to grow on a site prior to conversion.

10. Shrub seed should be planted in autumn or early winter. Distribute seed in patches or strips in selected areas, such as draws, benches, and north slopes, where snow may accumulate and protect young plants from browsing by wild ungulates. Reduce seeding rates or avoid seeding grasses and forbs where shrub seeds are distributed to reduce competition (Monsen 2005). Sagebrush seed should be broadcast, followed by light imprinting, harrowing, or chaining; most other shrubs should be drilled into the soil (Monsen 2005).

11. Whenever possible, plant site-adapted seed over other seed sources (Monsen 2005, Benson et al. 2011).

12. Establish funding sources to assist landowners with purchasing and planting seed mixtures that benefit CSTG.

13. Encourage seed companies to collect seeds from native forbs important to CSTG that are currently unavailable or in limited supply.

14. Ecologically appropriate stand enhancement (e.g., interseeding, patch seeding) or complete replacement should be required for re-enrollment of CRP stands in poor condition, particularly stands consisting of monocultures of exotic grasses (Fig. 31).

15. Provide for some flexibility within CRP rules to allow for improving (e.g., interseeding or patch seeding) stands through contract management.

16. Without periodic disturbance, some CRP stands may display reduced vigor, declines in forb abundance, and excess litter accumulation; thus, diminishing their suitability for CSTG. Approval to conduct managed haying or grazing should be based on whether fields need disturbance to enhance vigor and maintain plant species diversity. Frequency of disturbance should be based on regional conditions with less frequent disturbance allowed in more arid regions. In some areas, management of CRP fields over the course of the contract may not be necessary because of natural disturbance factors such as heavy, periodic use by wild ungulates.

17. In certain situations, haying, grazing, burning, and spraying are acceptable methods for managing CRP stands within the range of CSTG. Burning and haying may damage or kill sagebrush. Thus, neither activity is recommended where sagebrush is established in the stand, unless the sagebrush occurs in patches and can be avoided when burning or haying. Management activities should occur outside the nesting and early brood-rearing period, preferably after 31 July, but no sooner than 15 July. No management should be authorized until a stand is fully established, except for spraying to control weeds (Benson et al. 2011).

18. Emergency haying and grazing will generally have negative consequences to CSTG because food and cover are removed when they are already in short supply due to poor growing conditions caused by drought. Therefore, extreme caution should be exercised in authorizing emergency haying or grazing. More stringent rules need to be developed and applied to emergency haying and grazing to minimize negative effects. If emergency haying and grazing must be applied, such events should count as part of the managed grazing and haying cycle rather than being additive.

19. Work with the FSA to develop a CRP rule that allows for a waiver of the 25% payment reduction required for emergency haying or grazing if the landowner agrees to interseed the affected area with desirable forbs and grasses (Rodgers and Hoffman 2005).

20. Agencies responsible for administration of the CRP must make a concerted effort to ensure participants are abiding by rules governing managed and emergency haying and grazing. Although new rules pertaining to timing and frequency of managed haying and grazing are an improvement over the old rules, they still allow for disturbance regardless of whether a stand is in need of management. Fully-established fields can provide ideal habitat for CSTG for several years before suitability starts to decline. Prematurely grazing or haying these fields may diminish suitability for CSTG and should be discouraged.

21. Agricultural lands adjacent to native habitats should be given higher priority for enrollment in the CRP than those farther from native habitats.

22. Loss and degradation of sagebrush, shrub-steppe, mountain shrub, and riparian shrub cover types is clearly a severe habitat issue and should be justification for establishing National Conservation Priority Areas in portions of the western U.S. where these cover types occur. Priority areas should include those portions of the range where CSTG exclusively use native habitats and where native habitats and CRP lands occur in close proximity.

**Table 11. Recommended plant species for Conservation Reserve Program lands within occupied and potential range of Columbian sharp-tailed grouse in the western United States[1].**

| Category and scientific name | Common name | Status |
|---|---|---|
| Grasses[2] | | |
| *Nassella viridula* | Green needlegrass | Native |
| *Pseudoroegneria spicata* | Bluebunch wheatgrass | Native |
| *Elymus trachycaulus* | Slender wheatgrass | Native |
| *Bromus marginatus* | Mountain brome | Native |
| *Leymus cinereus* | Basin wildrye | Native |
| *Festuca idahoensis* | Idaho fescue | Native |
| *Poa secunda* | Sandberg bluegrass | Native |
| *Poa secunda (formerly, P. ampla)* | Sherman big bluegrass | Native |
| *Poa fendleriana* | Muttongrass | Native |
| *Achnatherum hymenoides* | Indian ricegrass | Native |
| *Elymus elymoides* | Squirreltail | Native |
| *Melica bulbosa* | Oniongrass | Native |
| *Elymus wawawaiensis* | Snake River wheatgrass | Native |
| Forbs[2] | | |
| *Medicago sativa* | Alfalfa | Introduced |
| *Vicia americana* | American vetch | Native |
| *Astragalus cicer* | Chickpea milkvetch | Introduced |
| *Balsamorhiza sagittata* | Arrowleaf balsamroot | Native |
| *Hedysarum boreale* | Utah sweetvetch | Native |
| *Onobrychis viciifolia* | Sainfoin | Introduced |
| *Lupinus argenteus* | Silvery lupine | Native |
| *Sanguisorba minor* | Small burnet | Introduced |
| *Eriogonum umbellatum* | Sulphur-flower buckwheat | Native |
| *Linum lewisii* | Lewis flax | Native |
| *Penstemon strictus* | Rocky Mountain penstemon | Native |
| *Trifolium* spp. | Clover | Native |
| *Crepis acuminate* | Tapertip hawksbeard | Native |
| *Polygonum* spp. | Knotweed | Native |
| Shrubs[2] | | |
| *Artemisia tridentata* | Big sagebrush | Native |
| *Amelanchier* spp. | Serviceberry | Native |
| *Prunus virginiana* | Chokecherry | Native |
| *Rosa woodsii* | Woods' rose | Native |
| *Ericameria nauseosa* | Rubber rabbitbrush | Native |

[1]See Monsen (2005) and Benson et al. (2011) for additional seed mixes and recommendations regarding site preparation, planting methods, and weed control.

[2]Grasses should comprise (by weight) 65–80% of the seed mixture, forbs 15–25%, and shrubs 3–5%.

## Grazing

Livestock grazing is perhaps the most contentious, politically sensitive, and polarizing issue facing those responsible for management of CSTG populations and their habitats due to the public misconception ranching is an ecologically benign activity (Freilich et al. 2003). There is much debate about grazing with regard to grouse and that debate is centered around the lack of rigorous data on effects of grazing on grouse populations (Hoffman and Thomas 2007). Cattle are known to be directly responsible for destroying nests and killing chicks by trampling (McDonald 1998, Manzer and Hannon 2007, Gillette 2014). In addition, extensive information exists on effects of grazing on plant communities upon which grouse rely. Numerous investigators have used this information to make inferences about negative impacts of improper grazing on CSTG habitats (Fig. 32). For example, plant species positively associated with CSTG use have decreased with excessive grazing (Klott and Lindzey 1990, Saab and Marks 1992). Destruction of riparian deciduous-shrub communities, which provide critical winter habitat for CSTG, has been identified as the primary negative consequence of grazing in Washington (Zeigler 1979, Stinson and Schroeder 2012). Inappropriate grazing of the understory of chokecherry stands in southeastern Idaho rendered stands useless as escape and loafing cover for CSTG (Parker 1970). Excessive grazing of climax grasslands in British Columbia shifted the species composition from desirable bunchgrasses to grazing-tolerant grasses (e.g., Kentucky bluegrass, *Poa pratensis*) and resulted in increased densities of sagebrush (Leupin and Chutter 2007). Schroeder and Baydack (2001) suggested excessive grazing may increase predation rates on grouse and their nests by reducing cover needed for concealment. Boisvert (2002) and Collins (2004) cautiously implied grazing and its subsequent effects on cover may have contributed to lower productivity of CSTG in grazed shrub-steppe compared to ungrazed mine reclamation lands in northwestern Colorado. In surveys conducted by Miller and Graul (1980) and Kessler and Bosch (1982), respondents identified past and present over-grazing as the highest ranking factor suppressing STG populations. Bart (2000) concluded grazing and its secondary effects caused extirpation of CSTG from roughly 75% of the historical range. Improper grazing practices have been, and continue to be, a serious problem within the range of CSTG (Hart et al. 1950, Zeigler 1979, Ritcey 1995, Hoffman 2001, UDWR 2002, Hoffman and Thomas 2007, Stinson and Schroeder 2012).

