STATE OF WASHINGTON Progress Report November 2019

Recovery of Columbian Sharp-tailed Grouse in Washington: Progress Report

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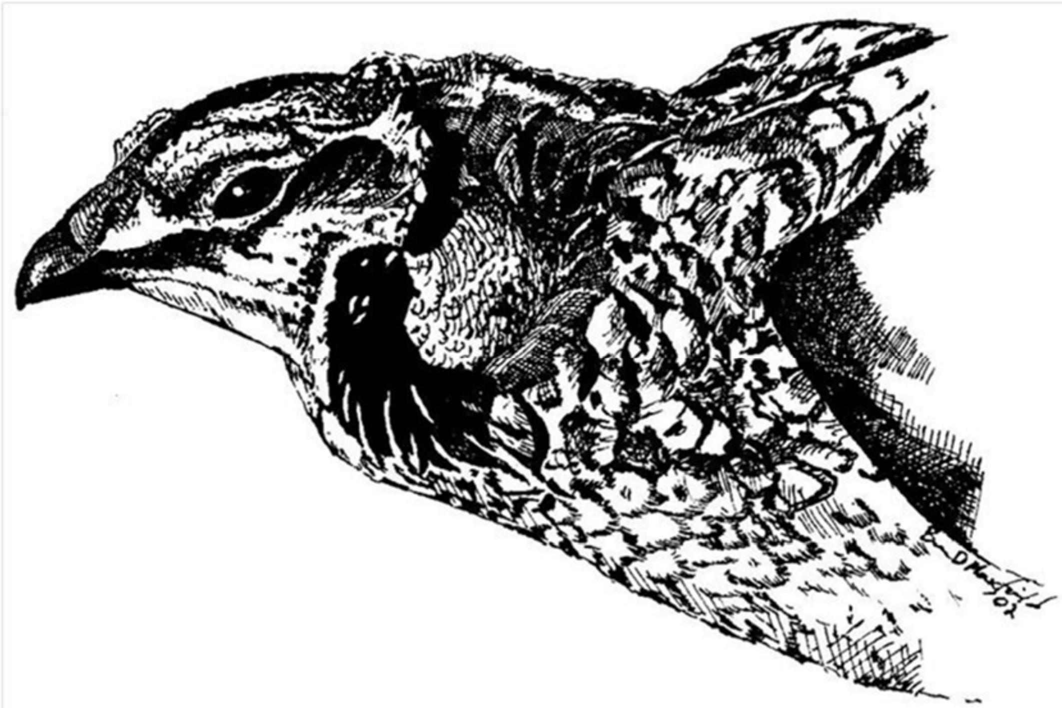
ABSTRACT

Declining populations and distribution of Columbian sharp-tailed grouse (*Tympanuchus phasianellus columbianus*) in Washington have resulted in serious concerns for their long-term conservation status and their uplisting to State Endangered in 2018. The overall population was estimated to be 864 associated with 40 active leks in 8 isolated populations in 2019. This was an increase in the population of 6.9% since 2018. The overall population declined 34% between 2015 and 2016, declined 2% between 2016 and 2017, and increased 26% between 2017 and 2018. Habitat loss due to wildfire appeared to play a large role in the declines and habitat recovery from wildfire may explain the recent increases. Translocations of sharp-tailed grouse from 'healthy' populations outside the state were conducted to improve the genetic and demographic health of populations within Washington. The Washington Department of Fish and Wildlife, in cooperation with the Colville Confederated Tribes and the Bureau of Land Management, translocated 526 Columbian sharp-tailed grouse from central British Columbia, southeastern Idaho, north-central Utah, and the Nespelem area of Washington to different populations in Washington State in spring 1998–2019. The release sites in Washington included Scotch Creek (NW of Omak in Okanogan County), Dyer Hill (S of Brewster in Douglas County), Swanson Lakes (S of Creston in Lincoln County), Greenaway Springs (SE of Okanogan), Nespelem (E of Nespelem in Okanogan County), and Tunk Valley (NE of Omak in Okanogan County). Three of the release sites included state and federally-owned public land, one was private land, and the other sites are Colville Tribal land; all but the one on private land are being managed for the benefit of wildlife and in particular, sharp-tailed grouse. In all release sites, sharp-tailed grouse declined prior to translocation, despite the acquisition and protection of habitat and ongoing habitat restoration efforts on and near the release sites. Translocations appeared to reverse the declines, at least in the short term.

On the front cover: Background photo of Chesaw Wildlife Area and sharp-tailed grouse under tree by Michael A. Schroeder; sharp-tailed grouse being release in Tunk Valley by Paul Bannick.

On page 1: illustration by Brian Maxfield. *On the back page*: illustration by Darrell Pruett.

RECOVERY OF SHARP-TAILED GROUSE IN WASHINGTON: PROGRESS REPORT



November 2019

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ACKNOWLEDGEMENTS

This project would not have been possible without the cooperation of wildlife agencies in Idaho, Utah, and British Columbia; we'd especially like to thank Randy Smith, Ron Greer, Ernest Leupin, Dave Reedman, and Doug Jury. Some capture efforts in Idaho and Utah were done cooperatively with Oregon Department of Fish and Wildlife who were obtaining birds for release in northeastern Oregon. Funding for this project was provided by the State Wildlife Grants Program and the Recovery Funds through the USFWS, National Fish and Wildlife Foundation, along with numerous other sources within WDFW, Bureau of Land Management (BLM), and Washington State University (WSU). Lisa Shipley and her students, technicians, and post-docs at WSU Pullman added a strong research component to the Lincoln County releases. Mike Finch, Jim Bauer, and Brian DuPont built settling boxes for the release of birds. The BLM has been a great supporter and sought additional funds to improve this project, particularly with the support of Jason Lowe. The list of those that have helped capture, transport, and monitor is too lengthy to include here and we would likely regrettably miss someone. Needless to say all of those that have helped, the progress we have made would not have been possible without you and your tremendous support, Thank you.

INTRODUCTION

Columbian sharp-tailed grouse were historically found in many of the shrub-grass habitats of central and southeastern Washington (Yocom 1952, Aldrich 1963). Currently surveys indicate that sharp-tailed grouse are virtually extinct everywhere except Okanogan, Douglas, and Lincoln counties (Fig. 1). The current range is approximately 3% of the historical distribution (Hays et al. 1998, Schroeder et al. 2000, Stinson and Schroeder 2012). Remaining populations are small and localized within isolated areas of relatively intact shrubsteppe, as well as, Conservation Reserve Program (CRP) fields (Table 1).

The Washington Department of Fish and Wildlife (WDFW) has a goal to recover and connect the endangered population- of sharp-tailed grouse in Washington. The state listed the species as threatened in 1998, up-listed them as endangered in 2018, published a recovery plan (Stinson and Schroeder 2012, Fig. 2), acquired over 15,000 hectares of sharp-tailed grouse habitat, developed management strategies to improve their habitat (Hallet 2006, Olson 2006, Peterson 2006, Hoffman et al. 2015, WDFW 2015), conducted research on their life history requirements (McDonald 1998), contributed to detailed analyses of population genetics throughout the sharp-tailed grouse range (Spaulding et al. 2006), and initiated translocations to increase and expand populations (Stonehouse et al. 2015), and. The Colville Confederated Tribes (CCT) has pursued a similar strategy of acquisition and restoration (Berger et al. 2005, Gerlinger 2005, Whitney 2014). The BLM lists the sharp-tailed grouse on their Sensitive Species list with a goal of minimizing or eliminating threats and improving the condition of habitat. The primary management strategy for the WDFW, BLM, and CCT has been to improve habitat on publicly-owned or leased lands that are currently, or were historically, occupied by sharp-tailed grouse and help facilitate enrollment of private lands in Farm Bill conservation programs. Habitat improvements include the reduction of grazing pressure, transition of cropland (mostly wheat) to grass-dominated habitats (such as in the federally-funded Conservation Reserve Program

[CRP]), restoration of native habitat, and planting of key habitat components such as riparian trees and shrubs.

