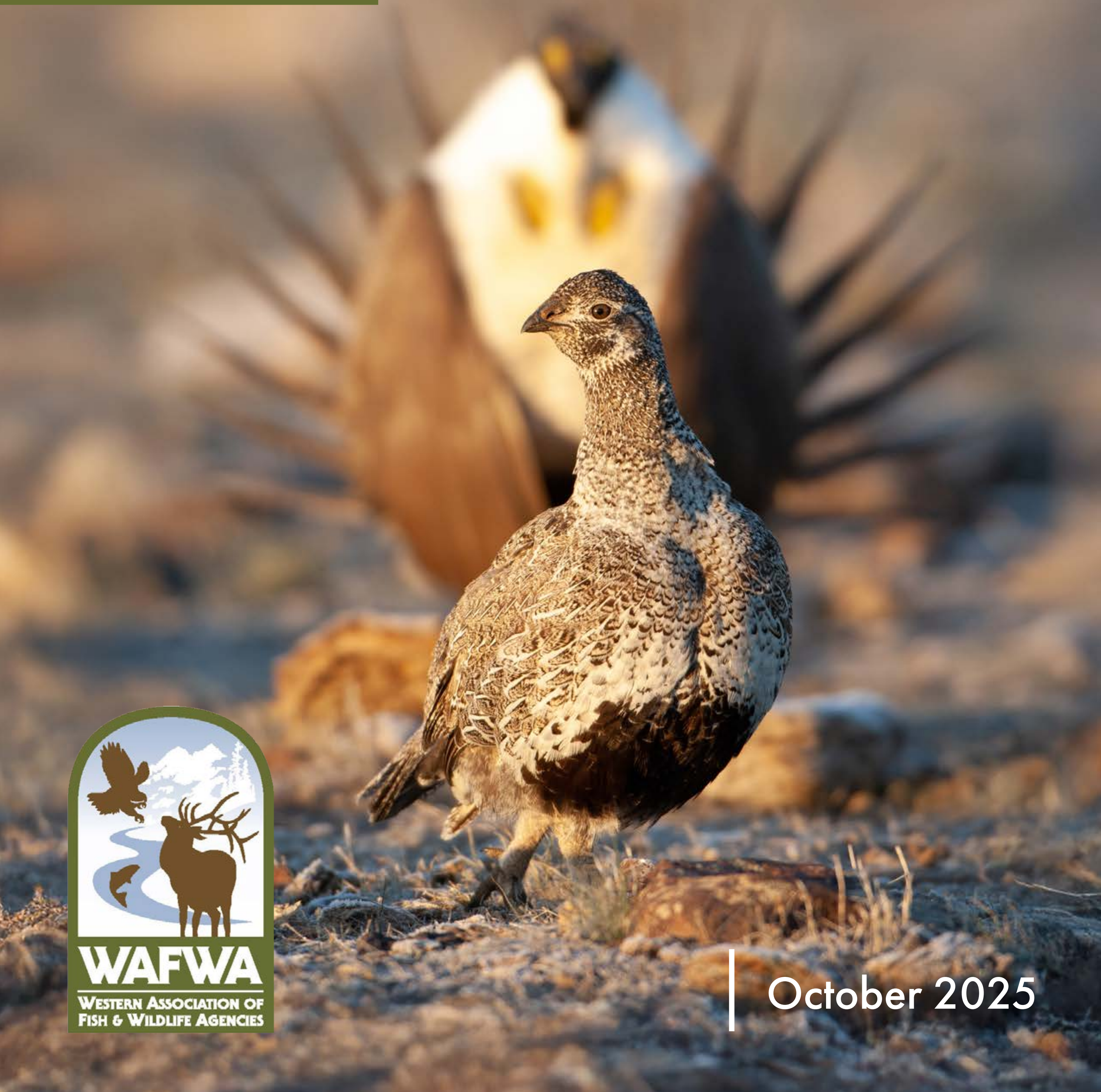
Translocation Guidelines for Greater Sage-Grouse, Gunnison Sage-Grouse, and Sharp-tailed Grouse



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Guidelines for Translocations of Greater Sage-Grouse, Gunnison Sage-Grouse, and Sharp-tailed Grouse in Western North America

LIST OF AUTHORS

Michael A. Schroeder, Washington Department of Fish and Wildlife, P.O. Box 1077, Bridgeport, WA 98813; michael.schroeder@dfw.wa.gov

Avery Cook, Utah Division of Wildlife Resources, Box 146301, Salt Lake City, UT 84114; averycook@utah.gov

David K. Dahlgren, Utah State University, 5230 Old Main Hill, Logan, UT 84322; dave.dahlgren@usu.edu

Shawn P. Espinosa, Nevada Department of Wildlife, 6980 Sierra Center Parkway, Reno, NV 89511; sespinosa@ndow.org

Jeff Knetter, Idaho Department of Fish and Game, P.O. Box 25, Boise, ID 83707; jeff.knetter@idfg.idaho.gov

Ann Moser, Idaho Department of Fish and Game, P.O. Box 25, Boise, ID 83707; ann.moser@idfg.idaho.gov

Justin R. Small, Nevada Department of Wildlife, 6980 Sierra Center Parkway, Reno, NV 89511; justin.small@ndow.org

Derek W. Stinson, Washington Department of Fish and Wildlife, P.O. Box 43141, Olympia, WA 98504; derek.stinson@dfw.wa.gov

Nicole I. Lindenauer, University of California, Davis, One Shields Avenue, Davis, CA 95616; nlindenauer@ucdavis.edu

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*Order of co-authorship was alphabetical.

Special Contributors

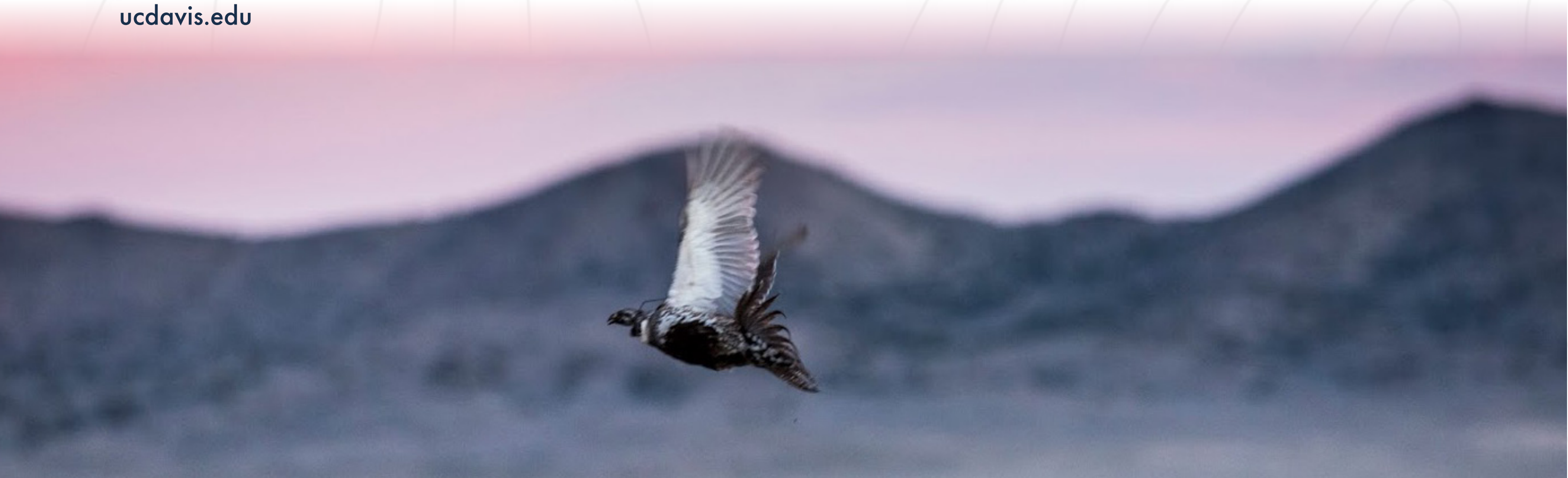
Leslie Schreiber, Wyoming Game and Fish Department, 2820 WY-120, Cody, WY 82414; leslie.schreiber@wyo.gov

Peter S. Coates, Western Ecological Research Center, USGS, 800 Business Park Drive, Suite D, Dixon, CA 95620; pcoates@usgs.gov

Steven R. Mathews-Sanchez, Western Ecological Research Center, USGS, 800 Business Park Drive, Suite D, Dixon, CA 95620; smathews-sachez@usgs.gov

Sara J. Oyler-McCance, Fort Collins Science Center, USGS, 2150 Centre Avenue Building C, Fort Collins, CO 80526; sara_oyler-mccance@usgs.gov

Shawna J. Zimmerman, Fort Collins Science Center, USGS, 2150 Centre Avenue Building C, Fort Collins, CO 80526; szimmerman@usgs.gov



Executive Summary

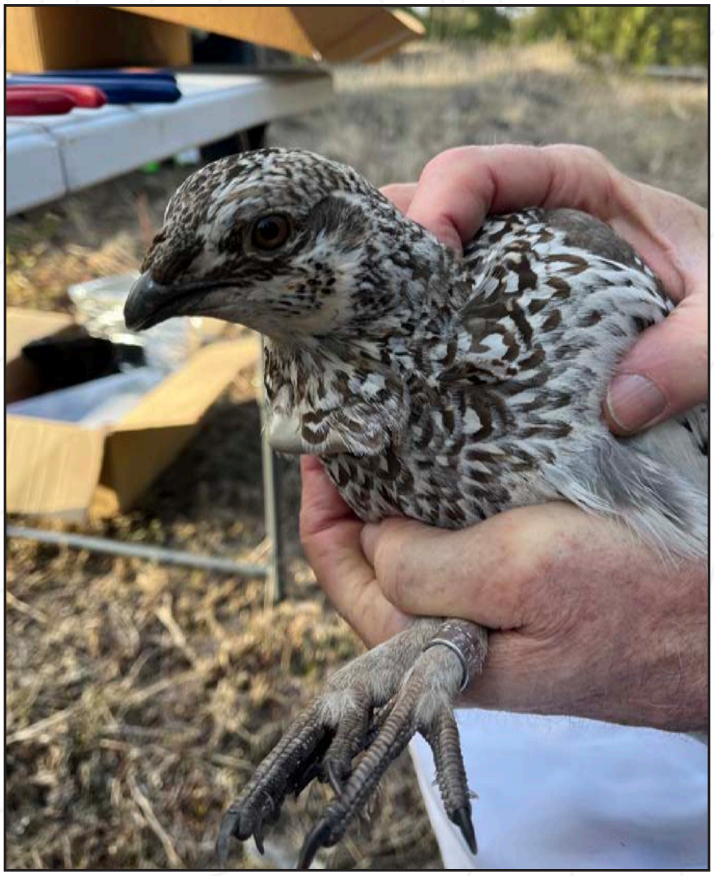
Restoration of grouse populations using conservation translocation (hereafter; translocation), the movement of wild animals from one location to another, has become a fundamental component of grouse conservation and management. Translocation is especially important in western North America, as conservation concerns for greater sage-grouse (Centrocercus urophasianus), Gunnison sage-grouse (Centrocercus minimus), and sharp-tailed grouse (Tympanuchus phasianellus) have increased. At the Western Association of Fish and Wildlife Agencies (WAFWA) annual winter meeting on 9 January 2005, agency directors agreed "to develop standards, prioritize projects for translocation and identify appropriate source populations for these translocation projects based upon appropriate scientific principles." This has been a lengthy collaborative process that has involved numerous research projects, extensive literature review, and development of translocation methods and protocols. The following document is a compilation of the results of that effort.