Few studies have evaluated effects of grazing systems on STG. None involve the CSTG, all are short-term and site-specific,

Figure 32. Degradation of herbaceous and shrub cover caused by improper grazing. (Photo by M. A. Schroeder/WDFW).

and results are inconsistent among studies. Pastures grazed with season-long grazing produced better grassland habitat for STG in southwestern North Dakota than pastures with a deferred-rotation grazing system (Mattise 1978). Intensive grazing of pastures in a rest-rotation system in northeastern Montana did not cause grouse to move from their traditional use areas to adjacent rested pastures or other areas of taller grass (Nielsen and Yde 1982). Instead, grouse used available shrubs or adjacent shrub-dominated coulees for cover. Of 41 nests located in various grazing treatments in south-central North Dakota, 21 were found in twice-over rotation system pastures at an average density of 1 nest/55.5 ha, 11 in idle pastures at 1 nest/47.2 ha, 6 in short-duration pastures at 1 nest/107.9 ha, and 3 in season-long grazing system pastures at 1 nest/215.8 ha (Sedivec et al. 1990). Also in south-central North Dakota, rest-rotation grazed areas had a similar density of successful nests compared to ungrazed areas, but actual nests/40.5 ha of non-grazed area were double that of grazed pastures (Kirby and Grosz 1995). The authors speculated greater cover within ungrazed areas attracted more predators, which contributed to a higher nest failure rate in ungrazed (nest success = 38%) than grazed (nest success = 63%) pastures. Numbers of males attending leks was closely related to density of residual cover left over from the previous year in north-central Montana (Brown 1966). Male numbers increased on 14 of 15 leks where density of residual cover around leks increased. Decreases in residual cover were accompanied by a decline in males on 16 of 20 leks (Brown 1966).

Direct effects of grazing are compounded by actions taken to control and protect livestock and to increase forage production for livestock (Freilich et al. 2003). Examples of such actions include building and subsequent presence of roads and fences, alteration of fire regimes, mechanical and chemical treatment of shrub-dominated communities to enhance grass production and control weeds, and conversion of native cover types to hayfields and pasture. These actions may have a greater impact on CSTG habitats than the vegetation changes caused by the grazing animals themselves; consequently, they are addressed separately in other sections of this document. Despite the many negative impacts associated with grazing, keeping private ranches intact is essential for preserving large tracts of habitat for CSTG (Hoffman and Thomas 2007, Stinson and Schroeder 2012). The alternative is habitat loss and fragmentation when ranches are sold for development. Ironically, some of the most overgrazed ranges occur on public lands due to a legacy of past overgrazing. While stocking rates have declined on public lands and many allotments are currently managed under a deferred- or rest-rotation system, these lands have not received adequate rest over multiple grazing seasons. Consequently, there has been minimal opportunity for recovery from past overuse (Knick et al. 2011).

Effects of grazing on native plant communities are complex and dependent upon intensity, season, frequency, and duration of grazing, distribution of grazing animals across the landscape, type of livestock, and current ecological condition of the plant community (Holechek et al. 2001). Various combinations of rotation and deferment, as well as continuous grazing, can be effective in improving range condition when these factors are given proper consideration (Blaisdell et al. 1982). No single grazing strategy can be applied across the range of CSTG. Grazing management must be tailored to the condition and potential of each grazing unit (Holechek et al. 2001), including recognition of when and where grazing is not an ecologically appropriate practice.

The ultimate goal should be to provide for a level of grazing that maintains and ideally improves long-term stability of CSTG habitats, while providing for viable ranching operations. This is a realistic goal considering there are already areas where healthy grouse populations occur on lands that are grazed by domestic and wild ungulates (Fig. 33). To accomplish this goal, wildlife professionals and livestock producers must become more tolerant, understanding, and respectful of each other's perspectives and focus on areas of mutual interest. Wildlife agencies should establish collaborative partnerships with private and federal entities to develop grazing plans that consider needs of CSTG. This approach will likely require agencies to contribute monetary resources to the partnership. Grazing systems that are cooperatively developed are likely to be most beneficial because there is ownership by all interests. Private ranches typically graze livestock for economic benefit and most public lands are managed under multiple-use mandates that include livestock grazing. Guidelines intended to lessen impacts of grazing on CSTG habitats must accept these realities to be effective.

**Figure 33. Where grazing is properly managed, healthy plant communities can be maintained. (Photo by G. L. Gillette/UI).**

*Guidelines:*

1. Management of public lands should reflect standards upon which other lands are managed and clearly demonstrate when, where, and how grouse and livestock management can be compatible.

2. Public land managers must consider all effects of grazing when deciding whether or not to allow grazing on lands under their care (Freilich et al. 2003).

3. Consider retirement of grazing privileges or adjustment of grazing management as an option in critical CSTG habitats when base property is transferred or the current permittee is willing to retire or change grazing on all or part of an allotment.

4. Prevent excessive use of riparian areas and mountain shrub patches. Do not graze these areas during late summer, autumn, and winter to avoid excessive use of desirable shrubs.

5. Incorporate habitat condition objectives for key wildlife species, such as sage-grouse and CSTG, into indicators of rangeland health where these species occur.

6. Grazing systems should allow for flexibility and adaptability to changing habitat and environmental conditions, such as drought, and provide for adaptive management as new knowledge of rangeland ecosystems become available.

7. Manipulate vegetation only when necessary to maintain, improve, or restore health of a plant community. Avoid projects designed to manipulate vegetation for the sole purpose of increasing forage for livestock.

8. Through land health assessments, develop and implement objective and quantifiable criteria for designating public lands unsuitable for livestock grazing or in need of long-term rest.

9. Identify key species in the plant community livestock are likely to use most heavily and use them as indicators of grazing intensity. If key species are not overgrazed, one can reasonably assume other species will not be either.

10. If an undesirable distribution of grazing is occurring within a grazing unit, animal distribution should be improved through herding, salting, and possibly developing additional water sources. The goal is to attract livestock away from areas important to grouse and encourage them to use areas of less importance.

11. Inappropriate grazing of readily-accessible portions of the range should not be tolerated because other areas receive little or no use. These readily accessible ranges (i.e., rolling or flat terrain) are the sites most often used by grouse for nesting and brood-rearing. Determination of grazing capacity should take into account slope and distance to water as well as forage production.

12. Timing of grazing should allow for growth and regrowth of key species. Avoid passive, season-long grazing wherever possible. Periods of use during the growing season should vary from year to year. At least once every 3–4 years a grazing unit should be rested. Grazed pastures should not be allowed to exceed acceptable utilization levels to compensate for rested pastures, nor should rested pastures be heavily grazed after they are rested.

13. The Habitat Suitability Index model for CSTG indicates optimum nesting and brood-rearing habitat occurs where Robel pole readings (Robel et al. 1970) of residual vegetation exceed 25 cm (Meints et al. 1992). Equating this value to standard use classes for key western range grasses (Holechek et al. 2001), only light (≤32%) utilization appears to be compatible with CSTG use on most ranges.

14. Under rest-rotational grazing, rested units should not be grazed until after the nesting season the following year, and then at light intensity. Under deferred-rotational grazing, a unit should be grazed only once within the year at light intensity and should be grazed at a different time the following year. If continual seasonal grazing is the only option due to access problems, short growing season, or both, stocking rates should be based on achieving light use of key species.

15. Precipitation, plant growth, and target grazing use level should be used to decide when to move livestock instead of relying on calendar dates. Whenever level of use exceeds 50% or the forb component of the plant community falls below 5–10% cover (depending on site potential), then a 2-year rest period is recommended to allow for recovery.

16. Land managers should be aware the compatible level of use of key plant species that will leave adequate cover for CSTG after livestock are removed will be lower than the level of use plants can sustain. Compatible level of use may change annually depending on growing conditions. What matters most is how much residual cover remains, not how much forage is removed (Holechek et al. 1982).

17. Because utilization measurements are difficult to interpret and compare from one year to the next, stubble height should be measured in addition to utilization to effectively monitor grazing. Stubble height is a more meaningful and practical measure of grazing intensity with regard to grouse. Stubble height is easy to measure, easy to interpret, and provides a common reference point for decision making regarding grazing levels (Holechek et al. 1982). The recommended average stubble height across the landscape to provide suitable nesting and brood-rearing cover for CSTG is 25 cm (range = 15–30 cm).