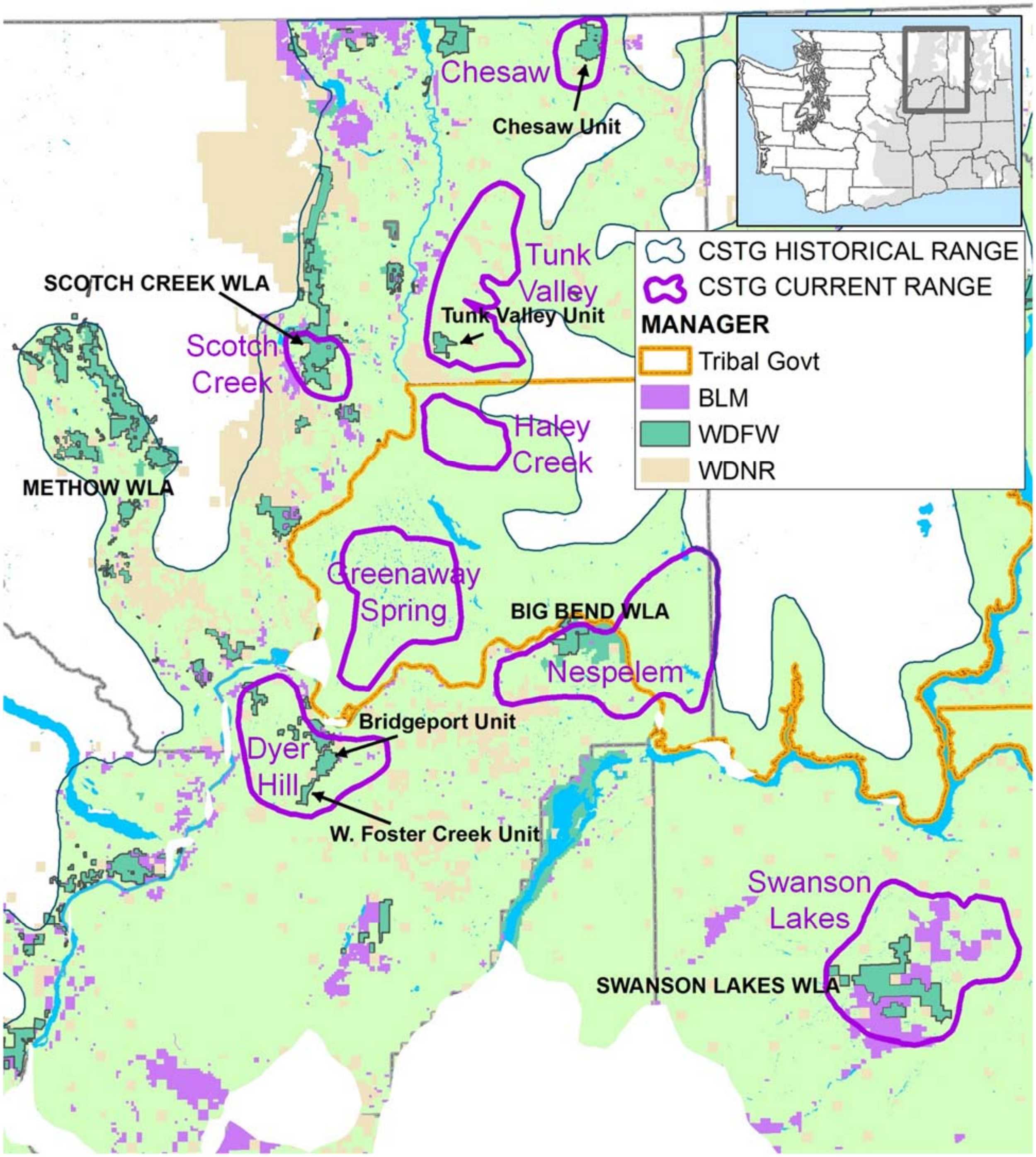

Fig. 1. Estimated historic and current range of sharp-tailed grouse in north-central Washington (modified from Schroeder et al. 2000). The Nespelem area is often divided into the Nespelem area in Okanogan County and the Big Bend area in Douglas County).

Table 1. Distribution of habitats (1993 Thematic Mapper) in Washington in relation to sharp-tailed grouse populations (adapted from Schroeder et al. 2000).

Range or population	Proportion of area (%)					Total area (km^2)
	Shrubsteppe[a]	Cropland	CRP	Forest-shrub	Other	
Total population	67.2	11.6	5.2	14.5	1.5	2,173
Tunk Valley	69.6	1.5	1.2	27.5	0.2	342
Greenaway Springs[b]	78.7	3.6	2.1	14.5	1.2	340
Chesaw	46.0	0.0	3.9	49.9	0.2	70
Scotch Creek	69.3	4.7	0.9	23.7	1.4	79
Dyer Hill	42.0	44.5	12.0	0.7	0.8	308
Nespelem[c]	65.7	5.1	6.9	19.6	2.7	513
Swanson Lakes	77.0	13.0	5.6	2.4	2.0	521
Unoccupied range	36.5	37.9	4.4	17.7	3.4	77,692
Total historical range	37.3	37.3	4.4	17.6	3.4	79,865

[a]Shrubsteppe includes shrubsteppe, meadow-steppe, and steppe habitats described by Daubenmire (1970).

[b] Greenaway Springs includes both Greenaway Springs and Haley Creek in Fig. 1.

[c]Nespelem includes the "Nespelem" area north of the Columbia River on Colville Confederated Tribal (CCT) lands and the "Big Bend" area south of the Columbia River in Douglas County.

Isolation poses a significant threat to the viability of remaining populations. Westemeier et al. (1998) described the reduction in genetic diversity and in population fitness over a 35-year period in a small, declining greater prairie-chicken (*Tympanuchus cupido*) population in Illinois. They reported that declines in fertility and egg hatchability correlated with a population decline from 2000 individuals in 1962 to less than 50 by 1994. Bouzat et al. (1998) genetically compared the Illinois population with larger populations in Kansas, Nebraska, and Minnesota and found that it had approximately 2/3 the allelic diversity of the other populations. Bellinger et al. (2003) found a similar reduction in genetic variation, though not in reproductive success, in greater prairie-chickens in Wisconsin. Their comparison of greater prairie-chicken samples collected in Wisconsin in 1951 with those collected from 1996 through 1999 revealed a 29% allelic loss.

Population augmentation efforts are one approach to address genetic issues associated with small populations (e.g., lack of genetic heterogeneity and fitness). In addition, by translocating birds from 'healthy' populations, a basic hypothesis can be tested. Specifically, is habitat limiting the growth and/or expansion of existing populations or is the problem related to the intrinsic 'health' of the birds? An increasing population trend following augmentation would support the hypothesis that a population 'health' problem existed. If the population size remains the same or continues to decline, and monitoring indicates that the translocated birds remained in the area and survived to attempt reproduction, data will support the conclusion that habitat quality and/or quantity is limiting population growth.

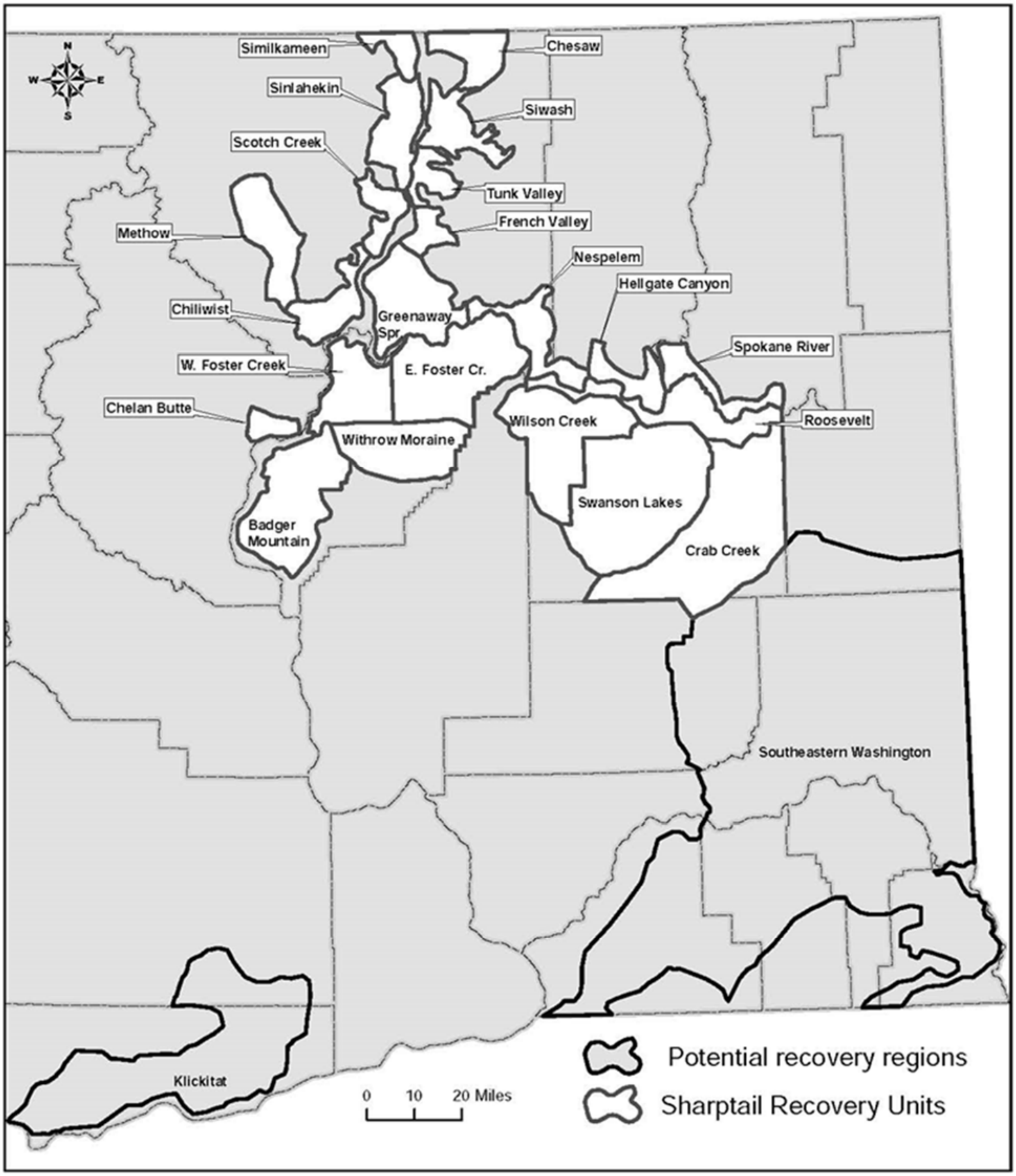

Fig. 2. Twenty-two Columbian sharp-tailed grouse recovery units and two potential recovery regions in Washington (Stinson and Schroeder 2012). The Big Bend population is in the East Foster Creek Unit, the Dyer Hill population is in the West Foster Creek Unit, and the Tunk Valley population is in the Tunk Valley and Siwash units.

METHODS

Inventory and monitoring

Leks can be defined as traditional locations where males perform their breeding displays. Because males sometimes display at satellite or temporary locations or lek sites may be altered slightly from one year to the next, lek locations ≤ 1 km from one another were grouped into lek complexes. In contrast, lek complexes were typically separated from the nearest lek complex by ≥ 2 km. Lek complexes were surveyed annually to obtain information on sharp-tailed grouse populations and annual rates of change (Schroeder et al. 2000). The survey protocol included multiple (≥ 2) visits to all known active complexes, searches for new previously unknown complexes, and occasional visits to historic complexes believed to be inactive. Some original data from the 1970s were lost so that only the summarized data (highest count) remains, despite some complexes having been observed on more than one occasion.

