Re-introduction of Sage-grouse to Lincoln County, Washington: Progress Report

Mike Schroeder, Mike Atamian, Howard Ferguson
Mike Finch, and Derek Stinson

Washington Department of
FISH AND WILDLIFE
Wildlife Program

ABSTRACT

The Washington Department of Fish and Wildlife, in cooperation with the U.S. Bureau of Land Management, initiated a project in 2008 to reintroduce greater sage-grouse (*Centrocercus urophasianus*) to the Swanson Lakes Wildlife Area in Lincoln County, Washington. The project was designed to establish a third population in the state in an area with more than 200 km^2 of shrubsteppe habitat on public lands. Prior to the first translocation in 2008 there were rare observations of sage-grouse in the release area. It was not clear whether these observations were birds dispersing from the closest population in Douglas County or whether these birds were 'remnants' from an endemic population known to occupy the area through the mid-1980s. From spring 2008 to spring 2011, 144 greater sage-grouse were translocated from southern Oregon to the Washington release site and their movements, productivity, habitat use, and survival have been monitored. In general, birds released in the fall fared poorly when compared with birds released in the spring. As of 21 October 2011, 18 female and 24 male sage-grouse are being monitored with telemetry and several other sage-grouse are also likely present, either with malfunctioning radio transmitters or no radio transmitters. The overall population in Washington was estimated to be 1165 in 2011, including the birds in the translocated population. We propose an additional translocation of 50 sage-grouse in spring 2012.

ACKNOWLEDGEMENTS

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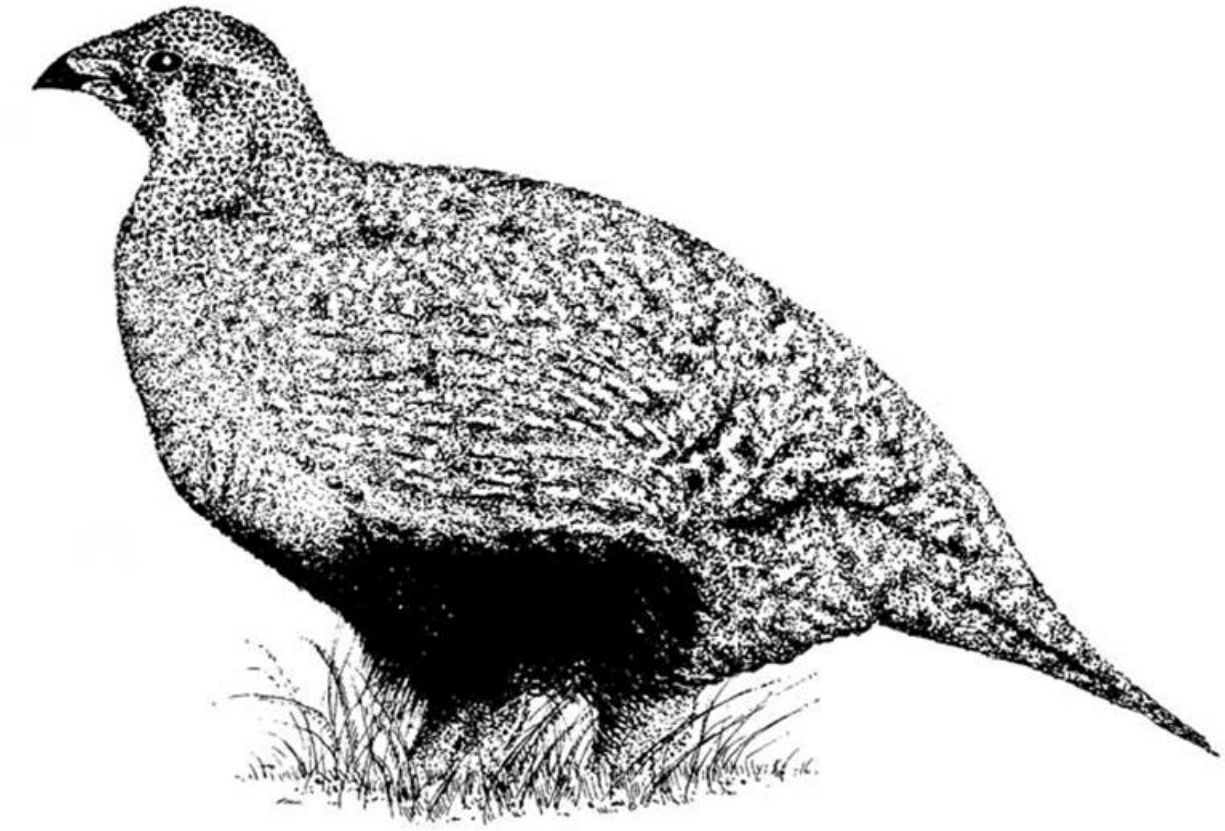
On the cover: Background photo by Michael A. Schroeder; Mike Finch and Todd Baarstad (handling bird) by Rich Landers; sage-grouse juvenile by Kim Thorburn, grouse with radio by Derek Stinson. Title page and back cover illustration by Darrell Pruett.

RE-INTRODUCTION OF GREATER SAGE-GROUSE TO LINCOLN COUNTY, WASHINGTON: PROGRESS REPORT



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Washington Department of Fish and Wildlife

Michael A. Schroeder, P.O. Box 1077, Bridgeport, WA 98813
Michael Atamian, 2315 North Discovery Place, Spokane Valley, WA 99216
Howard Ferguson, 2315 North Discovery Place, Spokane Valley, WA 99216
Mike Finch, Swanson Lakes Wildlife Area, Creston, WA 99117
Derek W. Stinson, 600 Capitol Way North, Olympia, WA 98501

Contact information: Michael A. Schroeder, 509-686-2692, schromas@dfw.wa.gov

Washington Department of FISH and WILDLIFE

BACKGROUND

Greater sage-grouse have declined dramatically in both distribution and population size in Washington. Of 76 lek complexes documented since 1960, 66% are currently vacant. Many of these vacant lek complexes (52%) are in areas where sage-grouse have been extirpated since the 1960s. The current range is about 8% of the historic range, occurring in 2 relatively isolated areas; one primarily on the Yakima Training Center (YTC) in southern Washington and the other centered in the Moses Coulee area of Douglas County in northern Washington (Schroeder et al. 2000, Fig. 1). Based on changes in number of males counted on lek complexes, the sage-grouse population size in Washington declined more than 50% from 1970 to 2011. The 2011 spring population was estimated to be about 213 in the Yakima Training Center (YTC, U.S. Department of Defense) population and 926 in the Moses Coulee population. Additional sage-grouse are now in the Crab Creek population (centered near the Swanson Lakes Wildlife Area), but it is largely supported with translocations. 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).