This document has been informed by recent and past research, as well as existing guidelines (e.g., Columbian sharp-tailed grouse [T. p. columbianus], Hoffman et al. 2015). In some cases, our review departs from published recommendations given new available science from recent translocation projects. However, techniques are always evolving, and it is essential these guidelines be updated periodically to incorporate new scientific information when it becomes available. For our rationale and additional citations, refer to the detailed discussions later in the review.

This document discusses facets of healthy grouse populations such as genetic diversity, effective population size, and dispersal ability to help inform managers considering translocation projects. Healthy populations are those large enough to readily recover from stochastic (both environmental and demographic) events, such as drought and extreme weather, as well as fluctuations in predation rates, disease, and habitat condition and modifications. In contrast, small and/or isolated populations often undergo genetic drift and experience Allee effects (e.g., inverse density dependence) that prevent recovery from stochastic and deterministic factors, leaving them at a relatively high risk of extirpation. Translocation is a tool used to bolster populations, although it is often carried out in concert with habitat improvement projects to maximize the effect. Population restoration using translocation is most effective where habitat conditions have been deemed conducive to support grouse populations.

It is important that an official letter of request for translocations between states and/or provinces be sent by the requesting agency to the wildlife agency director or bureau chief of the source state, province, or tribe. This letter, and any supporting proposal documents, needs to be sent far enough in advance of the desired translocation to allow adequate time for consideration, decision-making, and logistical preparation. Certain states already have translocation policies and protocols in place; therefore, the permitting process can take substantial time and planning. These approval policies add time and may also impact what is required in a proposal. The WAFWA Sage and Columbian Sharp-tailed Grouse Technical Committee (hereafter, Technical Committee) will also be available to evaluate translocation proposals prior to their implementation; however, we recognize approval or denial of the request for birds rests with the source entity. The Technical Committee is uniquely positioned to offer leadership and guidance on translocation projects, including the ability to conduct an informed review, and provide recommendations or assistance.

Defining the goal is the first issue to address when considering a translocation. For example, is the goal to reinforce an existing population to address shortcomings, reintroduce



grouse to an area where they historically occurred, or support populations while habitat improvements are made? The goal often guides the methodology and can impact the likelihood of success. A written proposal should address the following:

- project need; historical occupancy
- current population status
- potential release sites including habitat suitability
- quantity, and connectivity
- potential source populations including status, genetic and habitat compatibility with target population or area
- agreement with local managers
- translocation details such as project duration, number, sex, and age of translocated grouse
- season of translocation
- marking and transmitters
- capture and translocation methodology
- disease testing
- monitoring and evaluation
- predator control
- funding, and reporting schedule.

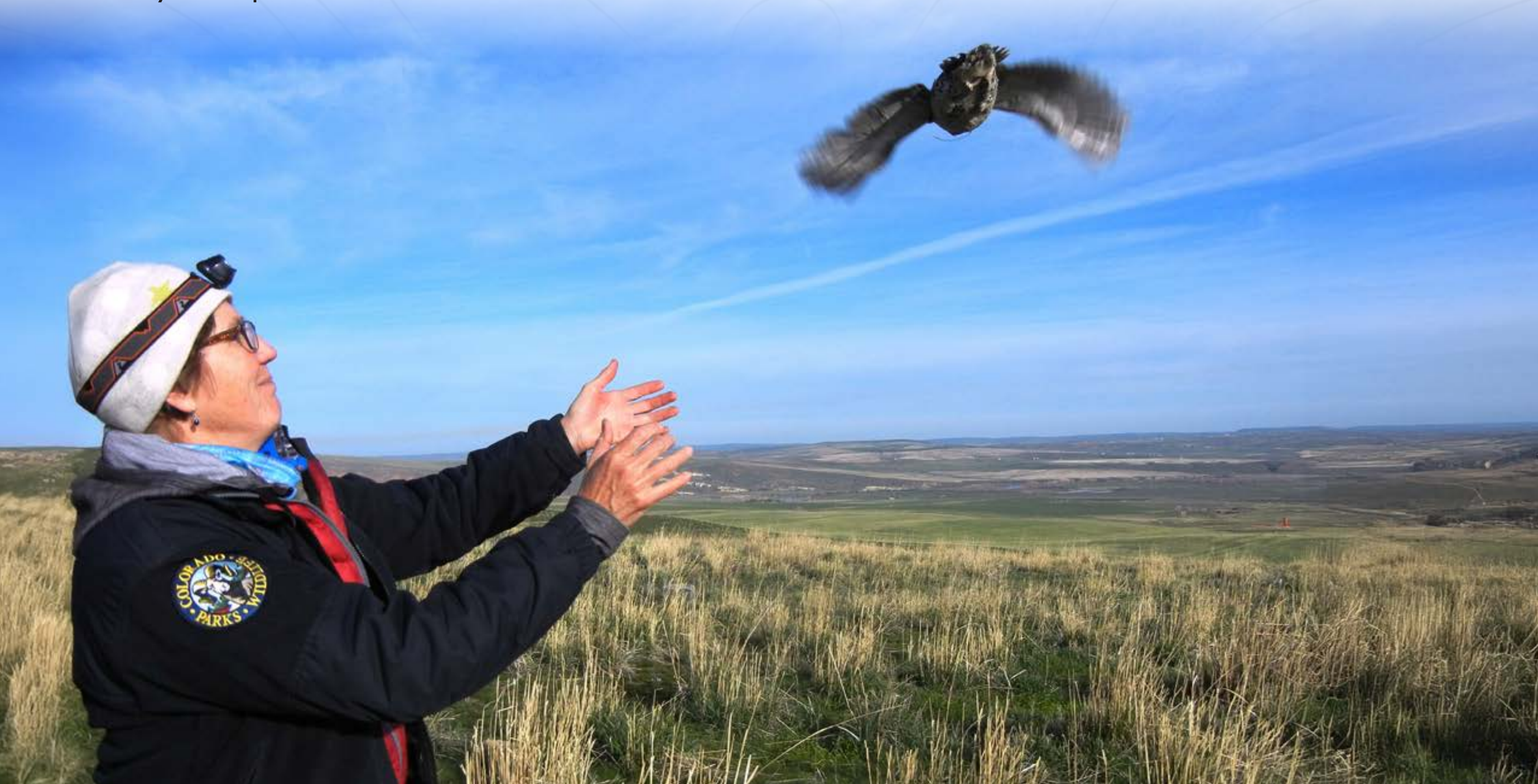
Upon completion of the translocation project, a report should be provided that covers actual translocation details and outcomes.

Existing protocols from previous studies can be adopted for areas that share similar site characteristics but may also vary depending on the goals of the project. Most importantly, new protocols or modifications should draw on previous failures and successes. Proposals that support well-designed experimental studies have strong advantages over trial-and-error processes. In that, these studies focus directly on empirical evaluation of outcomes from different methodologies, while controlling for factors that may otherwise confound information learned through trial and error. Nevertheless, detailed monitoring and additional studies should be encouraged to help shape strategic and successful protocols for all projects.

The Technical Committee will evaluate translocation proposals based on guidelines provided in this document, including the long-term potential for success as estimated by habitat quality, size and connectivity of the target location, and improvement of limiting factors that led to the original declines in the population. In general, efforts that benefit federally listed populations, subspecies, and species should be considered before non-listed populations.

Reinforcements should take priority over reintroductions, given the lower probability of success for reintroductions. The Technical Committee can provide an evaluation of an appropriate source population, including taxonomy, genetic relatedness, population size, and environmental similarity. Although tremendous variation exists in logistics and protocols, these considerations are critical for the best success of the translocation.

Currently, greater sage-grouse, Gunnison sage-grouse, and sharp-tailed grouse are experiencing long-term population declines across their respective ranges. In times of declining populations, it has become increasingly difficult for states and provinces to justify donating birds to another jurisdiction. Thorough planning and review will assure donor agencies that their wildlife resources are appropriately utilized, standard guidelines and methods are followed, and ultimately each translocation will build on existing knowledge and experience and contribute to the success of future translocations.

