#6

STATE OF NEVADA

DEPARTMENT OF WILDLIFE

Game Division

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MEMORANDUM

September 2, 2016

To: Nevada Board of Wildlife Commissioners, County Advisory Boards to Manage Wildlife, and Interested Publics

From: Brian Wakeling, Administrator, Game Division BPW

Title: **Washington Department of Fish and Wildlife Request for 20 Wild-trapped Female Sage Grouse for Translocation to the Yakima Training Center to Continue Efforts to Increase Genetic Diversity –For Possible Action**

Description: The Department received a request from the Washington State Department of Fish and Wildlife (WDFW), in cooperation with Joint Base Lewis-McChord Yakima Training Center (JBLM YTC), to capture and translocate 20 female sage-grouse from Nevada to JBLM YTC. This request is in support of a collaborative effort by JBLM YTC, WDFW, and the U.S. Fish and Wildlife Service (USFWS) to continue efforts in conducting genetic augmentation of the JBLM YTC sage-grouse population in south-central Washington. The Department is proceeding to fulfill the request and seeks the support of the Commission. The Commission may vote to support the Department's action.

Presenter: Wildlife Staff Specialist Shawn Espinosa

Agenda No: 6

Summary:

Nevada works cooperatively to ensure population viability within a variety of wildlife species among western states and provinces represented in the Western Association of Fish and Wildlife Agencies. One species that merits attention is the Greater Sage-grouse.

The State of Washington has requested permission to capture additional sage-grouse to augment an existing population on the Yakima Training Center (letter attached). Washington has

provided a status report of their progress on maintaining this population of sage-grouse in their state (attached).

Nevada's sage-grouse saw growth in the adult segment of the population last year; recent trend lek data indicates a 19% growth. Favorable conditions prevail throughout much of the occupied sage-grouse range, and the population that occupies the Montana Mountains will likely provide a reasonable source for these birds.

This is a well-studied endeavor with substantial promise. The Department intends to authorize the State of Washington along with the Joint Base Lewis-McChord Yakima Training Center to proceed with capture and translocation of 20 female sage-grouse from Nevada to the Yakima Training Center.

Recommendation:

The Department recommends that the Commission **VOTE TO SUPPORT THE AUTHORIZATION FOR THE CAPTURE AND TRANSLOCATION OF 20 FEMALE SAGE-GROUSE FROM NEVADA TO THE STATE OF WASHINGTON.**

State of Washington
Department of Fish and Wildlife
WILDLIFE PROGRAM
Mailing Address: 600 Capitol Way N, Olympia WA 98501-1091, (360) 902-2200, TTY (360) 902-2207
Main Office Location: Natural Resources Building, 1111 Washington Street SE, Olympia WA

(Summary: intent of the letters is to officially request 20 female sage-grouse from Nevada (fall 2016 release) for translocation to the Yakima Training Center to continue efforts to increase genetic diversity.

August 11, 2016

Mr. Tony Wasley
Director
Nevada Department of Wildlife
6980 Sierra Center Pkway, #120
Reno, Nevada 89511

Dear Mr. Wasley:

Washington State Department of Fish and Wildlife (WDFW) in cooperation with Joint Base Lewis-McChord Yakima Training Center (JBLM YTC) would like to request permission to capture and translocate 20 female sage-grouse from Nevada to JBLM YTC. This request is in support of a collaborative effort by JBLM YTC, WDFW, and the U.S. Fish and Wildlife Service (USFWS) to continue efforts in conducting genetic augmentation of the JBLM YTC sage-grouse population in south-central Washington. The partners involved conducted a similar effort during 2004-2006 in which both Nevada Department of Wildlife (NDOW) and Oregon Department of Fish and Wildlife (ODFW) provided sage-grouse. In 2014 and 2015, we initiated a repeat of the project with 18 female sage-grouse provided by Idaho Fish and Game (IDFG) and would like to continue efforts this fall with this request of 20 additional female sage-grouse to further decrease the chance of deleterious genetic effects on this essential population.

This genetic augmentation project is one of many pro-active conservation efforts being conducted throughout Washington State and on JBLM YTC. We have previously reported on the importance of the JBLM YTC population in maintaining this species in south-central Washington and as a connection between the larger Douglas County population to the north, and two recently established reintroduced populations in the state. Further, JBLM YTC's commitment to sage-grouse conservation is evident in their continued efforts to restore habitat impacted by past wildland fires; implementation of protection measures addressing fire prevention, suppression, and invasive species; recent expansion of their sage-grouse protection area to 77,000 acres; and their continued efforts to monitor the population. While WDFW will be assisting JBLM YTC with capture and

translocation, the installation has the staff and funding to monitor the released birds and have leveraged those resources to secure USFWS Recovery funding to support an associated research proposal. JBLM YTC is also working to secure funds for subsequent genetic analyses in 2017.

We have enclosed reports regarding the current translocation on the YTC, genetic analysis subsequent to the 2004-2006 effort, and current USFWS Recovery Grant funded graduate research proposal related to this request.

We appreciate the support and cooperation that we have received from NDOW on previous efforts and hope to be able to work together in the near future with approval of this request. Please give this request your full consideration. If you have any questions about this project, please contact Mike Schroeder (509) 686-2692.

