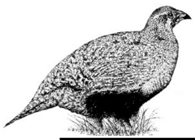
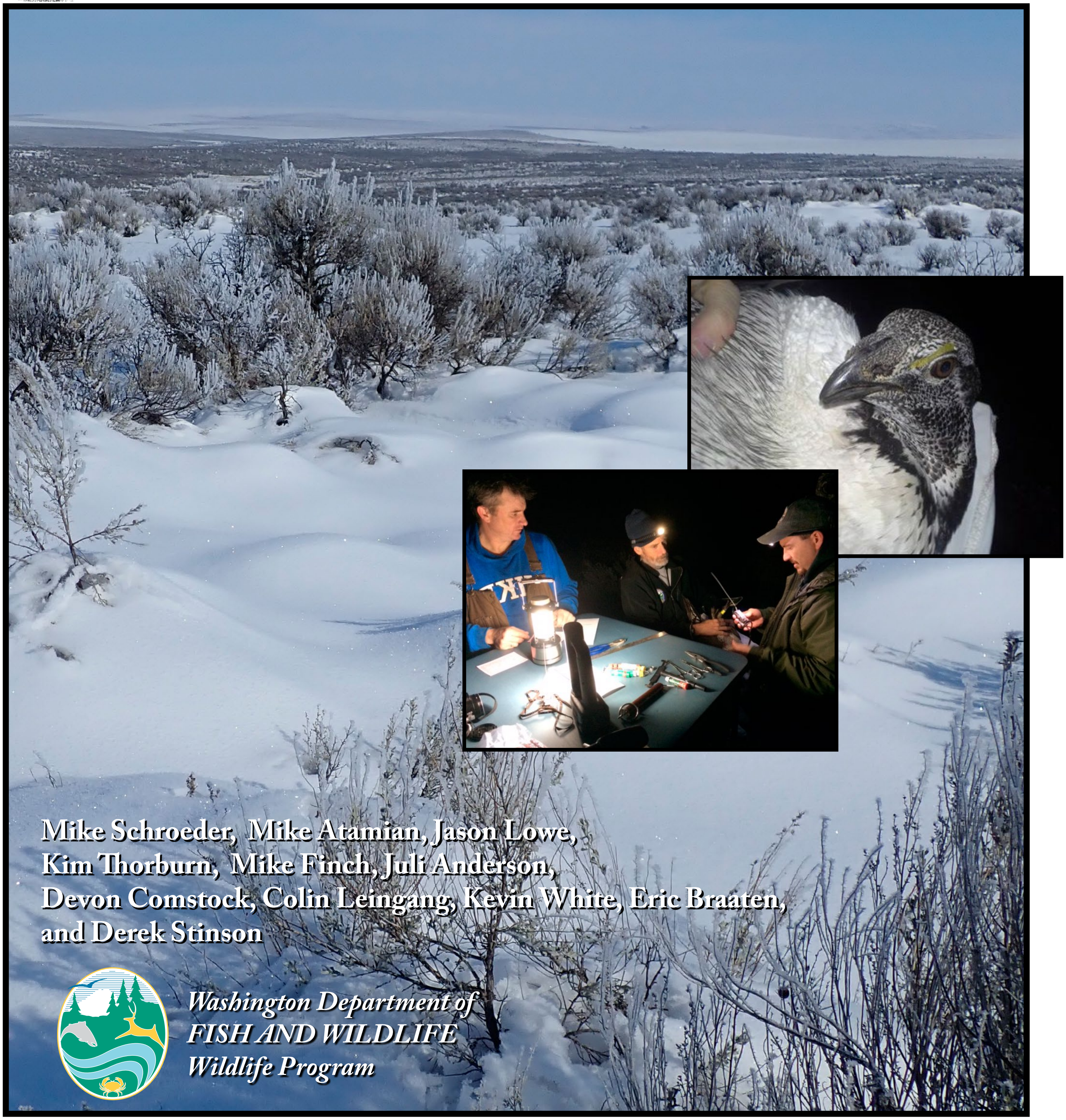


Recovery of Greater Sage-grouse in Washington: Progress Report



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FISH AND WILDLIFE
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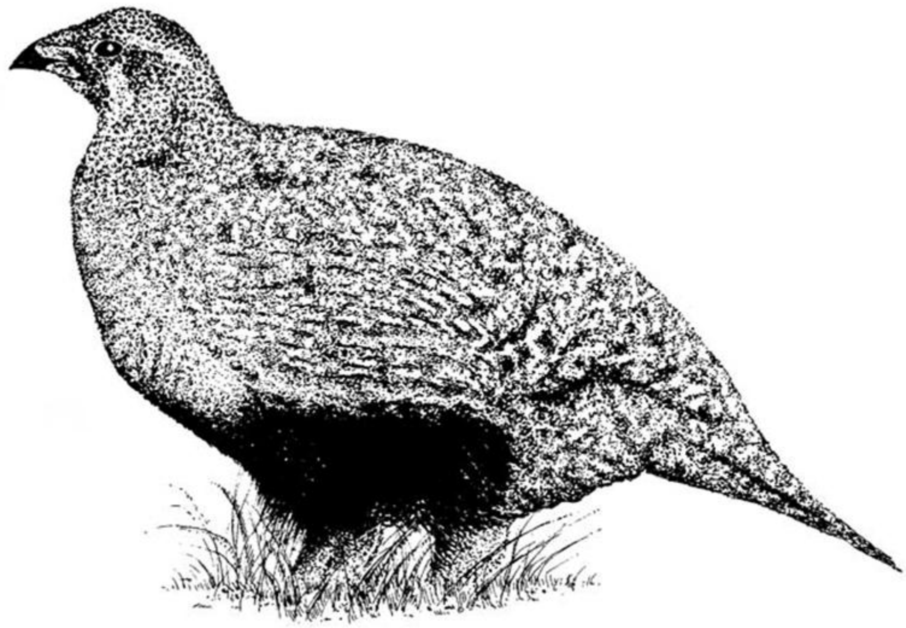
ABSTRACT

Declining populations and distribution of greater sage-grouse (*Centrocercus urophasianus*) in Washington have resulted in serious concerns for their long-term conservation status. The overall population was estimated to be 676 in 2019, associated with 21 leks. The birds were distributed between 3 populations including 585 birds with 17 leks in Moses Coulee, 78 birds with 3 leks in the Yakima Training Center (YTC), and 13 birds with 1 lek in Crab Creek. A fourth population, the Yakama Nation, appeared to disappear between 2018 and 2019. The overall population increased 32% between 2017 and 2018 and decreased 5% between 2018 and 2019. Governmental agencies and non-governmental organizations are attempting to restore populations of sage-grouse with the aid of land acquisition, habitat improvement, conservation programs, and translocations. Between 2004 and 2016 the Washington Department of Fish and Wildlife (WDFW), YTC, Yakama Nation, and others collaborated to translocate sage-grouse from other states (Nevada, Oregon, Idaho, and Wyoming) to 3 of the 4 populations in Washington. Six males and 93 females were translocated to YTC to genetically augment an endemic population, 145 males and 135 females were translocated to the Crab Creek area of Lincoln County to re-establish an extirpated population, and 85 males and 43 females were translocated to the Yakama Nation to re-establish an extirpated population. The translocation effort that appears to have had the greatest success so far in establishing an active lek and a documented breeding/nesting population is Crab Creek, although its long-term persistence may be reliant on periodic augmentation efforts.

On the cover: Background photo of Sagebrush Flats WLA by Mike Schroeder; male greater sage-grouse being processed by capture crew in Douglas County by Eric Braaten. Page 1 and back cover illustrations by Darrell Pruett.



RECOVERY OF GREATER SAGE-GROUSE IN WASHINGTON: PROGRESS REPORT AND PROPOSAL

December 2019

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INTRODUCTION

Greater sage-grouse have declined dramatically in both distribution and population size in Washington (Schroeder et al. 2000, 2004). The current range for endemic sage-grouse is about 8% of the historic range, occurring in 2 relatively isolated areas; one primarily on the JBLM YTC in south-central Washington and the other centered in the Moses Coulee area of Douglas County in north-central Washington (Schroeder et al. 2000, Fig. 1). These observed declines in populations and distribution in Washington were accompanied by observations of loss of genetic heterogeneity in northern Washington (Oyler-McCance et al. 2005). Additionally there is a small population of sage-grouse in the Crab Creek area in Lincoln County. This population is not endemic but was re-established using birds translocated from southern Oregon.

Historic and recent declines of greater sage-grouse in Washington are linked to conversion of native habitat for production of crops and degradation and isolation of the remaining native habitat (WDFW 1995, Hays et al. 1998, Stinson et al. 2004, Shirk et al. 2015). In the Moses Coulee population in north-central Washington (Fig. 1), sage-grouse occupy a 3,500 km^2 mosaic of mostly private lands used for dryland farming (mostly wheat), lands enrolled in the federal Conservation Reserve Program (CRP, including State Acres for Wildlife Enhancement [SAFE]), or lands with high-quality shrubsteppe (Table 1, Schroeder and Vander Haegen 2011). In contrast, the JBLM YTC population in south-central Washington was believed to occupy about 1,200 km^2 approximately 20 years ago but research in the last 6 years suggests that the current area of occupancy may be as low as 474 km^2 (456 km^2 on YTC and 18 km^2 on adjacent private land). The JBLM YTC is one of the largest shrubsteppe sites remaining in the state, due largely to its complex topography, isolated nature, and history of low intensity livestock grazing. Grazing by livestock was completely eliminated in 1995. Military training and fires pose the greatest threat to habitat security. Cross-country maneuvers with military vehicles decrease habitat quality through sagebrush mortality (Cadwell et al. 1996, Stephan et al. 1996) and disturbance to understory communities (Cadwell et al. 2001). Training activities also ignite wildfires that pose a significant threat to the existing habitat both on and adjacent to the installation. In 2018 and recent years, larger landscape-scale fires, a higher frequency of natural-caused wildfires (i.e., lightning), and fires originating from adjacent interstate highways (e.g., I-82, I-90) have impacted the installation's remaining unburned areas of suitable habitat to a greater degree than in previous years. Between 2014-2018 YTC experienced a 10% increase in new fire footprints which increased the total area of the installation burned from a single one-time fire event in the last 31 years to approximately 61% with many of those areas also being subjected to repeated fires over that same period of time. This local trend of increased fire frequency, larger landscape fires, and an increase in the wildland fire season is consistent across the range of sage-grouse.