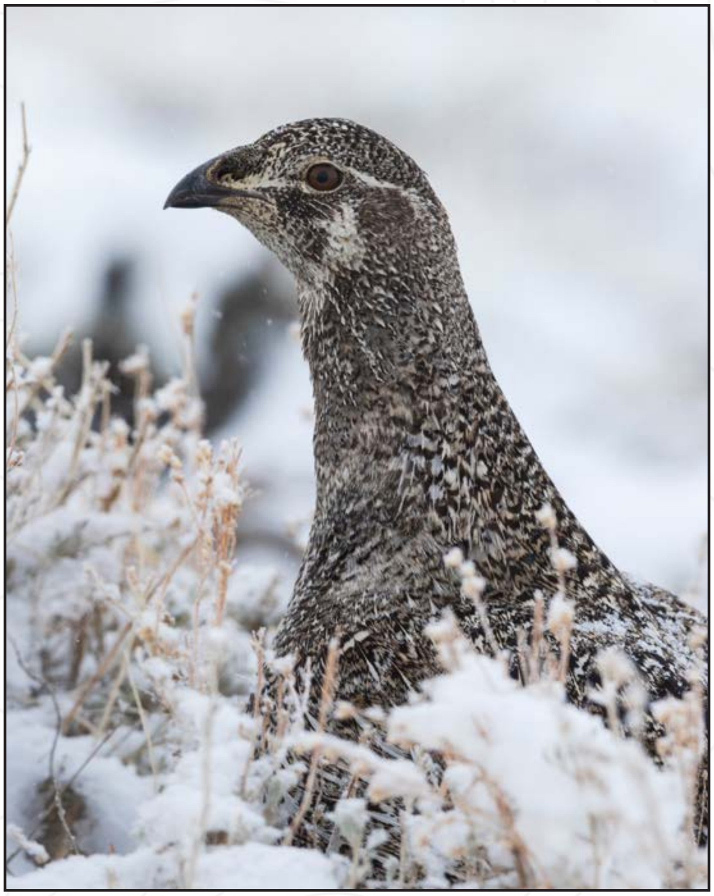


Introduction

Translocations of North American grouse have been conducted for greater sage-grouse (Reese and Connelly 1997; Hennefer 2007; Baxter et al. 2008, 2013; Stonehouse et al. 2015; Whiklo and Nicholson 2015; Gruber-Hadden et al. 2016; Duvuvuei et al. 2017; Chelak and Messmer 2019; Ebenhoch et al. 2019, Lazenby et al. 2021, Meyerpeter et al. 2025), Gunnison sage-grouse (Reese and Connelly 1997, Braun and Williams 2015, Zimmerman et al. 2019), sharp-tailed grouse (Snyder et al. 1999, Coates et al. 2010, Stonehouse et al. 2015, Mathews et al. 2018), greater prairie-chicken (Tympanuchus cupido; Snyder et al. 1999, Bateson 2014, Mussmann et al. 2017, Shepherd 2019, Toepfer and Huschle 2020), lesser prairie-chicken (Tympanuchus pallidicinctus, Snyder et al. 1999), rock ptarmigan (Lagopus mutus; Braun et al. 2011, Kaler and Sandercock 2011) white-tailed ptarmigan (Lagopus leucura; Braun et al. 1978, Hoffman and Giesen 1983, Braun et al. 2011, NMDGF 2016), willow ptarmigan (Lagopus lagopus), sooty grouse (Dendragapus fuliginosus, Bergerud 1988), ruffed grouse (Bonasa umbellus; Palmer 1913, Kurzejeski and Root 1988, Rusch et al. 2000), and spruce grouse (Canachites canadensis, Blomberg and Ross 2018). Historically, translocations of grouse into North America have even included species native to Europe such as hazel grouse (Tetrastes bonasia), black grouse (Tetrao tetrix), and capercaillie (Tetrao urogallus). Grouse translocations have been used to introduce birds into areas outside their endemic ranges (Phillips 1928), mostly to increase opportunities for hunting (e.g., ruffed grouse in the Matanuska Valley and on the Kenai Peninsula of Alaska; Steen 1995, 1999), but also to conduct research (e.g., sooty grouse in British Columbia and Washington; Bergerud 1988) or by mistake (e.g., greater sage-grouse into the former range of Gunnison sage-grouse in New Mexico before the sage-grouse taxonomy had been clarified; Allred 1946). The vast majority of translocations have been used to restore populations (Table 1). These restoration efforts can be divided into two general categories (Reese and Connelly 1997, Snyder et al. 1999):

- Reinforcement of grouse to existing populations; or
- Reintroduction into areas where they have been extirpated.

Documented translocations of greater sage-grouse (9,033 grouse), Gunnison sage-grouse (469 grouse), and sharp-tailed grouse (3,193 grouse) included 9,644 grouse moved for reinforcements, 2,673 for reintroductions, and only 378 for introductions to or from western North America (Table 1). As conservation needs for translocations have increased, a need for collaboration across jurisdictional lines has also increased. Cooperative management among agencies, non-governmental organizations, Native American tribes and private landowners is a fundamental component of successful



conservation efforts (Western Governors' Association 2004). This is particularly true for sage-grouse and prairie grouse, which are currently, or were historically found in most western states and provinces, and whose current or historical ranges encompass most western states, provinces, and other jurisdictions. Concern for declines in distribution and abundance of Gunnison sage- grouse resulted in their federal listing as threatened (USFWS 2014). Similarly, concern for greater sage-grouse and Columbian sharp-tailed grouse across the West has resulted in numerous petitions for federal listing of each species or subspecies under the Endangered Species Act of 1973 (Webb 2000, Banerjee 2004, Connelly et al. 2004).

Grouse are not covered by the North American Migratory Bird Treaty Act of 1918, and therefore states are tasked with management leadership. The Western Association of Fish and Wildlife Agencies (WAFWA) has aided this process in the past and appears increasingly capable of facilitating this process in the future. Stabilizing and/or increasing the distributions and populations of sage- and prairie grouse has been a goal of WAFWA since at least 1954 (Connelly et al. 2004). Because of the long-term conservation concerns for sage- and prairie grouse across the West, WAFWA directors considered the following resolution to deal with developing standards, prioritizing source populations, and evaluating target locations for translocations at their annual winter meeting on 9 January 2005:

*"**WHEREAS**, the Columbian sharp-tailed grouse, and Gunnison's and greater sage-grouse are of conservation concern to many western states; and*

***WHEREAS**, there are a number of states, provinces, and tribes interested in receiving grouse to reinforce existing populations or reintroduce into their historic range; and*

***WHEREAS**, these reinforcement and reintroduction projects have the potential to significantly benefit grouse conservation range wide; and*

***WHEREAS**, there are few potential donors for grouse translocation projects, and no standards for determining appropriate situations to conduct reinforcements and reintroductions; and*

***WHEREAS**, there is also a need to prioritize reinforcements and reintroductions to provide the greatest conservation benefit based upon scientific considerations.*

***NOW, THEREFORE, BE IT RESOLVED** that the Western Association of Fish and Wildlife Agencies directs its Technical Committee to develop standards, prioritize projects for translocation and identify appropriate source populations for these translocation projects based upon appropriate scientific principles. This includes the collection of range wide information to assist respective agencies in their efforts to stabilize or increase grouse populations."*

The purpose of this document is to address the central issue of the above resolution: create standards by which western agencies can prioritize and identify translocation projects, based upon appropriate scientific principles and emerging threats-based mapping products. Rationale is needed to identify: (1) why, when, where, and how grouse translocations are conducted; (2) uncertainties and assumptions included in projects; and (3) how success should be measured (Braun et al. 2011). Because there is some ambiguity about the subspecies designations of sharp-tailed grouse (Lautenbach et al. 2025), we consider sharp-tailed grouse throughout western North America, regardless of subspecies.

The goal to develop translocation guidelines and review translocation methodologies should increase the likelihood of future success, and provide an opportunity to learn from past experiences, successful or not (IUCN 1998, WPA and IUCN 2009, IUCN/SSC 2013). This document will be advisory in nature and state agencies have the ultimate right to determine translocation priorities and methodologies. Furthermore, each state determines if they are able to provide donor birds to a requesting agency or perform a reinforcement or reintroduction within their respective state.

Population Declines and Extirpation

<u>Healthy populations and habitats</u>

Healthy populations are those large enough to readily recover from fluctuations in population abundance typically attributed to disease, drought, and extreme weather, and with sufficient genetic diversity to have the ability to adapt to changing environments. They also express the behavioral plasticity to adapt to natural habitat fragmentation that may be part of the ecosystem (Holder et al. 1999, 2000; Martin et al. 2000). In the context of a species status assessment, the U.S. Fish and Wildlife Service has developed the 3Rs approach "to evaluate the current and future condition of the species" (USFWS 2016:4). The 3Rs refer to representation, resiliency, and redundancy (USFWS 2016:6):

"Representation describes the ability of a species to adapt to changing environmental conditions, which is related to distribution within the species' ecological settings."

"Resiliency describes the ability of the species to withstand stochastic disturbance events, which is associated with population size, growth rate, and habitat quality."

"Redundancy describes the ability of a species to withstand catastrophic events, which is related to the number, distribution, and resilience of populations."

Changes in land use (i.e., conversion from range to cropland), natural or human induced perturbations (i.e., wildfire, invasive plants, conifer encroachment, improper livestock grazing practices, and populations of wild horses over appropriate management levels), and various types of anthropogenic developments (i.e., transmission lines, roads, urban development, mining and energy developments) does not only reduce the quality and quantity of grouse habitat but reduces size and connectivity of existing habitat patches. Habitat fragmented by development and agriculture typically hosts higher populations of generalist predators (e.g., coyotes [Canis latrans] and common ravens [Corvus corax]) subsidized by human associated food (Boarman 2003, Coates et al. 2016a). Fragmentation that reduces connectivity among populations eventually results in smaller, isolated populations at higher risk of local extirpation.

Genetic Diversity

For populations to have a fair probability of long-term persistence (50–100 years), they must be large enough to maintain high levels of genetic diversity and/or are close enough to other populations to allow frequent exchange of genetic material (Dawson et al. 1987, Lande and Barrowclough 1987, Grumbine 1990, Cross et. al. 2023, Zimmerman et al. 2022, Zimmerman et. al. 2023). Spielman et al. (2004) reported heterozygosity was 35% lower on average in 170 threatened taxa compared with closely related non-threatened taxa. In a review of rare mammals, Garner et al. (2005) reported a pervasive and consistent loss in genetic diversity in populations that face demographic threats. They concluded that by the time species receive official conservation status (i.e., listing as threatened or endangered), they have already lost a substantial portion of their genetic variation.

A wide variety of genetic problems can occur with small, isolated populations and these genetic issues can interact with demographic and habitat problems, leading to population extirpation (Frankham et al. 2017, 2019). Inbreeding and low genetic diversity can result in low hatchability of eggs (Briskie and Mackintosh 2004), weak immune systems (Allendorf and Ryman 2002), reduced reproductive fitness (Höglund et al. 2002), and inability to adapt, therefore increasing extinction risk (Brook et al. 2002; Frankham et al. 2017, 2019). A relatively small, isolated population of sage-grouse in the Bi-State area on the border of California and Nevada, which is considered a Distinct Population Segment (DPS) by the U.S. Fish and Wildlife Service (USFWS 2010, 2019), exhibited reduced genetic diversity (Oyler-McCance et al. 2014) as well as reduced hatchability and decreased rate of population change compared to more robust populations within the same region (Coates et al. 2018).

With grouse, inbreeding depression likely contributed to the extinction of the heath hen (Tympanuchus cupido cupido), a subspecies of the greater prairie-chicken (Johnson and Dunn 2006) and declines and extirpations of other grouse populations in the wild (Storch 2007). The negative genetic consequences of bottlenecks and the benefits of translocation reinforcement has been documented in populations of Gunnison sage-grouse in Colorado (Zimmerman et al. 2019), greater sage-grouse in Washington (Zimmerman et al. 2024), and greater prairie-chicken in Wisconsin (Bellinger et al. 2003, Bateson et al. 2014, Bateson 2016) and Illinois (Westemeier et al. 1998b, Bouzat et al. 1998, Johnson et al. 2003, Mussmann et al. 2017). For example, fertility, hatching rate, and the population size of the Illinois population increased following reinforcement with birds from large healthy populations in Minnesota, Kansas, and Nebraska (Westemeier et al. 1998b). However, some have cautioned translocation is a short-term solution to reduce the risks of inbreeding and local extinction; unless population size increases, repeated reinforcements will be required (Bateson et al. 2014, Mussmann et al. 2017). Over time, without significant population responses, this is likely not sustainable. Studies have shown a consistent relationship between genetic diversity and population size in sage-grouse (Benedict et al. 2003, Oyler-McCance et al. 2005, Oyler-McCance and Quinn 2011). Johnson et al. (2003) reported genetic variation was significantly reduced in isolated populations of <2,000 greater prairie-chickens. Genetic and dispersal data from sage-grouse suggest demographic connectivity could be maintained for populations 5–10 km apart; dispersal of >20 km occurred but was unusual (Thompson et al. 2012b).