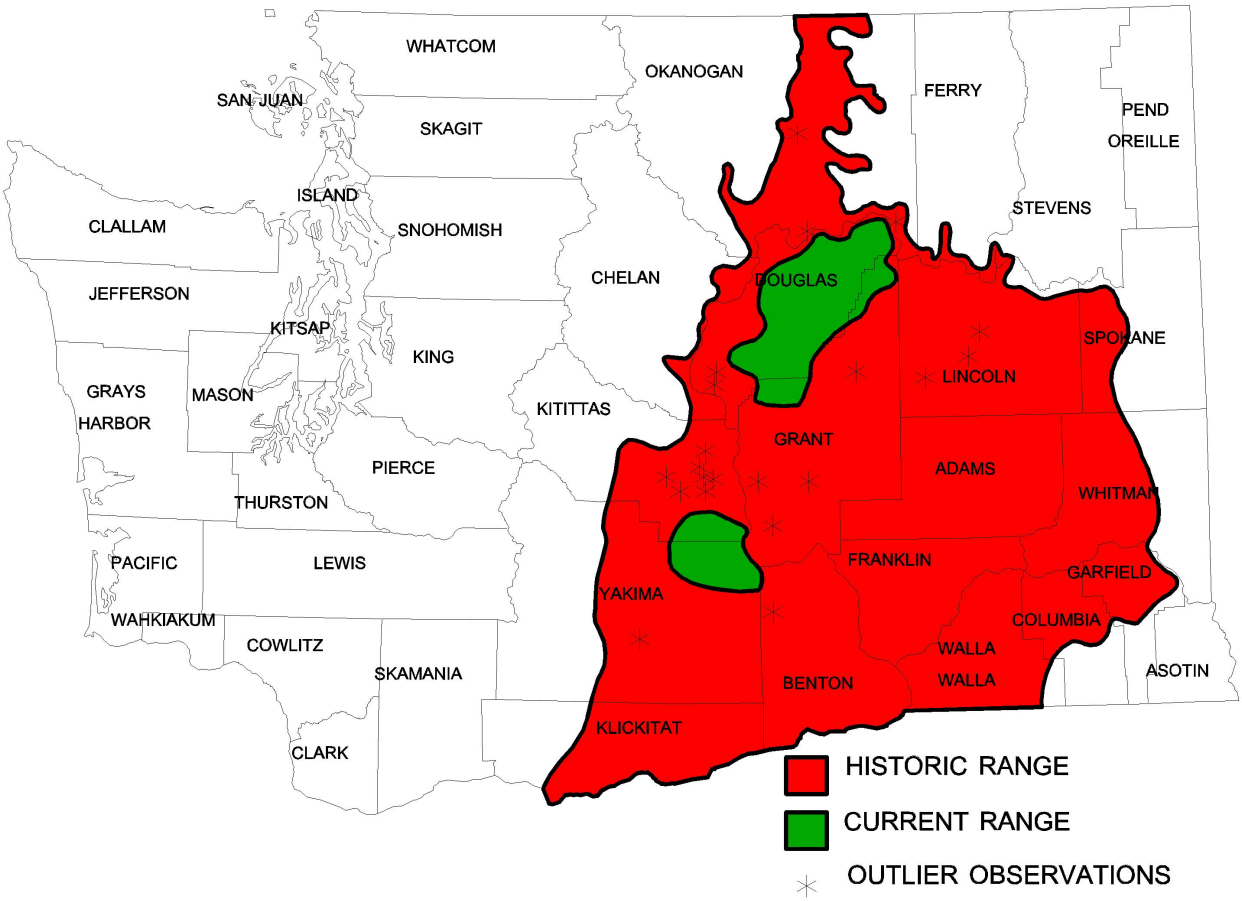

Fig. 1. Estimated historic and current range of greater sage-grouse in Washington prior to translocation efforts (Schroeder et al. 2000).

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 also considered by the U.S. Fish and Wildlife Service to determine that greater sage-grouse in Washington and northern Oregon represented a distinct population segment and that the population warranted a federal listing as 'threatened', though listing has been precluded by higher listing priorities (U.S. Fish and Wildlife Service 2001).

Historic and recent declines of greater sage-grouse in Washington are linked to conversion of native habitat for production of crops and degradation of the remaining native habitat (WDFW 1995, Hays et al. 1998, Stinson et al. 2004). In the Moses Coulee population centered in Douglas County (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), or lands with high-quality shrubsteppe (Table 1, Schroeder and Vander Haegen 2011). In contrast, the YTC population in Yakima and Kittitas counties 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 historic low intensity livestock-grazing program. Grazing by livestock was completely eliminated in 1995. Military training poses 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.

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. 2).

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	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.

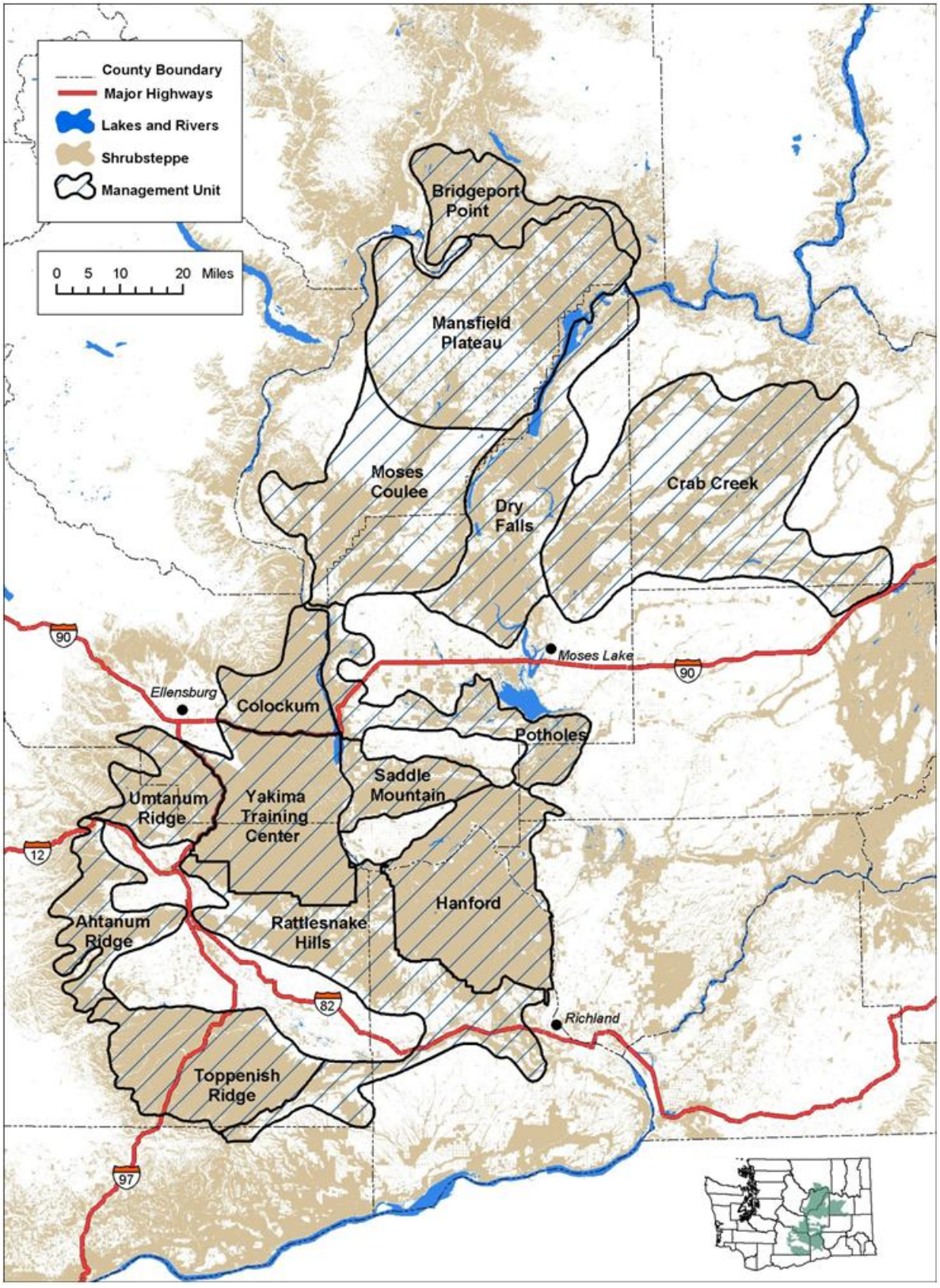

Fig. 2. Greater sage-grouse management units in relation to shrubsteppe cover types in Washington.

Isolation poses a significant threat to the viability of remaining populations (Stinson et al. 2004). Westemeier et al. (1998) described the reduction in genetic diversity and in population fitness over a 35-year period in a small, declining greater prairie chicken (*Tympanuchus cupido*) population in Illinois. They reported that declines in fertility and egg hatchability correlated with a population decline from 2000 individuals in 1962 to less than 50 by 1994. Bouzat et al. (1998) genetically compared the same population with larger populations in Kansas, Nebraska, and Minnesota and found that it had approximately 2/3 the allelic diversity of the other populations. Bellinger et al. (2003) found a similar reduction in genetic variation, though not in reproductive success, in greater prairie chickens in Wisconsin. Their comparison of samples collected in 1951 with those collected from 1996 through 1999 revealed a 29% allelic loss.