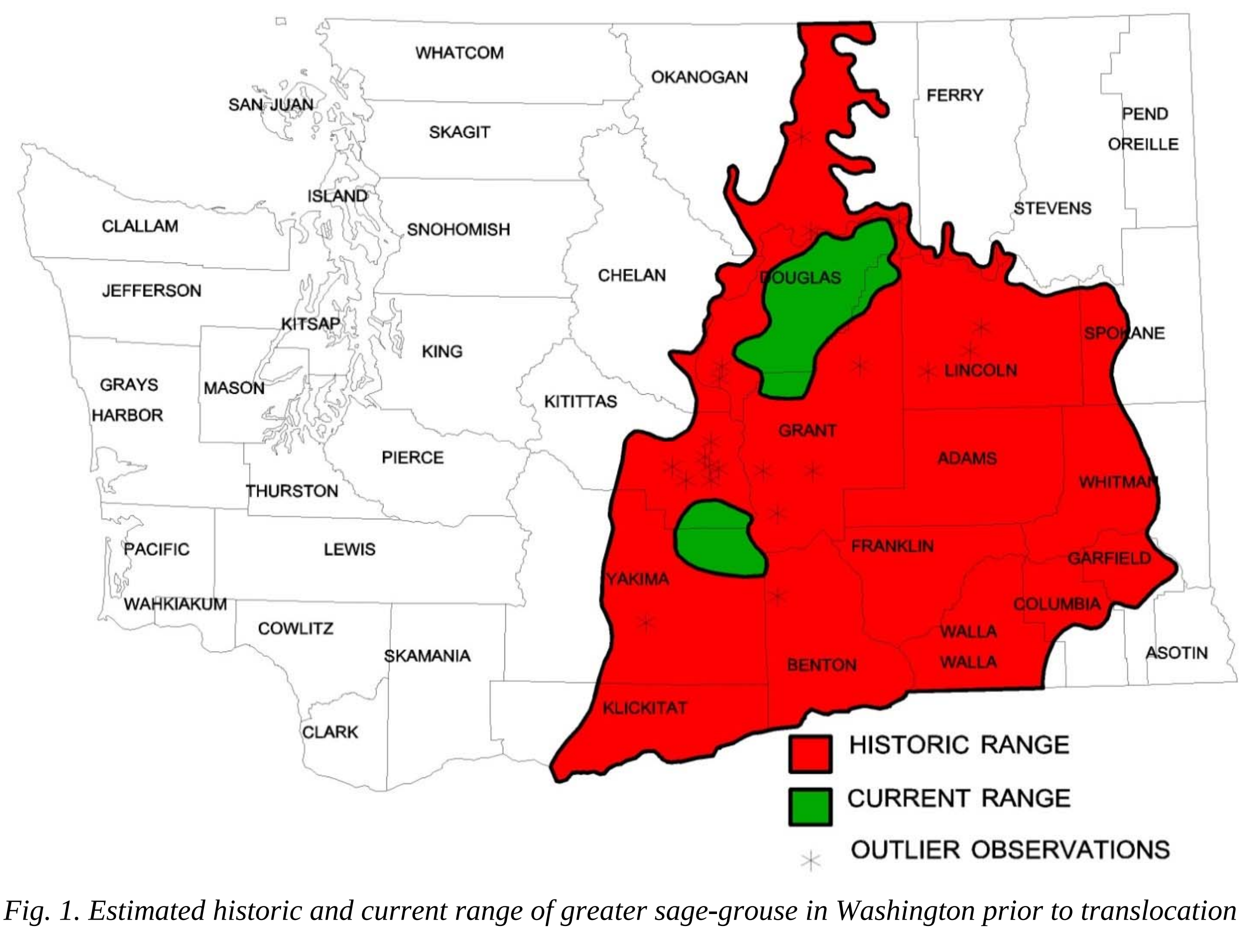

Fig. 1. Estimated historic and current range of greater sage-grouse in Washington prior to translocation efforts (Schroeder et al. 2000).

Table 1. Potential habitat quantity in relation to current and historic distribution of greater sage-grouse in Washington (adapted from Table 1 in Schroeder et al. 2000; population names from Fig. 3). The translocated birds in the Toppenish Ridge area (Yakama Nation) are not included below because of the small number of birds and the poorly defined area of occupancy.

Range or population	Proportion of area (%)				Total area (km^2)
	Shrubsteppe[a]	Cropland[a]	CRP[b]	Other[b]	
Moses Coulee/Mansfield Plateau	44.3	35.1	16.7	3.9	3,529
Yakima Training Center (YTC)	95.6	0.5	1.9	1.9	1,154
Crab Creek	52.0	36.0	11.0	1.0	3,276
Total occupied range[c]	57.0	26.6	13.0	3.4	4,683
Unoccupied range	42.3	42.8	5.5	9.4	53,058
Total historical range	43.5	41.5	6.1	8.9	57,741

[a]Landsat Thematic Mapper, 1993.
[b]Determined from aerial photos dated 1996.
[c]The total occupied range does not include the Crab Creek area.

Long-term declines in distribution and abundance of greater sage-grouse in Washington are the primary reasons why the Washington Department of Fish and Wildlife (WDFW) listed the greater sage-grouse as 'threatened' within the state (Hays et al. 1998). These population declines (Schroeder et al. 2000, Connelly et al. 2004, Garton 2011), their isolated nature, and their previous status as a subspecies (*C. u. phaios*) were used by the U.S. Fish and Wildlife Service in 2001 to determine that greater sage-grouse in Washington and northern Oregon represented a distinct population segment and that the population segment warranted a federal listing as threatened. Both the "warranted" and "distinct population segment" decisions were reversed in 2015 (U.S. Fish and Wildlife Service). Although greater sage-grouse in Washington State are no longer federally listed as a candidate species, the areas occupied by the two endemic populations (Moses Coulee and YTC) and the two translocated populations (Crab Creek and Yakama Nation) are federally acknowledged as "Priority Areas for Conservation" (U.S. Fish and Wildlife Service 2013b, Fig. 2).

A greater sage-grouse recovery plan was published in 2004 for Washington, which stated as its primary goal "to establish a viable population of sage-grouse in a substantial portion of the species' historic range in Washington" (Stinson et al. 2004). The recovery plan established numerous management units (Fig. 3) to aid in the identification and implementation of management and recovery actions (Stinson et al. 2004). Greater sage-grouse have also been observed in all other management units, and in some cases outside established management units (e.g. a male was photographed near Haley Creek, east of Omak on 30 January 2004). The management units were not designed to limit management and recovery activities, but to focus activities. Even so, enhancement of existing populations was identified as the highest priority (Stinson et al. 2004, Stinson and Schroeder 2014). The recovery plan listed the following strategies, all of which have been applied and/or attempted in at least a portion of the greater sage-grouse range in Washington (Stinson et al. 2004:57). The purpose of this report is to address some of the key activities, particularly inventory and monitoring (item 1 below), translocations (item 3 below), and research (item 9 below).

1) Inventory and monitor the greater sage-grouse populations in Washington.
2) Protect sage-grouse populations.
3) Enhance existing populations and re-establish additional populations with translocations.
4) Protect sage-grouse habitat on public lands.
5) Work with landowners to protect the most important sage-grouse habitat on private land.
6) Facilitate and promote the use of incentives, such as Farm Bill conservation programs, to benefit sage-grouse.
7) Facilitate management of agricultural and rangelands that are compatible with the conservation of sage-grouse.
8) Restore degraded and burned sage-grouse habitat within sage-grouse management units.
9) Conduct research necessary to conserve sage-grouse populations.
10) Cooperate and coordinate with other agencies and landowners in the conservation, protection, and restoration of sage-grouse in Washington.
11) Develop public information materials and educational programs for landowners, schools, community organizations, and conservation groups as needed.