Effective Population Size

A desirable goal of species recovery is to restore a viable population. While no universally accepted definition of what constitutes a viable population currently exists, generally it is the smallest size at which populations can maintain genetic variability and persist over time. Viable populations should be able to withstand fluctuations in abundance and recruitment associated with annual variation in food availability, predation, disease, weather, and habitat conditions (see discussion for "healthy" population above). Most conservation biologists agree a population of a few thousand or more individuals is desirable for long-term persistence (Lynch and Lande 1998, Frankham et al. 2002, Reed et al. 2003). Although much smaller populations may sometimes persist (Pacheco 2004), they tend to lose genetic diversity and are at higher risk of decline and eventual extinction. Grouse populations naturally fluctuate with environmental conditions, and this natural variability puts smaller populations at greater risk of local extinction.

Spring census population sizes (Nc) of sage- and sharp-tailed grouse can be estimated with the aid of lek counts (Patterson 1952, Jenni and Hartzler 1978, Beck and Braun 1980, Autenrieth et al. 1982, Emmons and Braun 1984, Connelly et al. 2004, Connelly and Schroeder 2007, Fedy and Aldridge 2011, Garton et al. 2011, Hoffman et al. 2015); however, it is effective population size (Ne) that determines whether the population is large enough to maintain genetic health and avoid inbreeding. The effective population is the proportion of a population expected to pass on their genetic information from one generation to the next (Frankham et al. 2002); it is affected by fluctuations in population size, clutch size, sex ratio, reproductive skew, and generation length (Frankham 1995). Because of their lek mating system, sage- and sharp-tailed grouse often have reduced Ne relative to other birds because few males do the majority of breeding. In addition, dramatic fluctuations in population size strongly influence Ne and are common in grouse population dynamics (Lindstrom 1994, Frankham 1995, Williams et al. 2004, Row and Fedy 2017). Stiver et al. (2008) reported Ne can also be affected by variance in female reproductive success, annual survivorship, and the frequency of off-lek copulations.

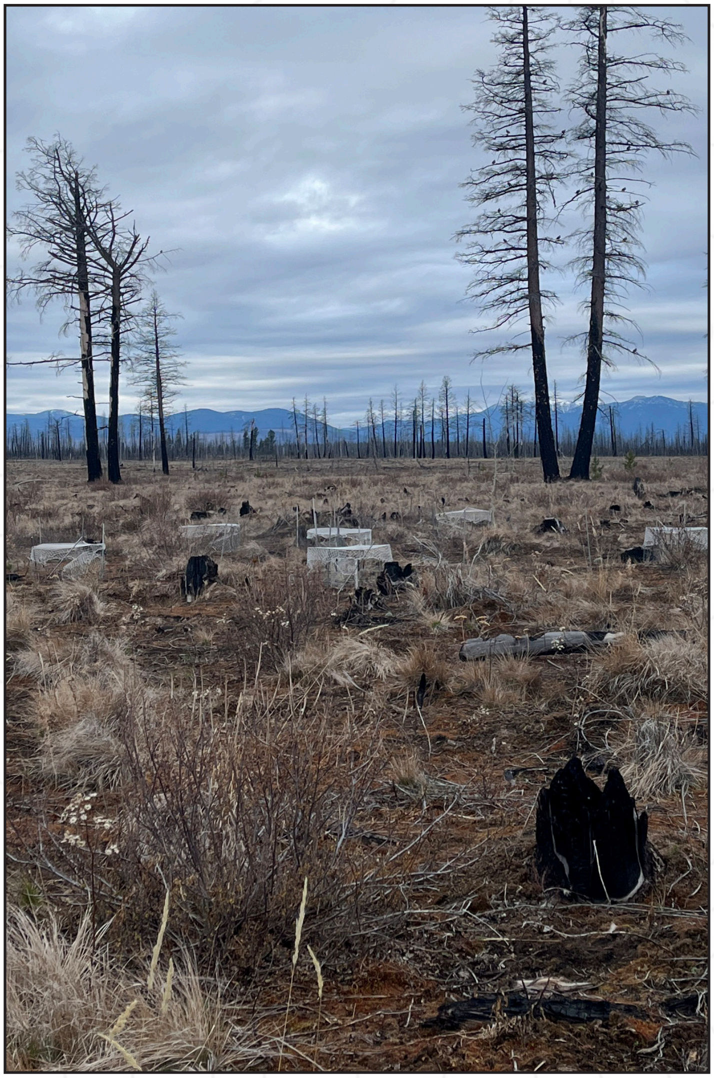
To mitigate genetic issues that may reduce the likelihood of a population's persistence for the next 100 years, Allendorf and Ryman (2002) recommended the maintenance of at least 95% of a population's heterozygosity. Because the generation interval for sharp-tailed grouse is about 2 years, an Ne of 450–500 is likely necessary to achieve this goal (Allendorf and Ryman 2002). However, estimates of Ne from a sister taxon, the greater prairie-chicken, represented 10% of lek counts (i.e., Ne/Nc ratio = 0.10; Johnson et al. 2004). In addition, Pruett et al. (2011) estimated Ne for the lesser prairie-chicken, using demographic and genetic data; based on demographic data, the Ne/Nc ratio was 0.341 compared to 0.01–0.07 from genetic data, suggesting an Ne of 500 would require an Nc of 1,500–50,000. Although little direct data is available for sharp-tailed grouse, Temple (1992) argued that approximately 10% of sharp-tailed grouse produce successful recruits and Fandel and Hull (2011) argued that a minimum breeding population of 500 was a useful management goal. Additional research is necessary to identify the Nc for sharp-tailed grouse that would maintain Ne at or above 500 individuals. Johnson et al. (2003) reported genetic variation was significantly reduced in isolated populations of <2,000 greater prairie-chickens and recommended managers attempt to maintain populations of >2,000 birds. McNew et al. (2017) predicted a population of 280 sharp-tailed grouse reinforced with 10 females every ten years would likely persist for 50 years, though it would still lose ~20% of its genetic diversity. This number (≥280) may be useful as an interim objective, although a larger population (>2,000) would be needed to avoid loss of genetic diversity over the long term.

Previous studies of greater sage-grouse in Washington and Gunnison sage-grouse in Colorado estimated Ne/Nc ratios of 0.16 and 0.19, respectively (Schroeder 2000, Stiver 2008). This suggests an Nc in excess of 3,200 sage-grouse in a distinct population (with relatively unencumbered movement of birds throughout the population's boundaries) would be necessary to maintain genetic diversity and be considered a viable population. Using McNew's (2017) reasoning for sharp-tailed grouse, and considering the higher reproductive bias for sage-grouse (i.e., a smaller number of dominant males do most of the breeding), the interim objective population level for sage-grouse would probably need to be ≥350 (higher than the ≥280 recommended for sharp-tailed grouse)

Dispersal and Isolated Populations

Dispersal is an important demographic trait that maintains genetically healthy populations. Some frequency of long-distance dispersal may be important for population persistence, particularly in fragmented habitat near the periphery of a species' range (Bush et al. 2010, Davis et al. 2015). Genetic analysis of greater prairie-chickens in Wisconsin showed that habitat fragmentation and loss or reduction of dispersal capabilities among subpopulations dramatically affected levels of genetic variability in surviving populations (Johnson et al. 2004). Even in naturally patchy environments like those the Gunnison sage-grouse historically occupied, cumulative habitat alteration has reduced or eliminated genetic connectivity (Oyler-McCance et al. 2005, Zimmerman et al. 2022).

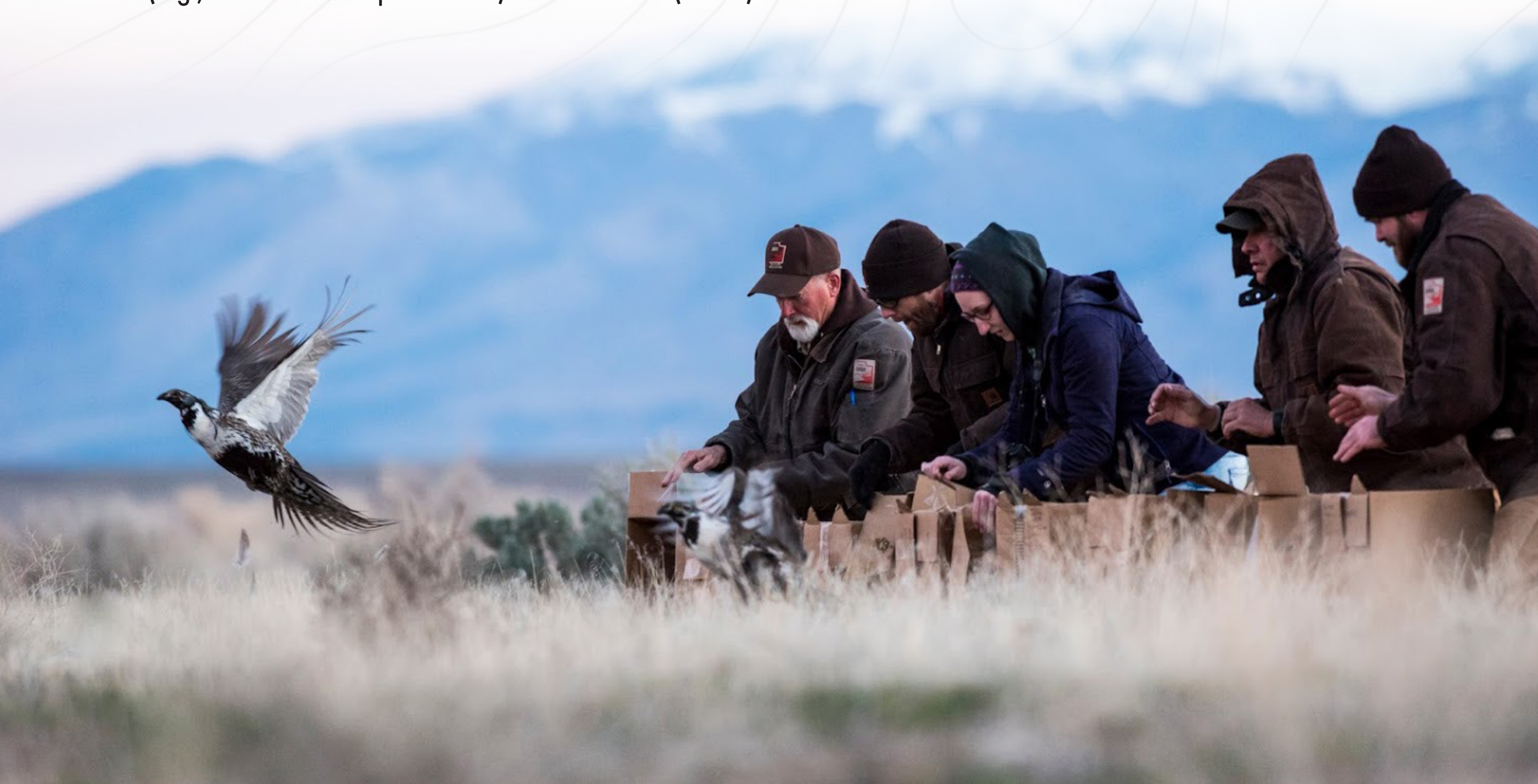
The amount of immigration needed to connect populations genetically is not certain, but low levels of immigration (that



results in offspring contributing to the subsequent generation) can prevent fitness declines in small, isolated populations (Whitlock and McCauley 1999; Frankham et al. 2015, 2017, 2019). Johnson et al. (2004) suggested minimal levels of migration needed to maintain a viable greater prairie-chicken population may be much larger than the one-migrant-per-generation 'rule' (Mills and Allendorf 1996). Frankham et al. (2019) recommended >5 contributing immigrants per generation to prevent genetic decline, which for species with an Ne/Nc ratio of 0.125, may mean ~40 individuals. Completely isolated populations with an Ne of 20, 50, and 100 may require genetic augmentation via translocation after approximately 2, 10, and 21 generations respectively (Frankham et al. 2019).

