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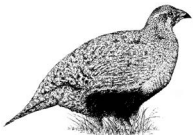

Recovery of Greater Sage-grouse in Washington: Progress Report

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FISH AND WILDLIFE
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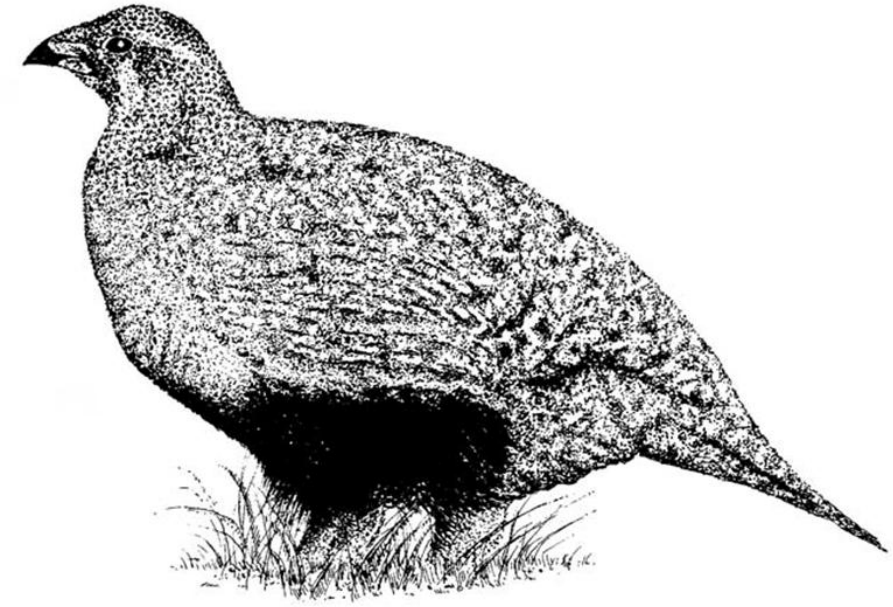
ABSTRACT

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 744 in 2016, associated with 27 leks. The birds were distributed between 4 populations including 536 birds with 18 leks in Moses Coulee, 140 birds with 7 leks in the Yakima Training Center (YTC), 60 birds with 1 lek in Crab Creek, and 8 birds with 1 lek in the Yakama Nation. This estimated population was more than 20% lower than the previous low population record for the state of Washington. 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 have 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 the YTC area to augment an endemic population, 145 males and 135 females were translocated to the Crab Creek area 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 is Crab Creek.

On the cover: Background photo of Badger Mountain, Douglas County by Jon Gallie; Male sage-grouse on a lek in Oregon by Joe Higbee. Page 1 and back cover illustrations by Darrell Pruett.

RECOVERY OF GREATER SAGE-GROUSE IN WASHINGTON: PROGRESS REPORT



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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 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 consistent with the observations of rapid loss of genetic heterogeneity in northern Washington (Oyler-McCance et al. 2005). Additional birds are found in areas where they have been translocated including the Yakama Nation in southern Yakima County and Crab Creek in Lincoln County.

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 YTC population in south-central Washington occupies about 1,200 km^2, which is one of the largest, high-quality shrubsteppe sites remaining in the state. Good habitat quality on the YTC is largely due 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.

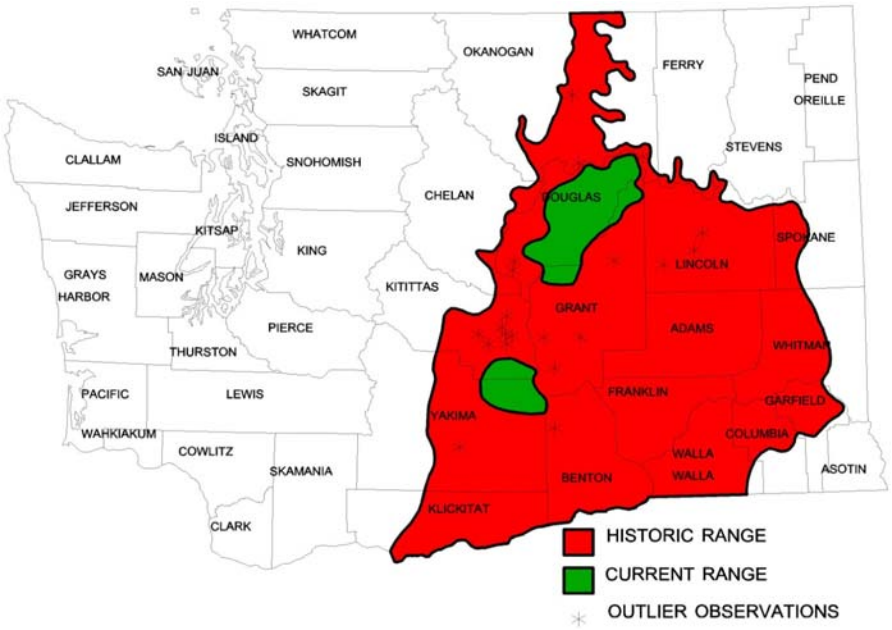

Fig. 1. Estimated historic and current range of greater sage-grouse in Washington prior to translocation efforts (Schroeder et al. 2000).