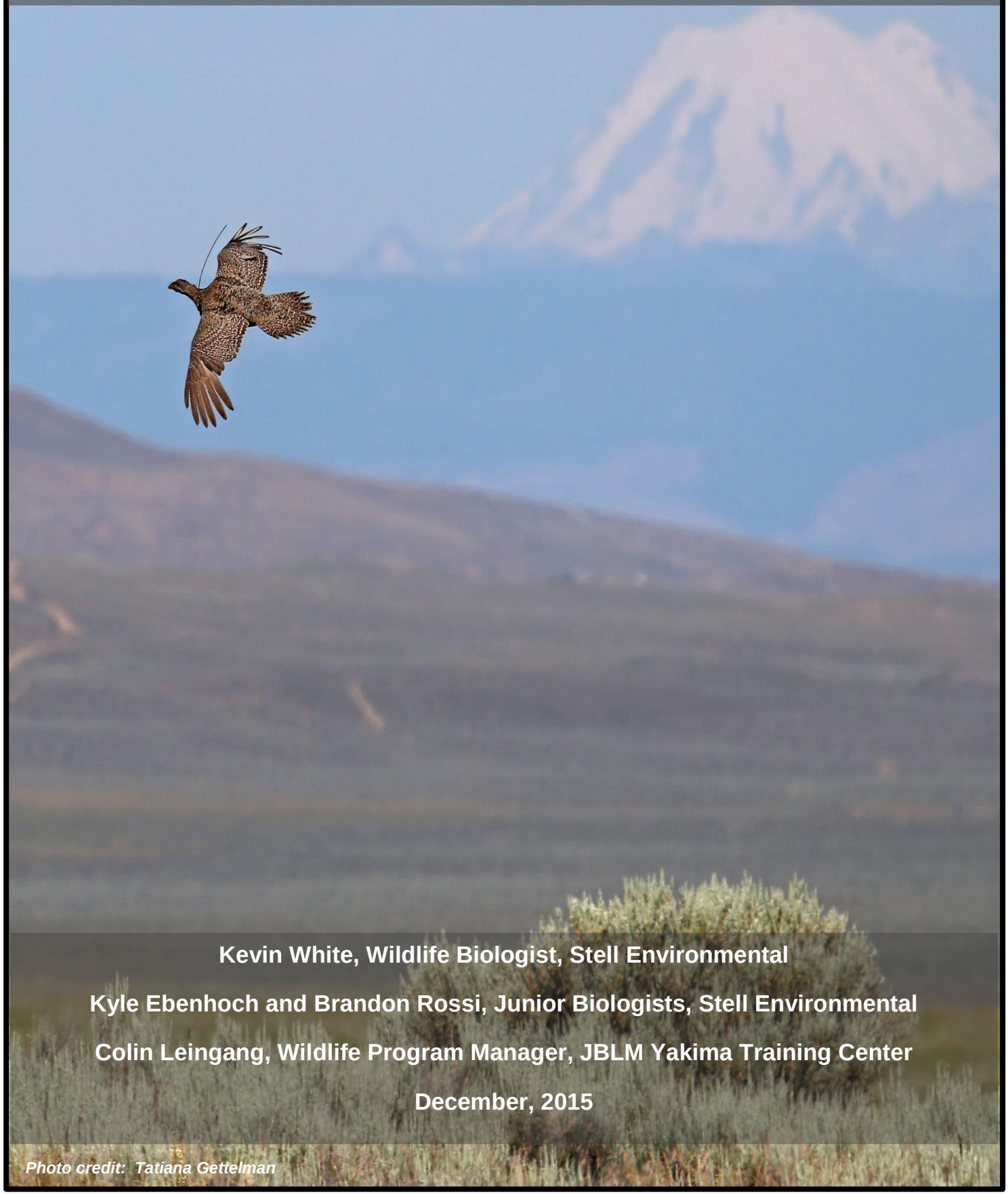
Sincerely,

Eric Gardner, Assistant Director
Wildlife Program

Enclosures

cc: Shawn Espinosa

Translocation of Greater Sage-Grouse from Owyhee County, ID to Yakima Training Center, Yakima, WA 2014-2015: Progress Report



Kevin White, Wildlife Biologist, Stell Environmental

Kyle Ebenhoch and Brandon Rossi, Junior Biologists, Stell Environmental

Colin Leingang, Wildlife Program Manager, JBLM Yakima Training Center

December, 2015

Photo credit: Tatiana Gettelman

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INTRODUCTION

Greater sage-grouse (*Centrocercus urophasianus*; hereafter sage-grouse) numbers have rapidly declined and are currently reduced to inhabiting 56 percent of their historic range, which once spanned 1.2 million km^2 (Schroeder et al. 2004, USFWS 2013). Within Washington State, only two endemic populations remain with one in Douglas County (Moses-Coulee population) and the other in Yakima and Kittitas counties (Yakima Training Center [YTC] population). These two sage-grouse populations occupy only 8 percent of their historic range (Schroeder et al. 2014). Between 1970 and 2014, Washington has observed an approximate 80 percent loss in the total sage-grouse population (Schroeder et al. 2014). Recently, two new populations have been re-introduced into Washington: the Crab Creek population at Swanson Lakes Wildlife Area, and the Yakama Nation population near Toppenish, WA (Schroeder et al. 2014). Including these reintroductions, the 2015 sage-grouse population estimate for Washington was 1,004 individuals (Stinson 2015).

The continued decline of sage-grouse populations has been attributed to fragmentation and habitat loss associated with agricultural and urban encroachment; livestock grazing; energy development; fire; and to a lesser extent, military training (Connelly et al. 2004). Although there are no accurate harvest rates from historical hunting data, overharvest was believed to be a factor in population declines and legal sage-grouse hunting in Washington ended in 1988 (Stinson 2004). Even though population estimates remain low in Washington State and the probability of extinction for both the Moses Coulee and YTC population is high (Garton et al 2015), the U. S. Fish and Wildlife Service (USFWS) removed the species range-wide as a Candidate for listing under the Endangered Species Act (ESA), citing multiple ongoing conservation efforts involving state and federal agencies, private landowners, and various organizations to include those in Washington as well (USFWS 2015).

Sage-grouse populations in Washington are geographically and genetically isolated from the majority of other populations across their current distribution (Oyler-McCance et al. 2005, Zink 2014, USFWS 2015). Low genetic diversity can lead to decreased fitness and limit a population's ability to adapt to fluctuating environmental conditions (Westemeier et al. 1998, Brook et al. 2002). Furthermore, isolated populations have an increased risk of inbreeding depression, which makes them more susceptible to population pressures, such as parasites and disease transmission (Westemeier et al. 1998, Oyler-McCance et al. 2005). Given the lack of a recent population bottleneck, within the past 0.2-4.0 generations (Luikart & Cornuet 1998), and the known drastic reduction in population size since 1970, it can be concluded that these declines have been constant for decades (Oyler-McCance et al. 2005).

Translocating sage-grouse from other genetically analogous populations continues to be used as a means of augmenting population numbers and increasing genetic heterogeneity. By introducing different alleles from different populations and allowing them to proliferate over multiple generations through random mating, genetic diversity is thereby elevated within a population. However, only 3 of 56 translocation attempts have been deemed successful between 1933 and 1997 (Reese and Connelly 1997). Success for those translocations was simply defined in terms of subsequent lek attendance, abundance, and whether sage-grouse still occupied that given area. This is inherently biased towards more recent studies which may partially explain

the low rate. Detailed investigations into translocating sage-grouse have been performed more recently (Strawberry Valley, UT (Baxter et al. 2008); Clear Lake NWR, CA (Bell & George 2012); Anthro Mountain, UT (Gruber 2012); Lincoln County, WA (Schroeder et al. 2014) and attribute increased lek attendance, survival, and upward population trends to their relative success.