18. Ecological condition of rangelands is especially important to develop grazing prescriptions (Blaisdell et al. 1982). Depleted or poor condition ranges will respond slowly or possibly not at all to the best grazing management because pressure is maintained on already sparse desirable grasses and forbs by grazing animals. Control of unwanted species, reseeding with desirable species, and rest are often necessary in this situation.

19. Restored or rehabilitated sites should not be grazed until at least the end of the second growing season following treatment and perhaps longer depending on the vegetation type treated, growing conditions before, during, and after treatment, species included in the seed mix, and severity of competing weedy species (Stevens 2004).

20. If fences are necessary to properly manage grazing, they should be marked.

## Energy Development

A growing body of literature suggests rapidly expanding energy development in the western U.S. will cause a range of adverse effects to prairie grouse (Robel et al. 2004, Kuvlesky et al. 2007, Walker et al. 2007, Pruett et al. 2009, Hagen 2010, Johnson and Holloran 2010, Naugle et al. 2011). Foremost are loss and fragmentation of habitat, disturbance and displacement, physiological stress, introduction of predatory and competitive organisms, and direct mortality due to collisions. Magnitude of impacts will depend on amounts, intensity, and duration of disturbances, specific locations and arrangements of disturbances, and ecological importance of affected habitats (Kuvlesky et al. 2007, Wyoming Game and Fish Department 2010, Doherty et al. 2011, Naugle et al. 2011). Large-scale developments within habitats critical to survival and reproduction of grouse are especially problematic. Due to site fidelity, grouse will often continue to occupy disturbed sites even though their fitness may be compromised (Hagen 2010). Additionally, grouse moving to unaffected habitats cannot do so without consequences. Any adjacent suitable habitats will be occupied. Thus, displaced grouse moving into these areas will cause increased intraspecific competition. Conversely, displaced grouse may be forced to use marginal habitats. In either case, the ultimate outcome is lower demographic rates (Hagen 2010).

Due to the lack of historical energy development within CSTG range, there is little research regarding the immediate and lag effects of energy development on CSTG habitats and demographics. Until recently, energy development within the range of CSTG was primarily limited to coal mining and affected <1% of the range (Hoffman and Thomas 2007). Wind energy projects were rare and much of the oil and gas activity was outside or near fringes of occupied range. Recent projections, however, indicate a 50% increase in the demand for energy by 2030 (Committee on Global Oil and Gas 2007). This situation has prompted the federal government to promote development of domestic energy supplies and fostered increased production and use of renewable energy sources though amendments to the National Energy Policy and Conservation Act and passage of the American Recovery and Reinvestment Act of 2009. As a consequence of these actions, oil, gas, and wind-energy developments have expanded into core areas occupied by CSTG in the western U.S. (Fig. 34; Lu et al. 2009, Hagen 2010, Naugle et al.

Figure 34. Until recently, energy development other than coal mining was rare within the occupied range of Columbian sharp-tailed grouse. This is no longer the case as oil, gas, and wind-energy developments have expanded into core areas occupied by Columbian sharp-tailed grouse. (Top photo by R. W. Hoffman/retired CPW; bottom photo by M. A. Schroeder/WDFW).

2011). Hoffman and Thomas (2007) reported approximately 75% of occupied CSTG range in Colorado and Wyoming has medium to high development potential for oil and gas resources. They predicted oil and gas development could become the single most threatening activity on lands occupied by CSTG in Colorado and Wyoming if these resources are developed to their fullest potential. Likewise, wind-power developments in Idaho, Utah, Oregon, and Washington may have serious detrimental effects if these developments do not take needs of CSTG and other prairie grouse into account (Kuvlesky et al. 2007, Pruett et al. 2009, Hagen 2010, Johnson and Holloran 2010). Over 30 years ago, Miller and Graul (1980) predicted increasing energy development, along with continued livestock grazing, would have the greatest future impact on CSTG.

The only completed investigations of CSTG and energy development pertain to coal mining. Reclamation practices on surface-mined lands have improved dramatically due to passage of the Surface Mining Control and Reclamation Act of 1977. Modern reclamation actions have created habitats that are highly attractive to CSTG for breeding, nesting, and brood-rearing; however, it takes 10-15 years post-mining for the benefits to manifest (Fig. 35; Hoffman 2001, Boisvert 2002, Collins 2004). Hoffman (2001) reported reclaimed mine lands in northwestern Colorado supported a higher density of leks (1 lek/170 ha) and larger leks (mean = 22 males/lek) than any other cover type, including native shrub-steppe. Reclaimed mine lands accounted for only 1% of occupied range of CSTG in northwestern Colorado, but supported 18% of known active leks (Hoffman 2001). Boisvert (2002) documented significantly higher nesting success and survival of CSTG using mine reclamation lands compared to other cover types. Collins (2004) found that several reproductive parameters, including clutch size, nesting success, and chick survival, were higher for grouse using mine reclamation lands than native shrub-steppe during a moderate drought year, but only clutch size differed during a severe drought year. Although coal mining activities displace CSTG in the short-term, available evidence indicates CSTG clearly benefit from modern reclamation practices in the long-term (Fig. 36; Hoffman 2001, Boisvert 2002, Collins 2004). The primary concern with regard to mine reclamation lands is what happens to these lands following bond release (Hoffman 2001). In most cases, mined land reverts back to its original use, which is usually grazing, with no assurances the land will be managed in ways that are beneficial, or at least not detrimental, to CSTG (Hoffman 2001, Hoffman and Thomas 2007).

**Figure 35. Reclaimed surface coal mine site in northwestern Colorado. (Photo by R. W. Hoffman/retired CPW).**

**Figure 36. Active surface coal mine site in northwestern Colorado before reclamation. (Photo by R. W. Hoffman/retired CPW).**

Most research on effects of energy development on grouse in the West has focused on greater sage-grouse. Naugle et al. (2011) conducted a review of relationships between sage-grouse, and oil and gas development and related infrastructure. All studies they reviewed reported negative impacts of energy development on sage-grouse, including reduced survival, avoidance of suitable habitats near developments, lower reproductive performance, decreased lek attendance, and increased susceptibility to disease (i.e., West Nile virus). No studies reported any positive influence of oil and gas development on populations or habitats of sage-grouse. Hagen (2010) synthesized current data on impacts of energy development, including associated infrastructure, on prairie grouse distribution and demography. Results indicated moderate to large displacement effects and small to moderate demographic effects.

Few well-designed studies have directly examined the potential impacts of wind-energy development on prairie grouse. To date, none have been completed on CSTG. In Wyoming, LeBeau (2012) determined proximity to wind turbines did not influence female greater sage-grouse survival or nest and brood-rearing habitat selection, but nest and brood survival decreased in habitats closer to turbines. In Kansas, Sandercock et al. (2013) found reductions in lek persistence of greater prairie-chickens near wind turbines and avoidance of turbines by females during the breeding season, but found no impacts of wind power development on nest site selection, female reproductive effort or nesting success, or population numbers. In the same study population, annual survival of females increased in the period following wind farm construction compared to the pre-construction period; mortalities due to collisions were rare and most involved collisions with fence or power lines and not wind turbines (Winder et al. 2014). These and other finding related to the impacts of energy development must be viewed with caution because there may be a 2–10 year time lag before negative responses are detected (Walker et al. 2007, Harju et al. 2010). Wind-energy developments may present a greater threat to grouse in the long-term than coal, oil, and gas developments because they are permanent fixtures on the landscape. Furthermore, habitat requirements of prairie grouse (i.e., preference for open, exposed sites on locally elevated areas) often coincide with preferred locations for siting wind turbines, increasing the potential for conflicts.

Sharp-tailed grouse appear to adapt to human disturbance more so than other species of prairie grouse, provided suitable habitats are still available to the birds (Braun et al. 2002, Williamson 2009). For instance, CSTG have been documented using suitable habitats near roads, fences, power lines, and houses, and within areas actively mined for coal (Hoffman and Thomas 2007). Nonetheless, there is some threshold density of anthropogenic features, as yet to be determined, above which CSTG will avoid or reduce their use of suitable habitats (Hoffman and Thomas 2007).