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 sage-grouse as 'threatened' within the state (Hays et al. 1998). These population declines (Schroeder et al. 2000, Connelly et al. 2004, Garton 2011) and their isolated nature 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).

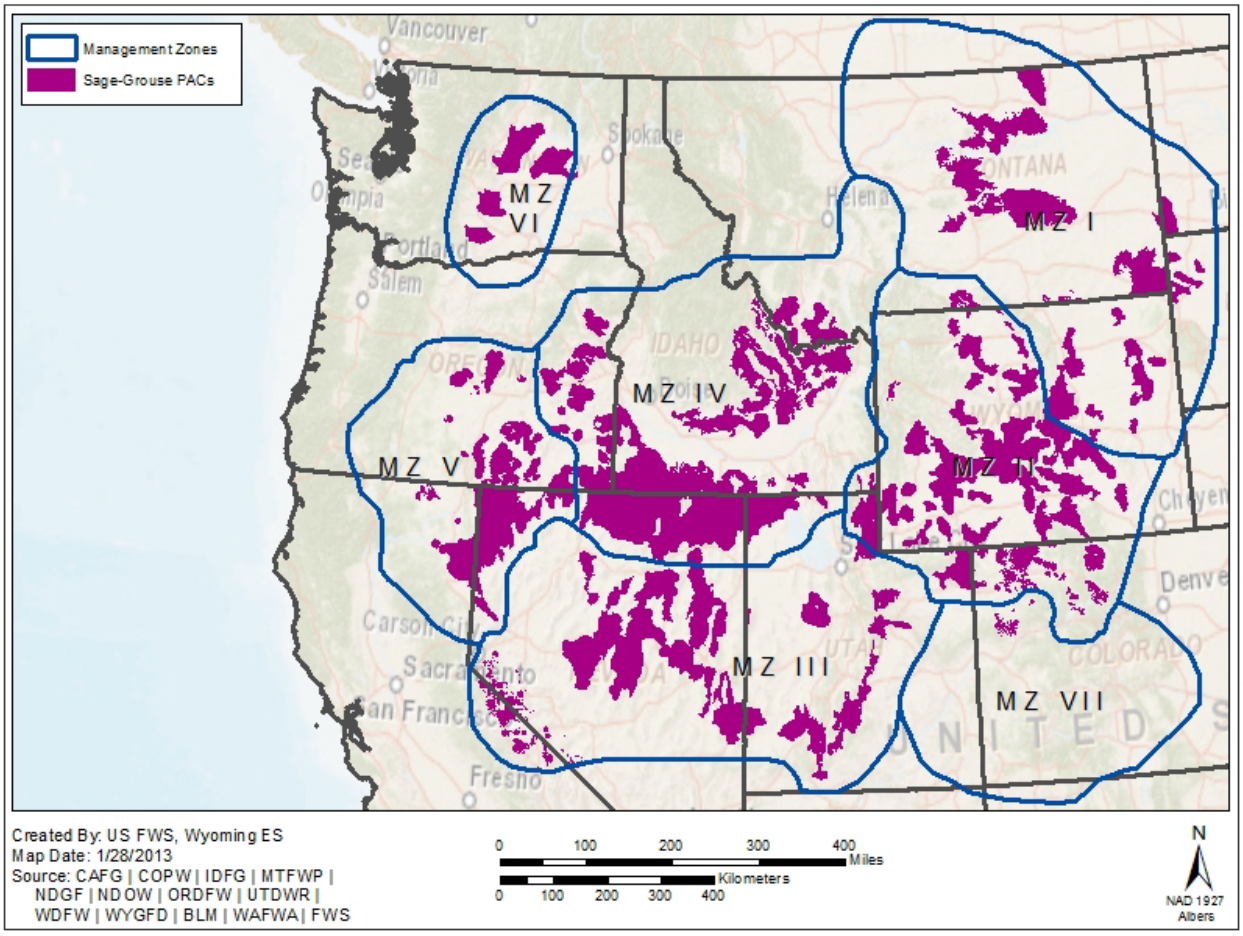

Fig. 2. Priority Areas for Conservation (PACs) for greater sage-grouse in North America (U.S. Fish and Wildlife Service 2013b). Washington State is in management zone 6 (MZ VI) as defined by Stiver et al. (2006).