A genetic augmentation of the sage-grouse population on YTC was conducted between 2004 and 2006. Short-term objectives of that effort were to evaluate the feasibility of trapping, transporting, and releasing birds from source populations to the installation and ultimately determine movements, survivorship, and reproductive success of translocated sage-grouse as it relates to genetically augmenting a population. The long-term goal of the project was to facilitate responses to and changes in genetic diversity of the YTC population (ED 2009). During this initial project, a total of 61 sage-grouse were translocated from Hart Mountain National Antelope Refuge (31 females, 1 male, and 2 unknown) and Humboldt and Elko counties in Northern Nevada (22 females, and 5 males). Based on post-translocation genetic testing performed in 2011 on samples collected on YTC, sage-grouse demonstrated recent admixing of genetic material between resident and translocated populations which may be nearing equilibrium (Small et al. 2011). Movements, productivity, and survival of these translocated sage-grouse were all within the observed ranges from similar studies (Musil et al. 1993, Baxter et al.2008, Bell & George 2012, and Gruber 2012). Despite these consistencies, the overall YTC population numbers continued to decline (White 2015*a*) which accentuated the need to conduct another genetic augmentation.

This progress report details a second effort to augment the genetics of the YTC population through translocation efforts that occurred in 2014 and 2015 with the overall goal of releasing an additional 40 sage-grouse to obtain a comparative sample size to the 2004-2006 augmentation. This report focuses on providing preliminary results of movements, reproductive success, and survivorship of translocated sage-grouse on YTC in 2014 and 2015. Results were compared to similar translocation efforts for sage-grouse across Washington, Idaho, Utah, and California.

STUDY AREA

Sage-grouse captured in Owyhee County, ID were translocated to the YTC, (Longitude 120° 20′ Latitude 46°40′) a 1,324 km^2 area of shrub-steppe habitat owned by the U.S. Army within Yakima (664 km^2) and Kittitas (660 km^2) counties, Washington (Figure 1). The area lies within the Columbia Basin sage-grouse management zone (VI) and within the YTC Priority Area of Conservation (PAC) as identified by the Conservation Objectives Team (COT) report (USFWS 2013). This area has remained relatively undeveloped except for army training facilities, historic homesteads, and 2,652 kilometers of improved and unimproved roads making YTC one of the largest contiguous blocks of shrub-steppe habitat in Washington State. Military training is the primary land use incorporating both active and reserve component forces that conduct realistic training exercises to enhance unit readiness. Recreational opportunities for hunters and other outdoor enthusiasts are provided. Spatial and temporal land-use restrictions occur annually over 314 km^2 of habitat from 1 February to 15 June to reduce disturbance from military and recreational activity during the sage-grouse breeding, nesting, and brood-rearing periods.

Interstates 90 and 82 bound the north and west respectively, private land abuts the southernmost portion, and the Columbia River delineates the eastern boundary (Figure 2) making YTC a relatively isolated area. Due to the isolation, minimal dispersal occurs between other adjacent PACs (Yakama Indian Nation ~30 km south, Moses Coulee ~50 km north). The climate is characterized by hot, dry summers and cool, wet winters. During 2012-2015 mean temperatures in January ranged from -8° C to 6° C and mean temperatures in July ranged from 33° C to 35° C. Mean annual precipitation between January 2012 and July 2015 was 16.3 cm with 65% occurring as snow during November through March (U.S. Department of Commerce Climatological Database, Yakima Air Terminal).

Elevation ranges from 126 m to 1,283 m. Four mountain ridges, Manastash, Umtanum, Boylston, and Yakima bisect YTC in an east-west direction with many lateral ridges traversing north and south. Land between the mountain ridges is characterized by flat valleys, rolling hills, and steep draws.

YTC is within the big sagebrush (*Artemisia tridentata)* – bluebunch wheatgrass (*Pseudoroegneria spicata)* vegetation zone (Daubenmire 1988). Perennial grasses such as bluebunch wheatgrass, Sandberg bluegrass (*Poa secunda*), and Idaho fescue (*Festuca idahoensis*), dominate the upland understory. The overstory is comprised of shrubs including big sagebrush, threetip sagebrush (*A. tripartita*), rubber rabbitbrush (*Ericameria nauseosa*), yellow rabbitbrush (*Chrysothamnus viscidiflorus*) and antelope bitterbrush (*Purshia tridentata*). Scabland sagebrush (*A. rigida*) is often found on shallow soils along ridge tops. Rubber rabbitbrush, yellow rabbitbrush, and cheatgrass (*Bromus tectorum*) typically dominate disturbed areas. Dominant riparian species include willows (*Salix spp.)*, roses (*Rosa spp*.), Lewis' moc orange (*Philadelphus lewisii*), golden currant (*Ribes aureum*), several species of rushes (*Juncus spp.)* and sedges (*Carex spp*.).

Sage-grouse predators found on YTC include, but are not limited to coyotes (*Canis latrans*), American badgers (*Taxidea taxus)*, weasels (*Mustela spp*.), bobcats (*Lynx rufus)*, common ravens (*Corvus corax*), golden eagles (*Aquila chrysaetos*), northern harriers (*Circus cyaneus*), red-tailed hawks (*Buteo jamaicensis*), and Swainson's hawks (Buteo swainsoni).

METHODS

Translocations

Sage-grouse hens were captured and translocated in March 2014 and 2015. Trapping was conducted under Idaho Fish and Game (IDFG) Wildlife Bureau collection permit number 140225 issued on 10-March-2014. Additional trapping coordination was conducted between YTC staff and IDFG's southwest regional office staff.

All sage-grouse were trapped using the night-lighting method on and near known active leks (Giesen et al. 1982, Wakkinen et al. 1992), and following the sage-grouse translocation recommendations of Reese and Connelly (1997). After capture, all birds were brought back to a processing area where a uniquely-numbered metal leg band and an 18-22 g necklace-style transmitter (Advanced Telemetry Systems series A4000 Insanti, MN) with 8 hr mortality

sensors were attached. Sex and age were determined for all captured birds based on plumage