Numbers of grouse attending lek complexes were analyzed using the greatest number of grouse observed on a single day for each complex for each year. This technique is well established for greater sage-grouse (*Centrocercus urophasianus*), but it may have biases. Despite potential biases, lek counts provide an assessment of a population's long-term trend (Connelly et al. 2004). The population size was estimated by doubling the counts of grouse on lek complexes to account for the females which typically visit leks only once so are rarely counted. We estimated annual rates of population change by comparing total number of grouse counted at lek complexes in consecutive years. Sampling was occasionally affected by effort and/or size and accessibility of leks. Those not counted in consecutive years were excluded from the sample for the applicable intervals. Annual instantaneous rates of change for each population were estimated as the natural logs of the number of grouse counted on leks in one year divided by the number of grouse counted on the same leks the previous year.

Translocations and research

Translocations were addressed with a four-stage process: 1) consideration of release sites; 2) consideration of source populations; 3) conducting the actual capture and translocation; and 4) monitoring and evaluation of results (Griffith et al. 1989, Reese and Connelly 1997). Release sites (stage 1) were selected based on their historical or current occupancy. The historical presence of sharp-tailed grouse throughout most of eastern Washington has been well established (Yocom 1952, Aldrich 1963). The current distribution of sharp-tailed grouse has also been documented with the aid of extensive state-wide surveys (Hays et al. 1998, Schroeder et al. 2000). The grouse population has declined substantially from 50 years ago, but appears to have become somewhat stable in the last 25 years. Genetic diversity and allelic richness are significantly lower in Washington than in populations in Utah, Idaho, and British Columbia (Warheit and Schroeder 2003). Some of this lack of genetic diversity appears to be due to the small size and isolation of populations in Washington relative to other occupied areas.

Because of the declines in sharp-tailed grouse populations throughout Washington and the isolation and small size of the remaining populations, several locations were considered for translocation efforts. Five primary sites were identified based upon assessments of their size, habitat quality, and management potential (Fig. 1): Scotch Creek (northwest of Omak in Okanogan County), Dyer Hill (south of Brewster in Douglas County); Swanson Lakes (southeast of Wilbur in Lincoln County); Nespelem (east of Nespelem in Okanogan County); Greenaway (southeast of Okanogan in Okanogan County), and Tunk Valley (northeast of Omak in Okanogan County). Three of the release sites are on or adjacent to state and federally-owned public land and the other sites are Colville Tribal land; all are being managed for the benefit of wildlife. The Dyer Hill site also was recommended by McDonald and Reese (1998) as the primary target for improvements in the statewide sharp-tailed grouse population. All of the release sites are recommended in the statewide recovery plan for sharp-tailed grouse (Fig. 2, Stinson and Schroeder 2012).

Why have populations of sharp-tailed grouse been reduced or eliminated on the prospective release sites and has subsequent management adequately addressed the explanations for previous declines? The cause of observed declines in sharp-tailed grouse populations can be split into three major categories: degradation of quantity and quality of habitat, increases in densities of generalist predators such as common ravens (*Corvus corax*), great-horned owls (*Bubo virginianus*), and coyotes (*Canis latrans*), and isolation of remnant populations due to the lack of dispersal corridors between adjacent populations. The three causes of declines are relevant in all of Washington's populations to various degerees and they also interact with each other. Some of the explanations for the declines have been directly addressed with management activities. The primary emphasis of WDFW and partners has been habitat restoration, which has been conducted at all the potential release sites. These sharp-tailed grouse-focused activities include replacement of poor-quality non-native grass/forb habitats with native shrubsteppe vegetation for spring and summer habitat and establishment of shrubs and trees necessary for improvement of wintering habitat. CRP also has resulted in the conversion of large areas of cropland to potential sharp-tailed grouse habitat since the late 1980's. Although a significant amount of habitat work has been done, there is still more to do and all partners are actively restoring or improving habitat (e.g. early CRP plantings have become monocultures of exotic grasses that need to be reseeded with native seed mixes). However, because some of the remaining populations have endured severe 'bottlenecks' in abundance, we believe some of these populations have lost some of their intrinsic ability to respond positively to habitat improvements due to their reduced genetic diversity (Westemeier et al. 1998, Bellinger et al. 2003, Johnson et al. 2003). We believe augmentations have potential to address this issue (IUCN/SSC 2013).

Source populations (stage 2) were considered for translocations. The sharp-tailed grouse is currently divided into six extant subspecies (modified from Aldrich 1963, Fig. 3). Sharp-tailed grouse in Washington are within the Columbian subspecies range; this subspecies is distinguishable by its grayer color, smaller size, and shrubsteppe and mountain shrub habitat. Taxonomic differentiation of subspecies has been somewhat arbitrary and ambiguous. Recent genetic analyses indicate that sharp-tailed grouse in Utah, British Columbia, Idaho, and Washington are more similar to each other than to any other region (Warheit and Schroeder 2003, Spaulding et al. 2006). Any population within these areas appears to be a genetically appropriate source population for translocation into Washington (Fig. 4).

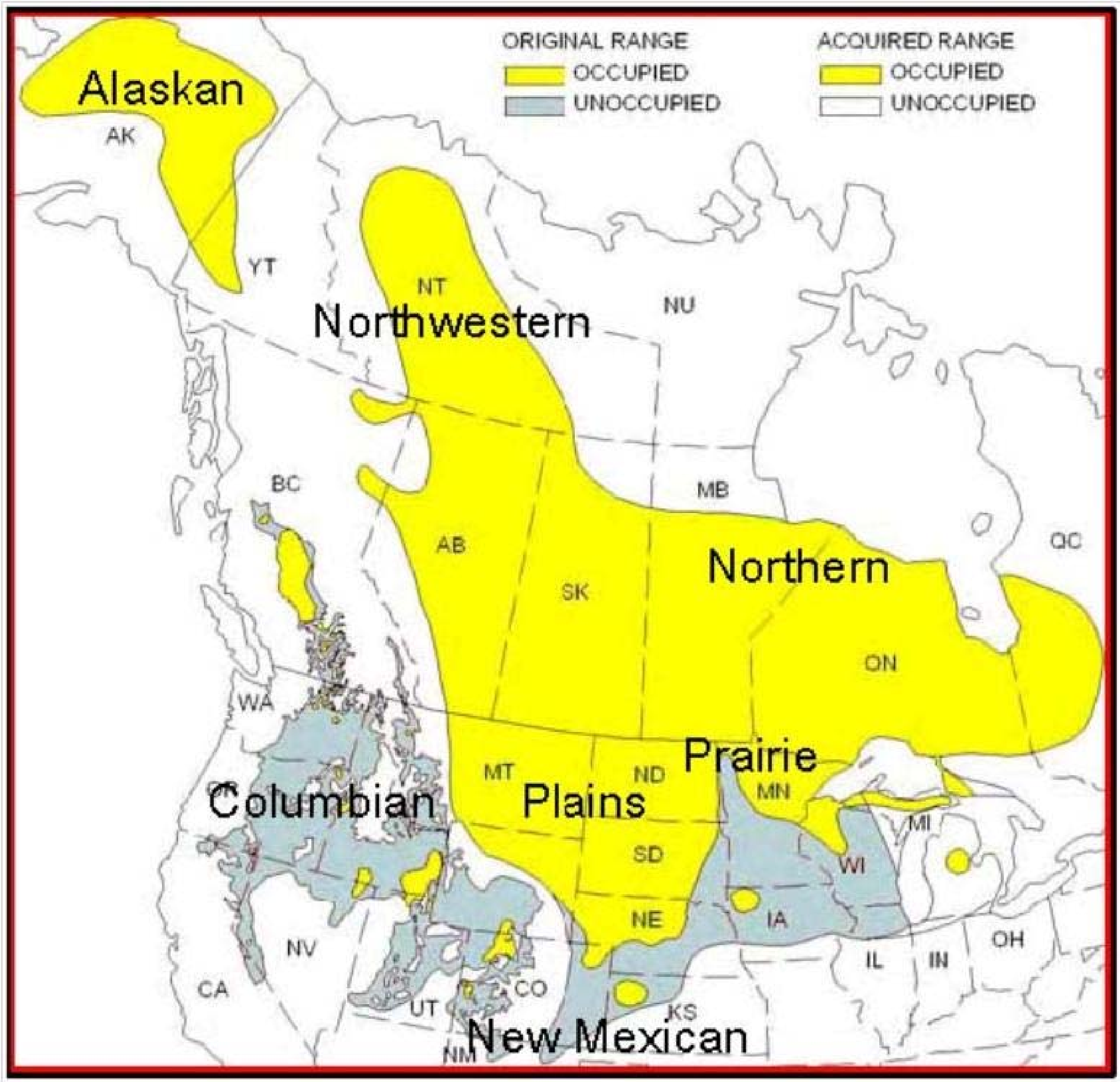

Fig. 3. Distribution of sharp-tailed grouse subspecies in North America (modified from Aldrich 1963).

Sharp-tailed grouse are generally captured for translocation (stage 3) during the spring breeding period (first three weeks of April) with the aid of walk-in traps on leks (Schroeder and Braun 1991). All birds are weighed, measured, and banded with unique numbered bands. All females and a subset of males are fitted with necklace-mounted, battery-powered radio transmitters. In addition, sex and age are determined (Henderson et al. 1967, Caldwell 1980) and feather samples are collected for subsequent genetic testing. Birds are transported by plane or car in an individual box or a portion of a box that is small enough to contain the bird's movement. The bottom of each box is lined with absorbent material to reduce contact between feces and the birds' feet.