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 activites, 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.

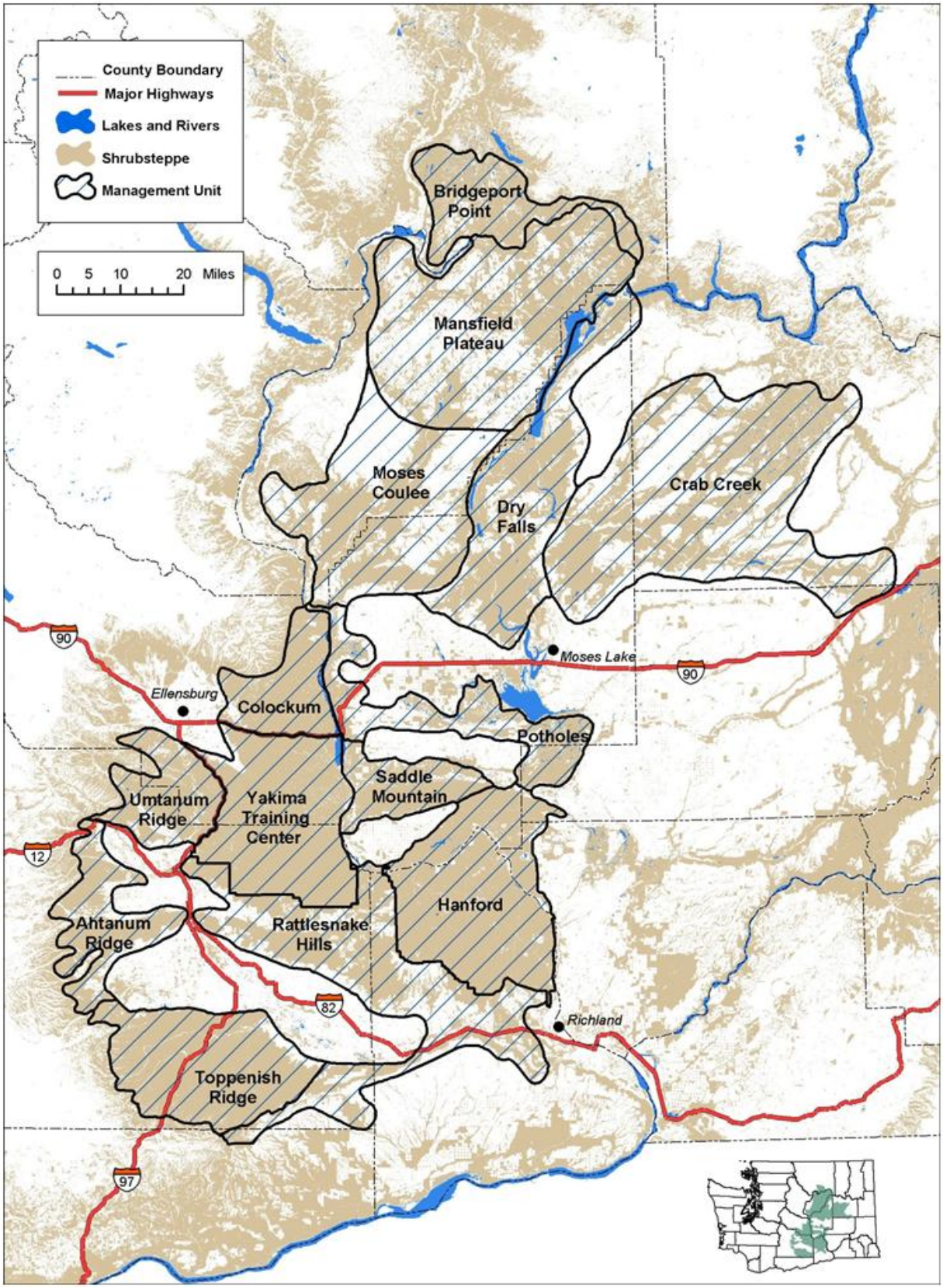

Fig. 3. Greater sage-grouse management units in relation to shrubsteppe cover types in Washington.