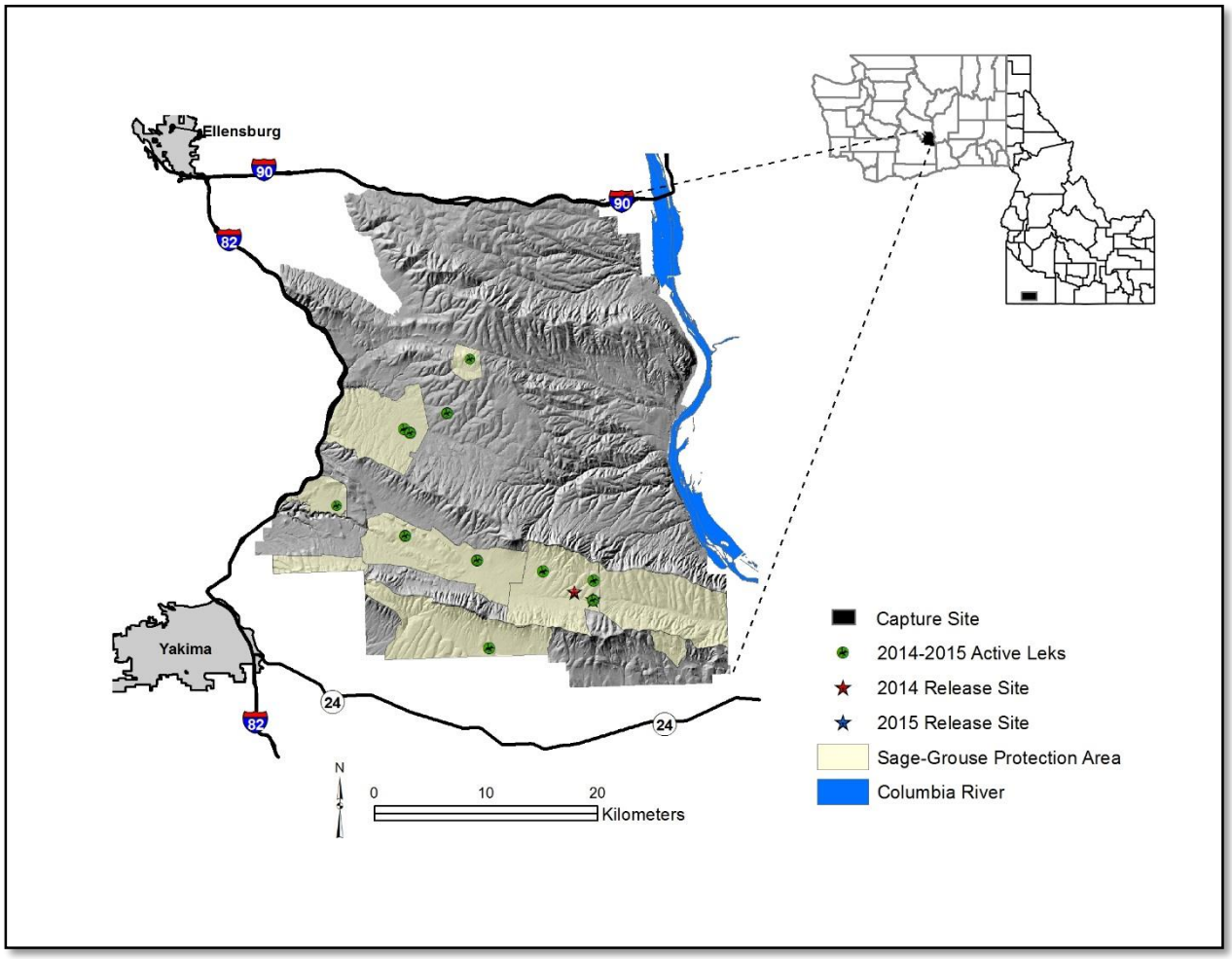

Figure 1. Capture and release locations of sage-grouse translocated to YTC, Yakima, WA in 2014 and 2015

and length and condition of the 9th and 10th primaries (Beck et al. 1975, Braun and Schroeder 2015). Additionally, feathers were collected (2014 and 2015) to allow for future genetic analyses and blood was drawn to test for disease (2015 only). Small pet carriers were used during transport and cat litter was added to reduce contact with feces.

Data Collection

All collared sage-grouse were relocated a minimum of twice weekly from the ground using a telemetry receiver (ATS R-4000 Advanced Telemetry Systems, Isanti, MN), omni-directional roof-mount antenna, and 3-element Yagi antenna. Data points were obtained visually or by triangulating the radio-signals. To triangulate the location of each bird, a minimum of three bearings are obtained at angles-of-incidence greater than 35° and less than 145° and locations are recorded with a GPS unit using Universal Transverse Mercator (UTM) coordinates (Schroeder et al. 2014). Corresponding bearings were entered into the program Locate III

(Version 3.1) where an estimated point and associated error were calculated.

Data analysis

Data analysis was mostly partitioned with respect to age (yearling or adult) and time covariates. For time, the first interval spanned from each respective release date to 31 May, which will hereafter be referred to as time interval 'I'. May 31 marks the end of the spring season as denoted by Stonehouse (2013) in Lincoln County, WA. An eight day difference between release dates in 2014 and 2015 resulted in the total length of 'I' differing across years. The second time interval, 'P', encompassed all time after 31 May of the respective release year until the cut-off date (10 November 2015) for data analysis. Sage-grouse released in 2014 are denoted as ID'14 and ones released in 2015 are denoted as ID'15. Monitoring of sage-grouse locations and fate is still on-going and attempts will be made to replace transmitters at the end of their life-cycle for birds that continue to survive.

Movement

Average maximum dispersal distances from release sites were calculated for all ID'14 and ID'15 sage-grouse across the two covariates (age and time). The maximum dispersal point for each sage-grouse was identified as the single furthest point from its respective release site. The straight line distance between these two points was then calculated using the Near tool in ArcGIS (ArcGIS Version 10.1, Environmental Systems Research Institute, Redlands, CA) and averaged across the two covariates.

Average daily distance moved was also identified for all ID'14 and ID'15 sage-grouse across the same covariates. Using the Point Distances tool in Geospatial Modeling Environment (GME Version 0.7.2.0), the straight line distance was calculated between each consecutive relocation point for each sage-grouse and then divided by the number of days between consecutive points (Bruce et al. 2011) to obtain the average daily distance moved.

Home Range

We created 95% fixed kernel home ranges (Worton 1989) and 50% fixed kernel core areas (Samuel et al. 1985) with the plug-in bandwidth estimator (Gitzen et al. 2006, Jones et al. 1996) in GME. Home range size (km^2) was calculated in ArcGIS. Due to sample size constraints with home range estimation; sage-grouse with < 30 data points were not analyzed (Kernohan et al. 2001). Home range size could not be analyzed with respect to time, due to insufficient sample sizes of telemetry locations within each of the specified time periods. Therefore, home range size was analyzed for all telemetry points for each individual since the date of their release until 10 November, 2015. Additionally, subsequent relocation points from nesting hens were removed to reduce bias and autocorrelation. Composite home ranges of resident (White 2015*b*) and translocated sage-grouse (time interval P) as well as core areas were projected using ArcGIS and 2-dimensional overlap was calculated (Millspaugh et al. 2004).

Productivity

Nesting activity of translocated sage-grouse was monitored to determine the distance hens nested from the release site, nest propensity, nest success and brood success. The distance hens nested from their release site was calculated from the straight line distance using the near tool in ArcGIS. Nest propensity is defined as the proportion of radio-marked sage-grouse which attempt to initiate a nest. A nest is deemed successful if at least 1 egg hatches. Apparent nest success was calculated as the proportion of successful nests compared to the number of nesting attempts (Schroeder 1997). Sage-grouse nesting attempts were documented following visual observations after triangulating from a distance of 30-40 m (Schroeder 1997) or after two different individuals performed 2 close range (roughly 30-40 m) triangulations approximately 2 days apart resulting in a similar (≤ 10 m) estimated location. Once a visual or estimated nest location was documented, we left the area to minimize disturbance (Fischer et al. 1993, Sveum et al. 1998) and monitored the incubation status 2-3 times a week from a greater distance (≥ 200 m) until the nest hatched or failed. Once the hen vacated the nest, clutch size was estimated by counting egg shells. If a nest failed, the hen was continually monitored 2-3 times a week to determine renesting rates.