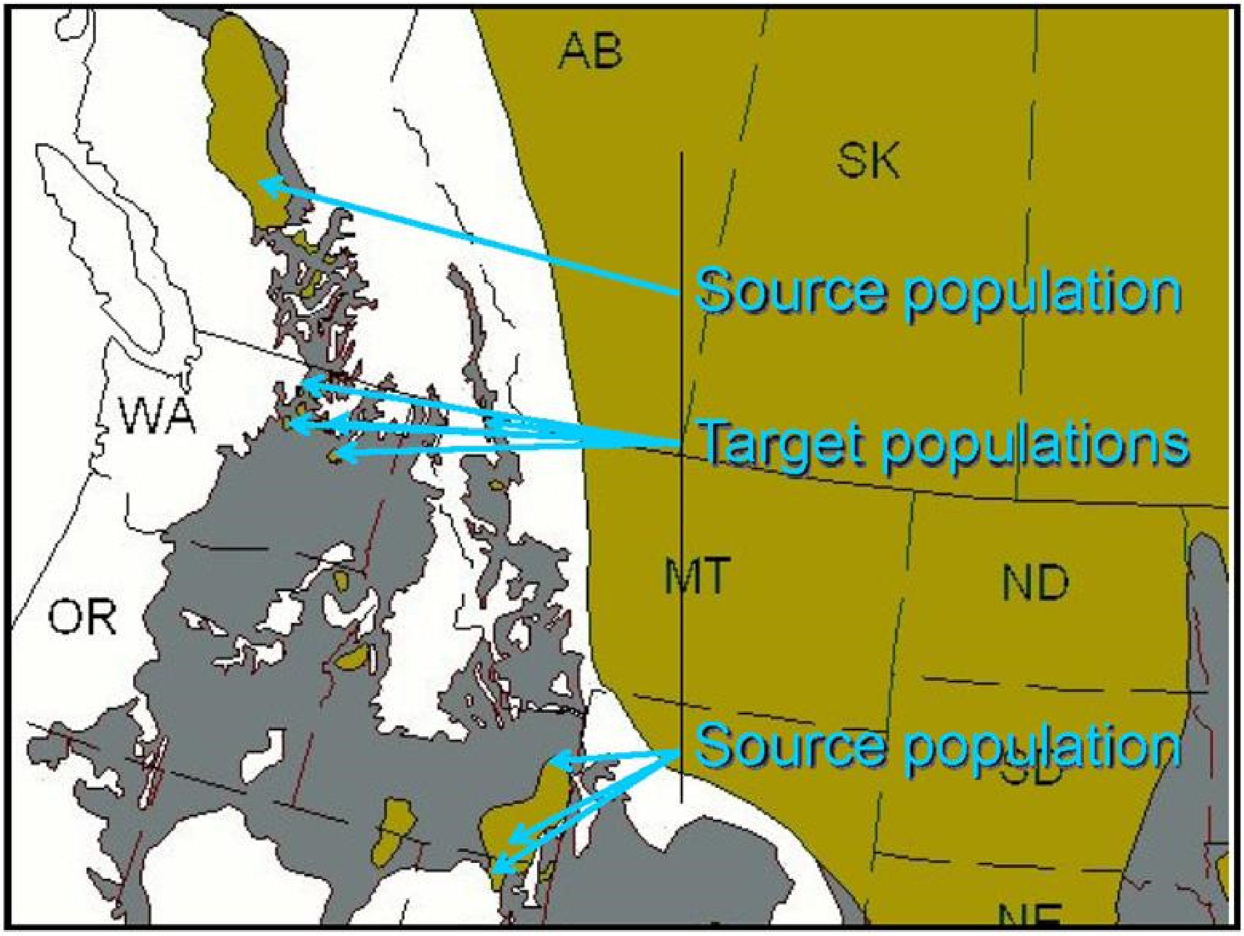

Fig. 4. Location of source populations for translocations within the range of Columbian sharp-tailed grouse in relation to the target populations in Washington.

Prior to 2008, birds were released directly from boxes. Starting in 2008, birds have been held in settling boxes for a minimum of about 15 minutes prior to release, using a box design modified from those described by Musil (1989). This allows small groups of birds to be held and released together when the box was opened with a cord from a blind to minimize stress during release. All birds are released in the target location prior to darkness the same day they were captured, or the following morning. All birds destined for translocation receive a health certificate from a veterinarian that is accredited within the donor state or province. The US Department of Agriculture maintains a disease list for which all translocated birds are screened.

Monitoring and evaluation (stage 4) are conducted with the aid of lek surveys and radio telemetry (VHF transmitters). Sharp-tailed grouse are located visually or by triangulation with the aid of portable receivers and 3-element Yagi antennas. Fixed-wing aircraft are used to locate lost birds on a regular basis throughout the year. All locations are recorded by Universal Transverse Mercator (UTM) coordinates. Disturbance of birds, particularly at nest sites, is avoided. The specific objectives for telemetry include examinations of movement, habitat and landscape use, productivity, and survival. These evaluations provide essential information to determine whether additional translocations, habitat improvements, release locations, and/or translocation methodologies are necessary (Toepfer et al. 1990, IUCN/SSC 2013).

RESULTS AND DISCUSSION

Inventory and monitoring

The total population estimate for sharp-tailed grouse in Washington was 864 in 2019 (Table 2, Fig. 5). Birds were observed on 38 lek complexes. Two additional leks on inaccessible private land were not visited, but were assumed to be active because they were active when last checked in 2017 or 2018. During the last 50 years a total of 132 lek complexes have been documented; currently only ~30% of these are active. The average annual rate of population change (instantaneous) since grouse were first monitored in 1954 was -4.3%. Most of the subpopulations studied (Table 2), except for Dyer Hill and the Methow declined 2% to 9% during the same period. One population (Methow) was extirpated and the Dyer Hill population increased. The size of the remaining subpopulations varies from 32 at Chesaw to 244 at Dyer Hill.

Table 2. Population characteristics for sharp-tailed grouse in Washington State (see Figs. 1 and 2 for locations).

Population	Active leks (% of total)	Total leks	2019 population estimate (% change)	Average annual rate of change (1st year monitored)
Tunk Valley	5 (38.5%)	13	108 (20.5%)	-2.9% (1954)
Greenaway Springs	2 (16.7%)	12	54 (7.7%)	-8.8% (1970)
Chesaw	2 (33.3%)	6	32 (0%)	-6.7% (1989)
Scotch Creek	3 (21.4%)	14	54 (-10.5%)	-4.9% (1954)
Dyer Hill	7 (46.7%)	15	244 (6.8%)	0.7% (1970)
Big Bend	7 (43.8%)	16	108 (3.8%)	-5.4% (1970)
Nespelem	7 (33.3%)	21	138 (20.9%)	-2.2% (1979)
Swanson Lakes[a]	7 (22.6%)	31	126 (-4.7%)	-5.4% (1959)
Methow[b]	0 (0.0%)	4	0 (0.0%)	-31.4 (1974[a])
All populations combined	40 (30.3%)	132	864 (6.9%)	-4.3% (1954)

[a]The current Swanson Lakes population is entirely found in the Swanson Lakes Recovery Unit (Fig. 2), but the historical area referenced here includes Lincoln and Spokane counties.

[b]The Methow population was last known to be active in 1981.

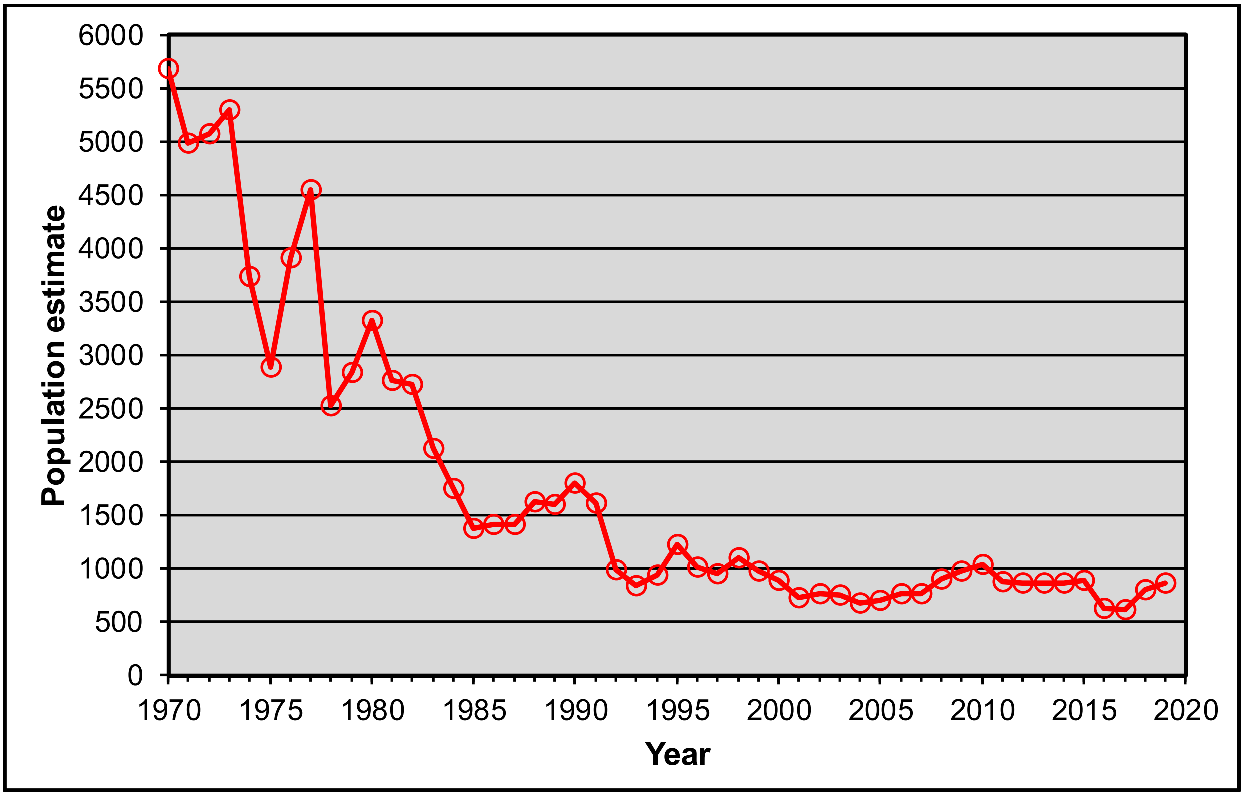

Fig. 5. Population estimate for sharp-tailed grouse in Washington State.