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 (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. 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 augumentations, 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. Although greater sage-grouse were differentiated into two subspecies, *C. u. urophasianus* and *C. u. phaios* (Aldrich 1946), genetic analysis by Benedict et al. (2003) and Oyler-McCance et al (2005) do not support this subspecies distinction. Nevertheless, rangewide genetic data (Benedict et al. 2003) indicate that there is still enough variation between populations to warrant close scrutiny (Oyler-McCance 2005). For example, an examination of 45 populations throughout the range of greater sage-grouse showed that Washington sage-grouse were relatively homogenous with regard to genetic material and somewhat different from adjacent populations. Their analysis also showed that distance between populations was the largest factor explaining variation between most populations. Despite the slight differences between Washington sage-grouse and those found elsewhere (e.g., sage-grouse in Oregon and Nevada are 10-15% lighter than birds in Washington), Oyler-McCance et al. (2005) recommended augmentation of Washington populations from the geographically closest populations (in this case southern Oregon, northern Nevada, and southwestern Idaho. Their recommendation for augmentation was based on a clear conservation concern supported by the lack of genetic heterogeneity 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 & feather samples are obtained for both disease testing and genetic analysis. All birds are banded with a unique numbered metal band; all hens and a subset of males received necklace-mounted, battery-powered radio transmitters (predicted duration of 24 months) or Northstar solar-powered GPS transmitters prior to release. 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 special box that permits the simultaneous remote release of multiple birds following a quiet acclimation period of at least 15 minutes.

Monitoring and evaluation (stage 4) was conducted with the aid of lek surveys and radio telemetry (VHF and GPS transmitters). Sage-grouse marked with VHF transmitters were 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. Locations for birds marked with GPS transmitters 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 744 in 2016 (Fig. 4). This was the lowest population estimate ever recorded for the state of Washington by a substantial number (> 20% lower than the previous low estimate in 2014). Birds were observed on 27 leks with a total of 82 leks documented in the last 50 years (33% of known leks active). The total number of documented leks does not include several leks that were documented prior to the mid-1960s or leks that appeared to be temporary.

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 management 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).

Lek surveys in 2016 showed that 18 of 41 historical leks were active with an estimated population of 536 (Fig. 5). Many of the 41 historical leks have not been active for many years and they are no longer monitored annually. The only year with a lower population estimate was 1985, though the lek suveys appeared to be abnormally low that year and leks were not surveyed thoroughly. In contrast, the low population estimate in 2016 appears to be a continuation of the decline started in 2010. The most logical explanation for the decline was the dramatic alteration in the abundance of CRP. This was due to conversion of CRP to wheat, CRP to SAFE, and wheat to CRP. Even though roughly the same acreage is enrolled in conservation programs, there is a lag effect associated with the time it takes for a field of planted vegetation to reach maturity (Schroeder and Vander Haegen 2011).