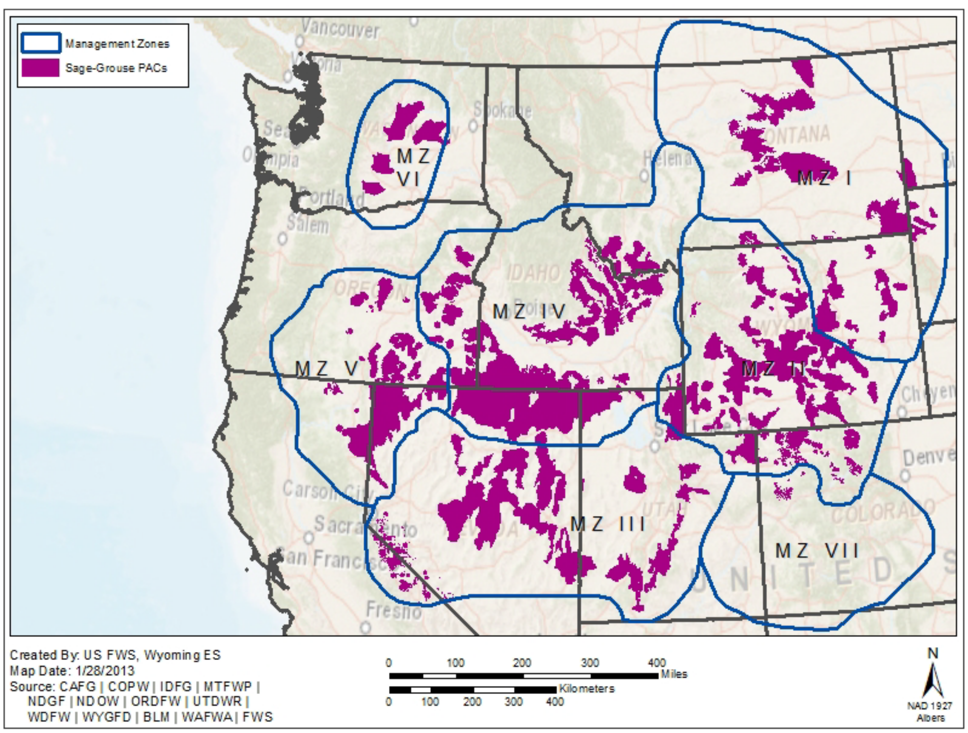

Fig. 2. Priority Areas for Conservation (PACs) for greater sage-grouse in North America (U.S. Fish and Wildlife Service 2013b). Washington State is in management zone 6 (MZ VI) as defined by Stiver et al. (2006).

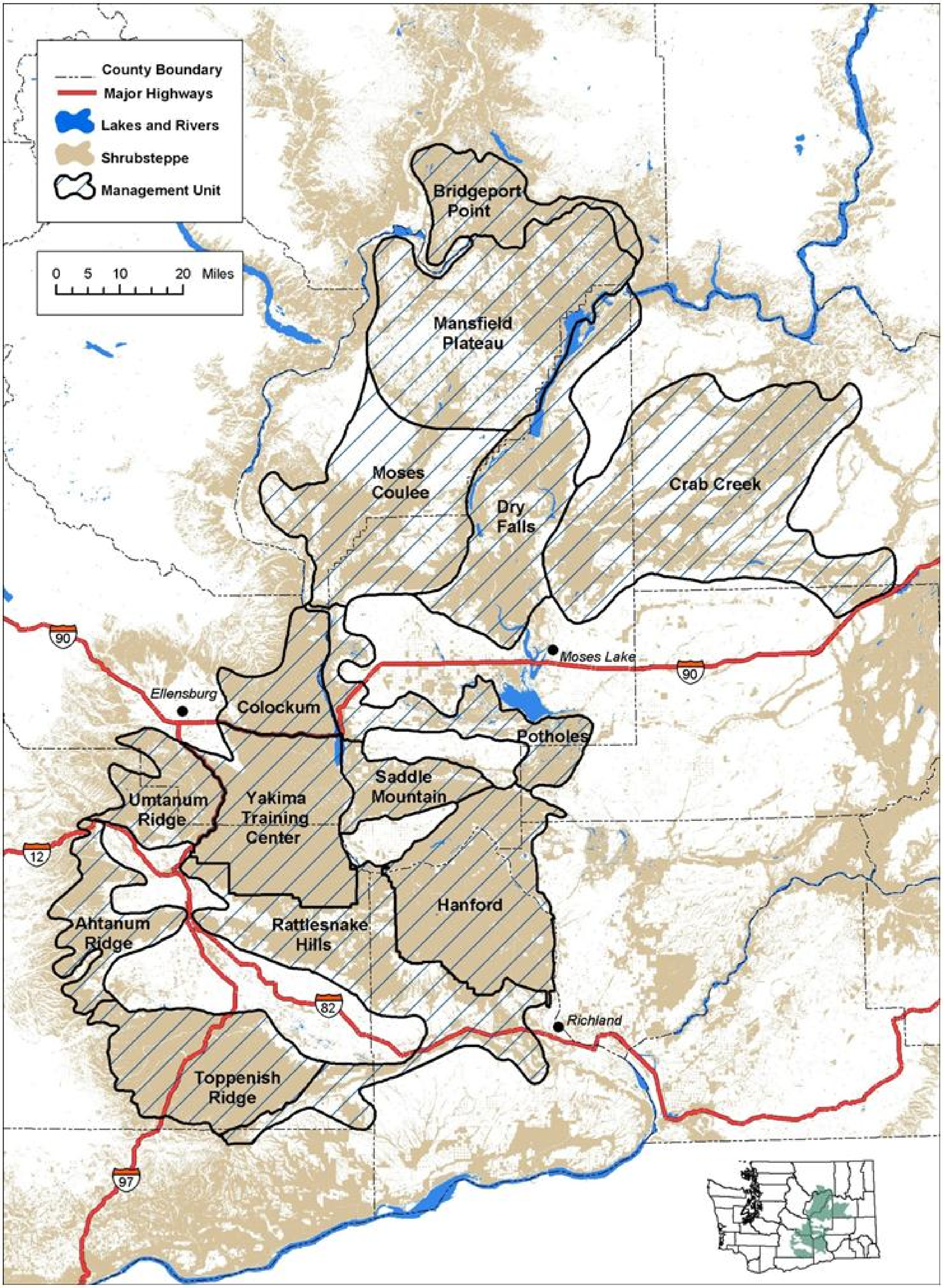

Fig. 3. Greater sage-grouse management units in relation to shrubsteppe cover types in Washington.

METHODS

Inventory and monitoring

Leks can be defined as traditional locations where males perform their breeding displays. Because males will sometimes display at satellite or temporary locations, and because lek locations can be altered slightly from one year to the next, lek locations ≤ 3 km from one another were grouped into lek complexes. In contrast, lek complexes were typically separated from the nearest lek complex by ≥ 6 km. Lek complexes were surveyed annually to obtain information on sage-grouse populations and annual rates of change (Schroeder et al. 2000). The survey protocol included searches for new and/or previously unknown complexes and multiple (≥ 3) visits to all known complexes. Some original data from the 1970s were lost so that only single high counts remained, despite some complexes having been observed on more than one occasion.

Numbers of males attending lek complexes were analyzed using the greatest number of males observed on a single day for each complex for each year. This technique is well established for greater sage-grouse (Connelly et al. 2000, 2003, 2004), but it may have biases that result in males being undercounted and the sex ratio of males to females being inadequately estimated (Jenni and Hartzler 1978, Emmons and Braun 1984, Walsh 2002, Walsh et al. 2004). Despite these potential biases, lek counts provide an assessment of a population's long-term trend (Connelly et al. 2004). The population size was estimated using a sex ratio of 1.6 females per 1.0 males (Stinson et al. 2004). We estimated annual rates of population change by comparing total number of males counted at lek complexes in consecutive years. Sampling was occasionally affected by effort and/or size and accessibility of leks, and 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 males counted on leks in one year divided by the males counted on the same leks the previous year.

Translocations and research

Translocations were addressed with a 4-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. Release sites (stage 1) were selected based on their historical or current occupancy. Translocations consisted of two types: 1) augmentations of existing populations and 2) introduction of grouse to areas where sage-grouse had been extirpated (Griffith et al. 1989). In the case of augmentations, translocations can be used to address demographic or genetic short comings in the population (e.g. low genetic diversity of sage-grouse in Washington, Oyler-McCance et al. 2005). In the case of introductions, the target area should have habitat that is suitable in quantity, quality, and configuration.

To maximize the likelihood of a successful translocation, the source population (stage 2) should be relatively close, abundant, and occupy similar habitat (IUCN/SSC 2013). Since the populations in Washington are experiencing declines, birds have been obtained from other states with healthy/secure populations. All states have had long-term population declines; however, some states have experienced more dramatic declines than others including Washington, California, Utah, Colorado, North Dakota, and South Dakota, and the Canadian Provinces of

Alberta and Saskatchewan (Connelly and Braun 1997, Connelly et al. 2004, Garton et al. 2011). States with populations considered to be relatively secure include Oregon, Nevada, Idaho, Montana, and Wyoming. The lack of genetic heterogeneity and/or conservation concerns in the Washington populations are the reasons translocations to Washington have been recommended. Oyler-McCance et al. (2005) recommended augmentation from the geographically closest populations (in this case southern Oregon, northern Nevada, and southwestern Idaho). One problem that has been considered is phenotypic variation; sage-grouse in Oregon and Nevada are 10–15% lighter than birds in Washington.

Sage-grouse are generally captured (stage 3) during the spring breeding period (late March/early April) or in late summer/early autumn (e.g., October). Capture with the aid of night lighting (Giesen et al. 1982, Wakkinen et al. 1992) has proven to be very successful when birds are attending leks and spring releases have been determined to be more successful than other periods (Reese and Connelly 1997). All birds destined for translocation should receive a health certificate from a veterinarian that is accredited within the donor state. The U.S. Department of Agriculture maintains a disease list for which all translocated birds are screened. West Nile Virus (WNV) has been documented in greater sage-grouse from Wyoming, Montana, Oregon, and Alberta, Canada. Because infected birds either die or clear WNV and develop antibodies within 10 days, all areas where populations have had an outbreak of WNV within 10 days of the translocation should be eliminated from consideration (K. Mansfield, WDFW Veterinarian, pers. comm.). This is generally not a concern in spring translocations since the vector of WNV, *Culex* mosquitoes, are not active in early spring. Sex and age are determined for all captured birds (Beck et al. 1975, Braun and Schroeder 2015). Blood and feather samples are obtained for both disease testing and genetic analysis. All birds are banded with a unique numbered metal band. Birds are transported by car in individual boxes that are small enough to contain the birds' movement. The bottom of each box is lined with a material to reduce contact between feces and the birds' feet. The birds are released as soon as possible, typically within 36 hours of capture. In the Crab Creek area, they usually are released at first light on an active lek with the aid of a settling box that permits the simultaneous remote release of multiple birds following a quiet acclimation period of at least 15 minutes. On JBLM YTC birds are generally released directly from the transportation boxes. Although the potential impacts of the release methods have not been evaluated, anecdotal observations suggest that males often walk or fly to the lek while females tend to scatter in different directions.