Genetic work by Benedict et al. (2003) and Oyler-McCance et al. (2005) indicated that the two Washington sage-grouse populations might have experienced similar loss of genetic diversity. They based their conclusions on diversity and divergence of mitochondrial and molecular DNA. Samples were collected from more than 1000 greater sage-grouse from 45 populations throughout the range. The YTC population had only 1 of 38 mitochondrial haplotypes and the Moses Coulee population had 3 of 38 haplotypes present (Benedict et al. 2003). This is in comparison to an average of 6.4 haplotypes across 16 populations with sufficient samples to study. Microsatellite variation in Washington illustrated similar trends suggesting a need for immediate conservation action (Oyler-McCance et al. 2005).

CURRENT MANAGEMENT AND RECOVERY EFFORTS

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 also 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).

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.

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.

In order to implement these strategies and achieve these goals, the recovery plan established numerous management units (Fig. 2) to aid in the identification and implementation of management and recovery actions (Stinson et al. 2004). The northern population (Moses Coulee population) is located primarily in the Mansfield Plateau and Moses Coulee management units while the southern population is primarily in the Yakima Training Center Management Unit. 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. Crab Creek is the only management unit, other than the three units with current populations, to have recently supported an endemic breeding population.

Enhancement of existing populations was identified as a high priority in the greater sage-grouse Recovery Plan (Stinson et al. 2004). Because the majority of the Moses Coulee population occupies private land, most management efforts have focused on programs designed to encourage management practices that benefit sage-grouse. Chief among these are federal conservation programs such as the Conservation Reserve Program (CRP) and State Acres for Wildlife Enhancement (SAFE) which support nesting sage-grouse (Schroeder and Vander Haegen 2011).

Within the Yakima Training Center population, the U.S. Army restricts training in many core sage-grouse areas (approximately 18,000 ha) and implements aggressive fire prevention and fighting techniques (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*). In addition to the management responses to military activities, the YTC also discontinued grazing by livestock in 1995 (Stinson et al. 2004).

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). In addition, by translocating birds from 'healthy' populations, a basic hypothesis can be tested. Specifically, is habitat limiting the growth and/or expansion of the YTC population or is the problem related to the intrinsic 'health' of the birds? An increasing population trend following augmentation would support the hypothesis that a population 'health' problem existed. If the population size remains

the same or continues to decline, and monitoring indicates that the translocated birds remained in the area and survived to attempt reproduction, data will support the conclusion that habitat quality and/or quantity is limiting population growth.

In March 2004, 25 female sage-grouse were captured with the aid of night-lights (Wakkinen et al. 1992) in Elko and Humboldt Counties, Nevada, and translocated to the YTC. In March 2005, 18 female and 5 male sage-grouse were captured on the Hart Mountain National Antelope Refuge in Lake County, Oregon (Hart Mountain) and translocated to the YTC. Both of these translocations were designed to augment the existing population. In contrast, 12 female and 19 male sage-grouse were captured at Hart Mountain and released on the Yakama Indian Nation (YIN) adjacent to the southern Washington population in an effort to re-introduce birds to a portion of their historic range. An additional 5 males were captured at the Wind River Indian Reservation and released on the YIN in April 2006. In August 2006, 18 female and 7 male sage-grouse were captured at Hart Mountain; 4 females and 5 males were released on the YIN and 14 females and 2 males were released on the YTC.

Although successful breeding has been documented for the 109 translocated sage-grouse in southern Washington, the results are preliminary and additional work is currently underway to evaluate movement, survival, and productivity of the released birds as well as a possible population-level response to the overall translocation effort. A rebound in the YTC population has not been observed to date; the reasons may relate to a reported rangewide population low, or habitat issues. In recent years, habitat on the YTC has been affected by an increase in Army training and also possibly by an associated increase in wildfires. Although genetic samples have been analyzed to determine if the augmentation was successful at introducing new genetic material to the population, these results have not been conclusive. A similar project involving translocation of 63 sharp-tailed grouse (*Tympanuchus phasianellus*) onto the Scotch Creek Wildlife Area in north-central Washington revealed that even a positive response might be delayed a few years following a translocation effort (Fig. 3). The reason for this delay is that a portion of the translocated individuals die before they are able to breed, a portion are not able to either breed and/or nest successfully, and a portion of the young produced do not survive to successful reproduce. Consequently, it is essential that translocation efforts be supported with multi-year commitments by the agencies and individuals involved.

LINCOLN COUNTY TRANSLOCATION PROJECT

Translocations of greater sage-grouse should include four basic stages in order to maximize the opportunities for successful reestablishment or augmentation efforts (similar to Griffith et al. 1989). The first stage is to identify potential release sites based on quantity and quality of habitat on, and near, the sites. In addition, the historic presence and current status of greater sage-grouse near the release sites needs to be established. The second stage is to identify source populations for translocation to the proposed release sites. This should include a genetic analysis. The third stage is to conduct the translocation as efficiently as possible in a way that minimizes the length of captivity and maximizes survival and productivity. The fourth stage is to monitor and evaluate the success or failure of the reestablishment or augmentation effort and to determine future management goals and efforts. This fourth stage is particularly important so that all translocation

efforts, even those that are unsuccessful, will provide valuable information for future efforts. The translocation effort was designed to adhere to recommendations outlined by Reese and Connelly (1997).

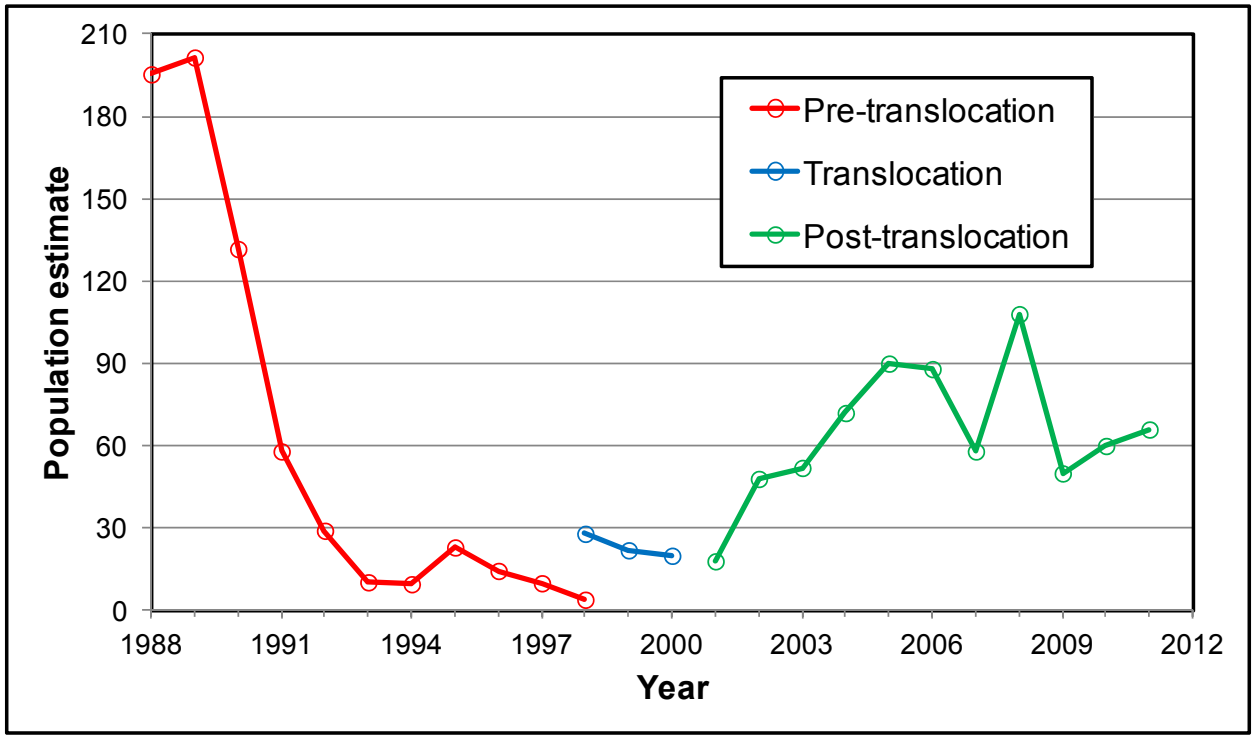

Fig. 3. Estimated population of sharp-tailed grouse on the Scotch Creek Wildlife Area in Washington before and after translocation of 63 sharp-tailed grouse in 1998, 1999, and 2000.