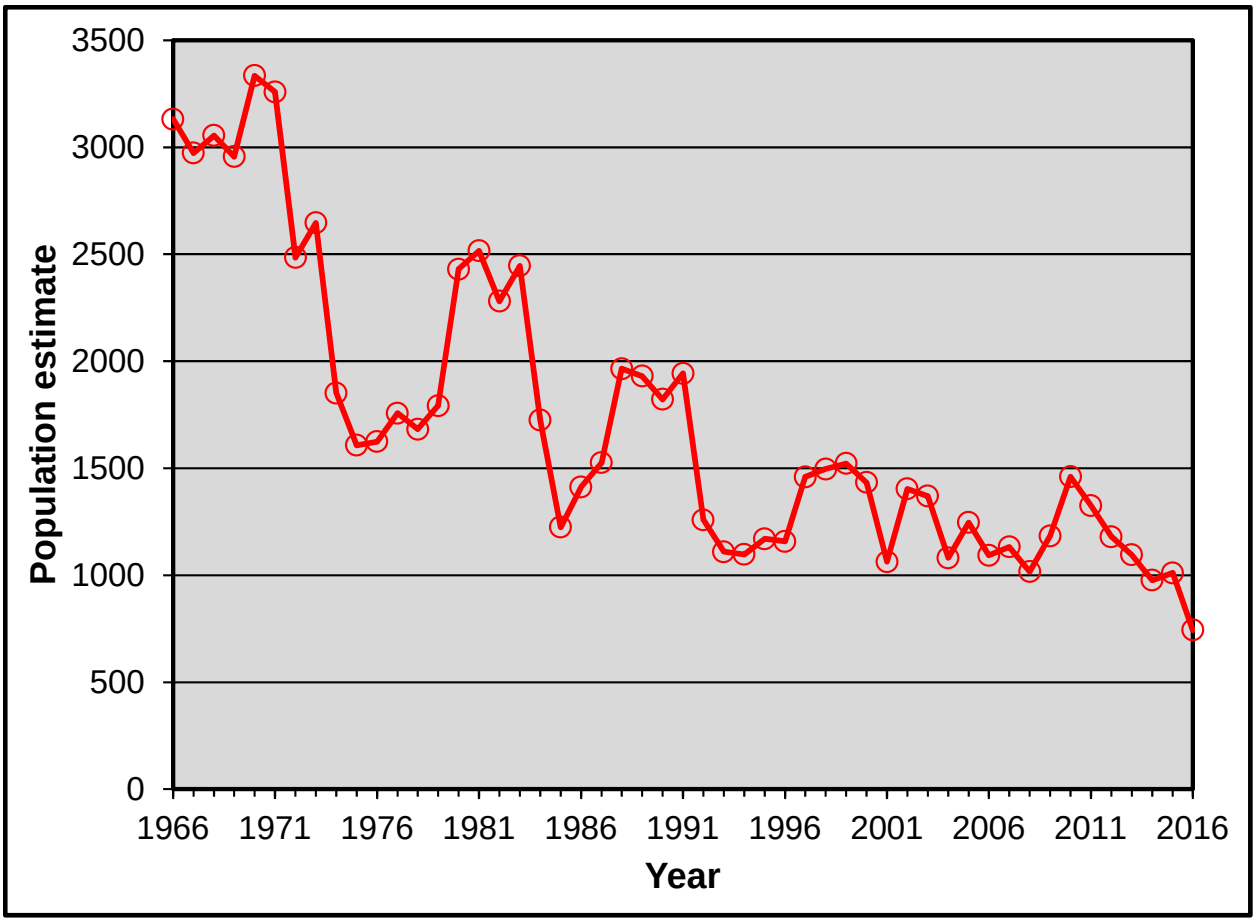

Fig. 4. Population estimate for greater sage-grouse in Washington State.

YTC

The endemic population of greater sage-grouse in the Yakima Training Center (Fig. 3) primarily occupies native habitat on public land (Table 1). Lek surveys in 2016 showed that 7 of 27 historical leks were active with an estimated population of 140 (Fig. 5). This was the lowest population estimate ever recorded for the YTC in more than 50 years of surveys. Habitat loss, degradation, and fragmentation as a result of the military's land-use and associated wildland fires is the likely cause of the declining sage-grouse population trend on the installation. Other possible factors such as inbreeding depression, predation, and disease may contribute to local declines.

Within the YTC population, 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 encompasses 77,000 acres (approximately 31,400 ha) of the installation. Given wildland fire often results from its land-use, YTC implements an aggressive fire prevention and suppression program (YTC 2002). 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). Firing range observation towers also 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. In addition to the management responses to military activities, the YTC also discontinued grazing by livestock in 1995 (Stinson et al. 2004).