Translocations and research

Overall

A total of 526 sharp-tailed grouse have been translocated to key populations in Washington State since 1998, including 38 in 2019 (Appendix A). Most of the grouse came from Idaho, but smaller numbers were translocated from Utah, British Columbia, and Washington (Fig. 4). When the results for translocations to Dyer Hill, Swanson Lakes, and Scotch Creek were combined into a single analysis they showed that translocations had a positive effect on estimates of population size, even after translocations ended (Fig. 6). In contrast, wildfires appear to have had a dramatic negative effect on sharp-tailed grouse populations affected by wildfires in 2012 (Big Bend population affected by 33,000 ha Barker Canyon Complex wildfire and Swanson Lakes population affected by the 9000 ha Apache Pass wildfire) and 2015 (Scotch Creek and Tunk Valley populations affected by the 120,000 ha Okanogan Complex wildfire). All the populations with leks within the wildfire perimeters were clearly affected by wildfire, but the effect may gradually disappear after a few years (Fig. 7). Although the longer-term effect may be positive, particularly in higher precipitation zones where bunchgrasses respond rapidly and unburned habitat can become dominated by woody vegetation, this effect has not been detected yet. One risk that is difficult to assess is the long-term genetic and demographic impacts of severe population bottlenecks. These types of analyses are also complicated by numerous confounding variables that can cause complex interactions.

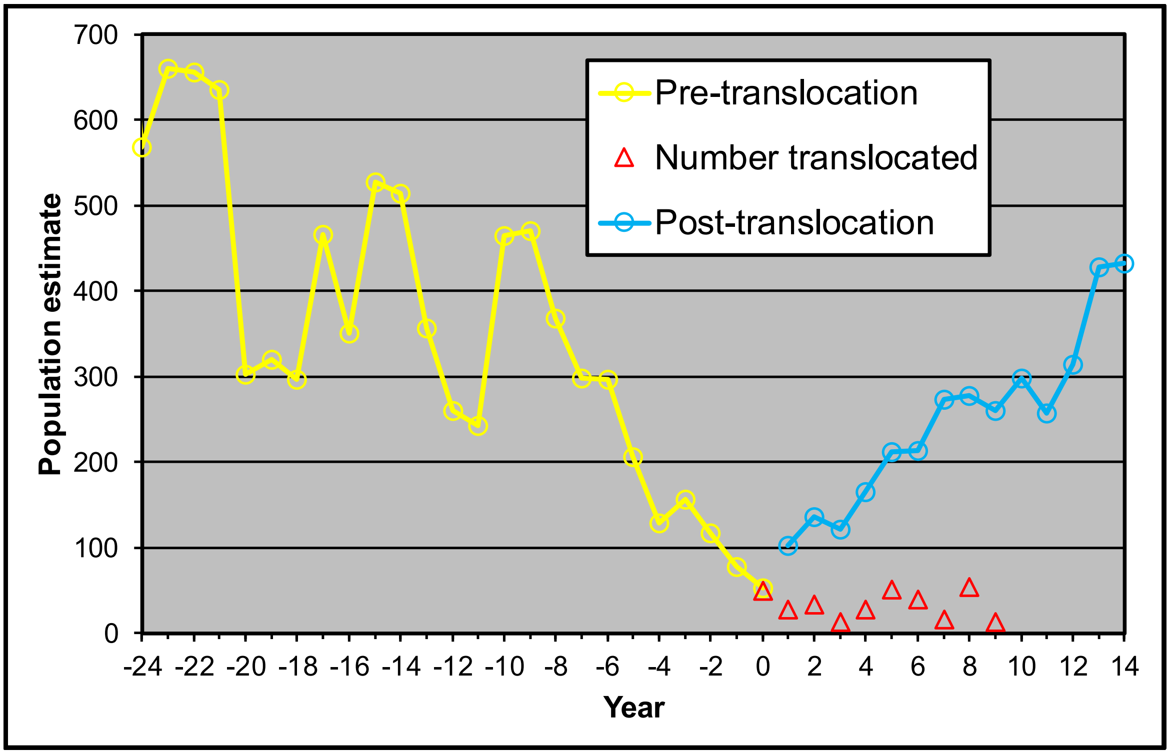

Fig. 6. Population estimate for combined populations (Dyer Hill, Swanson Lakes, and Scotch Creek) of sharp-tailed grouse prior to, and after initiation of translocations in Washington State.

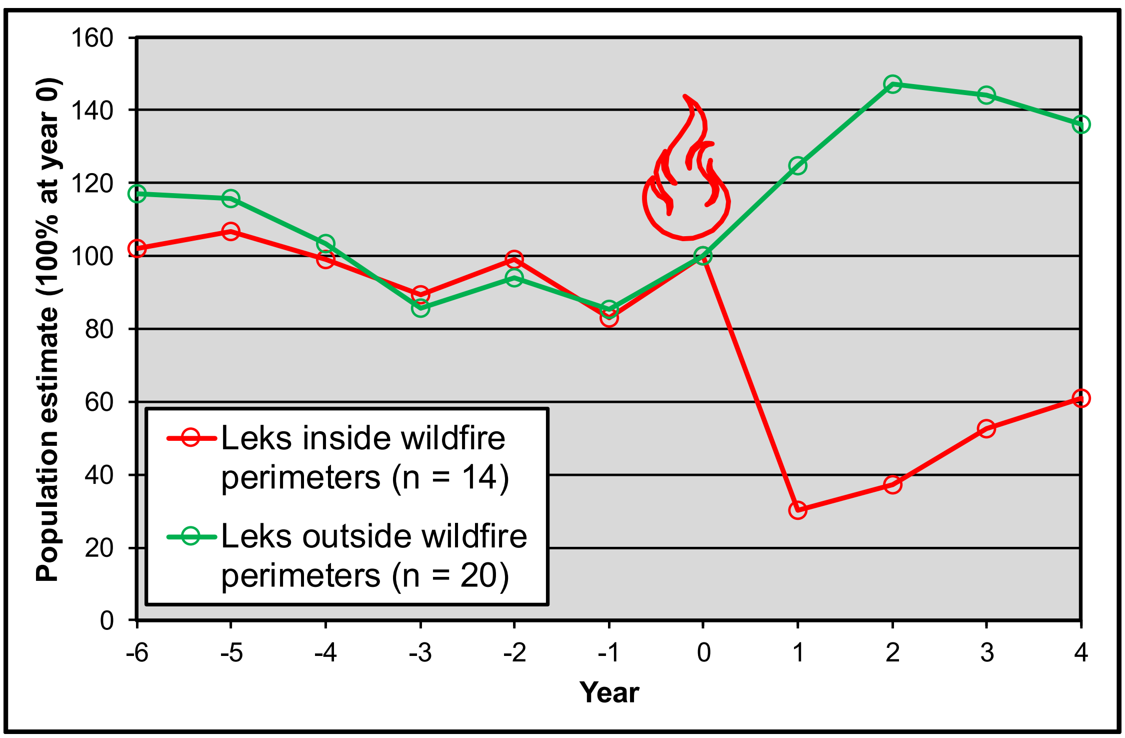

Fig. 7. Combined effects of wildfires on Scotch Creek, Tunk Valley, Big Bend, and Swanson Lakes populations of sharp-tailed grouse in Washington. The annual rates of population change for burned vs. unburned leks are centered at 100% for the year of the wildfire within each population.

Scotch Creek

Experimental translocations in 1998, 1999, and 2000 were successful in augmenting one population of sharp-tailed grouse in Washington at the 9700 ha Scotch Creek Wildlife Area, northwest of Omak. Birds for this translocation were obtained from the Rockland area in southeastern Idaho (26 males and 25 females) and the Colville Confederated Tribal Reservation in Washington (6 males and 6 females, Appendix A). Prior to the translocation, surveys indicated that the Scotch Creek population had declined to 1 lek with 2 displaying males. This population increased after the translocation (Fig. 8). The population was set back in 2016, apparently as a result of the Okanogan complex wildfire in summer 2015, but it appears to have recovered somewhat in 2017, 2018, and 2019 (Fig. 8). An additional translocation of 19 birds was conducted in 2019 (Appendix A), but this was done after the 2019 lek counts were completed (details of the translocation are in the Tunk Creek section of this report).