STAGE 1: RELEASE SITES

Because of declines in greater sage-grouse throughout Washington (overall population estimate of 1165 in 2011) and the isolation and small size of remaining populations, there are four different locations that were considered for translocation efforts. Two priority areas include the YTC population (estimated to be 213 in 2011), which was initially augmented in 2004, and the YIN, which was initially reintroduced in 2006 (see earlier background discussion). A third priority area is the northern population of greater sage-grouse centered in Douglas County (estimated to be 926 in 2011). Although this is still being considered, it is likely that any translocation effort will be delayed until additional genetic information can be obtained and analyzed. The reason for caution is that sage-grouse in Douglas County have been documented to have at least one unique haplotype (Benedict et al. 2003) and the importance of this characteristic has yet to be assessed. Furthermore, reproductive data collected for radio-marked birds in north-central Washington have shown that they have the largest average clutch size and the highest rate of nesting and renesting of any studied population in North America (Schroeder 1997). When these factors are considered, along with population data showing that the population is relatively stable (Fig. 4), the need to augment the population is not believed to be critical at this time.

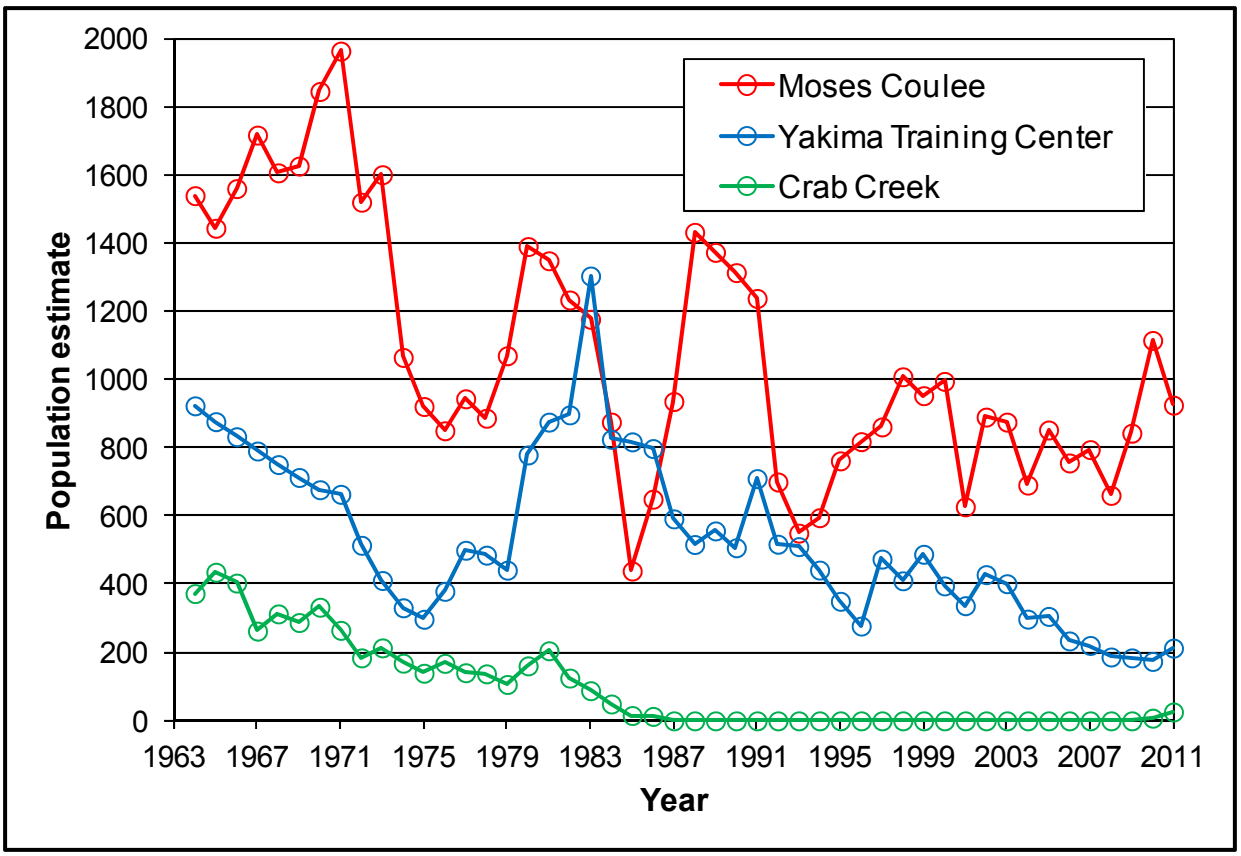

Fig. 4. Estimated population size for greater sage-grouse in different regions of Washington between 1964 and 2011.

The fourth priority area for translocations is the Crab Creek Management Unit, primarily in Lincoln County (Fig. 2). The historic presence of sage-grouse in the Crab Creek area has been well-established (Yocum 1956), as well as their extirpation (Fig. 4, 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 and Odessa), 1984 (Cannawai Creek), and 1986 (Creston Butte). Although the breeding population appears to have been extirpated in the area, an occasional sage-grouse is observed, possibly reflecting a small undocumented population or movement from the nearest known population in Douglas County (Fig. 1).

Why have populations of greater sage-grouse been essentially eliminated in the Crab Creek Management Unit? Has subsequent management on the prospective release site adequately addressed the explanations for previous declines in numbers of sage-grouse? There are numerous possible reasons for the sage-grouse population decline and extirpation. These include: historic declines in habitat quantity and quality; changes in densities of predators such as common ravens; and isolation of remnant populations due to the lack of dispersal corridors between adjacent populations.

Some of the explanations for the declines in sage-grouse have been directly addressed with management activities, in particular habitat restoration. The WDFW purchased about 8,000 hectares in Lincoln County in the early 1990s, which became the Swanson Lakes Wildlife Area.

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), the WDFW is actively managing habitat at Swanson Lakes for the benefit of prairie grouse (including both sharp-tailed grouse and greater sage-grouse). Modifications in the management practices include elimination of grazing on the wildlife area, re-vegetation of disturbed and non-native pastures, and control of noxious weeds. In addition, the Bureau of Land Management (BLM) recently purchased about 8,000 hectares adjacent to Swanson Lakes Wildlife Area. 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. 2007). Widespread programs such as CRP also have resulted in the conversion of vast areas of cropland to potential sage-grouse habitat since the mid-1980s (Schroeder and Vander Haegen 2011), and CRP has a large influence on the private lands in the area.

There is a greater proportion of shrubsteppe in the Crab Creek area (Table 2) 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, along with the relatively large blocks of suitable and/or improving habitats (Fig. 5), 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.

Table 2. Estimated landcover in relation to land ownership within the Crab Creek Sage-grouse 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	77.19
DNR	76	21	2	1	141.74
BLM	92	05	1	2	204.04
Other government land	91	07	0	1	23.27
Private land	47	40	12	1	2,829.79
Total for management unit	52	36	11	1	3,276.04

STAGE 2: SOURCE POPULATIONS

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 are being obtained from other states. 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.