Although dispersal by juveniles may be advantageous in widespread and connected populations, dispersal may be detrimental if emigration is not compensated by immigration. Schroeder and Boag (1987) suggested the spring component of dispersal in spruce grouse may be determined by a recessive sex-linked genotype. If the inclination to disperse is genetically determined, habitat fragmentation and the higher risks involved in dispersing may result in selective reduction or elimination of the 'disperser genotype' due to the higher risks associated with dispersal, resulting in an increasingly isolated population. However, Martin et al. (2008) reported frequency and distance of natal dispersal in the Great Bustard (Otis tarda), also a lekking species, were affected by the size and spatial arrangement of groups, and therefore not determined genetically. Birds (mostly males) in larger subpopulations were less likely to disperse, and dispersing birds from more isolated subpopulations had to travel greater distance, exposing them to higher mortality risks (e.g., collisions with powerlines). Martin et al. (2008) interpreted the differences as expressions of phenotypic plasticity. Results supported the current view that dispersal is an evolutionarily complex trait conditioned by the interaction of individual, social, and environmental causes that vary between individuals and populations (Martin et al. 2008). Thompson et al. (2012a) also hypothesized that a combination of mechanisms in conjunction with mating system contributes to dispersal patterns.

Frankham et al. (2017:133) stated, "genetic rescue should be routinely considered as a conservation option for small outbreeding populations with limited gene flow." An interim strategy may include maintaining genetic connectivity between separate populations by a program of periodic translocations and, ideally, genetic monitoring. What distance between populations results in isolation for sage- and prairie grouse? Most local studies in sage-grouse have reported that natal and breeding dispersal for most individuals are typically <10 km (Cross et al. 2017), with few >20 km. Thompson et al. (2012a) concluded infrequent inter-population dispersal in sage-grouse should be sufficient to maintain genetic connectivity of healthy and stable populations 20–30 km apart, but because dispersal distances >10 km are infrequent, the probability of demographic rescue of small, isolated populations or the colonization of vacant habitat patches beyond 10 km is low. However, using genetic samples from 763 leks in Idaho, Montana, North and South Dakota, Cross et al. (2017) confirmed there is a small highly mobile segment of populations that readily dispersed farther than previously known; in 41 instances of breeding dispersal, 7 were >50 km, and 1 was 194 km. They suggested such movements may alleviate some of the genetic consequences of the lek-based breeding system.



Techniques for Reinforcement and Reintroduction of Grouse

<u>Conservation Translocation of Wild Birds</u>

Conservation translocation (both reinforcement and reintroduction) of wild birds has been and will continue to be an important component of the recovery strategy for grouse (Table 1). The translocation (capture, movement, and release) of wild-trapped wildlife is an increasingly common management practice and has long involved game birds. However, early projects to establish populations of sage-grouse, sharp-tailed grouse, prairie-chickens, and other grouse species had low success rates because:

- They were limited to small numbers of birds.
- Adaptive divergence (i.e., out-breeding depression) was expressed, which reduced augmentation success and population potential. (Zimmerman et al. 2024)
- They were short in number of year duration.
- Translocated birds tended to disperse away from release sites.
- Older translocated birds were less likely to contribute to productivity (Toepfer et al. 1990, Reese and Connelly 1997, Snyder et al. 1999, Mathews et al. 2016, 2021); and
- Habitat suitability and spatial extent was not appropriate for long-term sustainability.

Translocations of sharp-tailed grouse to reinforce existing populations have been conducted successfully in Washington, Idaho, and Colorado (Hoffman et al. 2015, Schroeder et al. 2024). Reinforcement projects that release birds at active leks of an existing population are likely to have greater success than attempts to re-establish new populations because females settle sooner and disperse shorter distances (Coates et al. 2006, Hennefer 2007). Populations of Columbian sharp-tailed grouse have been re-established after extirpation in Colorado (Hoffman et al. 2015), northern Nevada (Mathews et al. 2021), and southern Idaho (Smith 2012); however, most reintroductions failed, including northeastern Oregon (apparently due to limited wintering habitat), Utah (following habitat loss due to fire), and miscellaneous locations in Washington, Nevada, and Idaho (Table 1, Hoffman et al. 2015).

Toepfer et al. (1990) noted the amount of good quality habitat at the release site is the ultimate factor determining success of translocations. For sharp-tailed grouse, they recommended protecting or restoring habitat sufficient to support a population of >200 birds, which they estimated would require a minimum of 3,000 ha, including >1,000 ha of undisturbed grass-shrub habitat within a radius of 310 ha for sharp-tailed grouse. However, a greater amount of contiguous cover is desirable. Modeling by McNew et al. (2017) suggested a minimum dynamic area of 5,600 ha is needed to support 280 sharp-tailed grouse, assuming a density of 5 birds/100 ha, based on an average from the literature. A more realistic density for western habitats with lower precipitation may be 2 birds/100 ha. Bart (2000) noted that no population of Columbian sharp-tailed grouse has persisted on areas <5,000 ha, and McNew et al. (2017) suggested a population of 280 birds would require periodic reinforcement. These areas are smaller than some have suggested is needed for greater prairie-chickens; 9,300 ha (Jacobs 1959) or 18,600 ha (Hamerstrom et al. 1957).

Sage-grouse require larger areas than sharp-tailed grouse; Toepfer et al. (1990) recommended at least 5,000 ha, with 3,300 ha undisturbed, be available for sage-grouse translocation projects. Stinson et al. (2004) estimated density of sage-grouse in occupied management units of Washington at~0.4 sage-grouse/km2, but most of that area was unsuitable and unoccupied. A density of 1.5 sage-grouse/100 ha would require ~23,330 ha to support a population of 350, but the population would need to be connected to other populations and total ~3,200 birds to remain genetically healthy over the long-term (Schroeder 2000).

Although translocations to maintain genetic diversity in populations going through a bottleneck is important, some consideration should also be given to preserving the character of some unique populations. Oh et al. (2019) found that the 5 populations evaluated have genomic differences that could impact translocation outcome, Zimmerman et al. (2019) shows that the genetic distinctiveness of the Gunnison sage-grouse populations is also associated with environment-related genomic differences, and Zimmerman et al. (2024) points to the genomic differences between source and recipient greater sage-grouse populations that may influence translocation outcome. Importantly, populations that occupy environmentally similar conditions, or most similar conditions, may not always be best genetically suited for their reciprocal environments (Zimmerman et al. 2024). Recent genome-wide analyses found that the Washington birds differed genetically from their reinforcement source populations in ways that may be related to some of these known fecundity and size differences, potentially leading to the lower than expected amounts of genetic gains from translocation efforts

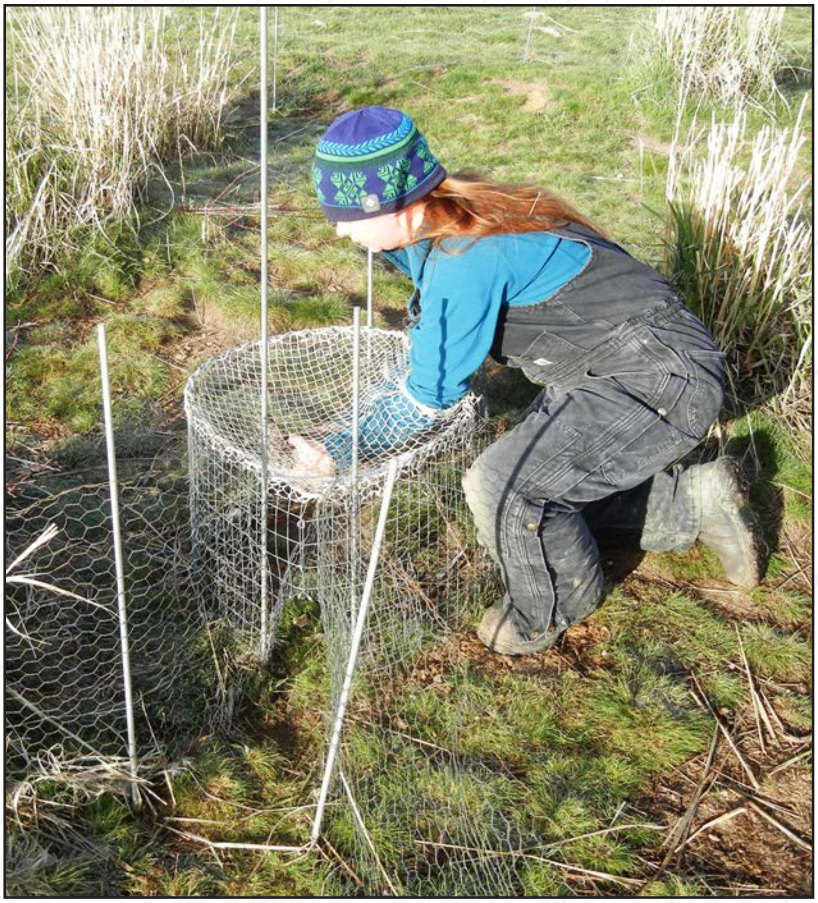
(Zimmerman et al. 2024). Another genomic analysis has indicated greater sage-grouse in Washington are the most unique of any population in North America (Oh et al. 2019). The Washington birds are more likely to nest, renest, and lay more eggs than is typical elsewhere (Schroeder 1997). They are also 15% larger than sage-grouse to the south (MAS, unpublished data). Similar issues have been identified for sharp-tailed grouse (Spaulding et al. 2006, Hoffman et al. 2015, McNew et al. 2017). The next most unique population is the Bi-State DPS, which exhibited strong genetic uniqueness in northern and southern subpopulations (Oyler-McCance et al. 2014). Translocations often require tradeoffs between maintenance of unique genetic characteristics and retention of important species on the landscape. In certain situations, it may be impossible to achieve both.