Monitoring and evaluation (stage 4) was conducted with the aid of lek surveys and radio or satellite telemetry (VHF and GPS transmitters). Sage-grouse marked with necklace-mounted, battery-powered VHF transmitters (usually Advanced Telemetry Systems, Holohil, or American Wildlife Enterprises) were located visually or by triangulation with the aid of portable receivers and 3-element Yagi antennas. Transmitters had a predicted duration of 12–24 months. Fixed-wing aircraft were used to locate lost birds as needed throughout the year. Locations for birds marked with rump-mounted GPS transmitters (Northstar solar-powered) were downloaded from satellite. All locations were recorded by Universal Transverse Mercator coordinates. Disturbance of birds, particularly at nest sites, was avoided. The specific objectives for telemetry included 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, Connelly and Reese 1997).

These same techniques were also applied to resident sage-grouse in Washington. This included trapping with the aid of night lighting at Crab Creek, Moses Coulee, and YTC. All of the resident captured birds were banded, and some were fitted with VHF or GPS transmitters. The purposes for this research included: 1) examination of movement, habitat and landscape use, productivity, and survival of resident birds; 2) comparison of resident and translocated birds; 3) comparison of data collected with VHF and GPS transmitters; and/or 4) assessment of recruitment.

RESULTS AND DISCUSSION

Inventory and monitoring

Overall

The total population estimate for sage-grouse in Washington was 676 in 2019 (Fig. 4). This was a moderate decrease (5%) from 2018 (710). This is in contrast to the increase (32%) recorded between 2017 and 2018. The trend since 2010 is still clearly downward. Birds were observed on 21 of 61 leks documented in the last 65 years (34% of known leks active). The total number of documented leks does not include leks documented prior to the mid-1950s, leks that appeared to be temporary, or miscellaneous single males.

Moses Coulee

The population of greater sage-grouse in the Moses Coulee area (Moses Coulee and Mansfield Plateau management units, Fig. 3) is the largest population in Washington State. Because the majority of the Moses Coulee population occupies private land (Table 1), most management efforts have focused on private land programs designed to encourage practices that benefit sage-grouse. Chief among these are federal conservation programs such as the CRP and SAFE which support nesting sage-grouse (Schroeder and Vander Haegen 2011, Shirk et al. 2017).

Lek surveys in 2019 showed that 17 of 32 historical leks were active with an estimated population of 585 (Fig. 5). The overall population increased 41% between 2017 and 2018 and 1% between 2018 and 2019. The increases are notable reversals following consistent declines between 2010 and 2017. The 2019 population is still less than half the population observed in 2010. This current population trend is also different than observed in the other three Washington populations (all down, data in following sections) and the adjacent state of Oregon (down 25% between 2018 and 2019; Lee Foster, personal communication). Given the temporal association, a plausible explanation for this long-term decline was the dramatic alteration in the abundance of CRP. In 2010 a large number of CRP contracts ended resulting in a conversion of CRP to wheat, CRP to SAFE, and wheat to CRP. Even though at the end roughly the same acreage was enrolled in conservation programs, there is a lag effect associated with the time it takes for a field of newly planted vegetation to reach maturity (Schroeder and Vander Haegen 2011). Many of these planted fields now outwardly appear to be suitable for sage-grouse.

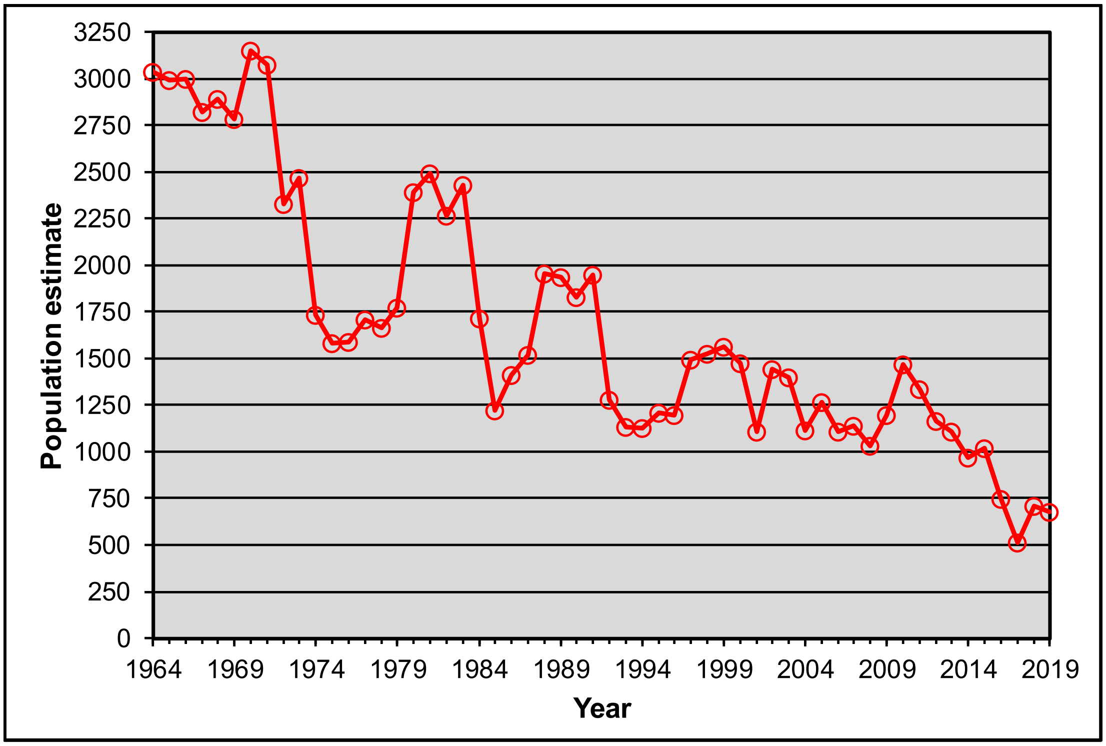

Fig. 4. Population trend for greater sage-grouse in Washington State.

JBLM YTC

The endemic population of greater sage-grouse on the JBLM YTC (Fig. 3) primarily occupies native habitat on public land (Table 1). Lek surveys in 2018 showed that 6 of 20 historical leks (historical leks exclude leks observed to be active in only 1 year) were active with an estimated population of 112 (Fig. 5). This was a moderate increase from the estimate of 101 birds in 2017. The population subsequently declined 36% to 78 in 2019, the lowest population estimate ever recorded for the installation in more than 50 years of surveys. Only 3 of 20 historical leks (11%) were active in 2019, a dramatic decline since 2018. The long term decline of the JBLM YTC population is likely due to habitat loss, degradation, and fragmentation as a result of the military's land-use and associated wildland fires. Other possible factors such as inbreeding depression, predation, and disease may contribute to local declines. It is clear that the population on the JBLM YTC is at immediate risk of extirpation.

Within JBLM YTC, the U.S. Army has designated areas of protection for the species. These Sage-grouse Protection Areas (SGPA's) contain both temporal and spatial restrictions on military training and other land-uses and encompass 31,809 ha, or approximately 25% of the installation. Given wildland fire often results from its land-use, JBLM YTC implements an aggressive fire prevention and suppression program (YTC 2002) which was significantly modified in 2011 to reduce the frequency of wildfire occurrence and potential for fires escaping designated fire containment areas. Despite these efforts, JBLM YTC continues to be impacted by fires resulting from its military land-use, lightning strikes, and human-caused fires originating on adjacent private lands and interstate highways. A revision of the installation's Integrated Wildland Fire Management Plan is underway and is expected to be completed by autumn 2020.

In order to restore areas impacted by military maneuvers and wildfires, the Army seeds bunchgrasses and forbs and plants tens of thousands of bare root seedlings of Wyoming big sagebrush on hundreds of hectares each year (YTC 2002). Between 2011 and 2017 JBLM YTC completed sagebrush seeding/planting efforts on approximately 14,000 ha of previously burned areas. Military range observation towers no longer required have been removed in key sage-grouse areas to reduce the number of perches and nesting platforms for raptors and common ravens (*Corvus corax*) and raven nests have also been removed on other structures. Fences within 2 km of leks and those in high use areas on JBLM YTC have been marked or removed. Additionally, several land acquisitions/conservation easements occurring off the installation and additional perch/fence removal projects and implementation of perch deterrent on and/or adjacent to JBLM YTC were agreed upon as mitigation measures associated with the recent Vantage to Pomona 230KV Transmission Line Project and are currently in various stages of implementation. In addition to the management responses to military activities, the JBLM YTC also discontinued grazing by livestock in 1995 (Stinson et al. 2004).