After successful hatch, the brooding hen was located a minimum of 2 times weekly and initial brood size was assessed at 4 weeks. Nocturnal spotlight brood counts were used additively to the typical daytime brood flushes in an attempt to obtain more accurate brood counts and recruitment numbers (Dahlgren et al 2010). Brood survival (≥ 1 chick surviving) was assessed at 50 days post-hatch (Schroder 1997) and calculated as the proportion of successful broods compared to the number of successful nests (Aldridge 2001).

Survival

Biweekly sage-grouse locations were used to determine the survival of each individual. Mortality dates were recorded as the mid-point between the last known live location and the first known mortality date (Schroeder 1997). Survival was estimated using a Kaplan-Meir estimate (Kaplan and Meier 1958) across age classes and time intervals ‘I’ and ‘T’ where ‘T’ is the total survival from release to 10 November 2015. Annual survival for ID’14 sage-grouse was also calculated.

RESULTS

Translocation

Ten sage-grouse hens (8 yearling and 2 adult) were captured on 24 March 2014 in Owyhee County, Idaho, transported, and released on the YTC in Yakima, WA in the early evening of 25 March. A second translocation effort was conducted on the night of 15 March 2015 when 9 female sage-grouse were captured; however, two mortalities occurred during processing so only 7 (5 yearling and 2 adult) were transported and released near YTC’s largest lek on 16 March (Figure 2). One additional sage-grouse (yearling) was captured on the night of 16 March and released on 17 March in the same location (Table 1, Figure 2). All sage-grouse

were released on YTC approximately 18 hours after capture.

Table 1. Capture locations for 2014 and 2015 translocations. All coordinates are in WGS 84 datum.

2014			**2015**		
Capture Locations		*Age*	*Capture Locations*		*Age*
42.24085	116.00961	J	42.24794	116.01086	J
42.23999	116.00754	J	42.24037	116.01065	J
42.24085	116.00961	J	42.24033	116.01022	J
42.22567	115.98302	J	42.21765	115.99837	J
42.22567	115.98302	J	42.21765	115.99837	J
42.22567	115.98302	J	42.22863	115.98300	J
42.21547	116.00063	J	42.22245	115.99489	A
42.20699	116.01057	J	42.24794	116.01086	A
42.24348	116.00580	A	42.22362	115.99197	A
42.19723	115.99168	A	42.22355	115.99187	A

Movement

Between 2014 and 2015 1,170 locations were obtained for the 18 radio-marked translocated sage-grouse. The largest dispersal distance for ID'14 was 47.85 km while the largest for ID'15 was 55.80 km. Average maximum dispersal distances for both ID'14 and ID'15 sage-grouse were slightly higher during time 'I' than time 'P' (Table 2). Similarly, average daily movement was higher for ID'14 and ID'15 during time 'I' than time 'P'. ID'14 yearlings dispersed further than adults; however, the opposite trend was noted for ID'15 sage-grouse (Table 2). On average, ID'15 adults and yearling exhibited larger daily movements than ID'14.

Home Range

Twelve of 18 sage-grouse contained a sufficient sample size to estimate home range. Home range sizes for ID'14 were much smaller than for ID'15 (Table 3). Total occupied area was considerably lower for translocated sage-grouse (285 km^2) compared to the radio-marked residents (430 km^2) with only 36% of the translocated sage-grouse distribution overlapping the resident sage-grouse distribution (Table 4, Figure 2). Similarly, the translocated 50% kernel density core-use area was lower (37 km^2) compared to that of the resident sage-grouse (89 km^2) with only a 22% overlap

Table 2. Average ($\bar{X}$) maximum dispersal distance (km) ± standard error and the average daily distance moved (km) ± standard error for ID'14 and ID'15 sage-grouse across time 'I' and 'P'. Results of age class (A = adult; Y = yearling) dispersal and distance moved were calculated from time since release to 10 November 2015.

	Maximum Dispersal (km)		**Distance Moved (km)**	
Cohort	*ID'14*	*ID'15*	*ID'14*	*ID'15*
$\bar{x}_I$	19.77 ± 3.87	20.23 ± 6.02	1.34 ± .16	2.27 ± .28
$\bar{x}_P$	18.73 ± 4.16	18.06 ± 4.87	0.54 ± .03	0.80 ± .08
$\bar{x}_A$	18.37 ± 2.98	35.36 ± 13.29	0.63 ± .05	1.75 ± .25
$\bar{x}_Y$	22.36 ± 4.19	20.28 ± 4.38	0.58 ± .11	1.04 ± .10

$\bar{X}_I$ = Average maximum dispersal and average daily distance moved of translocated sage-grouse from release until 31 May of the respective release year.

$\bar{X}_P$ = Average maximum dispersal and average daily distance moved of translocated sage-grouse from 1 June of the release year until 10 November, 2015.

$\bar{X}_A$= Average maximum dispersal and average daily distance moved of adult translocated sage-grouse from time since release until 10 November 2015.

$\bar{X}_Y$= Average maximum dispersal and average daily distance moved of yearling translocated sage-grouse from time since release until 10 November 2015.

Table 3. 95% fixed kernel home range size (mean ± SE) of ID'14 and ID'15 sage-grouse with ≥ 30 data points since time of release.

Home Range Size (km^2)			
Cohort	*ID'14 (n=6)*	*ID'15 (n=6)*	*All (n=12)*
$\bar{x}$	121 ± 31.72	392 ± 111.85	256 ± 68.87
Range	24-242	55-823	24-823