*Guidelines:*

1. Laws comparable to the Surface Mining Control and Reclamation Act should be passed to regulate oil, gas, and wind developments. This legislation should provide for a level of bonding that ensures sites disturbed by these activities are reclaimed in a timely and effective manner.

2. In accordance with its duel responsibility of facilitating energy development and protecting the nation's natural resources, the federal government should pass legislation establishing a new, long-term, dedicated funding source to adequately provide BLM, USFS, USFWS, and state wildlife agencies the necessary means to monitor, evaluate, and protect habitats and wildlife populations affected by energy development.

3. Greater cooperation must occur among federal and state agencies, and industry to ensure consistency in permitting requirements, monitoring and research efforts, and formulation of effective management practices that transcend local, state, and regional jurisdictions.

4. The hierarchy of dealing with impacts of energy development should be to avoid, minimize, and mitigate.

5. Appropriate federal and state agencies should be consulted early in the planning process. Close coordination with federal agencies during lease sales is the best approach to potentially avoid energy development in key habitats. Species experts should play a key role in identifying sensitive and critical habitats within development areas and in formulating management, mitigation, and reclamation practices to avoid or minimize impacts to these areas. Species experts also should help delineate areas of non-habitat and marginal habitat within proposed developments where activity could occur with minimal impacts.

6. Develop and implement a process to ensure compliance with policy, laws, regulations, and agreed upon management practices to minimize and mitigate adverse impacts of energy development on CSTG populations and their habitats.

7. Responses of CSTG to various types and levels of energy development must be ascertained through scientifically sound studies that include control areas, pre- and post-construction evaluations, and unbiased data collection that meets peer review and legal standards. Studies must be long-term (5–10 years) to account for any delayed responses to development, and use consistent methodologies to allow for comparisons among studies. Such studies must identify "threshold impacts," which are levels of development and disturbance that impair key habitat functions by directly eliminating habitat, disrupting access to or use of habitat, and causing avoidance and stress (WGFD 2010).

8. Until more information is available, the practical approach to dealing with energy development is to apply published guidelines for wildlife species most threatened by a development. Within the range of CSTG, this generally will be greater sage-grouse.

Standard, best, and specific management practices have been developed for addressing impacts of energy development on greater sage-grouse (WGFD 2010). These practices are founded on rigorous studies that have identified threshold impacts of oil and gas development on greater sage-grouse. Specific threshold impacts have not been ascertained for wind development projects. Only general and interim guidelines have been formulated for dealing with wind development projects due to the lack of completed research on this subject (Kuvlesky et al. 2007, Johnson and Holloran 2010, Wind Turbine Guidelines Advisory Committee 2012).

9. The Core Area Strategy is not a rational approach for managing CSTG. The intent of this strategy is to allow greater flexibility for development in non-core areas as long as connectivity between core areas is maintained (WGFD 2010, Doherty et al. 2011). With only 10% of the historical range occupied by CSTG, all currently occupied habitats must be considered core areas, especially because there is no connectivity between these areas.

10. Agencies must use a landscape approach to plan and mitigate large-scale energy developments because impacts are not limited to project areas; nor are mitigation opportunities. The landscape that pertains to CSTG should include major lek complexes, associated nesting and brood-rearing habitats, winter habitats, and travel corridors between seasonally occupied habitats.

11. Where different types of energy development occur on the same landscape or where different companies operate in the same area, agencies and industry must formulate guidelines that account for collective impacts and cumulative effects from all sources of development.

12. Approval for development should include measures to eliminate or reduce negative impacts from other land uses (e.g., grazing, agriculture, recreation) within and adjacent to development areas.

13. Maintain quality CSTG habitats in areas adjacent to development to ensure natural re-colonization after development activities have ceased.

14. Off-site mitigation should include options for enhancing existing habitats and restoring previously occupied habitats outside the impacted area. Depending on the importance of the disturbed area to CSTG, off-site mitigation should equal or exceed the area rendered unsuitable due to energy development. Off-site mitigation should only be considered when feasible mitigation options are not available within or immediately adjacent to the impacted area or when off-site mitigation would provide more effective mitigation than could be achieved on-site. On- and off-site mitigation should occur in addition to interim and final reclamation requirements on the impacted site.

15. Avoid energy developments that render a site unsuitable for use by CSTG whenever possible. Exceptions can be made for surface coal mining, which by its very nature totally eliminates habitat on a temporary basis until the pit is refilled and the surface reclaimed. Areas disturbed by surface coal mining should be reclaimed as quickly as possible once coal is removed.

16. Whenever possible, locate energy developments in degraded or unoccupied areas, such as croplands.

17. Map and validate seasonal habitats of CSTG within areas of potential energy development in order to establish biologically relevant no surface occupancy (NSO) stipulations. Rarely are nesting and brood-rearing habitats uniformly distributed around leks. Thus, defining buffers around leks where no surface occupancy can occur may have little biological relevance. Greater benefit may be derived from protecting an area farther from a lek because it supports critical habitat and allows activity in another site closer to a lek that is in marginal or non-essential habitat. Stipulations for NSO are primarily established to protect leks and encompass areas around leks used by males. No Surface Occupancy stipulations may provide little in the way of protection against development for nesting and brood-rearing females depending on the proximity of nesting and brood-rearing habitats around the lek. Protecting leks and areas used by males is less important than protecting surrounding nesting and brood-rearing habitats. Lek sites are probably not limiting and can shift locations in response to disturbance. The same is not the case for nesting and brood-rearing areas.

18. In the absence of habitat information, standard NSO stipulations are necessary to provide some level of protection surrounding leks. The most biologically relevant NSO stipulation for CSTG is within 2 km of any occupied lek. This figure is based on movements of females from their lek of capture to nesting and brood-rearing areas (Meints 1991, Apa 1998, McDonald 1998, Collins 2004, Boisvert et al. 2005). An occupied lek is defined as a lek where attendance has been documented for ≥1 breeding season within the most recent 5-year period. Obtaining industry support for an NSO stipulation of 2 km is probably unrealistic. Therefore, NSO stipulations of 0.8–1.0 km are acceptable if restrictions are placed on density of wells and infrastructure surrounding leks.

19. Minimal activity should occur during breeding and early brood-rearing periods (15 Mar to 15 Jul). When this is not possible, restrict activity to between 0900 and 1600.

20. Where activity must occur within known CSTG wintering areas, conduct these activities outside the period between 15 November and 14 March when possible.

21. Phase and concentrate development where feasible to maintain large areas of undisturbed habitat. Minimize development footprints by clustering roads, pipelines, and power lines, using existing road, pipeline, and utility corridors, drilling multiple wells from pads using directional drilling, and arranging wind turbines in blocks rather than linear configurations.

22. If new roads are required, close and reclaim existing roads that access the same area. Where possible, route roads, power lines, and pipelines through low impact areas. Coordinate construction and use of roads among companies operating in the same area. Roads should be gated to preclude use by unauthorized vehicles. Use remote instrumentation to reduce traffic volume. Close and reclaim roads as soon as they are no longer needed.

23. Install perch deterrents on power poles and fence posts where appropriate (see guidelines for reducing predation). Follow guidelines developed by the Avian Power Line Interaction Committee (1996) when possible.

24. Follow guidelines for minimizing collisions with fences and overhead lines.

25. Use noise reduction equipment on compressors and other equipment. Utilize topographic features to suppress noise and conceal facilities from leks. Use electric rather than diesel or gas to power equipment wherever possible.

26. Take effective action to control mosquito larvae in waste water pits and other stagnant pools of water created by development.

27. Use early and effective reclamation techniques, including an aggressive interim reclamation program to return disturbed habitats to useable condition for CSTG as quickly as possible. Development should progress at a pace commensurate with reclamation success.

28. Develop and implement plans for controlling noxious weeds and other invasive plants.

29. Develop fire prevention and control plans for construction and operational phases of development.

30. Reclamation and restoration seed mixes should be suitable for the specific site and include a diversity (≥10 species) of native grasses, forbs, and shrubs, and if appropriate, introduced forb species (see Table 11 for recommendations). Reclamation and restoration practices should follow effective and proven guidelines (Monsen 2005, Benson et al. 2011). Do not allow livestock grazing until vegetation is fully established and can withstand light grazing.

31. Agencies, industry, and private contractors should share information on the most cost effective and efficient methods for reclaiming and restoring disturbed sites. For instance, oil, gas, and wind development companies could benefit greatly by reviewing practices used by the coal industry to reclaim surface mined lands.