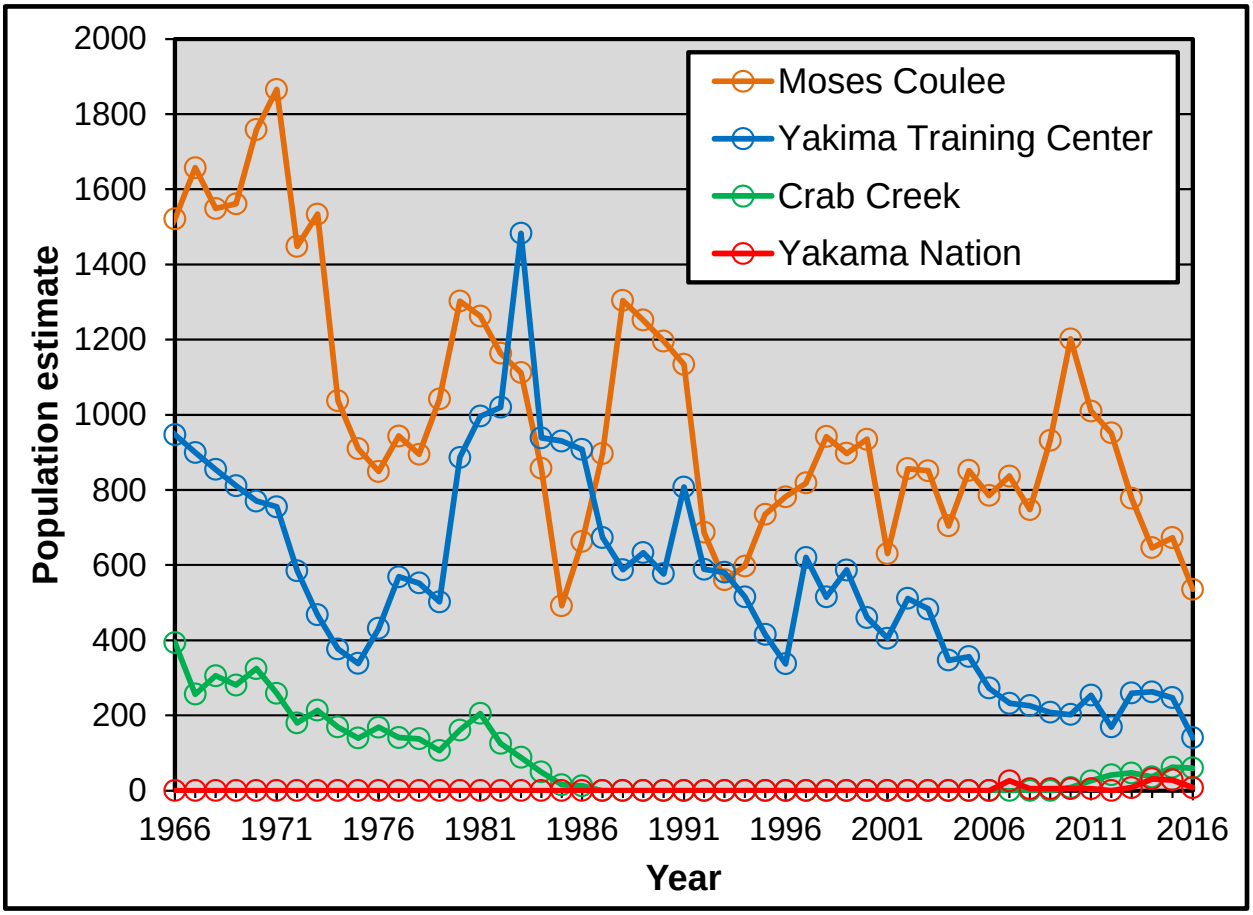

Fig. 5. Population estimates for greater sage-grouse in 4 populations in Washington State.

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). Five leks were documented in the Crab Creek area for the 1954-1986 period; they were last known to be active in 1954 (Cormana Lake), 1978 (Marlin), 1978 (Odessa), 1984 (Cannawai Creek), and 1986 (Creston Butte). Following translocations starting in 2008, a lek was established in a new location that continues to be active. The high male count for 2016 was 23 males observed on 5 April and the population was estimated to be 60. Despite the fact that there was no translocation in 2016, the lek count was only one fewer than the count of males observed in 2015 post release (Fig. 5).

Yakama Nation

Three males were observed on a single lek associated with the Yakama Nation, with a population estimate of 8 (Fig. 5). The lek formed in 2013 on private land adjacent to the Yakama Nation and

was formed following a translocation effort (Appendix A). The population of sage-grouse on the Yakama Nation was extirpated before the mid-1960s (Schroeder et al. 2000).

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) have been translocated from Oregon, and most of the birds (280) have been translocated to Crab Creek. Fifty-seven 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 observations of movements with the translocations between 2004 and 2016, it is possible that some of these birds ended up in the Washington populations.

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.

YTC

A population augmentation effort was initiated in 2004 to address genetic issues associated with the YTC population (e.g., lack of heterogeneity and small population size). A total of 99 sage-grouse was translocated from Nevada (43), Oregon (38), and Idaho (18) to the YTC. The total includes 93 females and 6 males (Table 2) that were introduced during two separate projects (2004–2006 and 2014–2016). Subsequent monitoring indicates that translocated females have nested successfully on 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 fall population during the first augmentation effort, there is no genetic evidence based on a post-augmentation genetic analyses conducted in 2011 to conclude that translocated birds from the first release (2004–2006) successfully recruited young into YTC's breeding population. As such, a second augmentation effort (2014–2016) was implemented and further genetic analyses is being proposed to evaluate the success of this effort.

Sixty-eight resident sage-grouse (24 males, 44 females) were captured between 2012–2016 to investigate the spatial distribution (i.e. seasonal and core-use areas) and demographic rates across YTC. This research was implemented to validate the expanded sage-grouse protection area that resulted from the GTA EIS mitigation (U.S. Army 2011) and to address current and future land-use actions that may impact sage-grouse habitat. A comprehsive report is being written from this research that will incorporate results pertaining to sage-grouse distribution and core-use areas

(annually and seasonally), reproduction rates (e.g, nest propensity, apparent nest success, clutch size etc.), nest-site habitat selection, and survival rates from radio-marked birds.

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.

Research is currently being conducted at Washington State University by Kyle Ebenhoch as part of his master's research that includes: investigationg daily and seasonal movements, survival, home ranges, productivity, and habitat selection among translocated and resident sage-grouse. Thus far, work has begun on the movement, survival, and habitat selection aspects of this research; however, sage-grouse relocation data will continue to be added to this project through August 2017 at which time the final analyses will begin. All writing and data analysis are projected to be completed by December 2017.

Crab Creek

The WDFW purchased 8,094 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 (Fig. 6). An additional 518 ha of land owned by the Washington Department of Natural Resources was leased. Because 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 and greater sage-grouse). The BLM has acquired land adjacent to and near the Swanson Lakes Wildlife Area. The Lakeview Ranch is a 5,135 ha parcel located approximately 10 km north of the town of Odessa in southwest Lincoln County. Twin Lakes is a 6,201 ha parcel located approximately 25 km southwest of Davenport in central Lincoln County. Coffeepot Lake is a 377 ha parcel located 17 km west of Harrington in Lincoln County. 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 of the greater sage-grouse reintroduction area in the Crab Creek Sage-grouse Management Unit, Washington. BLM lands are outlined with yellow, WDFW lands with green, and WDNR lands with brown.