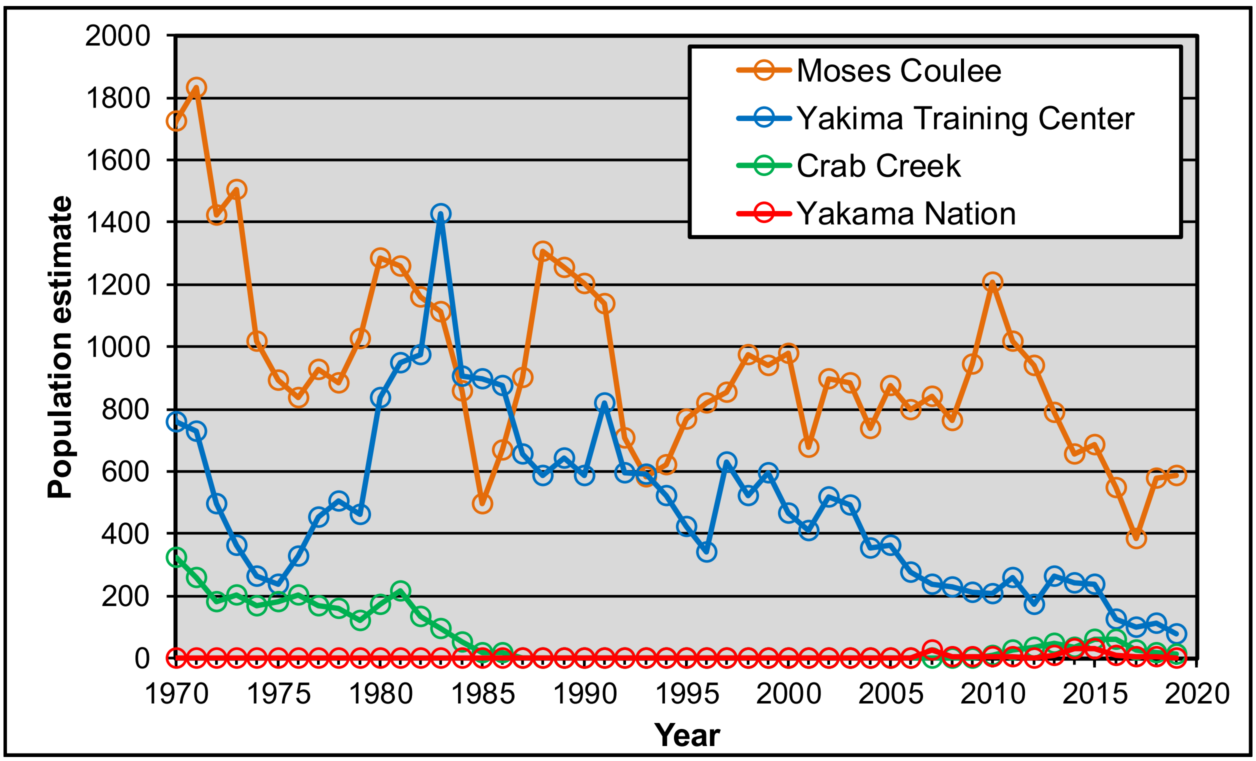

Fig. 5. Population trends for greater sage-grouse in 4 populations in Washington State.

Crab Creek

The historic presence of sage-grouse in the Crab Creek area has been well-established (Yocum 1956), as well as their extirpation (Fig. 1, Schroeder et al. 2000). Six leks were documented in the Crab Creek area for the 1954–1986 period; they were last known to be active in 1955 (Gloyd Seeps), 1974 (Trunk Corner), 1978 (Marlin), 1978 (Odessa), 1984 (Cannawai Creek), and 1986 (Creston Butte). Translocations to reestablish this population were initiated in 2008 and continued through 2015; in 2011 a lek was established in a new location that continues to be active. The high male count at this lek in 2016–2019 was 23, 10, 7, and 5, respectively. These counts do not include random sightings such as; a single male observed displaying once near Coffeepot Butte in 2018, and 11 males flushed once in 2019 on Twin Lakes Area within a mile of the lek, but were never observed displaying. The 2019 total population was estimated to be 13. The marked population decline since the last translocation in 2015, the small size, and the relative isolation suggest that continued augmentations are needed to ensure long-term persistence of the population (Fig. 5).

Yakama Nation

The population of sage-grouse on the Yakama Nation was extirpated before the mid-1960s (Schroeder et al. 2000). A lek formed in 2013 on private land adjacent to the Yakama Nation following translocation efforts (Appendix A). A single male was observed on this lek in 2018, however this male appeared to be absent in 2019 (Fig. 5).

Translocations and research

Overall

A total of 507 sage-grouse were translocated to Washington from 4 states (Nevada, Oregon, Idaho, and Wyoming) between 2004 and 2016 (Appendix A). The total does not count 6 birds that died during processing or transit. Most of the birds (373) were translocated from Oregon, with Crab Creek receiving the majority (280). In addition to the 507 sage-grouse noted above, 57 mostly juvenile sage-grouse (not counting 6 birds that died during transit or release) were moved from Oregon to British Columbia on 21 August 1958 (Campbell and Ryder 2010). The birds were released about 6 km north of Okanogan County, Washington. Based on movements of the birds translocated to Washington between 2004 and 2016, it is possible that some of the birds translocated to British Columbia in the late 1950s ended up in Washington.

Moses Coulee

No translocations have been conducted in the Moses Coulee population though at least 3 males and 4 female moved into the population from the translocations in Crab Creek. Two of the females died in eastern portions of Moses Coulee, apparently after colliding with large transmission lines. The other two females remained in the Douglas population near known leks until their transmitter batteries failed. All three male returned to Crab Creek, two spent approximately a week in Douglas and appeared to have visited known leks prior to returning.

JBLM YTC

Two population augmentation efforts have been attempted to address genetic issues associated with the JBLM YTC population (e.g., lack of heterogeneity and small population size). A total of 99 sage-grouse have been translocated from Nevada (43), Oregon (38), and Idaho (18) to the installation. The total includes 93 females and 6 males (Table 2) that were introduced during two separate efforts (2004–2006 and 2014–2016). Subsequent monitoring indicates that translocated females have nested successfully on JBLM YTC during both projects with chicks being observed alive at 50–60 days post-hatch during the initial effort (2004–2006). Although chicks may have been recruited into the autumn population during the first augmentation effort, there is no genetic evidence based on a post-augmentation genetic analyses conducted in 2011 (Small et al.) to conclude that translocated birds from the first release (2004–2006) successfully recruited young into JBLM YTC's breeding population. As such, a second augmentation effort (2014–2016) was implemented and further genetic analyses will be conducted to evaluate the success of this effort.

Table 2. Number of greater sage-grouse translocated to the Yakima Training Center (YTC) in Washington, 2004–2016.

Translocation date	Age and sex	Source populations			Total
		Nevada	Oregon	Idaho	
Spring 2004	Adult female	10	0	0	10
	Yearling female	15	0	0	15
Spring 2005	Adult male	0	4	0	4
	Yearling male	0	1	0	1
	Adult female	0	9[a]	0	9
	Yearling female	0	8	0	8
Autumn 2006	Juvenile male	0	1	0	1
	Adult female	0	2	0	2
	Juvenile female	0	13	0	13
Spring 2014	Adult female	0	0	2	2
	Yearling female	0	0	8	8
Spring 2015	Adult female	0	0	3[b]	3
	Yearling female	0	0	5	5
Autumn 2016	Adult female	12[a]	0	0	12
	Juvenile female	6[a]	0	0	6
Total	Male – total	0	6	0	6
	Female – total	43	32	18	93

[a]One additional female died during the translocation.
[b]Two additional females died during the translocation.

Seventy-seven resident sage-grouse (24 males, 53 females) were captured during 2012–2017 to investigate the spatial distribution (i.e. population-level home range and core-use areas) and demographic rates across JBLM YTC. This research was implemented to validate the expanded Sage-Grouse Protection Area that resulted from the Grow The Army EIS mitigation (U.S. Army 2011) and to address current and future land-use actions that may impact sage-grouse habitat. A comprehensive report is being written from this research that will incorporate results pertaining to sage-grouse distribution and core-use areas (annually and seasonally) and population vital rates (i.e. annual survival and nest survival rates). Kyle Ebenhoch (Washington State University graduate student) recently completed his master's research (Ebenhoch 2017) that compared population vital rates of resident and translocated sage-grouse on JBLM YTC from 18 years of radio-tracking data. Newly translocated sage-grouse had larger daily movements (0.64 km/day) and smaller home ranges (88.18 km^2) than residents and previously translocated birds. Annual survival and nest survival was the same for translocated and resident birds, and nest initiation rates were the same after the first year (Ebenoch et al. 2019).

Crab Creek

The WDFW purchased 7,720 ha in Lincoln County (most of the Crab Creek area is in Lincoln County) in the early 1990s, which became the Swanson Lakes Wildlife Area (SLWA, Fig. 6). An additional 518 ha of land owned by the Washington Department of Natural Resources was leased. The acquisition was funded by the Bonneville Power Administration to compensate for habitat lost during the construction and operation of hydroelectric projects in the Columbia Basin (Northwest Power Planning Council 2000). WDFW actively manages habitat at Swanson Lakes for the benefit of prairie grouse (including both sharp-tailed grouse [*Tympanuchus phasianellus*] and greater sage-grouse). The BLM has acquired 29,642 ha in the Crab Creek Management Unit. BLM Twin Lakes and Telford Recreation Areas are immediately adjacent to SLWA, while other parcels (Lakeview Ranch, Rocky Ford, Govan, and Wilson Creek) protect nearby shrubsteppe and riparian habitat. Management of the BLM areas has focused on supporting wildlife habitat, seasonal livestock grazing, and wildlife-based recreational opportunities. The BLM also is considering prairie grouse in their management plans and is involved in the national strategy to "develop the partnerships needed to design and implement actions to support robust populations of sage-grouse and the landscapes and habitats upon which they depend" (Stiver et al. 2006).