Another consideration that has been historically overlooked from the standpoint of sage-grouse is diet and adaptation to sagebrush digestion. There is considerable geographic variation in composition and concentration of secondary compounds among and within sagebrush varieties (Welch 2005), suggesting sage-grouse populations across the species' ranges may be adapted to select and digest the distinct chemistry of local sagebrush varieties (Frye et al. 2013, Oh et al. 2019). Based on their genomic analyses, Oh et al. (2019) stated peripheral populations, like Washington's and the Bi-State, may possess important adaptations and serve as important genetic reservoirs of diversity that would be useful for translocations to other populations. Macdonald et al. (2017) suggested peripheral populations of species may be a valuable resource for translocation to reinforce vulnerable populations facing rapid ecological or climate change elsewhere. Small peripheral populations would first need to recover from population bottlenecks before any such translocation could be considered. Currently, no evidence exists of increased post-release mortality linked to potential lack of suitable adaptations from peripheral populations like Washington State (Schroeder et al. 2020). However, research focused solely on dietary relationships and fitness post translocation is needed.

Translocation of Eggs and Broods

Alternatives to translocating breeding-aged birds between populations include movement of chicks or eggs. Westemeier et al. (1991) described a successful exchange of greater prairie- chicken eggs between nests in two remnant populations in Illinois. Although it requires intensive monitoring of females because exchanges should be of clutches in close synchrony, this technique may have potential in the future for 'assisted dispersal' between isolated populations of grouse. Egg-swapping was used to facilitate geneflow between populations of the endangered streaked horned lark (Eremophila alpestris strigata), but success has not been confirmed with genetic data (DWS, unpublished data).

Thompson et al. (2015) removed greater sage-grouse eggs from wild nests, reared chicks to 1–10 days of age, and facilitated their adoption into wild broods. They reported removing entire clutches during laying or very early in incubation had better results than replacing partial clutches with artificial eggs (>50% of these females renested). Although at least a quarter of the reared chicks released into surrogate broods before 10 days of age were unable to adjust and survive, they suggested brood adoption may have potential as an alternative to translocating adult sage-grouse. The potential benefits included: 1) increased size of recipient broods; 2) increased survival due to dilution of predation risk in broods with more chicks; 3) increased predator detection; 4) increased reproduction of yearlings the following year compared to translocated yearlings; 5) egg collection has less of an impact on the source population than removing breeding age females, and 6) movement of translocated chicks is likely to be smaller than movement of translocated breeding-aged birds (Thompson et al. 2015). However, Thompson et al. (2015) did not monitor survival after 28 days and it is not known if any of these birds contributed to future breeding populations. This technique requires radio-marked females in source and target populations because of the strict timing requirements of collecting eggs and



adopting out chicks to females with similar aged broods. It also requires a facility for incubating eggs and rearing chicks in adequate numbers to ensure subsequent genetic exchange from successful reproduction. This technique has potential for assisted dispersal but will be difficult to scale up for large numbers (WAFWA 2017a).

Mathews et al. (2021) suggested that offspring of translocated individuals may be the drivers of a successful reintroduction of sharp-tailed grouse in Nevada. Generating offspring at the release location from translocated birds, however, requires many pre-nesting females to be translocated due to relatively high mortality between release date to brood-rearing period and/or loss of nests. To overcome this limitation, Lazenby (2020) and Meyerpeter et al. (2021, 2024, 2025) carried out reinforcements of greater sage-grouse populations in North Dakota and California by moving females with their entire broods which ensured the production of offspring. A separate advantage of brood translocation is that females are unlikely to abandon their semi-mobile chicks, resulting in reduced post-release movements compared to translocated breeding-aged birds (Meyerpeter et al. 2021). Furthermore, the introduced chicks are likely to develop natal philopatry to the release site, increasing their likelihood of staying and breeding the following year (Dunn and Braun 1985). An additional issue with translocated breeding-aged birds is that they often will not successfully breed until they have become acclimated to their new location; for females translocated in spring, this may not happen until a year after translocation (Toepfer et al. 1990). Meyerpeter et al. (2024) compared the contributions of pre-nesting females to females with broods to the reinforcement populations and assessed impacts to the source populations. Most pre-nesting females did not attempt reproduction post-release, while most females translocated with their broods successfully reared their chicks in the reinforced populations. They found that brood translocations contributed to population growth rates 11–30% more than pre-nesting female translocations and minimized negative impacts to source populations by removing fewer breeding-aged females and immediately reversed population decline at recipient sites (Meyerpeter et al. 2024, 2025). Though fewer females are removed from the source site compared to pre-nesting translocations, this also means that fewer individual females' genetics are introduced to the recipient site. However, pre-nesting females are not guaranteed to reproduce that year, whereas translocated chicks are likely to establish site philopatry and contribute both maternal and paternal genetics from the source population (Meyerpeter et al. 2024).

In North Dakota, Picardi et al. (2021a) found post-release females with chicks had limited movements compared to larger exploratory movements by pre-nesting females. Additionally, post-release female habitat selection patterns differed between those with behaviors of settlement versus exploratory states of movement. Although brood translocations may be more expensive to execute, the benefits of limited post-release movements, increased genetic diversity, and increases in survival and population recruitment may be worth the additional costs. However, from a logistical standpoint, tracking radio-marked females through the nesting period and capturing them post-hatch is much more time consuming, and thus more costly, than capturing adults near leks in the spring.

Lindenauer (2025; in prep) tested brood augmentation in translocated greater sage-grouse by combining chicks from multiple source population broods. This approach aimed to introduce greater genetic diversity per brood to the recipient site while minimizing the removal of reproductively successful females from the source population. They found no negative effect of manipulating brood size and confirmed successful integration of adopted chicks. Although this method requires significant logistical efforts, including the simultaneous capture of two broods of similar age, it may benefit small source populations by reducing the number of brooding females removed while maximizing the number of chicks released and increasing genetic diversity at recipient sites (Lindenauer 2025; in prep). However, tracking enough brooding females at the source population to ensure compatible brood pairings adds to the cost and time investment compared to normal brood translocations (i.e., only natal chicks in the brood).

Pen-Rearing

The use of pen-reared birds has been used in the past, particularly with greater prairie-chickens (Swedarsky et al. 1997, USFWS 2010), but it has also been suggested for other species such as sage-grouse (Apa and Wiechman 2015, 2016; Thompson et al. 2015). Pen-rearing is often discussed as a management option because translocations involve considerable travel costs, permit fees, logistical difficulties, low survival, and disease concerns (e.g., closure of borders due to an outbreak of avian influenza or COVID-19). However, captive-reared grouse also have disease concerns, and they are costly to produce, less mobile than wild birds, more vulnerable to predators, and may have difficulty adapting to native foods or moving to appropriate seasonal habitats (Ligon 1946, Pyrah 1961; Johnson and Boyce 1990, 1991; Spurrier et al. 1994, Huwer 2004; Oesterle et al. 2005; Huwer et al. 2008; Thompson et al. 2015; Apa and Wiechman 2015, 2016). Attempts to re-establish wild populations from captive flocks have had little success (Toepfer et al. 1990, Merker 1996, Storch 2007, Thompson et al. 2015), even when releases are accompanied with controls of potential predators. Grouse are difficult to maintain in captivity, they are vulnerable to disease and stress, the males fight with each other during the breeding season, and males and females may be intolerant of each other outside the breeding season (Storch 2007).

Captive breeding has generally been limited to species with no potential source populations, such as Attwater's prairie-chicken (Tympanuchus cupido attwateri), a subspecies of greater prairie- chicken. After >20 years of captive breeding and releases of Attwater's prairie-chicken, there is little indication of success (Cuervo 2008). Captive breeding facilities for Attwater's prairie- chicken have experienced outbreaks of reticuloendotheliosis viruses (REV), which has resulted in transmission to wild birds upon release (Morrow 2017). Although studies on the prevalence of diseases within grouse species in pen-reared settings is lacking, captive-bred pheasants had significantly greater exposure to pathogens than wild pheasant (Dwight et al. 2021), and these birds were thought to act as a bridge host that spread disease within farm settings to wild populations following their release. Thompson et al. (2015) reported some success reinforcing wild sage-grouse broods with captive reared chicks, and Merker (1996) believed captive rearing of sharp-tailed grouse may have potential if the young are properly conditioned for predator avoidance and releases are timed to avoid periods of high mortality (Merker 1996). However, such a project would likely require substantial funding of significant duration to develop and improve rearing and release protocols, and probably would not be undertaken while sources of wild birds are available (WAFWA 2017a).

In 2017, the Wyoming State Legislature passed a bill, allowing the captive rearing of greater sage-grouse. To comply with the new legislation, the Wyoming Game and Fish Commission promulgated rules and regulations in Chapter 60 which governs the captive rearing of sage-grouse. The current regulation allows for one private bird farm to receive certification to raise greater sage-grouse and that licensee may collect up to 250 eggs from wild hens per calendar year. At present, one private bird farm holds this certification, has maintained consistent licensure since 2018, collected eggs from the wild once, and maintains a self-sustaining captive sage-grouse population. Currently, all certifications issued under Chapter 60 will expire December 31, 2027 to comply with the sunset clause in the most recent legislation. To date, no captive reared sage-grouse have been released from this facility.

Consideration and Prioritization of Translocations

Given local extirpation, small population size, and isolation of many sage-grouse and sharp-tailed grouse populations in western states and provinces, translocation is an important consideration. The polygynous breeding strategy and population fluctuations reduce Ne, such that any isolated population <350 sage-grouse or <280 sharp-tailed grouse should be considered for reinforcement (based on McNew et al. 2017) given that adequate habitat still exists. Populations <1,000 may benefit from assisted dispersal to help counteract the potential for inbreeding, eventual loss of genetic diversity, and demographic fluctuations that might result in a bottleneck. To facilitate future projects, restoring a population large enough to serve as a source for translocations should be an important interim recovery objective.

With many local populations potentially in need, it is important to prioritize reinforcement efforts that will lead to the largest return on investment and/or highest likelihood of success. Prioritization should be based on long-term trends and explanatory causes, land management entities that can control large portions of the landscape for grouse habitat, size of occupied area, centrality in the overall range and importance for connectivity, funding opportunities, research and management support, source populations, and history of past translocations. Reinforcements have been more successful than reintroductions and have the advantages of preventing extirpations of currently occupied areas, improving genetic diversity adding dispersal phenotypes to the population, potentially increasing the size of the occupied area through increased population vigor, and improving connectivity. Reinforcements are generally shorter in duration than reintroductions, and therefore less costly, and may provide the most immediate benefit. McNew's (2017) suggestion that reinforcements with as few as 10 females every 10 years could be enough to address genetic issues in some populations is an example of a low-cost consideration. Reinforcement may also be needed as a stopgap measure to maintain a local population until habitat conditions can be improved to the point that the population is self-sustaining or can be reconnected to other populations.