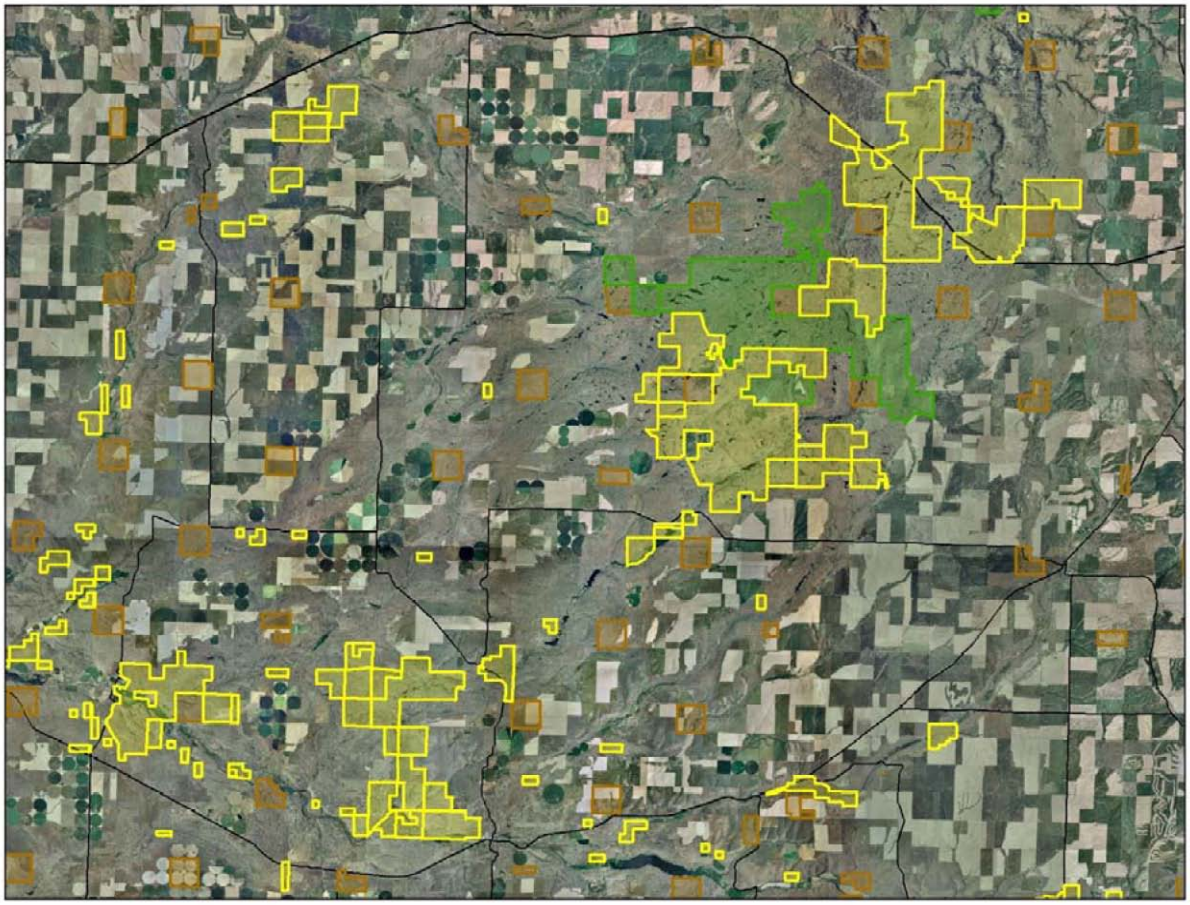

Fig. 5. Major public lands and landcover of the greater sage-grouse reintroduction area in the Crab Creek Sage-grouse Management Unit, Washington. BLM lands are outlined with yellow, WDFW lands with green, and WDNR lands with brown.

Although greater sage-grouse have been differentiated into two subspecies, *C. u. urophasianus* and *C. u. phaios* (Aldrich 1946), recent genetic analysis by Benedict et al. (2003) and Oyler-McCance et al (2005) do not support this subspecies distinction. Nevertheless, given the published reference to a western and eastern subspecies of sage-grouse, there still should be an effort to avoid translocating 'eastern' sage-grouse (eastern Idaho, Montana, Wyoming) to Washington unless absolutely necessary. Rangewide genetic data have indicated that although several greater sage-grouse populations might be suitable for translocation to Washington (Benedict et al. 2003), there is still enough variation between populations to warrant close scrutiny (Oyler-McCance 2005). For example, an examination of 45 populations through 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 (Fig. 6, 7).

Their analysis also showed that distance between populations was the largest factor explaining variation between most populations.

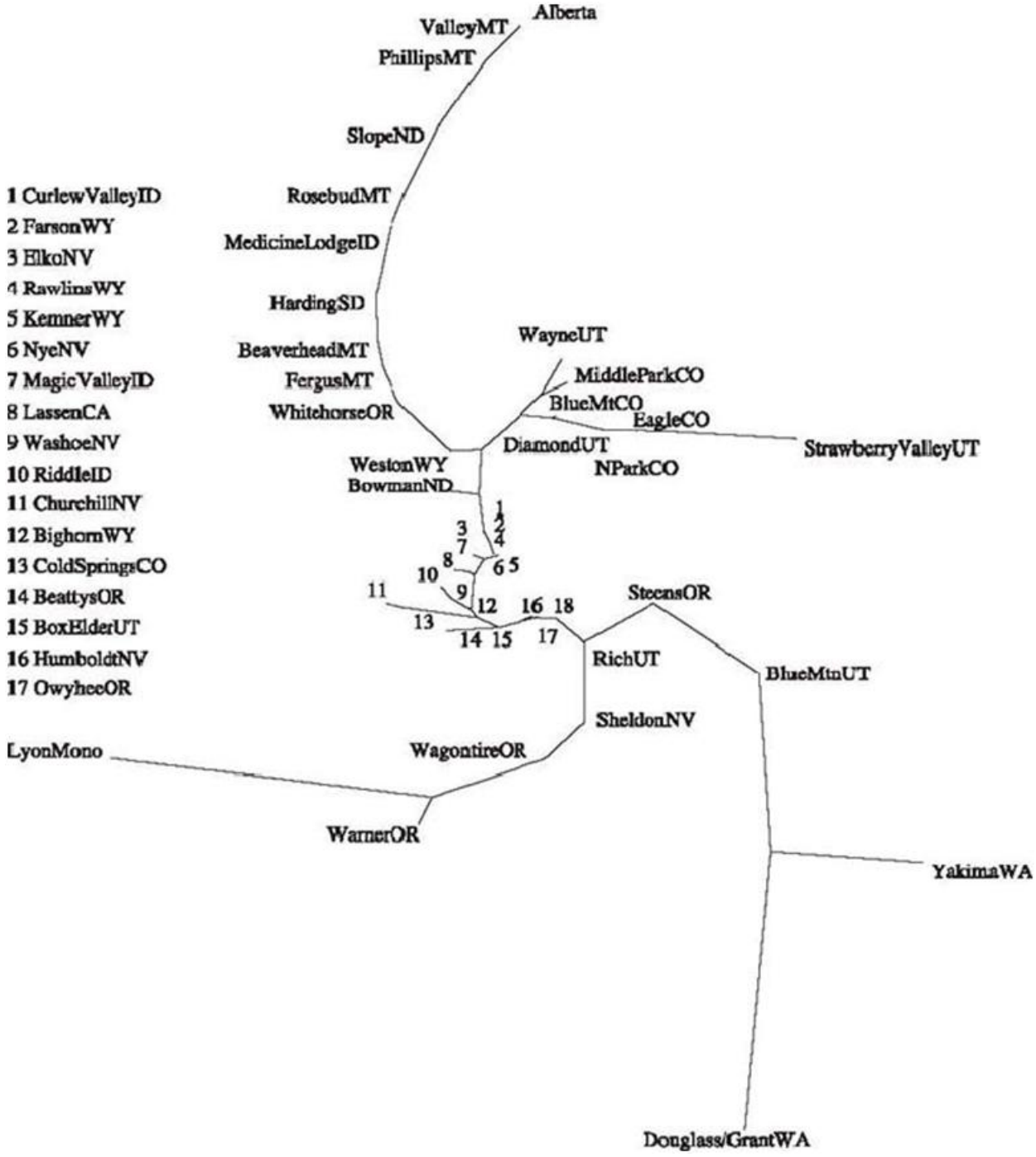

Fig. 6. Neighbor-joining tree constructed using the genetic distances for 45 populations of the greater sage-grouse (longer lines represent a greater genetic distance). Population names correspond with the map shown in Fig. 7 (Oyler-McCance et al. 2005).