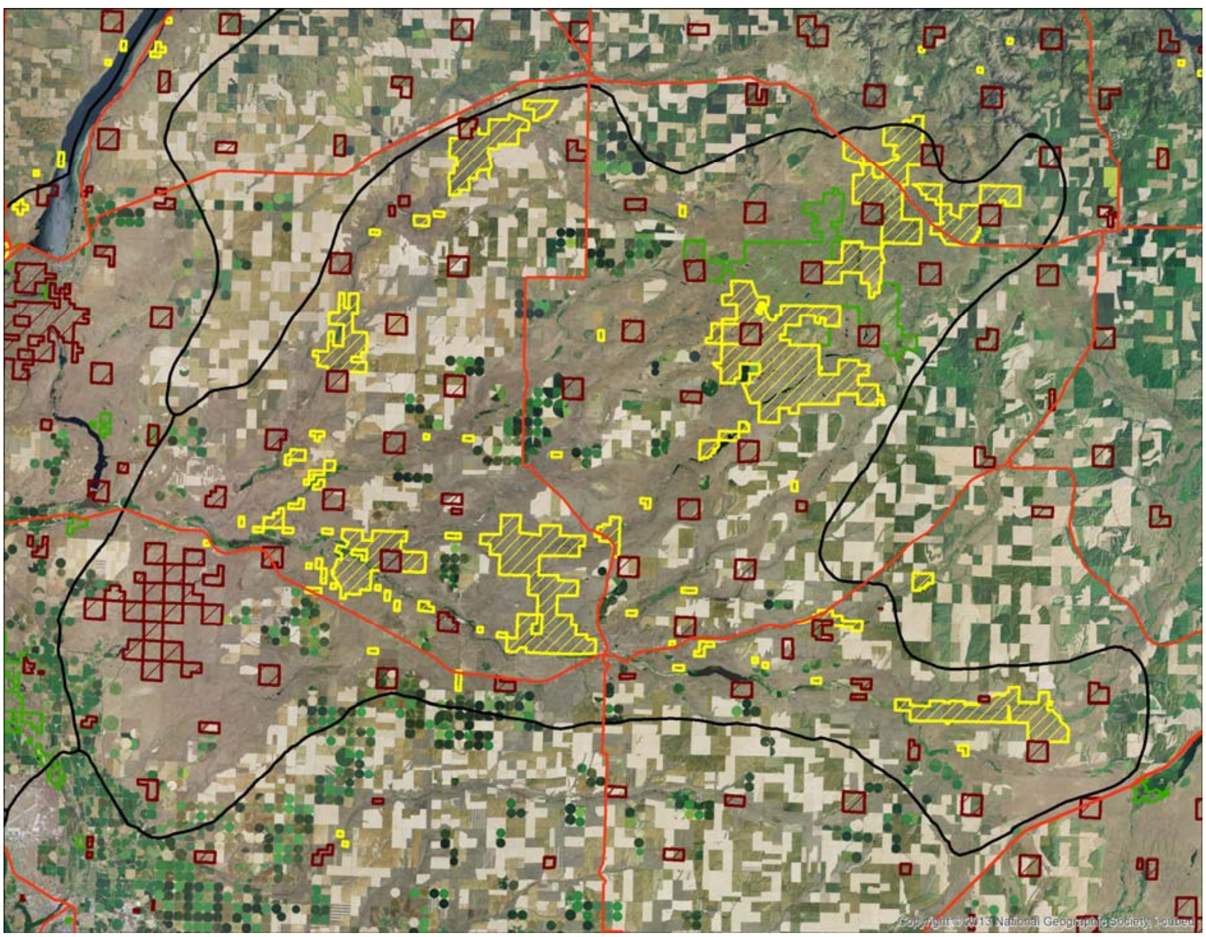

Fig. 6. Major public lands and landcover in the Crab Creek Sage-grouse Management Unit (black outline), Washington. BLM lands are outlined with yellow, WDFW lands with green, and WDNR lands with brown.

There is a greater proportion of shrubsteppe in the Crab Creek area (Table 3) than there is within the perimeter of the Moses Coulee population of greater sage-grouse in Douglas County (Table 1). When the revised patterns of land ownership are considered (following acquisition by the WDFW and BLM), along with the relatively large blocks of suitable and/or improving habitats (Fig. 6), it is clear that the management potential for sage-grouse in the Crab Creek Management Unit has improved dramatically since the birds were extirpated in the mid-1980s. Some of the specific activities include:

- Restoration of ~1,250 ha of old agricultural fields to shrubsteppe habitat on WDFW and BLM lands since 1995. There are 80 additional ha scheduled to be restored in 2020 contingent on funding.
- Cessation of grazing on 8,000 ha (SLWA) to provide adequate hiding and nest concealment cover.
- Grazing under conservative stocking rates on 8,000 ha of BLM land that monitoring has shown is providing cover adequate to meet sage-grouse guidelines (BLM 2014).
- Removal of 24 km of fence and marking of 200 km of necessary fencing.

Table 3. Estimated landcover in relation to land ownership within the Crab Creek Management Unit (Schroeder et al. 2000).

Ownership	Proportion of area dominated by each habitat (%)				Total area (km^2)
	Shrubsteppe	Cropland	CRP	Other	
WDFW - Swanson Lakes	81	10	6	3	77
DNR	76	21	2	1	142
BLM	92	05	1	2	295
Other government land	91	07	0	1	23
Private land	47	40	12	1	2,739
Total for management unit	52	36	11	1	3,276

From 2008–2015, 280 sage-grouse were released on and adjacent to the Swanson Lakes Wildlife Area (Table 4). The first translocation in 2008 had multiple purposes. First, it was hoped the translocated birds would ‘search’ for other sage-grouse and high quality habitats near the release site and thus would provide some additional certainty about the current lack of sage-grouse in the area. (There had been random sightings of birds since 1986.) Second, the released birds would help identify areas of suitable seasonal habitat, which would therefore enable refinement and prioritization of management actions. Third, the released males would have the opportunity to develop a small lek that could provide a focal point for subsequent releases. Fourth, the released birds would provide an opportunity to identify risk factors for the area, which may have been overlooked.

Table 4. Number of greater sage-grouse translocated from Oregon to the Swanson Lakes Wildlife Area in Washington, 2008–2015.

Sex Age	Spring 2008	Autumn 2008	Spring 2009	Spring 2010	Spring 2011	Spring 2012	Spring 2013	Spring 2014	Spring 2015	Total
Males – total	10	7	15	23	20	20	10	20	20	145
Adult	7	0	12	18	15	20	8	16	13	109
Yearling/Juvenile	3	7	3	5	5	0	2	4	7	36
Females – total	7	17	13	15	17	18	10	18	20	135
Adult	6	6	7	4	11	10	6	10	9	69
Yearling/Juvenile	1	11	6	11[a]	6	8	4	8	11	66
Total	17	24	28	38	37	38	20	38	40	280

[a]One additional female died during the translocation.

All grouse in 2008 were captured with the aid of night lights on the Hart Mountain National Antelope Refuge, Oregon and released on or adjacent to the SLWA. An autumn translocation was conducted in 2008, but mortality was so high that autumn efforts were discontinued. In 2009, grouse were captured north of Plush, Oregon. The release site was moved about 3 km west and onto BLM Twin Lakes Rec Area where the previous radio-marked birds were spending most of their time and where a lek eventually formed. In 2010 and 2011 grouse were captured in two locations in Oregon, north of McDermitt, Nevada and southwest of Vale, Oregon. In 2012, grouse were captured on Hart Mountain National Antelope Refuge and on Steens Mountain, Oregon. In 2013, grouse were captured north and west of Plush, Oregon. In 2014, grouse were captured north and west of Plush and around Beatys Butte, Oregon. In 2015 birds were captured north and west of Plush and south of Beatys Butte, Oregon.

Starting with the Autumn 2008 release, birds were placed in a settling box for about 15 minutes and the box opened remotely to allow the birds to exit calmly on their own, and minimize the chances of panic flushes that could ultimately result in longer movements away from the release area. Since the release site was moved to the proximity of the newly-formed lek, males have been observed walking out of the settling boxes and immediately joining other displaying males.

Between 2008 and 2016 over 7,000 locations were obtained for 221 VHF radio-marked sage-grouse. An additional ~20,000 locations were obtained for 20 GPS-marked males. Most movements were concentrated in and around WDFW's SLWA and BLM's Twin Lakes Area.

Habitat Selection – Portions of the VHF location data have been used in analyses of habitat use and selection by adults as well as for nest sites (Stonehouse et al 2015). The entire data set is currently being analyzed by a graduate student with WSU, and mesic habitat use by hens with broods is being analyzed by a professor at Whitworth University.

Breeding Age Survival – A survival analysis was performed in Program MARK using monthly encounter intervals for 217 individuals translocated between 2008-2015. (Thirty seven males did not receive radio transmitters and 24 birds released in the autumn of 2008 and two males that died prior to release were censored.) There were four groups in the analysis: adult females (63), yearling females (55), adult males (81), and yearling males (18). Yearlings were graduated into adulthood as of September 1st based on previous analysis assessing various graduation dates. First demographic (sex, age, etc.) and temporal (first spring, spring, autumn, etc.) models were run individually, then the top model of each was combined in an additive model. The top model included first Spring (the first March, April, and May in the area) additive with Adult Female (Table 5) and received 64% of model weight. The first Spring effect was negative with a beta value of -0.089 and 95% CI did not overlap zero, while the Adult Female effect was positive with a beta value of 0.40 and 95% CI did not overlap zero. First Spring parameter was present in all of the top three models, the top three models combined accounted for 99% of model weight (Table 5). 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 49% ± 4%, yearling females at 45% ± 5%, and males at 42% ± 4%. For all years thereafter female survival estimated at 57% ± 5% and male survival at 51% ± 4%.