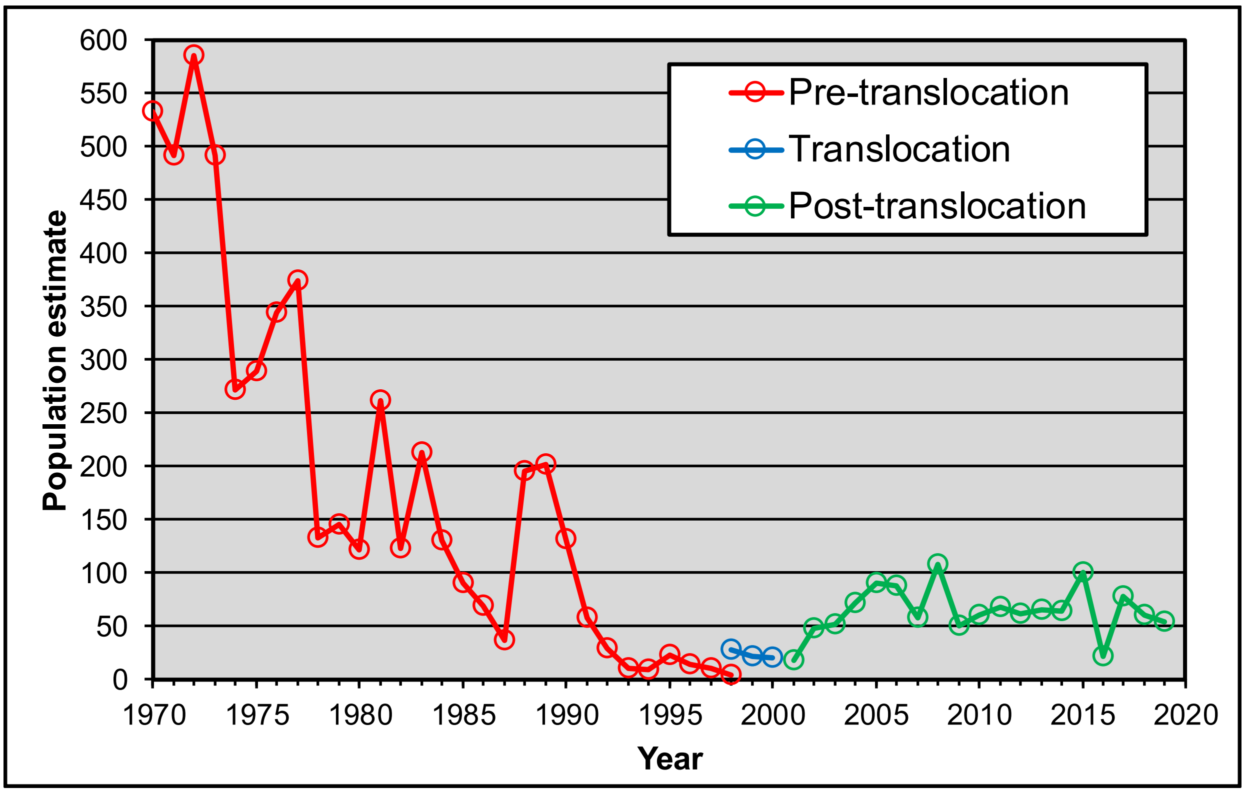

Fig. 8. Population estimate for sharp-tailed grouse at Scotch Creek in relation to the translocation of 63 grouse during spring 1998, 1999, and 2000.

Dyer Hill

The release sites in the Dyer Hill area are clearly within the historical range of sharp-tailed grouse and until relatively recently have had healthy populations of sharp-tailed grouse. Dyer Hill is near the Central Ferry Canyon, West Foster Creek, and Bridgeport wildlife areas in Douglas County. These state-owned areas include approximately 3,800 ha of potential sharp-tailed grouse habitat within a matrix of tens of thousands of additional hectares of private land, also with potential to support sharp-tailed grouse. Work is currently underway in the general area to restore old grain fields to shrubsteppe and to mark or remove fences for the benefit of grouse.

During 1999–2008 64 sharp-tailed grouse (35 males and 39 females) were translocated from Nespelem, Washington, south-central British Columbia, southeastern Idaho, and north-central Utah (Appendix A). The population has fluctuated in the years following translocation, but dramatically peaked in 2018 at a level higher than ever recorded (Fig. 9). It isn't clear if this was a result of the translocation, at least in part, or if this was do to other management activities such as CRP/SAFE and restoration of riparian areas. Direct observations and remote cameras have confirmed that grouse are feeding in planted water birch in the winter. The population increase in spring 2018 was not surprising following the observation of a single flock of 54 grouse during winter 2017/2018. This was the largest flock observed in Douglas County in the last 50 years.

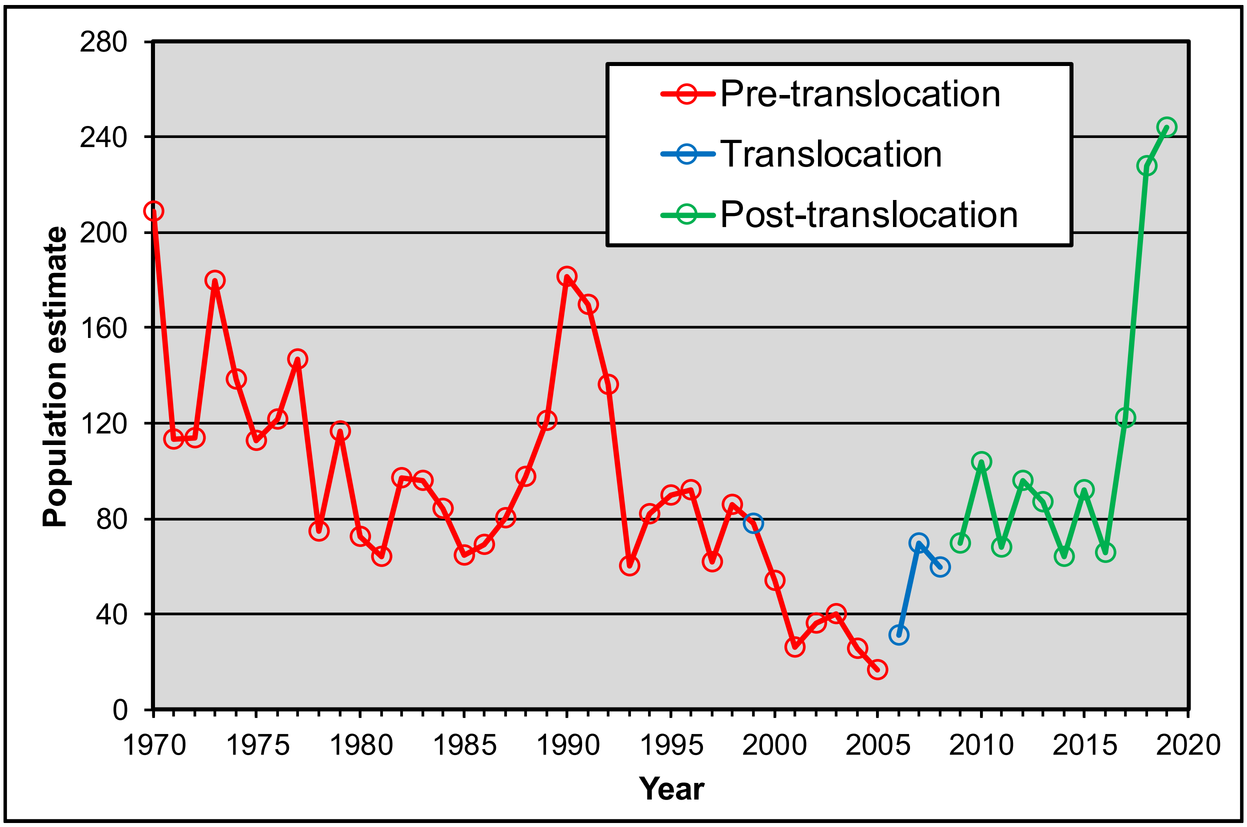

Fig. 9. Estimated population of sharp-tailed grouse in the Dyer Hill population in Washington before, during, and after translocation of 64 sharp-tailed grouse during 1999–2008.

Swanson Lakes

The Swanson Lakes Wildlife Area includes about 8100 ha, with an additional ~500 ha lease of Washington Department of Natural Resources land (Fig. 10). In addition, the BLM has purchased several properties adjacent to the wildlife area, providing an opportunity to secure connectivity of habitats among various agencies. BLM Twin Lakes Recreation Area is 6,200 ha located approximately 26 km southwest of Davenport in central Lincoln County and is immediately adjacent to Swanson Lakes Wildlife Area. BLM's Coffeepot Lake property is 400 ha located 19 km west of Harrington in Lincoln County. BLM's Lakeview Ranch is 5100 ha located approximately 9 km north of the town of Odessa in southwest Lincoln County. Management of all these area has focused on supporting wildlife habitat, conservative seasonal livestock grazing, and wildlife-based recreational opportunities.

Fig. 10. Major public lands and landcover of the sharp-tailed grouse reintroduction area in the Swanson Lakes Management Unit, Washington (Swanson Lakes population). BLM lands are yellow, WDFW lands green, and WDNR lands brown.

Since 1995, WDFW and BLM have worked to restore habitat and decrease anthropomorphic sources for perching and nesting for avian predators. This work includes restoration of more than 1,200 ha of former cropland, removal of unnecessary powerlines, poles, and fence, burial of needed powerlines, and marking of more than 200 km of fences. For more detailed list of recovery work done in the Swanson Lakes area please see the Crab Creek sub-section in the Translocation and Research section of the WDFW Annual Sage Grouse Progress Report (Schroeder et al. 2019).

During 2005–2013, 203 sharp-tailed grouse (113 males and 90 females) were translocated from south-central British Columbia, southeastern Idaho, and north-central Utah (Appendix A). The population has fluctuated in the years following translocation, but has consistently been higher than it was prior to translocation (Fig. 11). The translocated birds in the Swanson Lakes area have been the focus of sharp-tailed grouse research in Washington State (Stonehouse 2013, Stonehouse et al. 2015). This research included examinations of movement, habitat use, productivity, and survival. The basis for this research was approximately 5000 telemetry locations for 184 individual grouse.