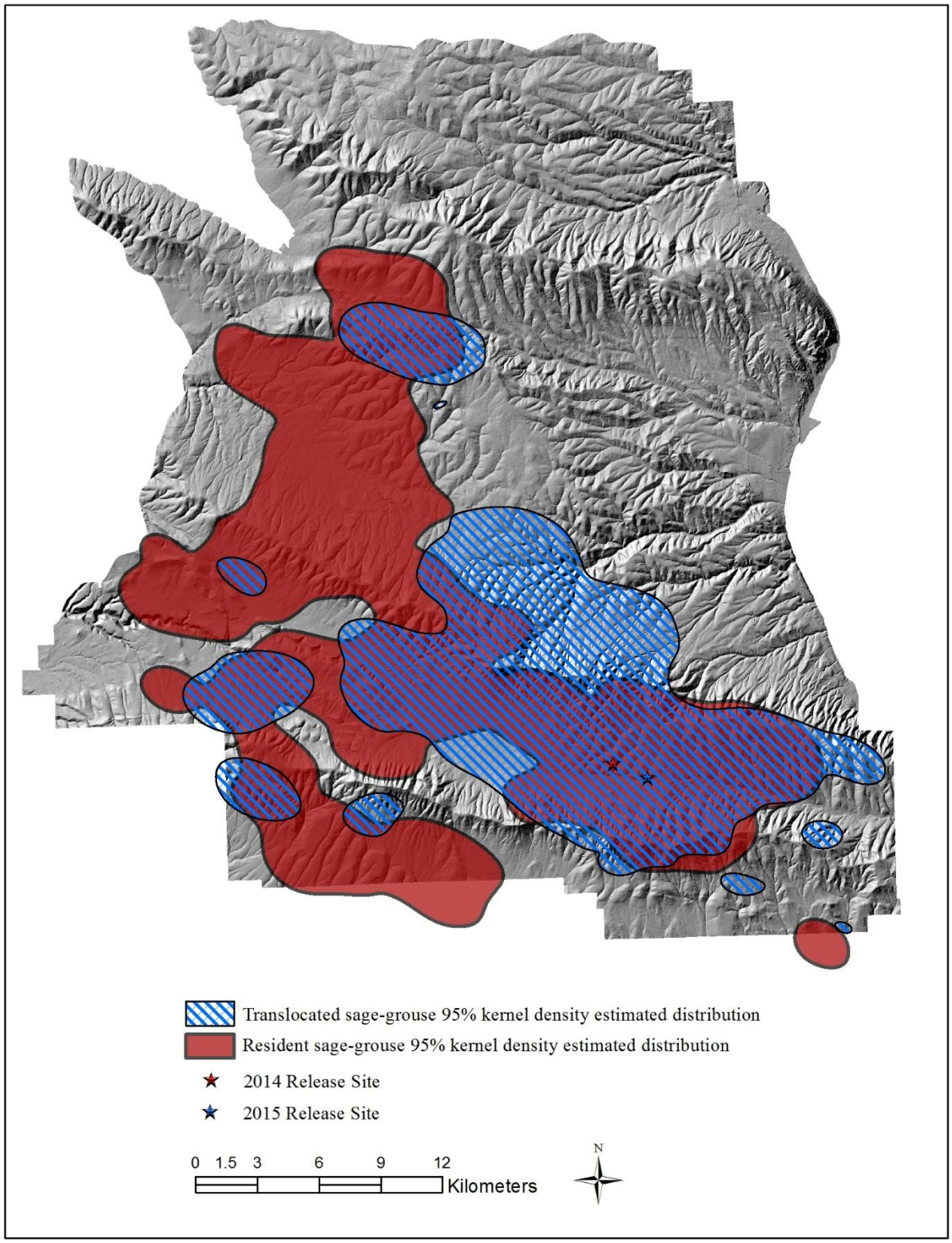

Figure 2. 95% kernel density estimate of resident (2012-2015) and translocated sage-grouse (ID'14 and ID'15 combined) distribution, including overlap of both cohorts, on the YTC, Yakima, Washington.

Table 4. 95% and 50% kernel density estimates for resident and translocated sage-grouse (ID'14 and ID'15 combined) distribution along with their corresponding shared space (% 2-D overlap) on the YTC, Yakima, Washington.

Area Occupied km^2			
	Resident	Translocated	Overlap
95% Distribution	430	285	190 (36%)
50% Core Area	89	37	23 (22%)

Productivity

ID'14 hens nested a greater distance (1.4 km) from their release compared to ID'15 released hens (837 m). Nest propensity for ID'14 was 60% lower than the resident rate (Table 5). ID'15 nest propensity rates were lowest, followed by ID'14 individuals and finally that of resident sage-grouse (Table 5). Conversely, nest success rates for translocated sage-grouse in 2014 and 2015 were higher than those of resident sage-grouse during the same years.

Clutch size was smaller for ID'14 and ID'15 release cohorts during their first nesting season when compared to the clutch size from resident sage-grouse (Table 5). However, clutch size of the ID'14 release cohort was greater in 2015 when compared to the resident clutch size that year. Caution should be taken when interpreting these results as sample sizes are dissimilar. While these nest success rates for translocated individuals may be promising, brood survival has been low (1/9, 11%; Table 5). When contrasting the two brood flush methods used this season (daytime vs. spotlight), an average of 2.0 additional chicks/brooding hen were detected using the spotlight method.

Table 5. Nesting metrics from ID'14 and ID'15 translocated sage-grouse compared to resident sage-grouse on the YTC, Yakima, Washington.

	2014		**2015**			
Cohort	*ID'14*	*Resident*	*ID'14*	*ID'15*	*All ID*	*Resident*
# Monitored	10	12	5	8	13	18
Nest Propensity	4/10 40%	12/12 100%	3/5 60%	3/8 38%	6/13 46%	15/18 83%
Nest Success	4/4 100%	5/14[b] 36%	2/3 67%	3/3 100%	5/6 83%	4/15[b] 27%
Brood Survival[s]	1/4 25%	2/5 40%	0/2 0%	0/3 0%	0/5 0%	2/4 50%
Clutch Size	4.3 (n=3)	6.9 (n=10)	8.3 (n=3)	6 (n=3)	7.1 (n=6)	7.8 (n=7)

[a] = calculated from number of successful nests
[b] = renesting attempts accounted for (2 in 2014 and 1 in 2015)

Survival

Survival for the ID'15 cohort was higher than the ID'14 cohort over both time intervals (Table 6). Similarly, adults and yearlings from the ID'15 cohort had higher survival rates than their ID'14 counterparts. The annual survival rate of the ID'14 cohort was 50%.

Table 6. Kaplan-Meir survival rates for ID'14 and ID'15 sage-grouse as a ratio and percentage across time covariates 'I' and 'T' and age class.

	Survival Ratio (%)	
Cohort	*ID'14*	*ID'15*
$\bar{X}_I$	8/10 (80)	8/8 (100)
$\bar{X}_T$	1/10 (33)[a]	5/8 (62.5)
Annual	5/10 (50)	-
$\bar{X}_T^A$	0/2 (0)	1/3 (33)
$\bar{X}_T^Y$	1/8 (50)[a]	4/5 (80)

$\bar{X}_I$ = Survival of all sage-grouse from release date until May 31 of the release year.

$\bar{X}_T$ = Survival of all sage-grouse from release date until November 10, 2015.

$\bar{X}_T^A$= Survival of adult sage-grouse from release date until November 10, 2015.