## Agriculture

While cultivation has benefited CSTG by providing additional sources of food, this benefit has not nearly compensated for the loss and fragmentation of habitats caused by agriculture (Fig. 37; Hart et al. 1950, Miller and Graul 1980, Connelly et al. 1998). Bart (2000)

**Figure 37. Historically, intensive agriculture was the leading cause of loss and fragmentation of habitats used by Columbian sharp-tailed grouse. Further conversion of native habitats for agricultural purposes is unlikely as few areas of tillable land remain within the occupied range of Columbian sharp-tailed grouse. (Photos by M. A. Schroeder/WDFW).**

estimated CSTG were extirpated from 20% of historical range due to intensive agriculture and associated activities. The amount of habitat lost to agriculture varies across the range. Approximately 95% of formerly occupied range in southern British Columbia is now used for agriculture (Ritcey 1995). Only 1 lek remained on the Tobacco Plains in western Montana following a 40-year period during which agricultural lands increased by 62% (Wood 1991). The most drastic declines of CSTG in eastern Oregon occurred when cultivation of crops replaced cattle ranching as the primary land use (Olson 1976). Hart et al. (1950) stated nearly all natural habitats of CSTG in Utah were appropriated by man for agricultural purposes and the only remaining native range consisted of stony, non-tillable land. Buss and Dziedzic (1955) estimated by 1920 approximately 80% of CSTG range in southeastern Washington was under cultivation. Between 1900 and 1990, habitat conversion to croplands, hay fields, and pasture in eastern Washington resulted in landscape-level decreases in native grassland (25% to 1%) and sagebrush (44% to 16%) cover types (McDonald and Reese 1998). Mean patch size declined from 3,765 ha to 299 ha for grasslands and 13,420 ha to 3,418 ha for sagebrush. The consequence of these changes has been a 92% decline in CSTG range in eastern Washington (Schroeder et al. 2000). The main reason CSTG still inhabit areas in northwestern Colorado and south-central Wyoming is because topographic constraints, along with a short growing season, limit the amount of land suitable for agriculture (Hoffman 2001, Hoffman and Thomas 2007).

Loss of habitat to agriculture primarily occurred during the first half of the 20th century. Further conversion of native habitats to croplands is unlikely as few areas of tillable land remain in the western U.S. Since the late 1980s, some losses caused by agriculture have been partially and temporarily alleviated through implementation of the CRP (Rodgers and Hoffman 2005). However, long-term status of the CRP is uncertain. In addition, changes in agricultural commodity prices could result in farmers not renewing contracts or seeking early releases. In Idaho alone, 85,000 ha of CRP land were converted back to row-crop agriculture between 2007 and 2014 (Gillette 2014).

*Guidelines:*

1. Manage for no net loss of native habitats on public lands, and strive for the same on private lands.

2. Improve existing habitats and restore formerly occupied habitats on public lands to compensate for loss of habitats on private lands.

3. Work with Farm Bill policy makers to remove incentives, including crop insurance coverage, for any new conversions of native cover to croplands.

4. Develop and utilize conservation easements to protect, enhance, and restore native habitats on private lands, including clauses that prevent any conversions of native cover types to croplands.

5. Identify priority areas where Farm Bill programs have the greatest potential to benefit CSTG.

6. Work closely with willing landowners, FSA, and NRCS to restore abandoned or unproductive farm ground using Farm Bill programs such as CRP, Wildlife Habitat Incentive Program, EQIP, and Grassland Reserve Program.

7. Every effort should be made to maximize the amount of land enrolled in the CRP within the occupied range of CSTG and within potential translocation sites. Encourage counties with critical CSTG habitats to apply for a waiver to exceed the 25% enrollment cap.

8. Provide data, technical assistance (including development of conservation plans), materials, and monetary support to the FSA and NRCS to protect, enhance, and restore habitats for CSTG on private lands, and where possible, to prevent any further conversion of native habitats to agricultural lands.

9. Implement a program for CSTG similar to the NRCS sage-grouse initiative (SGI) or develop projects funded by the SGI that can mutually benefit sage-grouse and CSTG where they are sympatric. Give projects a higher ranking for funding where outcomes will benefit both sage-grouse and CSTG. All areas where sage-grouse and CSTG are sympatric should be eligible for funding through the SGI.

10. Consider the potential for growing non-traditional crops (e.g., native grass seed) that will provide income to landowners and benefit CSTG.

11. Establish demonstration areas that integrate traditional and non-traditional farming practices, habitat restoration, sound grazing management, and best management practices to reduce erosion.

## Urban and Rural Development

Urban and rural developments have replaced agriculture as the leading cause of habitat loss and fragmentation within the range of CSTG (Fig. 38). Connelly et al. (2004) reported, within historical and current range of greater sage-grouse, human densities in 1900 were <1 person/km$^2$ in 51% of 325 counties and >10 persons/km$^2$ in only 4% of counties; by 2000 the corresponding figures were 31% and 22%, respectively. The area examined by Connelly et al. (2004) includes the entire range of CSTG in the western U.S. Buildings, roads, railways, power lines, fences, water impoundments, landfills, communication corridors, and other facilities associated with urbanization together greatly influence CSTG and their habitats (Hoffman and Thomas 2007, Stinson and Schroeder 2012). Many people want the amenities of urban areas, while enjoying the solitude, open spaces, and greater freedoms (less restrictive covenants)

Figure 38. Example of how impacts of multiple disturbances, including rural development, grazing, cultivation, fences, roads, and power lines render the landscape unsuitable for Columbian sharp-tailed grouse. (Photo by R. W. Hoffman/retired CPW).

of rural living. Consequently, rural developments tend to increase near urban areas. In contrast to highly urbanized areas, rural developments may continue to provide some habitats for CSTG. However, rural developments usually affect larger areas and may have a greater impact on CSTG than urban development. Studies of other prairie grouse suggest they exhibit a behavioral aversion to structures (Pitman et al. 2005, Pruett et al. 2009, Hagen 2010, Hagen et al. 2011). Thus, a single home placed in CSTG habitat may effectively reduce habitat availability to a much greater distance than might superficially appear.

People living in rural areas often own livestock, particularly horses, which are confined to small tracts of land. This situation exerts tremendous grazing pressure on the landscape, to the point where native habitats become highly degraded and useless to CSTG. Generalist predators such as skunks, raccoons, red fox, and corvids thrive in urban and rural environments. These human-subsidized predators, which might otherwise be absent or occur at low densities, can spread into undeveloped areas occupied by CSTG. Urban and rural developments also increase the likelihood that non-native predators (e.g., feral dogs and cats) will be introduced into CSTG habitats. In addition, rural areas may increase probability of disease transmission because CSTG using or passing through rural landscapes are more likely to come in contact with domestic fowl.

*Guidelines:*

1. Wildlife management agencies should play a proactive role in city and county planning, zoning, and development.

2. Encourage use of native vegetation in landscaping human developments.

3. Manage open space to benefit CSTG.

4. Consider the following options to minimize or prevent loss of CSTG habitats on private lands: cluster developments, density credits, development right transfers, land exchanges, open space, conservation easements, and fee title acquisition.

5. Educate county planners and commissioners about the status, distribution, and habitat requirements of CSTG so they can make sound decisions regarding development proposals and request appropriate mitigation measures.

6. Provide counties with the most recent and accurate information on location of leks and other critical habitats in compliance with state laws.

7. Assist counties to develop and modify land use and zoning plans to protect critical CSTG habitats.

8. Encourage counties to offer incentives to developers who protect and enhance CSTG habitats.

9. Document fate of leks in jeopardy due to development.

10. Provide testimony at county commission and planning meetings to avoid, minimize, rectify, or mitigate impacts of development on CSTG.

## Fire and Timber Management

Effects of fire on CSTG habitats are not well understood and vary regionally due to precipitation levels, vegetation types, and timing, intensity, frequency, and size of burns (Ritcey 1995, Hoffman and Thomas 2007, Stinson and Schroeder 2012). Fires that burn large contiguous patches of grassland, shrub-steppe, mountain shrub and riparian shrub communities may be detrimental to CSTG, especially where suitable habitats are limited. Conversely, fires that create a mosaic of burned and unburned areas within these plant communities may be beneficial. Historically, natural fires probably benefited CSTG in the long-term by setting back succession. Over the past 150 years, natural fire regimes in the west have been altered due to introduction of livestock, planting of non-native grasses, and invasion of exotic annual grasses and noxious weeds (Miller and Rose 1999, West 2000, Miller and Tausch 2002, Monsen 2005, Baker 2006). In some cases, fire frequency has decreased due to reductions in fine fuels caused by grazing (Miller and Rose 1999, Miller and Tausch 2001). In other cases, invasion and expansion of exotic annual grasses and noxious weeds have contributed to an increase in fires (West 2000). Monsen (2005) suggested natural recovery from fires is unlikely in plant communities altered by these disturbances.