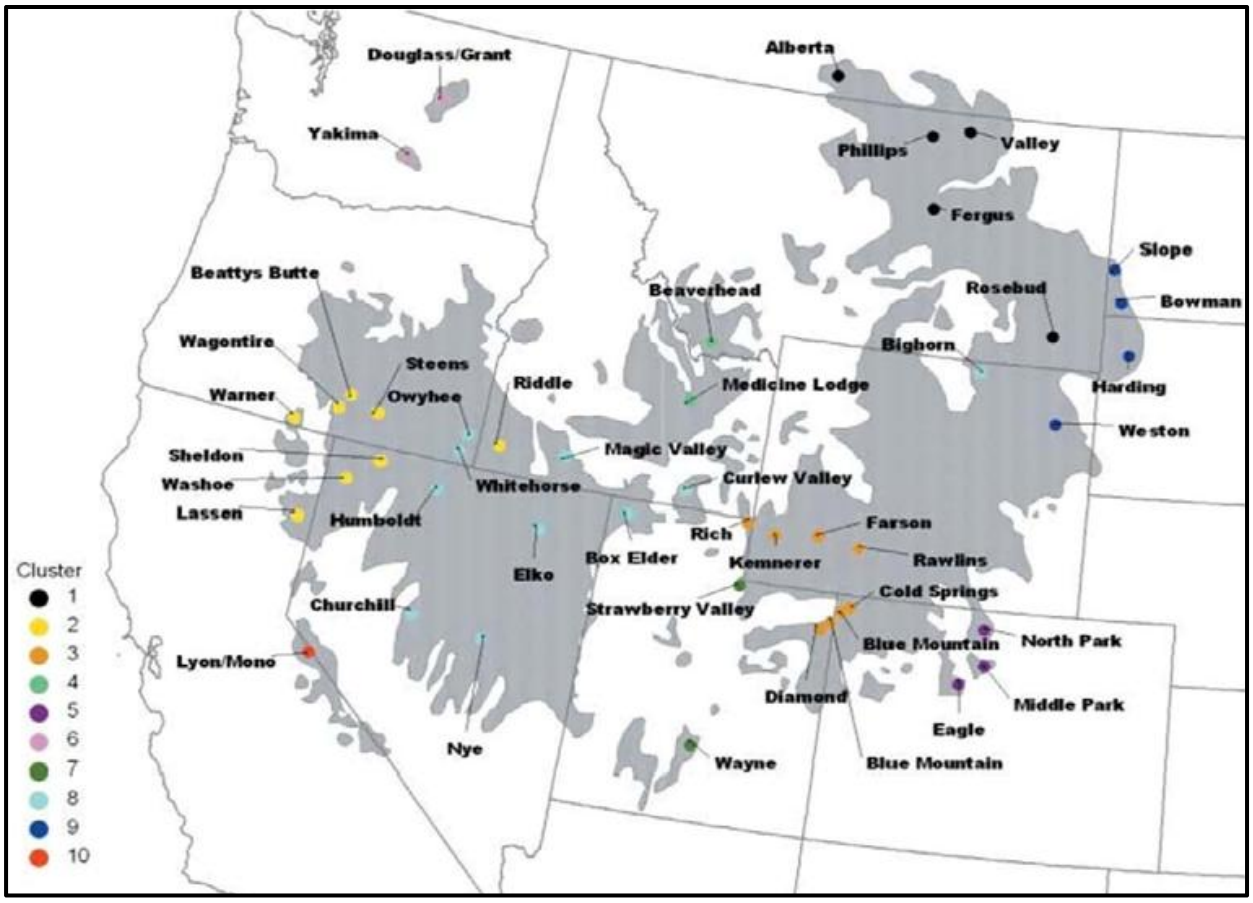

Fig. 7. Map of 45 sampling sites for a microsatellite analysis of greater sage-grouse. The populations are color coded by the cluster to which each population was assigned (Oyler-McCance et al. 2005).

Despite the slight 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 and northern Nevada. Their recommendation for augmentation was based on a clear conservation concern supported by the lack of genetic heterogeneity in Washington. With these factors in mind, it was hoped that birds could be obtained from previously used sources in northern Nevada and southern Oregon.

STAGE 3: CAPTURE AND TRANSLOCATION

Sage-grouse are generally captured during the spring breeding period (late March/early April) or in late summer or early autumn (e.g., October), but only when the situation proves favorable. 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 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 are screened. West Nile Virus (WNV) has recently 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 are eliminated from consideration (K. Mansfield, WDFW Veterinarian, pers. comm.). This is not a concern since the vector of WNV, mosquitoes, are not active in early spring.

Sex and age are determined for all captured birds (Beck et al. 1975). Blood samples are obtained for both disease testing and genetic analysis. Birds are banded with a unique numbered metal band and a single plastic colored band; necklace-mounted, battery-powered radio transmitters (predicted duration of 24 months) are placed on birds prior to release. Birds are transported by plane or car in individual box that are small enough to contain the bird's movement. The bottom of each box is lined with a material to reduce contact between feces and the birds' feet. The birds are released within 36 hours of capture, preferably as soon as possible. They are released at first light on the newly established 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 an hour.

This project was initiated in 2008 with a 5-year timetable. 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 (Fig. 8), 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 of the release site in subsequent years. 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.

The original goal was to translocate 40 greater sage-grouse each year (2008-2011), with an even sex ratio. The purpose of the even sex ratio is to facilitate the establishment of lek sites, encourage competition among males for breeding opportunities, and to compensate for the higher mortality of males. This is in contrast to an augmentation in which a higher number of females is usually preferred. Although 2012 was projected to be the final year of the project, higher mortality of sage-grouse in the first year, and smaller numbers of translocated birds forced a reevaluation. We now believe translocations at least through 2012 will be beneficial.

One hundred forty-four greater sage-grouse were released on the Swanson Lakes Wildlife Area between 2008-2011 (Table 3); fewer than the planned for 160 grouse during that interval. All grouse in 2008 were captured with the aid of night lights on the Hart Mountain National Antelope Refuge, Oregon. In 2009, grouse were captured north of Plush, Oregon. In 2010 & 2011, grouse were captured in two locations in Oregon, north of McDermitt, Nevada and southwest of Vale, Oregon. The birds were released within 36 hours of capture. Starting with the Autumn 2008 release, birds were placed in a settling box for up to 30 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.