Table 5. Model results from a 2018 analysis in Program MARK of 217 individual marked sage grouse translocated from southern Oregon to central Washington 2008–2015.

Model	AICc	Delta AICc	AICc Weights	Number parameters	Deviance
First Spring + Adult Female	945.41	0	0.64	3	939.40
First Spring	947.49	2.08	0.23	2	943.49
First Spring + Spring	948.81	3.40	0.12	3	942.80
Spring	953.94	8.53	0.01	2	949.94
Seasons	957.73	12.32	0	4	949.71
Adult Female	963.28	17.87	0	2	959.27
Sex*Age	966.39	20.98	0	4	958.37
First Year at site	966.55	21.14	0	2	962.54
Sex + Age	967.91	22.50	0	3	961.90
Sex	968.27	22.86	0	2	964.26
Null	969.87	24.46	0	1	967.87
Age	970.38	24.97	0	2	966.37
First Month at site	970.89	25.48	0	2	966.88
Post lek formation	971.68	26.27	0	2	967.67

Nest Success – From 2009 through 2016 we documented 75 nesting attempts by 52 VHF marked hens. Of these, 34 were successful- and 21 successful nests fledged (≥ 1 chick at 45 days). Four were unknown due to radio battery failure. Average duration of incubation was 27.4 days, with a range of 25 to 31 days. Of the 41 failed nests, 19 were attributed to mammalian predators (coyote, badger, etc.), four to ravens, nine were unknown, and five were due to unfertilized eggs. In this last case, all five nests were well over 40 days of incubation prior to being terminated either by researchers or by predators. 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 69 nests. We removed the five nests that failed due to unfertile eggs and one nest that we had insufficient data due to transmitter failure. We used the day in incubation, rather than calendar day for data input, resulting in 30 survival occasions. We assessed in single covariate models the effect of 17 covariates: 9 nest vegetation measurements, distance to power lines, distance to roads, distance to nearest road or powerline (could not be combined in additive model due to correlation), 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 6). We also created models to assess if there was annual variation in nest success, variation in nest success relative to the lek formation in 2011, and linear and quadratic trend in nest success relative to nest age. These 21 models were run initially, then the individual parameters/covariates that were significant (i.e. 95% CI for Beta estimates do not overlap zero) were combined in additive models. This included linear trend in nest age, clutch size, and Robel pole. The top model included a negative linear trend in nest age and positive effects of clutch size and Robel pole cover (Table 6). Taking the model averaged estimates from the top two models and using 27 days of incubation, our estimated nest success is 44.6 ± 4%. Clutch size potentially is a reflection of hen condition. However, this effect could also simply be due to fewer eggs being found at predated nests. Robel pole gives an overall estimate of cover at the nest; the average cover at our nest sites was 29cm. Increasing the Robel cover by 1cm increased predicted nest success by 1%, or 2.6% increase in nest success for every inch.

Predator Management – The re-introduction area supports a small and vulnerable grouse population persisting in an environment fragmented by agriculture (~9% of the Habitat Concentration Area) and has a high density of anthropogenic features such as roads, distribution lines, ranch buildings, and fencing (Stonehouse 2013, BLM 2014, Stonehouse et al. 2015). Fragmented agricultural landscapes can support abundant rodents, pigeons and European starlings, that in-turn attract and sustain predators that then opportunistically prey on grouse (Dunn 1977, Rich 1986, Reynolds and Tapper 1996, Moulton et al. 2006). Losses to predation are sustainable in large populations but have a more significant impact on small populations. Under these conditions various authors have suggested that predator reductions may be warranted in the short term to buffer grouse populations from elevated levels of predation (Connelly et al. 2000, Hagen et al. 2011, U.S. Fish and Wildlife Service 2013a).

Of the 148 confirmed mortalities of translocated birds, 74 were assigned to predation and 47 of these were assigned to raptors. In the study area, the most common raptor capable of killing adult sage grouse is the great horned owl, which was specifically assigned as the predator in 12 mortalities. We began great horned owl control in 2009 following the extremely high mortality event observed during the 2008 autumn translocations in which 23 of 24 birds died within three months of release.Ten mortalities were assigned to raptors and six of these specifically to great horned owl. Eight owls were relocated after this incident.

Removal of nest predators has been shown to temporarily improve nest success, juvenile survival, and population size in ground nesting birds, including grouse (Lawrence 1982, Kauhala et al. 2000, Coates and Delehanty 2004, Baines et al. 2008, Holt et al. 2008). In a similar sage-grouse augmentation program in Strawberry Valley, Utah, predator control resulted in a 24% increase in spring-summer survival and a 2.6 fold increase in chick-to-hen ratios (Baxter et al.

2008). Smith et al. (2010) conducted a meta-analysis of predator removal studies with data from 83 studies for 128 bird species. Predator removal had a significant positive effect on hatching success (+77%), fledging success (+79%), and breeding population size (+71%) compared to control areas. They concluded that predator removal is an effective conservation strategy for enhancing bird populations but the effect is temporary.

Table 6. Model results from a 2018 analysis in Program MARK of 69 sage grouse nests from birds translocated from southern Oregon to central Washington 2008-2015.

Model	AICc	Delta AICc	AICc Weights	Number parameters	Deviance
Linear Trend + Clutch + Robel	207.16	0.00	0.8045	4	199.13
Linear Trend + Clutch	209.99	2.83	0.1954	3	203.98
Linear Trend + Robel	224.53	17.37	0.0001	3	218.51
Linear Trend	228.96	21.79	0.0000	2	224.95
Quadratic Trend	229.87	22.70	0.0000	3	223.85
Clutch + Robel	230.48	23.32	0.0000	3	224.46
Clutch	232.83	25.67	0	2	228.82
Robel Pole	240.77	33.61	0	2	236.76
Hen Age	243.11	35.94	0	2	239.10
Hen Naiveté to Area	243.38	36.22	0	2	239.37
Null	244.44	37.27	0	1	242.44
Perennial Grass Height	244.93	37.77	0	2	240.92
Distance to Lek	245.32	38.16	0	2	241.31
% Sage Cover	245.49	38.33	0	2	241.48
% Annual Grass Cover	245.79	38.63	0	2	241.79
% Shrub Cover	245.87	38.70	0	2	241.86
Perennial Forb Height	245.95	38.78	0	2	241.94
Pre vs Post Lek Formation	246.10	38.93	0	2	242.09
% Perennial Grass Cover	246.14	38.98	0	2	242.13
Distance to Power Line or Road	246.20	39.03	0	2	242.19
Distance to Road	246.28	39.11	0	2	242.27
Julian Date of Initiation	246.41	39.25	0	2	242.40
% Annual Forb Cover	246.44	39.28	0	2	242.43
Distance to Power Line	246.44	39.28	0	2	242.43
% Perennial Forb Cover	246.44	39.28	0	2	242.44
Calendar Year	247.76	40.59	0	8	231.64

Mammalian predators have been the suspected predator in 59% of our known predated nests. Coyotes are the primary mammalian predator in this area, with badgers a distant second, and few fox, raccoon, weasel, and skunk observations. Master Hunters have been funneled to the project area to hunt coyotes since 2009 but with little success. Given low success of hunters and multiple observations of coyotes taking adult sage-grouse at the lek and on nests, we increased predator control activities in the project area in 2014. We contracted with APHIS to implement focused coyote abatement and common raven removal (permitted by the U.S. Fish and Wildlife Service) within 5 km of the lek. Ravens were included in the contract because of their documented contribution to 20% of nest failures in the project.

In spring 2014, Thirty nine coyotes within 5 km of the lek were removed over two days (April 22 and May 14) via helicopter. Twelve sites associated with known raven nesting activity were chosen to be baited with chicken eggs treated with DRC-1339, an avicide specific to black-pigmented birds. Additionally, to increase probability that only ravens were affected, elevated stations at each site were selected or built to exclude mammals. Each station was pre-baited with non-treated eggs and monitored directly and via remote camera for three weeks. Based on monitoring, 2 stations were removed because they did not demonstrate bait acceptance by ravens. On April 1, the 10 remaining stations were each baited with two treated eggs. Monitoring showed all eggs were removed from the stations in less than 24 hours. There is no way to confirm how many ravens were removed but if we assume one raven was lethally removed per treated egg, we estimate 20 ravens were removed. Additionally, one great horned owl was trapped and relocated.

In spring 2015, APHIS conducted coyote removals via helicopter within 5 km of the lek. The first flight was on March 9 and 43 coyotes were removed. A second scheduled flight was not flown due to helicopter mechanical issues and availability. Raven control via poison was not used in 2015 because raven survey results indicated overall density of ravens was not a significant issue. Individual ravens and nests were removed when in close vicinity to known grouse nest sites. A total of three adult ravens were lethally removed and multiple nests were knocked down but none had eggs present. Additionally, 11 great horned owls were lethally removed.

In spring 2016, APHIS conducted coyote removals via helicopter within 5 km of the lek and 58 coyotes were removed in two flights (39 on Feb 24 and 19 on May 6). Raven control via poison was not used this year because raven survey results indicated overall density was not a significant issue. Individual ravens and nests in close vicinity to known grouse nest sites were removed. One adult raven was lethally removed and multiple nests were knocked down but none had eggs present. Additionally, four great horned owls were lethally removed.

In spring 2017 APHIS conducted no coyote removals due to unavailability of a helicopter or supercub. Raven control via poison was not used this year because raven survey results indicated overall density was not a significant issue. Multiple raven nests were knocked down but none had eggs present. One great horned owl and one common raven were lethally removed.