Excessively long, as well as short, intervals between fires can negatively affect CSTG habitats. In the absence of fire, fuel loads may increase such that when a fire does occur, it may burn more intensively and over a larger area. Lack of fire can promote encroachment of conifers into grassland and shrub-dominated communities (Ritcey 1995, Leupin and Chutter 2007, Stinson and Schroeder 2012). Lack of fire also can encourage expansion and dominance of Gambel oak (*Quercus gambelii*), Rocky Mountain maple (*Acer glabrum*), and bitter cherry (*Prunus emarginata*), to the detriment of species more desirable to CSTG such as serviceberry, chokecherry, hawthorn, and aspen. Frequent fires have the potential to be more detrimental to CSTG habitats than lack of fire. From 1988 to 1999, 181 wildfires burned 14,567–20,866 ha of sagebrush rangeland, representing a loss of 13–19% within the distribution of CSTG in Utah (UDWR 2002). Sagebrush communities are exceptionally vulnerable to wildfires because sagebrush is slow to recover following fire (reviewed by Connelly et al. 2004). Wambolt et al. (2001) advised against burning in big sagebrush communities because herbaceous plant responses may be minimal and shrub values will be lost for decades. Baker (2006) also considered prescribed burning in big sagebrush communities as unwarranted.

Burning of dense sagebrush and thickly wooded areas has been recommended as a means of improving CSTG habitats in Utah (Hart et al. 1950), Colorado (Rogers 1969), and Wyoming (Oedekoven 1985). Leupin and Chutter (2007) noted CSTG in British Columbia have benefited from fires in 2 ways: by reducing shrub densities and conifer encroachment within the grassland ecotone, and by creating and maintaining openings within the forest ecotone. In contrast, Marks and Marks (1987) recommended top priority be given to controlling fires within areas occupied by CSTG in western Idaho because of limited availability of native cover types, particularly mountain shrub and hawthorn groves used as winter habitat. McArdle (1977) found less use of burned and sprayed areas by CSTG in southeastern Idaho compared to areas that were chained. He attributed this finding to slow regrowth of shrubs and, to a lesser extent, slow recovery of forbs in burned and sprayed areas. Stinson and Schroeder (2012) discouraged use of fire as a

Figure 39. Natural fire regimes in the western U.S. have been altered due to introduction of livestock, planting of non-native grasses, and invasion of exotic annual grasses and weeds. Consequently, most wildfires within the range of Columbian sharp-tailed grouse need to be suppressed to prevent further degradation of the landscape. Because of potential negative consequences of fire, land managers must exercise extreme caution when using prescribed fire as a management tool. (Photo by M. A. Schroeder/WDFW).

Figure 40. Prescribed fire in a dense oakbrush-dominated, mountain-shrub community designed to thin the overstory, enhance herbaceous understory, and promote sprouting of other shrubs, such as serviceberry. (Photo by S. Woodis/NRCS).

management tool for dry, Wyoming big sagebrush (*Artemisia tridentata wyomingensis*) communities in eastern Washington, but considered burning a potential tool for improving CSTG habitats in meadow steppe and prairie. Apa (1998) suggested fire management practices appropriate for greater sage-grouse habitats also would benefit CSTG where the two species are sympatric.

Most present day wildfires probably do not benefit CSTG because they tend to occur in the best remaining habitats (i.e., those areas with the greatest understory of grasses and forbs to carry a fire) or in areas degraded by invasion of annual grasses that are perpetuated by fire (Fig. 39). Nonetheless, controlled burns can be used to maintain, enhance, and restore CSTG habitats (Fig. 40). Plant communities respond differently to fire. Therefore, managers must adhere to burning techniques applicable for the conditions and vegetation types involved (Whisenant 2004). A conservative plan is the safest approach to using fire as a management tool to treat habitats occupied by CSTG (Hoffman 2001, Hoffman and Thomas 2007, Stinson and Schroeder 2012).

Timber harvest is an important industry within the range of CSTG in British Columbia (Leupin and Chutter 2007). The allowable harvest of timber has increased significantly in British Columbia as the province struggles to deal with the mountain pine beetle (*Dendroctonus ponderosae*) epidemic (Leupin and Chutter 2007). Beetle infestations are estimated to have impacted 7,000,000 ha of lodgepole pine (*Pinus contorta*)-dominated forests in British Columbia (Aukema et al. 2006). Local populations of CSTG have responded positively to clear-cut harvesting designed to remove the infested trees and slow down the spread of the beetles. The birds start using clear-cuts almost immediately and continue using them for 15-20 years post-harvest (Leupin and Chutter 2007). Clear-cut harvesting in British Columbia has helped to partially offset the detrimental effects of fire suppression and has clearly allowed CSTG to expand their distribution in parts of the province (Leupin and Chutter 2007). Key features that make clear-cuts beneficial to CSTG in British Columbia include the large scale at which they occur and the abundance of herbaceous cover and deciduous shrubs that appear in the early successional forests. In some situations, herbaceous and shrub cover is treated with herbicides to reduce competition with growing trees (Simard et al. 2003, Leupin and Chutter 2007), a practice that diminishes the suitability of the clear-cut for CSTG.

*Guidelines:*

1. Evaluate wildfires for their potential to improve habitat on a site-specific basis.

2. Suppress wildfires that threaten to burn large (>100 ha), contiguous blocks of habitat or that threaten to burn critical areas where habitat is limited.

3. Suppress wildfires in xeric (<30 cm annual precipitation) sagebrush communities, especially where threat of cheatgrass (*Bromus tectorum*) invasion is high.

4. Suppress wildfires that start during nesting and early brood-rearing periods (late Apr-Jul).

5. Reseed with native grasses (primarily bunchgrasses), forbs, and shrubs following wildfires in depleted ranges to promote recovery and limit invasion of noxious weeds. Any reseeding should be done in autumn or early winter.

6. Review fire management plans prepared by the USFS, BLM, and counties; where appropriate, provide advice on ways to modify plans to benefit CSTG.

7. Prescribed fire is the preferred method for improving vigor of CSTG habitats because it most closely mimics natural disturbance. However, prescribed fire may not be feasible in situations where size and shape of treatments and amount of vegetation removed must be precisely controlled to prevent damage to adjacent areas. In such situations, mechanical treatments are recommended (Stevens and Monsen 2004, Monsen 2005).

8. Prescribed fire or any other type of vegetation treatment should not be a substitute for good range management. Problems rooted in inappropriate range management practices cannot be rectified by vegetation treatments (Bunting et al. 1987).

9. When considering prescribed fire as a management tool, a concerted effort must be made to educate the local community about its positive benefits for managing CSTG habitats.

10. Most grasses and forbs within native cover types occupied by CSTG are moderately resistant to burns (Monsen 2005). Thus, fire can be used to improve yields and density of grasses and forbs in the understory of over-mature shrub communities. Composition, density, and distribution of grasses and forbs must be adequate to achieve the desired response to burning. Managers should inventory understory species present within the proposed burn area. If ground cover is <20% for perennial grasses and <10% for forbs, and only 50% of expected grasses and forbs are present, consider reseeding following the burn to promote recovery of the herbaceous community. If annual weeds comprise >10% of the ground cover, burning is not advisable as it may accentuate the weed problem. Chemical treatment may be necessary to control weeds, followed by burning and reseeding with desirable grasses and forbs.

Figure 41. Example of a successful prescribed fire within a big sagebrush community that created a mosaic of burned and unburned areas. (Photo by R. W. Hoffman/retired CPW).