The endemic population of sage-grouse at Crab Creek was extirpated in the mid-1980s (Fig. 3). There are numerous possible reasons for population declines and extirpations. These include historic declines in habitat quantity and quality, changes in densities of predators such as coyotes and common ravens, and isolation of remnant populations due to the lack of dispersal corridors between adjacent populations. One basic question addressed prior to translocations was: Has subsequent management adequately addressed the explanations for previous declines in numbers of sage-grouse? 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 possible explanations for the declines in sage-grouse have been directly addressed with management activities (Stinson and Schroeder 2014). These activities include habitat restoration, removal and marking of fences, treatment of invasive species, and habitat acquisition.

Some of the specific activities include:

- Agricultural fields were restored to shrubsteppe on >3,000 acres on WDFW and BLM lands since 1995 and 1,514 acres since 2004. An additional 300 acres are in the process of being restored and 1,000 more acres are proposed and awaiting funding.
- Boundary fences were marked on WDFW (55 miles) and BLM lands (71 miles).
- Grazing was ceased on the Swanson Lakes Wildlife Area to provide adequate hiding and nest concealment cover.
- Grazing on approximately 20,000 acres of BLM lands is under conservative stocking rates and monitoring has shown that it is providing adequate cover to meet sage-grouse guidelines (BLM 2014).

Table 3. Estimated landcover in relation to land ownership within the Crab Creek Management Unit.

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	204
Other government land	91	07	0	1	23
Private land	47	40	12	1	2,830
Total for management unit	52	36	11	1	3,276

During 2008-2015 280 sage-grouse were released on 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 they would provide some additional certainty about the current lack of sage-grouse in the area. Second, the released birds would help identify areas of suitable seasonal habitat, which would therefore enable refinement and priotization 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 evaluate the monitoring protocols as well as the potential for highlighting 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 in the middle of SLWA (Fig. 7). In 2009, grouse were captured north of Plush, Oregon. The release site was moved about 3 km to an area closer to 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, NV 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 approximately 7,000 locations were obtained for 221 VHF radio-marked sage-grouse. An additional ~20,000 locations were obtained for 20 GPS radio-marked males. Most movements were concentrated in and around WDFW Swanson Lakes Wildlife Area and BLM's Twin Lakes Area, which tends to have greater sagebrush cover. 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 and post-doctoral student with WSU, and mesic habitat use by hens with broods is being analyzed by a professor at Whitworth University. Additionally adult survival and nest success analyses have been conducted, but not finalized, as part of a WSU senior undergraduate thesis project.