$\bar{X}_T^Y$= Survival of yearling sage-grouse from release date until November 10, 2015.

[a] This estimate takes into account 1 slipped transmitter and 2 collar failures so actual survival is likely different because the fates of those 3 females are unknown and were therefore censored from the analysis. The ratio is expressed as what was known to be alive with a functioning radio transmitter at the end of that time period.

DISCUSSION

Translocations

Sage-grouse were captured following the translocation recommendations set forth by Reese and Connelly (1997); information obtained from the successful sage-grouse reintroduction in Lincoln County Washington (Schroeder et al. 2014); and the first genetic augmentation effort (2004-2006) on YTC. The only exception was that birds were released in the late afternoon rather than held overnight and released the next morning while resident males were displaying on the lek. Likewise, all other releases at YTC during the 2004-2006 augmentation effort were also performed in the late afternoon. It was assumed that releasing translocated sage-grouse as soon as possible would decrease their stress levels and outweigh the potential added benefit of immediate integration with resident sage-grouse had they been held longer in transport boxes and released in the early morning on an active lek. It is unknown whether the

ID'14 and ID'15 hens would have integrated quicker into the population or stuck to the lek near where they were released since they were not released in the early morning. It was assumed that integration for most of the sage-grouse released both years was relatively quick (roughly 1-2 weeks) since they were observed with resident sage-grouse during monitoring efforts. Soft releases on the lek in the early morning while males are displaying has been demonstrated to be a successful method at quick integration with other sage-grouse (Schroeder et al. 2014). This method may help increase the probability of breeding and therefore increase nest propensity rates of translocated sage-grouse in future translocations on YTC.

Movement

Sage-grouse on YTC are considered non-migratory; however, habitat use varies seasonally (Livingston and Nyland 2002). Resident sage-grouse probably make these seasonal transitions easier than translocated individuals as the latter need to make large, exploratory movements when attempting to identify suitable habitat after initial release. Estimates of resident sage-grouse movements on YTC were not calculated so no comparison to ID'14 and ID'15 were made at this time. Gruber (2012) found that translocated hens had a slightly higher average movement distance when compared to resident sage-grouse. Seasonal movements across the species' range vary from 5 km (no migration, Wallestad 1975) to over 100 km (Leonard et al. 2000). The source population from which ID'14 and ID'15 sage-grouse were captured exhibit seasonal migrations with birds moving south to summer and returning to leks in the winter (Wik 2002). This may explain why some translocated hens made large movements months after their release.

Average maximum dispersal distances for ID'14 and ID'15 were much larger than those observed for the successfully translocated population in the Sawtooth Valley, ID (11.4 km; Musil et al. 1993), Anthro Mountain, UT (7.8 – 8.3 km; Gruber 2012) and the reintroduced sage-grouse population in Lincoln County, Washington (14 km; Schroeder et al. 2014). Similarly, the average distance moved between relocation points was also much higher during this study than for those translocated individuals at Anthro Mountain, UT (1.3 km and 1.7 km; Gruber 2012). The higher dispersal and daily movement distances of translocated sage-grouse on YTC from release until 31 May compared to time after 31 May demonstrates that translocated sage-grouse exhibit large exploratory movements, likely in search of suitable habitat before settling down. These extended movements increase predation susceptibility and have been shown to decrease overall survival (Kurzejeski and Root 1988, Beck et al. 2006). This assumption would seem to indicate that the YTC augmented population should have a lower survival rate than either of the aforementioned populations.

Extensive movements of translocated sage-grouse may be influenced by the rate at which they integrate with the resident population. This integration rate is often quantified through flocking observations with residents (Hennefer 2007). To track integration rates on YTC, monitoring efforts would need to consistently flush all newly translocated females and record all conspecifics, which was not a main objective of this research. Therefore, the rate at which ID'14 and ID'15 sage-grouse integrated with resident sage-grouse is unknown; however, several translocated sage-grouse were observed flocking with resident radio-marked sage-

grouse in the first couple weeks post release. It has been observed that translocated sage-grouse use resident sage-grouse to learn seasonal habitats within a new area (Gruber 2012, Duvuvuei 2013). If this behavior is present on YTC, it could imply that the translocated individuals that remained on YTC were integrated into the population, regardless of translocation year. Increasing the sample size of radio-marked resident sage-grouse during future translocations should help assess the rate of integration.

Extensive movements of translocated sage-grouse may lead individuals beyond YTC boundaries, which requires additional monitoring efforts. In 2015, sage-grouse movement's off-installation were monitored more frequently and consistently, allowing for greater understanding of spatiotemporal land-use beyond YTC. In 2014, 5 of 10 translocated sage-grouse were relocated off-installation, and similarly in 2015, 5 of 8 were relocated outside the YTC. The number of off-installation movements may be similar between years but the number and accuracy of relocations increased in 2015. Several of the sage-grouse that frequented lands beyond YTC's boundary returned. This is likely an indication that large tracks of suitable habitat do not readily exist beyond YTC's boundary to meet their year-round habitat requirements. However, it is important to continually monitor off-installation use and large movements beyond YTC's boundary as it provides managers with information of possible movement corridors that could link adjacent sage-grouse populations.

Home Range

YTC translocated sage-grouse home range size (256 km^2) was much larger than what was found at Anthro Mountain, Utah (59 km^2; Gruber 2012); in Lincoln County, Washington (65.63 km^2, Stonehouse 2013); and the YTC female resident home range size (66 km^2, White 2015*b*). Translocated sage-grouse on YTC are only using 36% of the habitat that resident sage-grouse occupy; however, they are providing information on additional utilized areas beyond what has been mapped as the current distribution for resident YTC sage-grouse. When compared to the core-use overlap of resident sage-grouse to translocated sage-grouse from Anthro Mountain, UT (73.4%); YTC translocated sage-grouse have a much lower overlap (22%). This may partially be explained by the smaller sample size on YTC (n=18) compared to the 60 sage-grouse translocated to Anthro Mountain. There is also the potential that the overlap between the resident and translocated sage-grouse on YTC was a function of the quantity and quality of suitable habitat when compared to Antho Mountain. Gruber (2012) determined that the home range size and the substantial percentage of overlap encompassed the majority of the suitable habitat found at Anthro Mountain. This could mean that YTC has a larger suitable area than Anthro Mountain allowing for sage-grouse to occupy a wider range of areas whereas Anthro Mountain suitable habitat is likely more constricted.