11. Time required for shrubs to re-establish is an important factor to consider when using fire as a management tool. Big sagebrush is the primary species of sagebrush found within the range of CSTG. Big sagebrush communities have a greater chance of being negatively impacted by fires than mountain shrub communities because they must recover from fire through seedling establishment (Winward 2004, Monsen 2005). Depending on the subspecies of big sagebrush, size and intensity of the fire, and climatic conditions, re-establishment may require >30 years (Wambolt et al. 2001). Better moisture conditions and greater annual seed production make mountain (*Artemisia tridentata vaseyana*) and basin big sagebrush (*Artemisia tridentata tridentata*) sites more suited for burning than Wyoming big sagebrush sites (Monsen 2005). However, even on mountain and basin big sagebrush sites, recovery can be unpredictable (Monsen 2005). Consequently, extreme caution must be exercised in using fire to treat any big sagebrush community (Fig. 41).

12. No more than 20% of an area should be burned. Several small burns varying in size from 2 to10 ha in a patchwork pattern are recommended over a single large burn. Where possible, retain pockets of live sagebrush plants and native grasses and forbs within the perimeter of the burn. Not all

over-mature or dense (>40% canopy cover) stands of sagebrush should be targeted for treatment. Some of these stands should be retained on the landscape as they may provide escape cover for CSTG, especially if stands occur near (≤400 m) leks. Defer additional treatments until the initially treated area again provides suitable habitat for CSTG.

13. Burns on broad ridgelines, mesas, benches, and flats will benefit CSTG more than burns along narrow drainages or on steep (>20%) slopes.

14. Burning should not occur during or following years of drought or during nesting and brood-rearing seasons. Late autumn and early winter burns will produce the best results with the least immediate impacts.

15. Burning for the sole purpose of improving forage production for livestock is discouraged.

16. Fire is an inappropriate tool for thinning sagebrush as fire kills sagebrush in patches or over broad areas with limited control over the final outcome. Thinning is best achieved using chemical or mechanical treatments.

17. Avoid using fire as a management tool in habitats prone to invasion of cheatgrass or other noxious weeds unless appropriate measures are taken to restore the understory with desirable perennial species using proven reseeding strategies.

18. With the exception of big sagebrush, most shrub species found within the mountain shrub type are fire tolerant and resprout after fire (Monsen 2005). This allows for shorter recovery time and precludes the need for reseeding or dependence on a natural seed source for re-establishment. Burning should only be considered for mountain shrub stands that are unsuitable for CSTG because they are too dense, over-mature, or dominated by species rarely fed-upon by CSTG during winter.

19. Due to the shorter recovery time, larger burns (15–20 ha) are acceptable within the mountain shrub type where it comprises >20% of the landscape. No more than 20% of a stand should be burned at one time. Subsequent burns can be conducted at 5–10 year intervals as needed.

20. Where mountain shrub communities comprise <20% of the landscape, a more conservative approach to burning is recommended. Individual burns should be smaller (2–10 ha), burn intervals should be longer (10–15 years), and ≤10% of the area should be burned at one time.

21. Where fire has been absent or suppressed for long periods of time within the mountain shrub type, species such as Gambel oak, Rocky Mountain maple, and bitter cherry, which provide little benefit to CSTG, may dominate the stand. Repeated burning of these stands at 5–10 year intervals may improve their value as habitat for CSTG by reducing prevalence of less desirable shrubs and allowing other shrub species (e.g., serviceberry and chokecherry) of greater importance to CSTG to become established. Repeated burning within the mountain shrub type also can be used to create and maintain herbaceous openings that may provide late summer and autumn habitats and snow roosting sites in winter.

22. Treated areas should be rested from grazing for ≥3years, and preferably 5 years, to allow for seedling establishment and development and resprouting of fire tolerant species. Every effort should be made to contain burns to areas in need of treatment. Consider mechanical treatments as an alternative to burning if there is any concern about controlling a burn.

23. When planning clear-cuts adjacent to areas occupied by CSTG, consider a scale and configuration that will best benefit the grouse; specifically, fewer larger (> 250 ha) clear-cuts are better than numerous smaller clear-cuts.

## Insecticides

Within the range of CSTG, carbaryl baits and diflubenzuron and malathion spray are sometimes applied on cultivated and non-cultivated lands, including native cover types, to control outbreaks of grasshoppers and Mormon crickets (*Anabrus simplex*) (Cunningham and Sampson 1996, APHIS 2002). Spraying may occur on private and public lands. Spraying on publicly-owned native habitats is usually done to protect adjacent, private croplands. Grasshoppers and Mormon crickets are a natural component of western rangelands. Control measures are only necessary when populations reach outbreak levels and threaten valuable resources (APHIS 2002). Although millions of hectares of rangeland are infested by grasshoppers or Mormon crickets every year, only a small portion of infested areas reach outbreak levels where suppression is justified. There is no simple biological explanation to predict where outbreaks will occur (Cunningham and Sampson 1996). Consequently, control measures must be rapid and effective to prevent excessive damage to crops. In most cases, the only option available is application of insecticides (APHIS 2002).

Effects of carbaryl baits and diflubenzuron on STG are unknown. McEwen and Brown (1966) reported 32% of 19 wild-trapped STG treated with malathion died within 72 hours. Lethal doses were 200–240 mg/kg. Increased vulnerability to predators and termination of breeding were attributed to sublethal doses. Treatment with dieldrin, which is no longer registered for use to control grasshoppers, was even more lethal (63% mortality) than malathion at lower doses (McEwen and Brown 1966). Ritcey (1995) reported an instance where CSTG chicks were found dead in an area that had been sprayed for grasshoppers in British Columbia. No mention was made of the insecticide used or the number of birds found dead. In some areas within the range of CSTG, treating areas to control insects is not economically effective, and therefore not a pertinent issue (Hoffman 2001).

The arrival of West Nile virus presents an additional potential problem with insecticides. Widespread use of insecticides to control mosquitoes could have detrimental effects on CSTG depending on insecticides used, timing of application, and site-specific factors such as proximity to brood-rearing areas. Use of larvicides and adulticides with low toxicity to vertebrates, which are administered in low concentrations, can mitigate risks (Rose 2004). Malathion is commonly used to kill adult mosquitoes (Rose 2004), and at high doses is lethal to STG (McEwen and Brown 1966). However, when used to kill mosquitoes, malathion is administered at low rates (219.8 ml/ha) and is judged safe for vertebrates (Rose 2004). Because insects are an important food source for STG chicks (Kobriger 1965, Bernhoft 1969), use of any general-acting insecticide in brood-rearing areas must be considered detrimental, regardless of application rate.

*Guidelines:*

1. If insecticide application is necessary, use the Reduced Agent and Area Treatments approach in which application rates are reduced from label-recommended levels and treated swaths are alternated with untreated swaths (Lockwood and Schell 1997, APHIS 2002).

2. Only apply 1 treatment/year within the same area.

3. Use ground application methods rather than aerial spraying where practical.

4. Avoid indiscriminate, widespread application of insecticides regardless of method of application. The objective should be to reduce insect populations to minimize crop damage, not to reduce populations to the greatest extent possible.

5. Avoid using insecticides in brood-rearing habitats whenever possible.

## Herbicides

Using herbicides to eliminate or reduce shrubs and increase grass production for livestock is a form of habitat conversion. Outcomes of applying herbicides can be difficult to predict due to combinations of site conditions, chemicals applied, application rates, means of application, timing of application, and interval between applications. The primary drawback of chemical treatments is effects on non-target species (Blaisdell et al. 1982, Vallentine 2004). Most chemical treatments will have some negative effects on CSTG habitats due to reductions of forbs and deciduous shrubs used for food and cover (Fig. 42; McArdle 1977, Kessler and Bosch 1982, Oedekoven 1985, Klott 1987, Stralser 1991, Hoffman and Thomas 2007, Stinson and Schroeder 2012). An indirect effect is reduction in insect populations that utilize forbs and shrubs killed by the herbicide application. In general, the larger the area treated and the greater the kill, the more detrimental herbicide applications will be to CSTG.