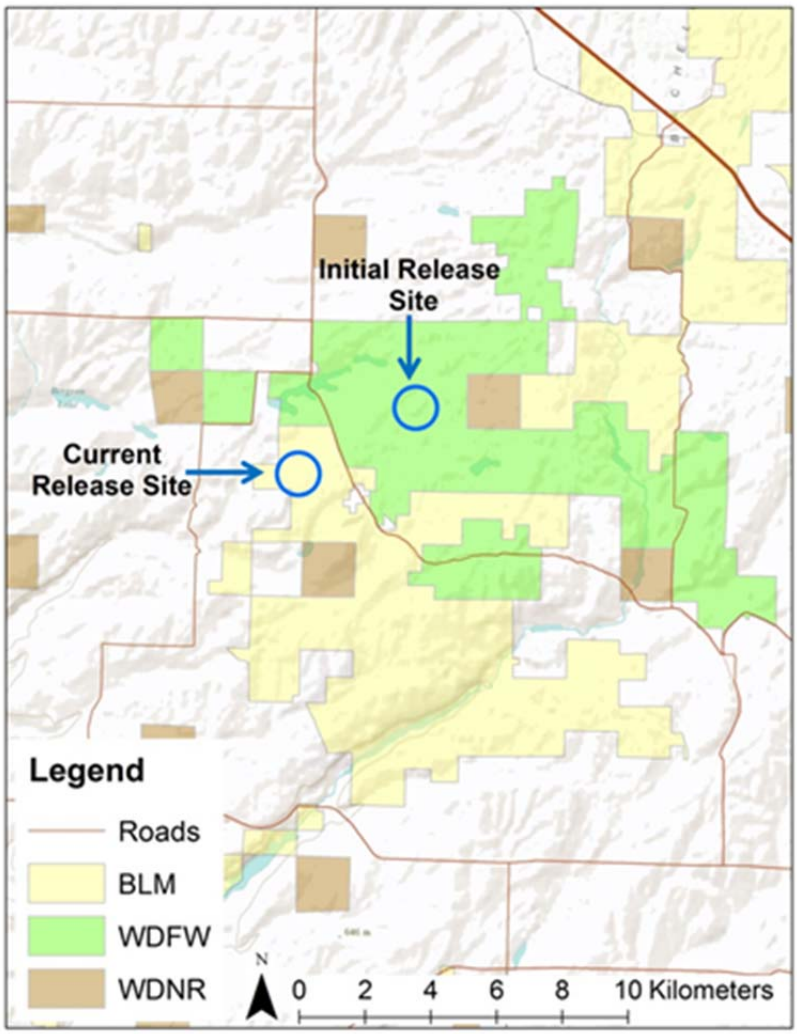

Fig. 7. Release sites for greater sage-grouse in Lincoln County, Washington. The initial location was selected because of habitat quality, lack of nearby fences, accessibility, and its location within a large patch of state (WDFW) and federal (BLM) land. The current site was selected because it was close to previously released grouse.

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 Eurpoean 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).

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. Protection of an threatened population of birds reintroduced with great effort and expense warrants consideration of all methods to ensure success, including predator control. Predator control is not a long-term management strategy on this project, but will be conducted over limited geographic areas and time span, and in conjunction with non-lethal predator management activities.

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 raven removal within 5 km of the lek. Ravens were included in this contract due to ravens being indicated as the predator in 20% of nest failures at that time.

A total of 39 coyotes were removed over two days (April 22 and May 14, 2014) via helicopter within 5 km of the lek. During the May flight 36 coyotes were removed from the area within 3 hours, and one coyote was shot actively stalking a group of 3 sage-grouse. 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 and 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 1st the 10 remaining stations were each baited with 2 treated eggs. Monitoring showed all eggs were removed from the stations in less than 24 hours. Assuming one raven was lethally removed per treated egg, we estimate 20 ravens were removed.

In 2015 APHIS was again contracted to conduct coyote removals via helicopter within 5km of the lek. The first flight was on March 9 and 43 coyotes were removed. A second flight was scheduled for late March early April, but was never flown due to helicopter mechanical issues and availability. Raven control via poison was not used this year due to raven survey results indicating 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 lethal removed, multiple nests were knocked down but none had eggs present. Additionally, 11 Great Horned Owls were lethally removed.

In 2016 APHIS was again contracted to conduct coyote removals via helicopter within 5km of the lek at total of 58 coyotes were removed in two flights (39 on Feb 24th and 19 on May 6th). Raven control via poison was not used this year due to raven survey results indicating overall density of ravens was not a significant issue. Individual ravens and nests were removed when in close vicinity to known grouse nest sites. One adult raven was lethal removed, multiple nests were knocked down but none had eggs present. Additionally, four Great Horned Owls were lethally removed.

In conjunction with lethal control the following non-lethal activities have been pursued:

- Approximately 15 miles of un-necessary interior fencing and associated fence posts often used as predator perches has been removed.
- Approximately 4.3 miles of power distributions lines representing 60 powerpoles have been removed by the BLM.
- A study on the effectiveness of various perch deterrent designs has been completed (Dwyer and Doloughan 2014), and a feasibility assessment to install perch deterrents or remove, bury, or relocate additional powerlines is being prepared.
- Two unstable barns have been demolished by the BLM for safety reasons and reduction of nesting habitat for ravens.
- 7-10 old combines and other junk metal has cleared cultural review and is slated for removal in 2017.
- 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.
- A total of eight great horned owls were banded and relocated in winter 2009 and spring 2010. One owl was captured and relocated in 2014 and four in 2015. None of the banded owls have been observed in the study area. Great horned owls were causing a significant number of adult sage grouse mortalities.

Yakama Nation

A Total of 128 sage-grouse was translocated to the Yakama Nation between 2006 and 2014 (Table). Based on the declining number of males at the only known lek, this translocation does not appear to be producing a successfully re-established population.

Table 5. 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 FOR 2017

Work will continue in all populations in 2017. In addition to the specific inventory, monitoring, translocation, and/or research projects described in this report, conservation activities will include habitat conservation planning, working with landowners on federal conservation program lands, and habitat management on state-owned wildlife areas. Specific plans for 2017 include:

- Translocate 20 female sage-grouse from Idaho to the YTC contingent on issuance of capture permit from IDFG.
- Monitor and analyze VHF-marked sage-grouse on the YTC.
- Monitor and analyze GPS-marked male sage-grouse in the Moses Coulee population.

- Analyze VHF and GPS data for sage-grouse in the Crab Creek, Moses Coulee, and YTC populations.
- Develop strategy to refine the mapped habitats within the sage-grouse recovery zones, priority areas, and/or populations.

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Appendix A. Number of greater sage-grouse translocated to Washington, 2006–2016. 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