Reintroductions are required to re-establish populations in formerly occupied range. Projects that offer the possibility that birds can re-occupy large areas and reconnect existing local populations are a high priority (Hoffman et al. 2015) and should be the focus for feasibility assessments. The project area should have connectivity with habitat adequate to support >280 sharp-tailed grouse or >350 sage-grouse, or the potential for habitat restoration and acquisition to establish connectivity to support these numbers. Sharp-tailed grouse may need 14,000 ha and sage-grouse 23,000 ha of habitat for long-term persistence (see discussion above). The quantity and quality of all seasonal habitat types in the project area is the most important factor in determining success of reintroductions (Toepfer et al. 1990, Reese and Connelly 1997), because habitat quality in the release area is a critical factor affecting the retention of nesting females (Coates et al. 2010).

Other issues that need to be evaluated in a potential project site include amelioration of threats, ownership and commitment to monitoring and management, existence of management plans, likelihood habitat will remain suitable, and potential for additional improvements. Also, internal connectivity, and hazards, such as highways, power transmission lines, and fences need to be considered. Such features could also contribute to elevated avian predator levels which may also need evaluation. Managers need to focus on mitigating the conditions that caused resident populations to decline, particularly improvements that will facilitate nest and brood success prior to implementing translocations.

Successful reintroductions require more resources and commitment in terms of number of birds, number of years of releases, and availability of a source population. They should not be undertaken without adequate evaluation of the proposed project area, timeline, and available resources (Reese and Connelly 1997). A habitat suitability assessment, spatially-explicit viability assessment, and a genetic assessment need to be a part of decision making.

Techniques for Reinforcement and Reintroduction of Grouse

Project Need

The need for translocation should be clearly established before a project is carried out. For example, is the goal to reinforce the population to address genetic and/or demographic shortcomings, or to reintroduce grouse to an area where they historically occurred? This need can be illustrated by determining population status, habitat availability, and/or demographic constraints (e.g., through an integrated population model and spatial modeling). This information should be clearly described in a translocation proposal. A proposal is a critical component for a successful translocation, not only for the agency managing the source population, but for the requesting agency. The proposal should include sections on project need, potential release site, source population, number of birds and associated sex and age, funding commitments, staffing commitments, post-release monitoring, and other translocation details. Additional detail on these sections are provided below.

If a translocation is needed, the population and/or genetic objectives needed to measure success or failure should be addressed. Generally, success of translocations should be determined by the effect on the population growth rate (Gruber-Hadden et al. 2016), the increase in genetic heterogeneity (Bateson et al. 2014) and trends over time (Fedy and Aldridge 2011). Additional examples of metrics used to measure progress include similarities in survival and reproductive rates with residents (Gruber 2012), increases in annual lek counts, and minimal permanent dispersal away from the project area (Baxter et al. 2008). For example, in the Bi-State DPS, a translocation was deemed necessary considering one published study's results using integrated population modeling to highlight that Parker Meadows subpopulation had reduced hatchability and population growth rates (Coates et al. 2018) coupled with other published findings of reduced genetic diversity in the same subpopulation (Oyler-McCance et al. 2014). Additionally, Toepfer et al. (1990) noted many translocation failures attributed to inadequate habitat may have been due to poor procedures and urged careful documentation so procedures can be evaluated later and improved over time.

Selecting a Potential Release Site

Habitat suitability. Selection of release sites is the most important decision in a translocation. Quantity, quality, and configuration of habitat is the most important factor influencing the outcome of the translocation. The project area for the proposed translocation should be fully described including land ownership, landscape features, and habitat availability, including seasonal habitats. A full habitat assessment should be completed based on habitat quantity and quality. Field assessment should follow standard published guidelines (e.g., Connelly et al. 2000, Hoffman et al. 2015, Stiver et al. 2015) and assessments can be reinforcement with spatially explicit models such as resource selection functions and habitat suitability models (e.g., Coates et al. 2016b).

With a reinforcement, the decision about habitat suitability can be determined prior to previous translocations or by the presence of an endemic, albeit stressed, population. This is perhaps one reason why reinforcements tend to be more successful than reintroductions. Reintroductions are more difficult to successfully achieve than reinforcements and, thus, care should be taken to fully address the release site for numerous characteristics when embarking on reintroduction. First, there should be solid evidence the area was formerly occupied by the focal species. If the area was never occupied in the past, the project would be classed as an introduction rather than a reintroduction and should be treated as a lower priority. Second, the release site should consist of enough connected habitat to eventually support an occupancy area of ≥14,000 ha for sharp-tailed grouse and ≥23,000 ha for sage-grouse (see earlier discussion; Toepfer et al. 1990, Reese and Connelly 1997, Coates et al. 2006). Third, seasonal habitat quality and the presence of human disturbance, on or near the potential release site should be considered. For example, for greater sage-grouse Knick et al. (2013) found the following criteria for occupied landscapes: (1) >40% dominated by sagebrush; (2) <1% dominated by conifers; (3) <10% dominated by cropland or orchard; (4) <3% dominated by anthropogenic development; (5) <0.05 km/km2 highways; and (6) <0.06 km/km2 powerlines. Others have had similar observations (Aldridge et al. 2008, Wisdom et al. 2011) and newer habitat models for occupancy, productivity, and survival are being developed. Habitat should be of sufficient quantity, quality, and configuration to support a year-round population of ≥280 sharp-tailed grouse or ≥350 sage-grouse. It is also important to consider how the recipient agency and its cooperators will maintain habitat into the future.

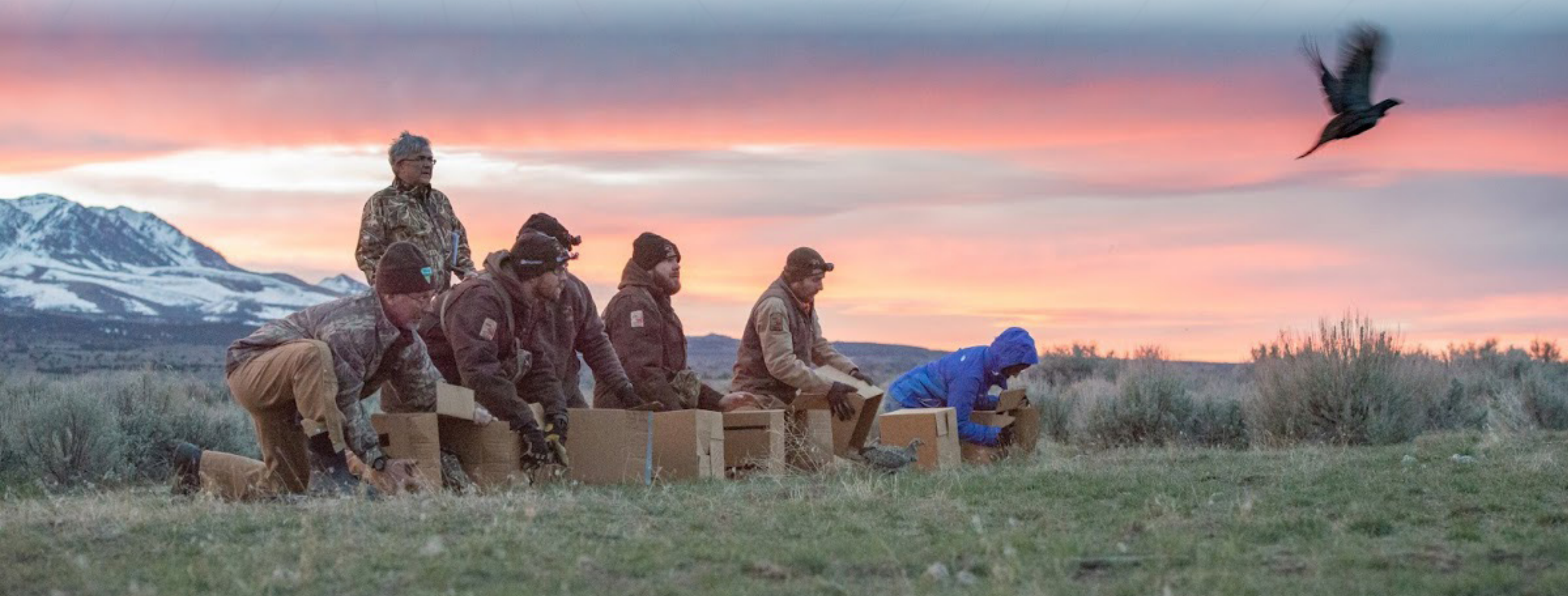
More detailed evaluations of a potential release site consist of additional characteristics. First, release sites that offer additional connections to currently occupied range should be prioritized (Robb and Schroeder 2012a, 2012b). Second, areas dominated by native cover or otherwise protected from conversion, should receive higher priority for translocations than areas dominated by Conservation Reserve Program (CRP) lands unless provisions are in place to ensure long-term persistence of CRP or similar cover types on the landscape. Third, the release of other pen-reared gamebirds and bird dog field trials in translocation areas should be avoided. These pen-reared birds can potentially increase incidental hunting mortality, disease transfer risk, predator attraction to the area, and nest parasitism (e.g., nest parasitism by ring-necked pheasants [Phasianus colchicus]; Kenaga et al. 1955, Westemeier et al. 1998a, Hagen et al. 2002). Fourth, key stakeholders, including private landowners, who may be interested in or affected by a proposed translocation project should be consulted.

Specific release site. The logical release site for a reinforcement is an existing active lek site. The ideal site for a reintroduction would be at a historical lek location (or, in the absence of data, an open hilltop for sharp-tailed grouse; an opening in the sagebrush in a larger plain for sage- grouse), surrounded by high quality nesting habitat. Care should be taken to avoid nearby obstacles such as powerlines and fences (Stevens et al. 2012a, b). For sharp-tailed grouse, the distance to winter cover should be considered. Coates et al. (2010) chose an initial release site for a sharp-tailed grouse reintroduction based on physiography and similarity to capture area. After two seasons of releases, they moved the release site 10 km for the next two seasons of releases based on movements and nest locations of previously released females; four years after the initial releases, a lek was well established at the second site and no birds were observed at the first site. They recommended birds be closely monitored in the first years of a translocation to use movement patterns and nesting locations to refine the location of subsequent releases (Coates et al. 2010). Additionally, releasing birds during the morning hours (e.g., nautical twilight) on a lek where resident grouse are present should facilitate interactions with resident birds (Kyle Ebenoch, personal communication). Another option is to use decoys and/or recordings of displaying males on the lek. Release sites should be located a sufficient distance from the source to minimize returns to the point of origin. For greater sage-grouse, Patterson (1952) implied birds were likely to return to their capture area if they were released < 80 km away. For brood translocations, the best release sites would be brooding habitat (mesic or other high forb abundance areas) near active leks, or other brooding areas known to be used by the reinforced population.