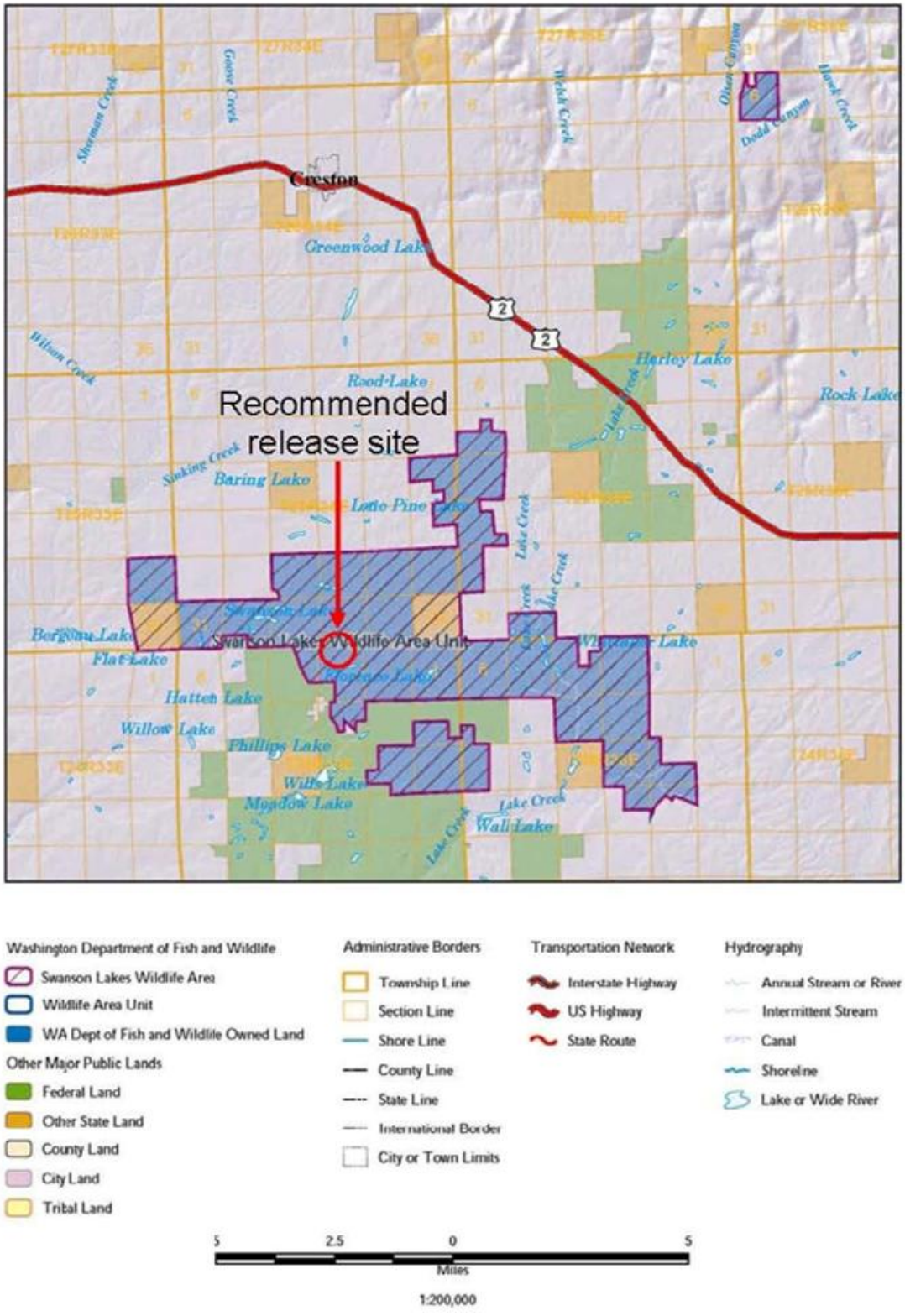

Fig. 8. Initial release site for greater sage-grouse in Lincoln County, Washington. The location was selected because of habitat quality, lack of nearby fences, accessibility, and its location within a large patch of state (WDFW) and federal (BLM) land.

Table 3. Number of greater sage-grouse translocated from southern Oregon to the Swanson Lakes Wildlife Area in Lincoln County, Washington, 2008-2011.

Sex and age category	Spring 2008	Autumn 2008	Spring 2009	Spring 2010	Spring 2011	Total
Males – total	10	7	15	23	20	75
Adult	7	0	12	18	15	52
Yearling/Juvenile	3	7	3	5	5	23
Females – total	7	17	13	15	17	52
Adult	6	6	7	4	11	34
Yearling/Juvenile	1	11	6	11	6	35
Total	17	24	28	38	37	144

STAGE 4: MONITORING AND EVALUATION

The success or failure of the reestablishment effort can be evaluated on and near the release site. Although establishment of the population over the long-term is the ultimate objective, success will also be addressed during this 5-year window. The specific objectives include examinations of movement, habitat use, productivity, survival, and population size. 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 1995, Connelly and Reese 1997). Because these data are currently being collected, the following analysis is brief and incomplete. Nevertheless, it provides some indication of the progress.

Movement

Radio-marked sage-grouse are located with the aid of portable receivers and 3-element Yagi antennas. Birds are located daily either visually or with triangulation during the first two weeks following release and at least once each week for the duration of the research. For triangulation, three or more azimuths are obtained < 1.5 km of target transmitters and at angles-of-incidence greater than 35o and less than 145^{o}. All locations are recorded with a GPS unit using Universal Transverse Mercator coordinates (nearest 10-m interval). For visual observations, an attempt is be made to avoid disturbance of birds, particularly at nest sites. Fixed-wing aircraft are used to locate lost birds on a regular basis throughout the year.

Between 2008 and 2011 3,898 locations were obtained for radio-marked birds (Fig. 9). The maximum observed dispersal distance from the point of release was 56 km by a male released in the spring of 2010. The average maximum observed dispersal from the release site for all animals with 2 or more locations was 13 km with no significant difference between the sexes or between years (Table 4). Average home range size (using minimum convex polygons) was 88 km^2 for 66 males and 71 km^2 for 64 females (difference not statistically significant). Although the longest movements and larger home ranges were observed following the spring releases, the autumn birds tended to die early and this may have affected the results.

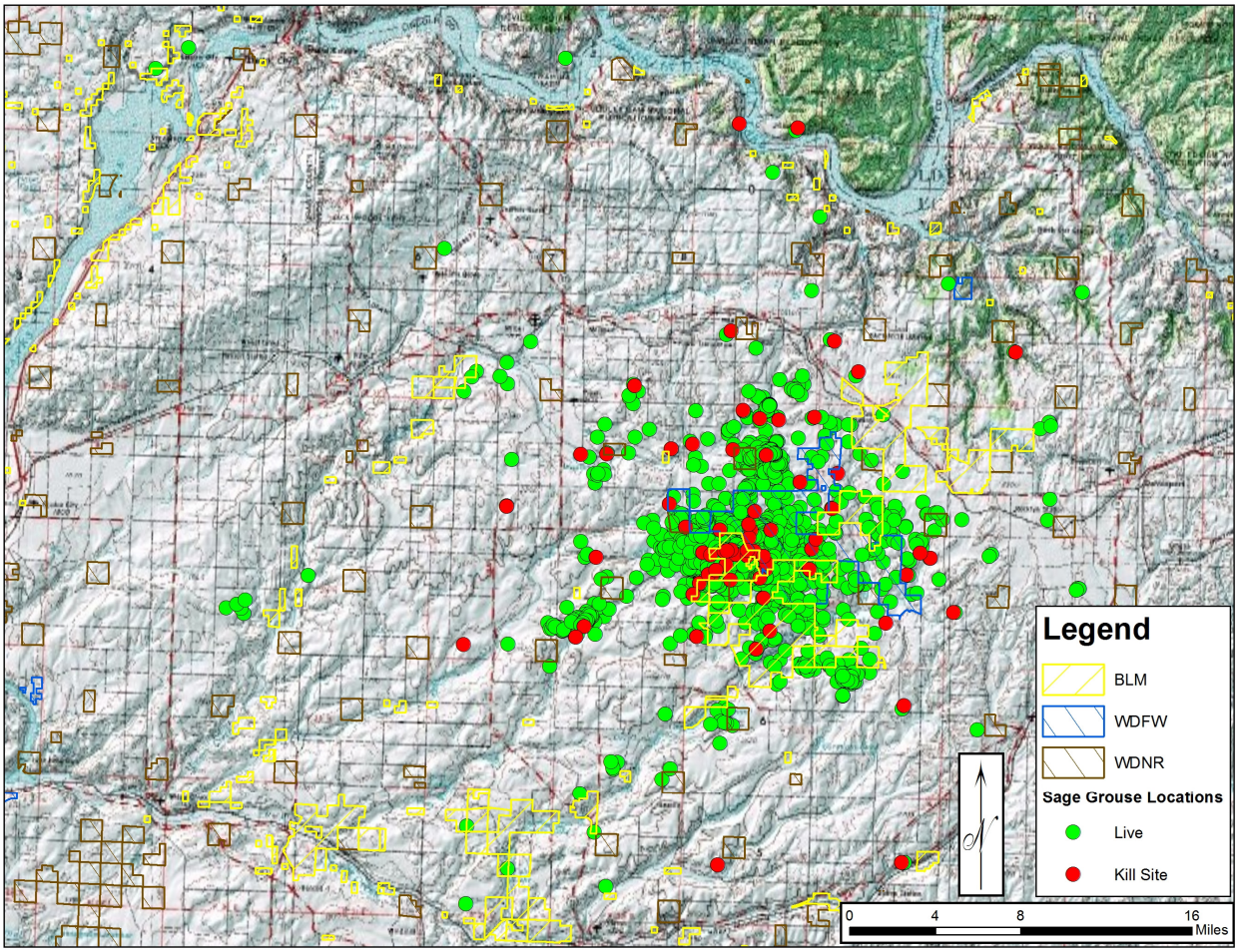

Fig. 9. All locations for sage grouse from initial release on March 31, 2008 through October 10, 2011.

Table 4. Average maximum dispersal and average home range size (minimum convex polygon) for greater sage-grouse translocated from southern Oregon to the Swanson Lakes Wildlife Area in Lincoln County, Washington, 2008-2011.