In spring 2018, APHIS conducted coyote removals via supercub within 5 km of the lek. Twenty eight coyotes were removed in four flights. Raven control via poison was implemented this year because raven survey results indicated overall density of ravens was a potential issue. Ninety six

DRC-1339 treated eggs were placed at multiple sites over three separate efforts (18 eggs on March 29, 33 eggs on April 4, and 45 eggs on April ?). Additionally, 12 great horned owls were lethally removed.

In spring 2019, APHIS conducted coyote removals via supercub within 5 km of the lek. Six coyotes were removed in two flights. Raven control was not implemented this year because raven survey results indicated overall density was not a significant issue. Raven nests were knocked down but did not have eggs present. No great horned owls were removed this year.

Removal of potential predator perches included:

- Approximately 1.4 miles of power distributions lines, 16 associated poles, ~two miles of telephone line, and 50 associated poles on a mix of private, BLM, and WDFW land are in the process of being removed. Both power line and telephone lines were co-buried along county road right of way.
- Approximately 4.3 miles of power distributions lines (representing 60 powerpoles) to wells on BLM property have been removed and where necessary, replaced with solar powered pumps.
- 68 powerpoles were outfitted with perch deterrent spike rails and spike caps on the central distribution line in the project area. A study assessing the effectiveness of the perch deterents is underway.
- Approximately 20 miles of unnecessary fencing and associated fence posts, often used as predator perches, were removed.
- A study on the effectiveness of various perch deterrent designs was completed (Dwyer and Doloughan 2014).
- Two unstable barns were demolished by the BLM for safety reasons and reduction of nesting habitat for ravens.
- An old windmill structure adjacent to the lek was knocked down.
- Seven to10 old combines and other junk metal cleared cultural review and were slated for removal in 2017 but low metal prices discouraged salvage by private entities. Instead staff removed what they could and then crushed and laid down the combines in a lower location, thus reducing value as perching and nesting substrate.
- Roads accessing core areas of public land are closed to minimize disturbance and avoid route and trash proliferation.
- Refuse at the Swanson Lakes headquarters is securely covered in dumpsters that prevent ravens from accessing any food that might subsidize their population.
- All public land (WDFW and BLM) access sites are routinely monitored and kept free of litter and trash.

Yakama Nation

A total of 128 sage-grouse was translocated to the Yakama Nation between 2006 and 2014 (Table 7). Based on the declining number of males at the only known lek, this translocation appears to have failed. After several years of decline, no birds were observed on the only known lek.

Table 7. Number of greater sage-grouse translocated to the Yakama Nation in Washington, 2006–2014.

Translocation date	Age and sex	Source populations			Total
		Nevada	Oregon	Wyoming	
Spring 2006	Male	0	19	0	19
	Female	0	12	0	12
Spring 2006	Male	0	0	5	5
Autumn 2006	Male	0	5	0	5
	Female	0	4	0	4
Spring 2007	Male	0	11	0	11
	Female	0	4	0	4
Spring 2013	Male	19	0	0	19
	Female	11	0	0	11
Spring 2014	Male	26	0	0	26
	Female	12	0	0	12
Total	Male – total	45	35	5	85
	Female – total	23	20	0	43

PLANS AND PROPOSAL FOR 2020

Work will continue in the three remaining populations in 2020. In addition to the specific inventory, monitoring, and research projects described in this report, conservation activities will include habitat conservation planning, habitat management on public lands, and working with private landowners to protect and develop wildlife habitat on their lands using all options available to them, including federal conservation programs.

There are also plans to resume translocation activities to the Crab Creek management unit. The current estimate of 13 birds (5 males) is clearly insufficient. We believe the evidence suggests that we failed to reach a threshold, either in number of birds or in number of leks (never more than one active lek), at which the population was robust enough to weather stochastic events. Specifically the 2016/2017 winter that drove sage-grouse populations down across the range resulted in a greater than 50% reduction in this population. It has continued to decline. Guidelines for re-introductions developed by the IUCN's Species Survival Commission (IUCN 1995) and recommendations outlined by Reese and Connelly (1997) and summarized by Stinson (2019) have been followed. Translocations of greater sage-grouse should include the four basic stages, discussed above in the Translocation and Research section in methods in order to maximize the opportunities for successful reestablishment or augmentation efforts (similar to Griffith et al. 1989).

Stage 1 – The release site would remain the same as during previous translocations, the single lek in the Crab Creek MU. It is essential that this translocation occur soon enough that there is still an established lek in the area. Reintroductions are inherently more difficult than augmentations.

Stage 2 – To maximize the likelihood of a successful translocation, the source population should be relatively close, abundant, and occupy similar habitat (IUCN 1995). Since the only close populations (north-central and south-central Washington) are also experiencing declines, birds from different states will have to be obtained. Despite the differences between Washington sage-grouse and those found elsewhere, Oyler-McCance et al. (2005) recommended augmentation of Washington populations from the geographically closest populations (in this case southern Oregon, northern Nevada, and southwest Idaho). At this time, it is hoped that birds can be used from previously used sources in northern Nevada and southern Oregon.

Stage 3 – Sage-grouse will be captured during the spring breeding period (late March/early April), using night lighting (Giesen et al. 1982, Wakkinen et al. 1992) on and around active leks between dusk and dawn. All birds destined for translocation will be required to receive a health certificate from a veterinarian that is accredited within the donor state. The US Department of Agriculture maintains a disease list for which all translocated birds will be screened. Sex and age will be determined for captured birds (Beck et al. 1975). Blood samples will be obtained for preliminary genetic analysis. All birds will be banded with a unique numbered metal band and a unique combination of plastic colored bands to allow individual identification. A subset of translocated birds will receive a tail mounted, battery-powered radio transmitters (predicted duration of 2-3 months).Birds will be transported by car to the release site within 24 hours of capture, preferably on the day of capture. Birds will be transported individually in empty boxes that are small enough to contain the bird's movement. The bottom of each box will be lined with a material to reduce contact between feces and the birds' feet. Birds will be released in the morning on the lek via a remotely activated release box.

We are proposing translocation of 20 males and 20 females in 2020. Although we would like to continue this effort for three years, we are cautious with our plans because of unpredictable situations in the potential capture locations including wildfire, dramatic population declines, and other considerations.

Stage 4 – The success or failure of the reestablishment effort will be evaluated on and near the release site. The specific objectives will include evaluations of: individual survival, recruitment, and population size. Individual survival will be assessed through the first three month following release, this time period was chosen based on the survival analysis of the original translocations to this area (see details above). Recruitment will be assessed via captures conducted on the lek the following spring and/or by genetic analysis of feathers. Population size will be assessed via lek monitoring. These evaluations will help provide essential information (presentations, reports, and publications) to determine whether additional translocations, habitat improvements, release locations, and/or translocation methodologies are necessary (Toepfer et al. 1990, IUCN 1995, Connelly and Reese 1997).

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Appendix A. Number of greater sage-grouse translocated to Washington, 2004–2016. When information is available, the translocated birds are differentiated by age (A = adult in spring or yearling or older in autumn, Y/J = yearling in spring or juvenile in autumn).

Target population	Translocation date	Source populations																
		Nevada				Oregon				Idaho				Wyoming	Total			
		Male		Female		Male		Female		Male		Female		Male	Male		Female	
		A	Y/J	A	Y/J	A	Y/J	A	Y/J	A	Y/J	A	Y/J	Adult	A	Y/J	A	Y/J
YTC	Spring 2004	0	0	10	15	0	0	0	0	0	0	0	0	0	0	0	10	15
	Spring 2005	0	0	0	0	4	1	9	8	0	0	0	0	0	4	1	9	8
	Autumn 2006	0	0	0	0	0	1	2	13	0	0	0	0	0	0	1	2	13
	Spring 2014	0	0	0	0	0	0	0	0	0	0	2	8	0	0	0	2	8
	Spring 2015	0	0	0	0	0	0	0	0	0	0	3	5	0	0	0	3	5
	Autumn 2016	0	0	12	6	0	0	0	0	0	0	0	0	0	0	0	12	6
Yakama Nation	Spring 2005	0	0	0	0	19		12		0	0	0	0	0	19		12	
	Spring 2006	0	0	0	0	0	0	0	0	0	0	0	0	5	5		0	
	Autumn 2006	0	0	0	0	5		4		0	0	0	0	0	5		4	
	Spring 2007	0	0	0	0	11		4		0	0	0	0	0	11		4	
	Spring 2013	19		11		0	0	0	0	0	0	0	0	0	19		11	
	Spring 2014	26		12		0	0	0	0	0	0	0	0	0	26		12	
Crab Creek	Spring 2008	0	0	0	0	7	3	6	1	0	0	0	0	0	7	3	6	1
	Autumn 2008	0	0	0	0	0	7	6	11	0	0	0	0	0	0	7	6	11
	Spring 2009	0	0	0	0	12	3	7	6	0	0	0	0	0	12	3	7	6
	Spring 2010	0	0	0	0	18	5	4	11	0	0	0	0	0	18	5	4	11
	Spring 2011	0	0	0	0	15	5	11	6	0	0	0	0	0	15	5	11	6
	Spring 2012	0	0	0	0	20	0	10	8	0	0	0	0	0	20	0	10	8
	Spring 2013	0	0	0	0	8	2	6	4	0	0	0	0	0	8	2	6	4
	Spring 2014	0	0	0	0	16	4	10	8	0	0	0	0	0	16	4	10	8
	Spring 2015	0	0	0	0	13	7	9	11	0	0	0	0	0	13	7	9	11
Total		45		66		186		187		0		18		5	236		271