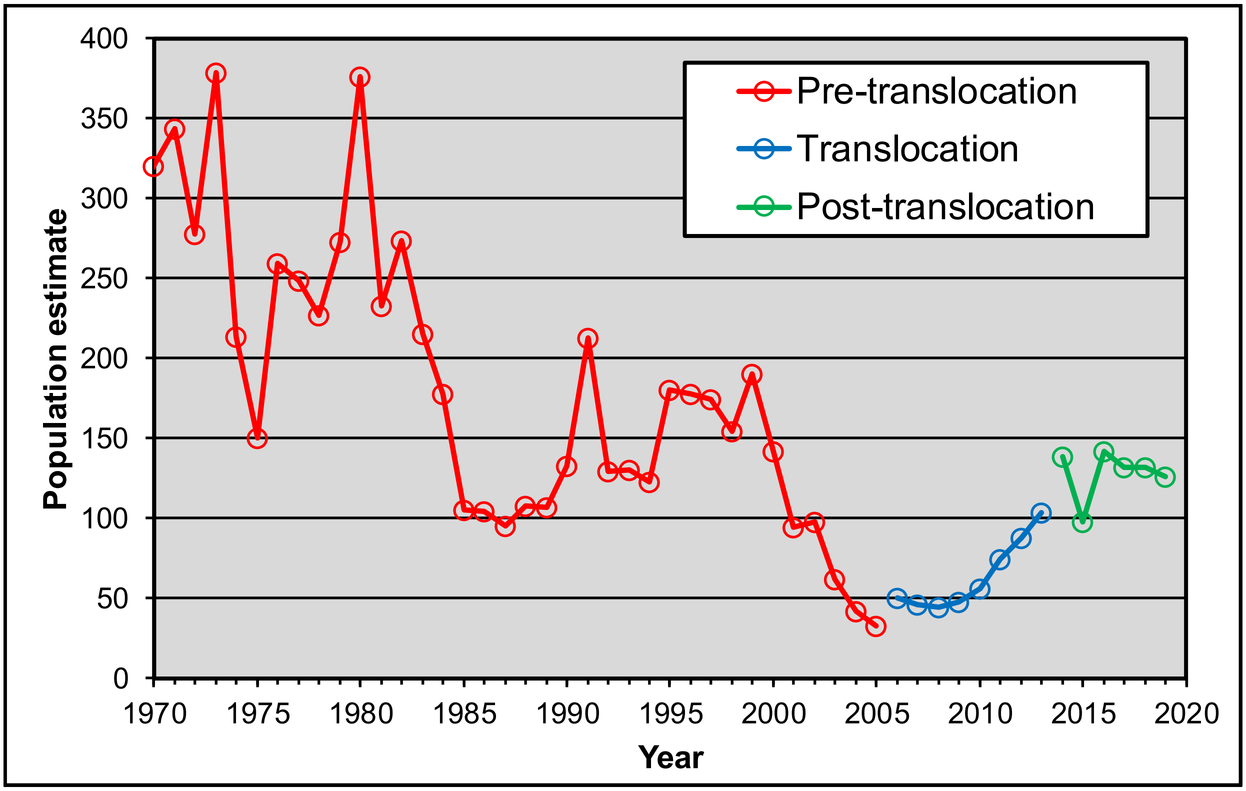

Fig. 11. Estimated population of sharp-tailed grouse in the Crab Creek population (and surrounding areas) in Washington before, during, and after translocation of 203 sharp-tailed grouse during 2005–2013.

Breeding Age Survival – A survival analysis was performed in Program MARK using monthly encounter intervals for 184 individuals translocated between 2005-2013 (19 males did not receive radio transmitters). There were four groups in the analysis: adult females (63), yearling females (27), adult males (67), and yearling males (27). Yearlings were graduated into adulthood as of April 1st of the year following capture based on previous analysis assessing various graduation dates. First demographic (sex, age, etc.) and temporal (1st spring, spring, fall, etc.) models were run independently, then the top model of each was combined in additive and interactive models. The top model was an additive model with Sex, Age, and 1st April–June for females only and received 62% of model weight (Table 3). April–June is the core lekking and nesting period at the study site, and thus potentially a time of low survival for both males and females. However, survival estimates form the second-best model indicated that for males, the difference in survival between this period and the rest of the year was not different (CI intervals overlapped). Using the monthly survival estimates from model averaging of the top three models, we estimate annual survival for the first year after translocation for adult females at 31%

± 2%, yearling females at 49% ± 3%, adult males at 60% ± 3%, and yearling males at 74% ± 3%. For all years thereafter female survival estimated at 41% ± 2% and male survival at 60% ± 3%.

Table 3. Model results from a 2018 analysis in Program MARK of 184 individual marked sharp-tailed grouse translocated from southern Idaho to central Washington 2005-2013.

Model	AICc	Delta AICc	AICc Weights	# Parameters	Deviance
Sex + Age + 1st April–June (females only)	733.64	0	0.62	4	725.61
Sex*1st April–June + Age	735.33	1.69	0.27	5	725.30
Sex + Age + 1st April–June	738.42	4.79	0.06	4	730.40
Sex + Age	740.13	6.50	0.02	3	734.12
Sex*Age	741.19	7.55	0.01	4	733.16
Sex	741.40	7.76	0.01	2	737.39
1st April–June	754.88	21.24	0.00	2	750.87
1st Month	756.82	23.18	0.00	2	752.81
1st Spring	757.13	23.49	0	2	753.12
1st Year	757.54	23.91	0	2	753.54
April–June	758.13	24.49	0	2	754.12
Age	759.08	25.44	0	2	755.07
Null	759.42	25.79	0	1	757.42
Four Seasons	760.74	27.11	0	4	752.72
Calendar Year	761.06	27.42	0	2	757.05

Nest Success – From 2009–2014 we documented 41 nesting attempts by 33 VHF marked hens, 21 were successful, and of these successful nests 14 fledged (≥ 1 chick at 45 days) and 2 were unknown due to radio battery failure. Average duration of incubation for successful nests was 24.25 days with a range of 24 to 26 days. Of the 20 failed nests, nine were attributed to mammalian predators (coyote [*Canis latrans*, badger [*Taxidea taxus*], etc.), three to common raven (*Corvus corax*), five were unknown, and three were due to hens being killed while off nest. No nest cameras were used on this project so predator identification was based on nest remains. Nest success analysis was performed in Program MARK using 40 nests, one nest was censored due to insufficient data. We used the day in incubation, rather than calendar day for data input, resulting in 27 survival occasions. We assessed in single covariate models the effect of 17 covariates: nine nest vegetation measurements, distance to power lines, distance to roads, distance to nearest road or powerline, distance to lek, clutch size, hen age (0 for adult and 1 for yearling), naiveté to site (0 for first year and 1 for all following years), and Julian date of nest initiation (Table 4). We also created models to assess if there was annual variation in nest success, and linear and quadratic trend in nest success relative to nest age. The top model contained only the linear trend in nest success relative nest age. There was some support for a quadratic trend relative to nest age and no support for any of the other covariates models (Table 4). Model average daily survival rates from the top two models result in an estimated 45.7% (0.05SE) nest success at 24 days and 25.7% (0.03SE) at 26 days. Though the naiveté covariate was not significant (95% CI for best estimate overlapped zero) the model indicates ~28% higher nest success for experienced hens. The lack of significance for naiveté effect is likely due to having only 11 nests from second year hens, of these nest all but three were successful. Also though the distance to power line covariate was not significant the model indicates higher survival for nests farther from power lines, i.e., ~eight % increase in nest success per every 500 m - from a power line.

Table 4. Model results from a 2018 analysis in Program MARK of 40 sharp-tailed grouse nests from sharp-tailed grouse translocated from southern Idaho to central Washington 2009 –2013.

Model	AICc	Delta AICc	AICc Weights	# Parameters	Deviance
Linear trend in nest age	111.83	0	0.6313	2	107.81
Quadratic trend in nest age	112.90	1.08	0.3687	3	106.87
Distance to Power Line	138.27	26.44	0	2	134.25
Naiveté to Site	138.81	26.98	0	2	134.80
Null	139.53	27.70	0	1	137.52
Clutch size	139.87	28.04	0	2	135.85
% Perennial Forb Cover	140.47	28.64	0	2	136.45
Distance to Road or Power Line	140.49	28.66	0	2	136.48
Hen Age	140.55	28.72	0	2	136.53
Perennial Forb Height	140.59	28.76	0	2	136.57
% Perennial Grass Cover	140.63	28.81	0	2	136.62
Distance to Road	141.26	29.43	0	2	137.24
% Annual Grass Cover	141.29	29.46	0	2	137.27
% Annual Forb Cover	141.36	29.53	0	2	137.34
Perennial Grass Height	141.46	29.63	0	2	137.44
% Shrub Cover	141.46	29.63	0	2	137.44
Julian Date Nest Initiation	141.50	29.67	0	2	137.49
% Sage Cover	141.51	29.68	0	2	137.49
Distance to Lek	141.52	29.69	0	2	137.50
Robel Pole	141.53	29.70	0	2	137.51
Calendar Year	145.67	33.84	0	6	133.55

Tunk Valley

WDFW's Tunk Valley Unit of the Scotch Creek Wildlife Area is 566 ha located about 12 miles northeast of Omak. The WDFW property is surrounded by private ranches. A declining population (Table 2, total estimate of 27 birds in 2017) and a desire to maintain/improve connectivity between the Tunk Valley and adjacent populations (Chesaw, Scotch Creek, and Greenaway Spring) led to a need to augment the population with grouse from a healthy population. During springs of 2018 and 2019 grouse were captured in an area near 70-Mile House, British Columbia. Most were released on a private ranch in the Tunk Valley and a smaller portion was released on the Scotch Creek area (Appendix A). The source population was in an area dominated by large-scale clearcuts. When mature, the forest habitat is generally dominated by lodgepole pine (*Pinus contorta*). When cut, pinegrass (*Calamagrostis rubescens*) and numerous species of shrubs dominate for a limited number of years.