Category	Spring 2008	Autumn 2008	Spring 2009	Spring 2010	Spring 2011	Total
Average maximum dispersal (km) ± Standard Error (n)						
Males	10±4 (9)	8±1 (7)	17±3 (15)	15±3 (20)	11±1 (18)	13±1 (69)
Females	14±6 (6)	11±2 (17)	14±2 (13)	13±2 (15)	11±2 (17)	12±1 (68)
Home range size (km^2) ± Standard Error (n)						
Males	27±17 (5)	7±2 (7)	132±40 (15)	143±37 (20)	35±12 (18)	88±13 (66)
Females	67±27 (4)	30±8 (14)	121±48 (13)	105±35 (15)	33±8 (16)	71±17 (64)

Habitat use

Habitat data has not been analyzed at the present time. Upon completion of the project habitat use will be evaluated for general categories of vegetation cover such as: 1) CRP; 2) wheat; 3) other crops; 4) riparian; 5) shrubsteppe; and 7) other habitats. Available cover is examined with satellite imagery (Geographical Information Systems) in three different ways. First, the quantity of each cover type on the study area is estimated. Second, the quantity of each cover within the perimeter of each bird's home range (minimum convex polygon) is estimated. Third, the quantity of each cover type within a certain distance of the release site is estimated; in the case of nest sites, the distance between a female's nest site and the release site is used. Comparisons of used and available habitat will be conducted with $\chi 2$ contingency tables (Neu et al. 1974, Thomas and Taylor 1990).

Productivity

Nest success is examined each breeding season (Schroeder 1997). Nests are considered successful if a minimum of 1 egg hatches. Specific evidence of possible predators are examined at unsuccessful nest sites. Brood success is estimated using radio-marked females that successfully produce broods that survive at least 50 days following hatch (assuming chicks can survive on their own after 50 days).

Due to radio failure no nesting was observed in the 2008 release. In 2009 only 3 nesting attempts were documented, 2 were predated and 1 nest contained unfertilized eggs. In 2010, 10 nesting attempts were documented, 3 were predated, 1 nest contained unfertilized eggs, and 6 hatched. Of the 6 hatches 2 hens fledged chicks, combined at least 5 chicks were fledged. In 2011, 11 nesting attempts were documented, 6 were predated, and 5 hatched. Of the 5 hatches 3 hens fledged chicks, combined at least 7 chicks were fledged.

Observations of banded and unbanded birds at leks are also used to evaluate the recruitment of new birds into the population as well as the presence of birds that may have been on the release site prior to the first translocation. The latter situation may indicate leks which were previously undiscovered. See population monitoring section below for more details on lek surveys.

Survival

Statistical analysis of the radio telemetry data for survival estimation will be conducted at the end of the project. Annual survival will be estimated for radio-marked sage-grouse using the Kaplan-Meier product limit estimator (SAS Institute Inc. 1988, White and Garrott 1990). Differences in survival will be compared between females and males with the log rank test (SAS Institute Inc. 1988, White and Garrott 1990). Specific evidence of possible predators is examined for recoveries of dead birds or radio transmitters (Darrow 1938).

Apparent survival for both sexes and age classes combined for the 1st Month post release was 41.2%, 20.8%, 71.4%, 74.3%, and 77.8% for the 2008 spring, 2008 fall, 2009, 2010, and 2011 releases respectively (Table 5). Apparent survival for the 1st Year was 11.8%, 0%, 32.1%, and 28.6% for the 2008 spring, 2008 fall, 2009, and 2010 releases respectively (Table 5). Apparent survival was calculated as the number birds known to have survived the time period of interest

divided by the number of birds released. This is a relatively conservative estimate given a number of missing birds could still be alive.

Table 5. Number of greater sage-grouse translocated from southern Oregon to Lincoln County, Washington, 2008-2011 by their status in the first month and first year. The missing category includes birds where the radio collar appears to have slipped off.

Release period Age and sex	Number	First month			First year		
		Survived	Died	Missing	Survived	Died	Missing
2008 spring							
Adult female	6	4	0	2	1	1	4
Yearling female	1	0	0	1	0	0	1
Adult male	7	2	1	4	1	2	4
Yearling male	3	1	1	1	0	1	2
2008 autumn							
Adult female	6	2	4	0	0	5	1
Yearling female	11	1	10	1	0	11	0
Yearling male	7	2	5	0	0	7	0
2009 spring							
Adult female	7	5	2	0	3	3	1
Yearling female	6	6	0	0	3	3	0
Adult male	12	7	4	1	1	9	2
Yearling male	3	2	1	0	2	1	0
2010 spring							
Adult female	4	2	1	1	0	2	2
Yearling female	11	9	1	1	4	6	1
Adult male	17	12	2	3	5	7	5
Yearling male	3	3	0	0	1	0	2
2011 spring							
Adult female	11	7	2	2			
Yearling female	6	4	2	0			
Adult male	14	12	0	2			
Yearling male	5	5	0	0			

Sage-grouse illustrated some distinct tendencies following translocation. Mortality was particularly high for the autumn translocation, with 20 of the known mortalities occurring in the month following release (Table 6). It is not clear why this high mortality occurred, but one possible explanation is that most of the translocated birds were juveniles (Table 3). Most movements were concentrated in and around WDFW Swanson Lakes Wildlife Area and BLMs Twin Lakes Area, which tends to have greater sagebrush cover (Fig. 9). When birds did move long distances off the primary study area, their risk of mortality appeared to be relatively high. There were also 10 mortalities in which the entire bird was recovered. Based on necropsies they have been attributed to: 1 collision with manmade objects (e.g. fences); 3 predators that lost or abandoned their kill; 1 disease; 1 human hunter; 2 were too decomposed to determine cause of death; and 2 awaiting necropsy results. As a result of these observations, additional management efforts have been directed toward marking of fences to make them more visible, removal of unnecessary fences, and posting of additional signs to educate hunters in areas with endemic and reintroduced populations of sage and sharp-tailed grouse.

Table 6. Mortality of greater sage-grouse translocated from southern Oregon to the Swanson Lakes Wildlife Area in Lincoln County, Washington, 2008-2011. At least some of the whole bodies appeared to be the result of collisions with fences. Some are in the process of being examined.

Category	Spring 2008	Autumn 2008	Spring 2009	Spring 2010	Spring 2011	Total
Mammalian (e.g. coyote, badger)	1	2	4	5	1	13
Great horned owl	0	6	1	1	1	9
Raptor	0	4	4	1	4	13
Disease	0	1	0	0	0	1
Manmade Structure (e.g. Fence)	0	1	0	0	0	1
Human Hunter	0	1	0	0	0	1
Unknown predator	3	8	8	7	4	30
Whole body (awaiting necropsy)	0	0	0	2	0	2
Total	4	23	17	16	10	70

As of 31 October 2011 there are 21 males and 17 females that can be located with the aid of telemetry. There are likely additional radio-marked birds present that cannot be located. These additional birds may have had radio transmitters 'slip' off (appears to have happened to at least 6 individuals) or they may be carrying failed transmitters (especially common for the spring 2008 translocation). The presence of these non-monitored birds has been confirmed by direct observation. Future plans involve translocation of 50 greater sage-grouse in spring 2012. No more autumn translocations will be used.

Population monitoring

Radio-marked males are located during the morning period to determine the locations of temporary and permanent leks. An attempt is made to regularly monitor these leks without disturbing the birds. In addition, all potential sage-grouse habitat within 20 km of the release site is inventoried to estimate lek density and attendance of males (Connelly et al. 2003). Surveys are conducted during March and April of each year. No lekking activity was documented in 2008 or 2009. In 2010 on two occasions banded males were seen strutting together with females seen or heard in the area. No unmarked birds were seen strutting with the banded males. In 2011 a lek site was established by males from previous years' releases just north of the 2010 area where limited strutting was seen. The highest count, prior to the 2011 release, was 6 collared males and 1 collared female, no uncollared birds were documented on the lek. For the 2011 releases, the release boxes were setup near the lek and birds were let out at first light. In all cases a portion of the released males joined the lek and strutted.

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