Productivity

Nest propensity from this study was similar to that from the 2004-2006 YTC augmentation (41-75%; ED 2009), the Strawberry Valley, UT augmentation (39% & 73%; Baxter et al 2008), the Anthro Mountain, UT augmentation (50-100%; Gruber 2012) but lower when compared to the source population in Idaho (72%; Musil et al. 2012). ID'14 and ID'15 hens had lower nest propensity rates in their first nesting season as one might predict due to translocation related

stress or inability to find suitable nesting locations. Sample sizes in the 2014-2015 study were smaller and are therefore not directly comparable. Presumably, range-wide average rates (80%; Crawford 2004) and YTC resident rates in 2014-2015 are all higher than those seen from translocated females. ID'14 and ID'15 hens nested closer to their release sites than the distance hens nested from their lek of capture from the source population (1.7 km; Wik 2002; 3.4 km; Musil et al. 2012). Suitable nesting habitat may be closer in proximity to the lek at which sage-grouse were released on YTC compared to the available habitat around leks at which sage-grouse were captured in Idaho.

Apparent nest success from this study was much higher than the 2004-2006 YTC augmentation (44-79%; ED 2009); the Strawberry Valley, UT augmentation (62-76%; Baxter 2008); the Anthro Mountain, UT augmentation (25-55%; Gruber 2012); the Lincoln County reintroduction (42-62%; Schroeder 2014); the rate from the source population (46%; Wik 2002; 60%; Musil et al. 2012) and the 2014-2015 YTC resident rate; however, sample sizes are dissimilar between studies. Renesting rates of sage-grouse from the source population was generally low (20%; Wik 2002) and no sage-grouse translocated to YTC attempted to renest. These two metrics (nest propensity and success) indicate a high level of local adaptability, which is one of the parameters Oyler-McCance (2005) thought would be preserved when choosing a geographically close source population.

Clutch size of sage-grouse nests varies, but often ranges from 6 to 9.5 (Connelly et al. 2000) with maximum clutches able to reach 12 eggs (Schroeder 1997). Average clutch size for translocated sage-grouse to YTC in 2014 and 2015 was greater than the clutch size reported for the source population (6.5) in 2002 (Wik) and slightly lower than the resident sage-grouse rate on YTC between 2012 and 2015 (White 2015*b*). Gruber (2012) reported an average clutch size of 8.3 and 7.1 for resident and translocated sage-grouse respectively which is very similar for both rates on YTC.

Brood survival is a metric that differs considerably among studies, and should be a primary metric of concern to managers. Brood survival of translocated sage-grouse during this study was lower than the 2004-2006 augmentation (0-80%; ED 2009); the Strawberry Valley, UT augmentation (47% & 58%; Baxter 2008); the Lincoln County reintroduction (≥ 50% brood survival each year since 2009; Schroeder et al. 2014); the source population (38% and 83%; Wik 2002) and the 2014-2015 YTC resident rate. The newly adapted spotlight brood flush methods will provide more comprehensive brood counts and a better understanding of brood survival during future monitoring efforts. However, additional research is needed on brood rearing habitat, brood predation, and other confounding factors that may affect brood survival.

Survival

Survival rates for ID'15 were higher for both time intervals. This may be expected for time 'T' given the greater amount of time ID'14 sage-grouse were monitored and exposed to predation pressure compared to ID'15. Low adult and yearling survival has been identified as a demographic parameter that may contribute to population declines (Johnson and Braun 1999). Age-specific survival rates for adult females (Table 6) from this study are biased by small

sample sizes. Nevertheless, the annual survival for ID'14 (50%) is a viable metric and is within the range that was observed during the 2004-2006 augmentation on YTC (38-83%; ED 2009). Conversely, the ID'14 annual rate is lower than that reported by Lincoln County, Washington (55%; Schroeder et al. 2014); the estimate of 62.4% by Bell and George (2012); 60% by Baxter (2008), and range-wide estimates (55-75%; Schroeder et al. 1999). When incorporating total survival for ID'14 since release, the estimate is markedly lower. In comparison to the source population (58% adult and 22% yearling; Wik 2002; 36%; Musil et al. 2012), the annual ID'14 rate and the rate of ID'15 since release is higher. Preliminary data suggest that survival of translocated sage-grouse to YTC have a similar, but lower survival than the resident sage-grouse (White 2015*b*). Larger home range size and exploratory movements of translocated sage-grouse compared to that of the resident sage-grouse likely increase their risk of mortality. However, the similarity in annual survival, and lowered daily distance moved post 31 May suggests that translocated sage-grouse may have acclimated to their new location. A more in depth known-fate survival analysis with the use of Program MARK will be conducted at a later date.

CONCLUSION

The Conservation Objectives Team identified range-wide PACs for sage-grouse (USFWS 2013). In Washington State, each PAC is geographically separate, which severely limits migration among populations thereby fostering an island effect. For this reason, each Washington State PAC has limited means of natural population augmentation through immigration and emigration, which often leads to a declining, genetically homogenous population.

The recovery of the species in Washington State is contingent upon reversing downward population trends and increasing the connectivity of disparate populations through various conservation efforts (Stinson et al. 2004). YTC has taken the initiative to reverse these trends through numerous conservation efforts including restoration of disturbed habitat (ED 2011), protecting intact habitat (Livingston 1998, ED 2012), assessing the effects of predators (Vernadero Group 2012, White and Lannoye 2014, Harris Environmental 2015), implementing various temporally separate augmentations (ED 2009, this study 2014-2015) and monitoring annual population trends (White 2015*a*). Translocating sage-grouse from other genetically analogous populations continues to be used as a means of augmenting population numbers and increasing genetic heterogeneity.

Annual sage-grouse survival is similar to that observed in other sage-grouse translocation studies, and nest survival rates have been remarkably high. The high nest survival of translocated sage-grouse from Idaho and the low resident rates in 2014 & 2015 need to be interpreted with caution due to low sample sizes. However, the ability to select a quality nest location (or defend the nest) may be a selective trait (or set of traits) that can eventually improve nesting success at YTC as interbreeding between these two populations occurs and the trait(s) are inherited. Management actions can increase the probability of interbreeding through continuous translocations. Subsequent genetic sampling is planned for implementation in 2016 to monitor the presence and rate of genetic admixing.

The low brood survival rates of the translocated Idaho sage-grouse could inhibit successful genetic admixing with the population at YTC. Translocated Idaho sage-grouse are mating with YTC male's at an average rate, successfully nesting at a high rate, but are not successfully raising chicks and recruiting them into the population. A more in-depth investigation is warranted to determine which environmental factors may be driving brood survival (e.g. quality brood rearing habitat, predator density, abiotic conditions). An additional 40 hens translocated to YTC would provide a similar sample size to the 2004-2006 augmentation that was effective at integrating new genetics into the population. Increasing the translocated sage-grouse sample size should increase the number of hens that nest, help address the concerns of low brood survival, and ultimately increase the probability of integrating new genetics into the population. The study and enhancement of environmental conditions on YTC combined with the relative success of the 2014 & 2015 augmentations merits the continuation of this promising effort to increase the genetic diversity and fitness of the YTC population.

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