Sharp-tailed grouse numbers appear to peak in the clearcuts about five years post-clearcut; this appears to be characterized by an optimal cover of grass, while replacement trees are still very small. Another factor appears to be the size of the clearcut. Preliminary observations suggest that attendance at leks is proportional to the size of the clearcut; clearcuts < 100 ha in size appear unlikely to support leks. Although surveys are not complete, it seems that the time from timber harvest leading to colonization by sharp-tailed grouse to the disappearance of sharp-tailed grouse from the regenerating unit may be about 20 years (Appendix B).

Six leks in British Columbia were used for trapping and translocation including Cunningham 4, Cunningham 6, East Twin Creek, Little White Lake 2, Loch Lomond Trail, and Raphael in 2018 (Appendix B). Seven leks in British Columbia were used for trapping and translocation including Cunningham 4, Cunningham 6, Little White Lake 2, McKinley Lake, Copper Johnny Creek, Hanging Tree 2, and Hanging Tree 3 in 2019 (Appendix B). The combined attendance at the trapping leks was 124 grouse in 2018 and 111 in 2019. Because the combined number of males was estimated (based on observation) to be 95 in 2019, it is likely that the translocation included about 20% of the birds on the target leks (both males and females). The impact would be much lower if the additional untrapped leks in the area were counted. Thirty-three birds (17 males and 16 females) were captured and translocated to the Tunk Valley during 23–27 April 2018 and 38 birds (19 males and 19 females) were captured and translocated to both the Tunk Valley and Scotch Creek during 16–25 April 2019. In 2019 the translocated birds were evenly divided between the Tunk Creek and Scotch Creek areas. Issues with translocations in 2018 (7 additional birds died during translocation) were addressed in 2019. Even so, two males died during transport, both appeared to be adversely impacted by being captured in the same trap. All surviving birds were translocated and released on the same day they were captured, roughly 12 hours after capture.

Other populations

Translocations have been conducted in other populations including Nespelem (63 males and 30 females during 2005–2012) and Greenaway Spring (25 males and 7 females in 2005 and 2011, Appendix A). Both of these were on land managed by the Colville Confederated Tribes. We did not have detailed data to examine the success of these translocations on tribal lands but the preliminary results were similar to the other translocations described earlier. The Greenaway Spring area is particularly important for connectivity among sharp-tailed grouse leks throughout the state of Washington due to its centrality (Robb and Schroeder 2012).

PLANS FOR 2020

Work will continue in all populations in 2020. In addition to the research projects specified below, conservation activities will include habitat conservation planning, working with landowners on federal conservation program lands, and habitat management on state-owned wildlife areas.

- Translocate additional 20 male and 20 female sharp-tailed grouse from British Columbia to Okanogan County, Washington.
- Continue monitoring VHF-marked sharp-tailed grouse associated with the Tunk Valley and Scotch Creek translocations.

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Appendix A. Number of sharp tailed-grouse translocated to populations in Washington, 1998–2019.

Target populations	Translocation year (always in April)	Source populations										
		SE Idaho		Nespelem, WA		South-central British Columbia		North-central Utah		Total		
		Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Total
Scotch Creek	1998	13	12	0	0	0	0	0	0	13	12	25
	1999	3	3	6	6	0	0	0	0	9	9	18
	2000	10	10	0	0	0	0	0	0	10	10	20
	2019	0	0	0	0	12	7	0	0	12	7	19
Dyer Hill	1999	3	2	0	0	0	0	0	0	3	2	5
	2005	5	3	0	0	7	5	0	0	12	8	20
	2006	0	0	0	0	0	0	5	5	5	5	10
	2007	1	0	0	0	0	0	7	7	8	7	15
	2008	6	5	0	0	0	0	1	2	7	7	14
Greenaway Spring	2005	0	0	0	0	5	1	0	0	5	1	6
	2011	20	6	0	0	0	0	0	0	20	6	26
Nespelem	2005	0	0	0	0	9	4	0	0	9	4	13
	2006	0	0	0	0	0	0	5	4	5	4	9
	2007	6	1	0	0	0	0	2	3	8	4	12
	2008	0	0	0	0	0	0	7	7	7	7	14
	2009	5	5	0	0	0	0	0	0	5	5	10
	2011	9	0	0	0	0	0	0	0	9	0	9
	2012	20	6	0	0	0	0	0	0	20	6	26
Crab Creek	2005	7	5	0	0	5	3	0	0	12	8	20
	2006	0	0	0	0	0	0	5	5	5	5	10
	2007	0	2	0	0	0	0	8	4	8	6	14
	2008	4	5	0	0	0	0	3	2	7	7	14
	2009	15	13	0	0	0	0	0	0	15	13	28
	2010	31	20	0	0	0	0	0	0	31	20	51
	2011	10	10	0	0	0	0	0	0	10	10	20
	2012	5	2	0	0	0	0	0	0	5	2	7
	2013	20	19	0	0	0	0	0	0	20	19	39
Tunk Valley	2018	0	0	0	0	17	16	0	0	17	16	33
	2019	0	0	0	0	7	12	0	0	7	12	19
Total		193	129	6	6	62	48	43	39	304	222	526

Appendix B. Sharp-tailed grouse lek counts for central British Columbia ("1+" refers to active leks with no count of birds.

Region	Lek Name	Type	<2004	2004	2005	2013	2017	2018	2019
Alexis Creek	Chilko River 1	Clearcut		6					
Alexis Creek	Chilko River 2	Clearcut		10					
Alexis Creek	Chilko River 3	Clearcut		10					
Alexis Creek	Chilko River 4	Clearcut		20					
Alexis Creek	Chilko River 5	Clearcut		16					
Alexis Creek	Chilko River 6	Clearcut		6					
Alexis Creek	Chilko River 7	Clearcut		10					
Alexis Creek	Mount Alexis 1	Clearcut		3					
Alexis Creek	Mount Alexis 2	Clearcut		12					
Alexis Creek	Mount Alexis 3	Clearcut		6					
Riske Creek	Barnes Lake	Grassland	1+						
Riske Creek	Doc English	Grassland	1+						
Riske Creek	Ferguson Ridge 1	Grassland							
Riske Creek	Ferguson Ridge 2	Grassland							
Riske Creek	Junction Area 1	Grassland	1+						
Riske Creek	Junction Area 2	Grassland	1+						
Riske Creek	Junction WMA	Grassland	1+						
Riske Creek	Leeches Lake	Grassland	1+						
Riske Creek	Litaco Road	Grassland	1+						
Riske Creek	Loran Creek	Grassland	1+						
Riske Creek	Lye Lake	Grassland	1+						
Riske Creek	Raven Lake	Grassland	1+						
Riske Creek	Raven Lake Road	Clearcut	15						
Riske Creek	Sword Creek	Grassland	1+						
Riske Creek	Taharti Lake 1	Clearcut	40						
Riske Creek	Taharti Lake 2	Clearcut	40						
70 Mile House	Augustine Flat 1	Clearcut		53	30	17	4		
70 Mile House	Augustine Flat 2	Clearcut			3				
70 Mile House	Augustine Flat N	Clearcut		19	12		0		
70 Mile House	Beaverdam Lake	Clearcut	1+						
70 Mile House	Clink Lake	Clearcut			25		0		
70 Mile House	Copper Johnny Creek	Clearcut							17

70 Mile House	Cunningham Lake 1	Clearcut	1+						
70 Mile House	Cunningham Lake 2	Clearcut		1					
70 Mile House	Cunningham Lake 3	Clearcut				7	4		
70 Mile House	Cunningham Lake 4	Clearcut				28	36	20	19
70 Mile House	Cunningham Lake 5	Clearcut					8	11	5
70 Mile House	Cunningham Lake 6	Clearcut						20	15
70 Mile House	East Twin Creek	Clearcut				8	21	22	6
70 Mile House	Foxtail Flat	Clearcut					6		
70 Mile House	Goodenough Lake	Clearcut			20		0		
70 Mile House	Hanging Tree 1	Clearcut			16		0		
70 Mile House	Hanging Tree 2	Clearcut					17		14
70 Mile House	Hanging Tree 3	Clearcut					11		15
70 Mile House	Hanging Tree 4	Clearcut							5
70 Mile House	Hanging Tree NW	Clearcut	1+						
70 Mile House	Holden 1	Clearcut		3					
70 Mile House	Holden 2	Clearcut				7			
70 Mile House	Holden 3	Clearcut		7					
70 Mile House	Holden 4	Clearcut		17					
70 Mile House	Little Big Bar Lake	Clearcut			9		0		
70 Mile House	Little White Lake 1	Clearcut			11		0		
70 Mile House	Little White Lake 2	Clearcut				5	22	20	17
70 Mile House	Little White Lake 3	Clearcut					3		
70 Mile House	Little White Lake 4	Clearcut							2
70 Mile House	Lock Lomond Trail	Clearcut				25	12	18	7
70 Mile House	McKinley Lake	Clearcut							14
70 Mile House	Mute Lake	Clearcut			30		0		
70 Mile House	Raphael	Clearcut				17	11	24	8
70 Mile House	Rayfield	Clearcut					3		
70 Mile House	Snag Lake	Clearcut		5					
70 Mile House	Valenzuela Lake	Clearcut			14		0		
70 Mile House	Valenzuela Lake N	Clearcut	1+						
70 Mile House	West White Lake	Clearcut	1+						
70 Mile House	White Lake	Grassland	1+		1+		0