Loss of deciduous trees and shrubs, due in part to use of herbicides, has been associated with declining CSTG populations in Utah (Hart et al. 1950) and Washington (Zeigler 1979). Klott (1987) reported abandonment of 2 active leks in south-central Wyoming after 160 ha of surrounding area was sprayed to remove sagebrush. Stralser (1991) compared habitat conditions surrounding 2 abandoned and 2 active leks in Lincoln County, Washington. Inactive leks were surrounded by habitat that was treated with herbicide and burned. These sites had higher coverage of annuals than areas surrounding active leks. McArdle (1977) believed loss of forbs was one reason CSTG preferred areas that were chained over areas that were burned or sprayed. Reseeding of ranges is often conducted following treatment with herbicides. Kessler and Bosch (1982) reported 67% of reseeding operations in CSTG habitats treated with

Figure 42. Herbicide applications are sometimes necessary to control spread of non-native invasive plants and reduce density of shrubs. The primary negative consequence of using herbicides is their detrimental effect on non-target plant species of value as food and cover to Columbian sharp-tailed grouse. For this reason, widespread application of herbicides is strongly discouraged. (Photo by Miles Benker/IDFG).

herbicides involved planting of introduced grasses, most commonly crested wheatgrass and smooth brome. Monsen (2005) cautioned that smooth brome is not compatible with native plant species and should not be planted where retention of native plant communities is desirable.

*Guidelines:*

1. Whenever possible, use mechanical treatments or fire instead of herbicides where shrub control is necessary to improve habitat conditions for CSTG.

2. Avoid using herbicides for the sole purpose of increasing forage production for livestock.

3. Avoid treating clear-cuts with herbicides to decrease competition between herbaceous vegetation and newly planted trees.

4. Use of herbicides to control invasive plant species is acceptable, provided herbicide is applied only to those areas in need of treatment.

5. Avoid indiscriminate, widespread application of herbicides.

6. The most effective control of noxious weeds will be realized when herbicides are used as part of a coordinated and integrated weed management program. Even then, success may be limited (Mack et al. 2000).

7. If herbicide application must be used to control shrubs, spraying with a tractor-mounted sprayer is recommended over aerial application (Snyder 1997). Spraying should be conducted in irregular patches to create a mosaic of treated and untreated areas. Treated areas should impact <25% of the site. Treat shrubs on a 10–15 year rotation to create an interspersion of treated areas in various stages of recovery.

8. If available, use herbicides that target specific plant species in need of control.

9. Encourage research and development of additional herbicides designed to act on specific plant species.

10. When using general-acting herbicides, managers should consider reseeding treated areas with native forbs and, where appropriate, desirable non-native forbs.

# Restoration

Figure 43. Restoration may involve complete removal of existing vegetation and reseeding with desired species of value to Columbian sharp-tailed grouse. (Photos by L. Rossi/CPW).

Protection and enhancement of occupied ranges alone will not suffice to ensure long-term stability of small, isolated CSTG populations (Stinson and Schroeder 2012). Active and passive restoration of formerly occupied habitats will be necessary to allow population expansion and reduce risk of extirpation due to stochastic factors (Mills et al. 2005). Historical evidence indicates isolated populations of prairie grouse ≤200 individuals do not persist (Toepfer et al. 1990). Therefore, high priority must be given to restoring habitats to increase all populations, but especially those supporting <200 birds. Equally important, priority must be directed at restoring habitats that connect existing populations, regardless of size.

Restoration may simply require resting or reducing domestic livestock use of the landscape and allowing habitats to naturally recover (Monsen 2005). Where important plant species are absent and a natural seed source is no longer present, active restoration becomes necessary, which is much more difficult and complex (Monsen 2005). Natural recovery of such landscapes, even with rest, is unlikely. Active restoration involves removing competitive species, preparing seed beds, and seeding desired species (Fig. 43, 44). Restoration should attempt to approximate naturally-occurring landscapes. However, restoring important plant species in some severely degraded areas may be impossible if commercial seed sources are lacking or procedures for establishment are unknown (Monsen 2005). In this situation, managers must develop restoration programs with a goal of establishing the most functionally and structurally diverse community that can exist on the site to protect soils, maintain remaining desirable native species, prevent further degradation, and support CSTG and other wildlife (Fig.45). Use of introduced species should not be excluded, but their inclusion requires careful consideration of their growth form, persistence, effect on native species, and value as food and cover for CSTG.

Restoration programs must include strategies for controlling and preventing noxious weeds (Benson et al. 2011). Concessions must be made to eliminate or modify land management practices that contributed to site degradation. Future uses of the site must be considered and agreed upon before implementing a restoration program. Remedial treatments must be carefully planned and directed. Managers must understand requirements for establishment of all species included in the seed mixtures. For example, seeds of some species should be broadcast while seeds of other species should be drilled at various depths (Monsen 2005, Benson et al. 2011). Lack of attention to site preparation and seeding practices could result in widespread failure. Federal, provincial, and state land and wildlife management agencies are encouraged to work cooperatively to support and fund native seed programs and to develop programs where they do not currently exist. These programs could have positive economic benefits to rural communities by contracting with private landowners to grow and harvest seed of locally adapted plants needed for restoration.

Use of CRP and mine reclamation lands indicate significantly altered landscapes can be restored to useable condition for CSTG (Boisvert 2002, Collins 2004, Rodgers and Hoffman 2005). However, these areas are primarily used for breeding, nesting, and brood-rearing. Lack of suitable winter habitat is often the limiting factor for CSTG in some areas (Hart et al. 1950, Marks and Marks 1987, Wood 1991, Stinson and Schroeder 2012). Restoring winter habitats presents a greater challenge than restoring breeding habitats because establishment of deciduous shrubs is more difficult compared to grasses and forbs, and requires more time before stands become suitable for use by CSTG (Fig. 46). Shrub seedlings are highly susceptible to grazing and drought, and do not compete well when planted with rapidly developing grasses and forbs (Monsen 2005, Benson et al. 2011). Temporary fencing may be necessary to exclude livestock and wild ungulates until shrubs are established. Additional work is needed to find ways to effectively restore winter habitats for CSTG.

Figure 44. Example showing successful restoration of a former Conservation Reserve Program field dominated by smooth brome (left) to a shrub-steppe community (right) primarily composed of big sagebrush, bluebunch wheatgrass, and desirable perennial forbs. (Photos by A. R. Sands/retired BLM).

Figure 45. Successful restoration using strip seeding to establish shrubs and herbaceous cover in northwestern Colorado. (Photo by R. W. Hoffman/retired CPW).

Figure 46. Winter habitat restoration project in north-central Washington. (Photo by M. A. Schroeder/WDFW).

# Conclusions

Most issues identified in this document are symptoms of the much greater problem of human population growth. Burgeoning human populations are placing an increasing demand on western landscapes for more resources, ways to make a living, places to live, and places to recreate. Addressing the human population issue is beyond the scope of this document, but failure to mention it perpetuates the illusion that ways can be found to maintain CSTG populations and their habitats in spite of increased human demands for natural resources and space. One only needs to review the conservation status of grouse in Europe and the histories of the heath hen (*Tympanuchus cupido cupido*) on the Atlantic coast and Attwater's prairie-chicken (*Tympanuchus cupido attwateri*) on the Gulf coast to predict the fate of CSTG in western North America if pressures to degrade, fragment, and convert CSTG habitats continue (Storch 2000, Johnsgard 2002). Unless this pattern of exploitation changes, expectations that wildlife managers can develop guidelines to increase or even maintain CSTG populations at present levels are irrational. The best that can be expected is to prevent extirpation and retain a few viable populations on the landscape (Fig. 47).

Restoration, enhancement, conservation, and protection of CSTG habitats are the most important factors that will ensure viable populations persist on the landscape. Such actions must include an ecosystem management approach because CSTG require a mosaic of ecological communities across a landscape to meet their habitat needs (Vodehnal and Haufler 2008). Implementation of these guidelines must start at the local level, but local implementation alone will not benefit CSTG in the long-term unless local efforts are integrated across broader regions. Conservation efforts must transcend political, social, and jurisdictional boundaries. Furthermore, these efforts must involve cooperation among different provincial, state, and federal resource management agencies and among these agencies, and the individuals and groups that depend on the land's resources.

A process needs to be initiated where fragmented habitats are reconnected via habitat corridors to minimize impacts of stochastic events and increase gene flow. Such a process is a long-term proposition and priority areas need to be immediately identified. Provisions need to be in place to address past and emerging factors responsible for loss, degradation, and fragmentation of habitats before large sums of money are directed at recovery. Funding needed to implement and achieve recovery far exceeds amounts currently allocated by various levels of government. Therefore, ways to secure additional funding must be identified, such as new legislation, modification of existing legislation, cost-share programs, partnerships, and private initiatives.


Figure 47. Wildlife managers face the difficult challenge of attempting to protect and enhance existing habitats and restore previously occupied habitats of Columbian sharp-tailed grouse in the wake of ever increasing demands on western landscapes. (Photos by R. W. Hoffman/retired CPW).

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