Predator management. Management of predators in the project area before and during translocations may need to be considered (Baxter et al. 2013). This may be necessary in areas where the landscape has been dramatically altered by agriculture and human development (which may negate the necessity for translocation), and in cases of very low population size (i.e., demographic trap). Grouse may be more vulnerable to predators in fragmented habitats (Vander Haegen et al. 2002, Herkert et al. 2003). Habitat changes and human-associated subsidies such as food sources, perches and nesting substrates (e.g., transmission lines and irrigation pivots) have generally increased the abundance of several species of generalist predators in largely agricultural landscapes, and throughout the western United States (Andrén 1992, Boarman et al. 1995, Baxter et al. 2008, Leu et al. 2008, Gibson et al. 2018), including American crow (Corvus brachyrhynchos), common raven (Corvus corax), black-billed magpie (Pica hudsonia), red fox (Vulpes vulpes), and great horned owl (Bubo virginianus) in Washington (Sauer et al. 2017), and possibly coyote, raccoon (Procyon lotor), and striped skunk (Mephitis mephitis).

Predators can have a significant top-down impact on small populations and on recently released birds not yet familiar with the local landscape (Hagen 2011). Translocated birds often make greater movements before settling into a new location (Coates et al. 2010, Picardi et al. 2021b), making them more vulnerable to predation (Stephenson et al. 2011, Baxter et al. 2013, Mathews et al. 2016, Thornton and Olsoy 2017). Predators may limit grouse populations in localized areas, particularly where habitat is fragmented, and predators benefit from human-associated food and nesting structures (WAFWA 2017b). Studies of the effectiveness of predator control have not consistently demonstrated an improvement in nesting success or population numbers of grouse and other birds, perhaps in part because of local/regional differences in predator communities, habitat condition, weather and climate patterns, and differences in study design and scale (Smith et al. 2010, Conover and Roberts 2017). The public would likely be more supportive of control activities that target specific locations and populations of predators in order to protect threatened or endangered populations of rare native species (Messmer et al. 1999).

Common raven populations have increased 3-fold in the western U.S. since the 1970s (Sauer et al. 2017), and the negative effect of ravens on nest success of grouse has been well documented (Manzer and Hannon 2005, Bui et al. 2010, Coates and Delehanty 2010, Dinkins 2013). For example, sharp-tailed grouse in southern Alberta had 8 times greater nest success in landscapes with <3 corvids/km2 as opposed to landscapes with ≥3 corvids/km2 (Manzer and Hannon 2005). In Wyoming, Bui et al. (2010) found higher occupancy rates of ravens were correlated with failed sage-grouse nests. Coates et al. (2020) found that sage-grouse nest survival fell below a threshold for population sustainability when raven densities exceeded 0.40 ravens km2. A rapid assessment of raven densities should be conducted within the proposed translocation area before actual implementation (see Brussee et al. 2021). If translocation efforts proceed, managers should implement efforts at reducing raven attractants such as open-pit landfills.



Several studies have evaluated the effectiveness of raven control to improve sage-grouse nesting success (Coates and Delehanty 2004, Dinkins 2013, Peebles 2016). A common application that results in intra- and inter-annual declines in ravens is the use of DRC-1339-treated egg baits (O'Neil et al. 2021). Where sage-grouse populations are small and in fragmented habitat, reduction of raven abundance may result in population increases, in conjunction with other conservation efforts such as habitat maintenance and improvement (Peebles 2016). However, gains in sage-grouse recruitment with raven control are short-lived, and long-term solutions to reduce human-subsidized raven populations are needed including reduced habitat fragmentation and reduced availability of supplemental food (e.g., roadkill, dead livestock, and garbage) and nesting and perching structures (e.g., power lines, telephone poles, communication towers; Jiménez and Conover 2001, Coates et al. 2016a). Raven control may not be necessary in locations where the primary nest predators are not ravens (e.g., coyotes, badgers; HWA Wildlife Consulting 2017). Coyotes are a predator of grouse eggs, chicks, and adults, but Taylor et al. (2017) reported coyote removals did not improve nest success or female survival in Bighorn Basin, Wyoming. Control of mammalian predators (including red fox and other mesocarnivores) during a translocation project in the Strawberry Valley, Utah, suggested a modest positive effect on sage-grouse survival (Baxter et al. 2013). Coyotes may play an important role in limiting the presence of red foxes. Foxes are well adapted to the fragmented agricultural landscape, can occur in high densities, and are a primary predator of ground-nesting birds (Sovada et al. 1995). Coyotes are known to harass and prey on red foxes, and where common, may exclude foxes; based on home range sizes, 1 coyote may displace 5 pairs of red foxes, so removal of coyotes could have unintended consequences (Sargeant et al. 1987).

Identifying a Source Population

Identifying candidate source populations can be challenging and requires numerous considerations. First, source populations should consist of robust population numbers to overcome potential negative impacts of removing individuals. For example, as stated earlier, candidate populations should consist of ≥2,000 for sharp-tailed grouse and ≥3,200 for sage-grouse. Another important consideration is the short- and long-term changes in population abundance. Grouse populations experience substantial interannual variation in population numbers, which exhibit oscillating patterns of consecutive years of decrease followed by years of increase. Short- and long-term trends can be estimated that account for this stochasticity (Coates et al. 2021) and targeting populations that do not show evidence of short- or long-term decline would be most advantageous. Timing translocations to align with years of increasing abundance during an oscillation for those candidate populations with neutral or increasing trends is recommended. Furthermore, previous sage-grouse and sharp-tailed grouse translocations have considered genetic analyses (Warheit and Schroeder 2003, Oyler-McCance et al. 2005) that supported using the nearest large source populations. Recent technological advances (Oyler-McCance et al. 2020) have enhanced the field of genomics and provide useful recommendations to improve reinforcement efforts (Zimmerman et al. 2019). Similarity in habitat and sagebrush species/subspecies and other potential environmental variables should also be considered (Welch 2005, Oh et al. 2019, Zimmerman et al. 2019, Zimmerman et al. 2024).

Once identified, the wildlife agency in the purposed translocation jurisdiction must be contacted about the potential to obtain a capture permit and their willingness to consider approving permits for the expected number of seasons, and any other information needs necessary to evaluate the request. An initial request may require significant lead time and/or travel to give a presentation for their fish and wildlife commission. The agency with the source population may need time to fully evaluate the potential for removed birds to harm their own populations. The permit may be issued by a separate unit of the agency that may have specific information, fees, and reporting requirements.

To prevent potential impacts to local source populations, consider moving 60 birds in a single season. Capturing a few birds from multiple leks is recommended to reduce the loss to any single lek, minimize the disturbance at capture locations, and increase the genetic diversity of captured birds. An additional precaution is to only trap leks that have relatively high attendance though it also may be useful to trap areas destined for adverse habitat alterations. For example, an area being converted, developed, or altered by plant succession may provide a useful source population. Another possibility is to capture and translocate intact broods, which require fewer breeding-aged females to be removed from the source site to achieve population restoration goals compared to pre-nesting translocations (Lazenby et al. 2020, Meyerpeter et al. 2021).

Translocation Details

Project duration. Snyder et al. (1999) indicated translocation success for prairie grouse was associated with longer project duration, apparently meaning >1 season. In theory, a 1- or 2-year reinforcement project can meet genetic objectives, if survival and reproductive success of the translocated birds are adequate and indicate successful interbreeding of the local resident and translocated birds. For reintroductions, several years of releases should be planned; often 2–3 years are required for a lek to become established, and at least 2–3 subsequent years will likely be needed to build the population. Thus, a period of 5–10 years should be planned when considering a re-introduction.

Season and date. Most grouse translocations have been done in the spring lekking period, in part because the animals are easier to find and capture when aggregated on or near lek sites and are less likely to disperse when released on an active lek. Snyder et al. (1999) concluded one feature of successful prairie-chicken and sharp-tailed grouse translocation projects was that birds were moved in spring; 50% of spring projects were considered successful by agency respondents. Conversely, they stated all 9 projects conducted during fall, summer, or winter had failed. Toepfer et al. (1990) mentioned apparent success of 3 or 4 prairie grouse translocation projects conducted in summer (not included by Snyder et al. 1999); they recommended releasing prairie grouse during summer when they are molting and sexually inactive to reduce dispersal. However, Hoffman et al. (1992) recommended spring releases, based on trapping success, post-release dispersal patterns and survival, and genetic considerations. They suggested the instinct of birds to breed and nest, when released during the peak of breeding, reduced movements more than molt and sexual inactivity. Another limitation they noted was the difficulty of capturing large numbers of prairie grouse in summer. Finally, moving birds in spring reduces the risk for West Nile Virus, which is likely not an issue until the weather warms and mosquitos are active.

Coates and Delehanty (2006) reported female sharp-tailed grouse captured later in the lek visitation period were more likely to nest and were more likely to already be inseminated by males in the source population. Therefore, they recommended capture of females beginning several days following the onset of female visits to leks. The peak of female visits varies as much as two weeks or more annually and trapping success frequently declines as the breeding season progresses; thus, their recommendation may only be feasible when leks are closely monitored. Mathews et al. (2016) suggested trapping sharp-tailed grouse later in the lekking period may have the added advantage of capturing more yearlings, which had higher survival rates than adults in their study. Higher yearling survival was also observed at the Swanson Lakes, Washington population reinforcement project (Schroeder et al. 2024).

Sage-grouse are also generally captured during the spring breeding period (late March/early April), as recommended by Reese and Connelly (1997), but occasionally in late summer or early autumn (e.g., October). Spring translocations of grouse were found to have reduced dispersal compared to translocating grouse in the fall (Reese and Connelly 1997, Coates and Delehanty 2006, Baxter et al. 2013). However, despite lower dispersal rates, pre-nesting females may still move considerable distances away from the release site, limiting their reproductive potential at the recipient site and resulting in low translocation success (Mathews et al. 2022). Conversely, the advantages of summer-fall captures, especially brood translocations, are: 1) reduced post-release movements when semi-mobile chicks are present (Picardi et al. 2021b, Meyerpeter et al. 2024); 2) increased reproductive rates at recipient sites when females are translocated with broods (Meyerpeter et al. 2024, 2025); 3) no disruptions to nesting; 4) allow time for males to find or establish a lek the following late winter/early spring; 5) occurred when populations are highest; and 6) allow relatively easy access to capture areas compared to early spring (mud and snow). Disadvantages of late summer/early fall captures are that broods or related individuals are often captured, limiting the genetic diversity of the reinforcement, and captures contain a substantial percentage of young-of-the-year, which may be more naive to predators and experience higher mortality rates (White et al. 2017).

Number, sex, and age of birds to release. Snyder et al. (1999) reported prairie-chicken and sharp-tailed grouse translocation projects considered successful typically released >100 birds over multiple seasons. Success was not defined and left to the reporting agency, but success presumably meant establishing a local population, restoring a local population to robust numbers or preventing expiration. Although an even sex ratio has often been used to facilitate the establishment of leks and to encourage competition among males for breeding opportunities, the importance of sex ratios has not been fully considered. In general, after one or more leks are well established, a bias toward translocated females is typically preferred because only a minority of males do most of the breeding, and almost all female grouse breed each year.

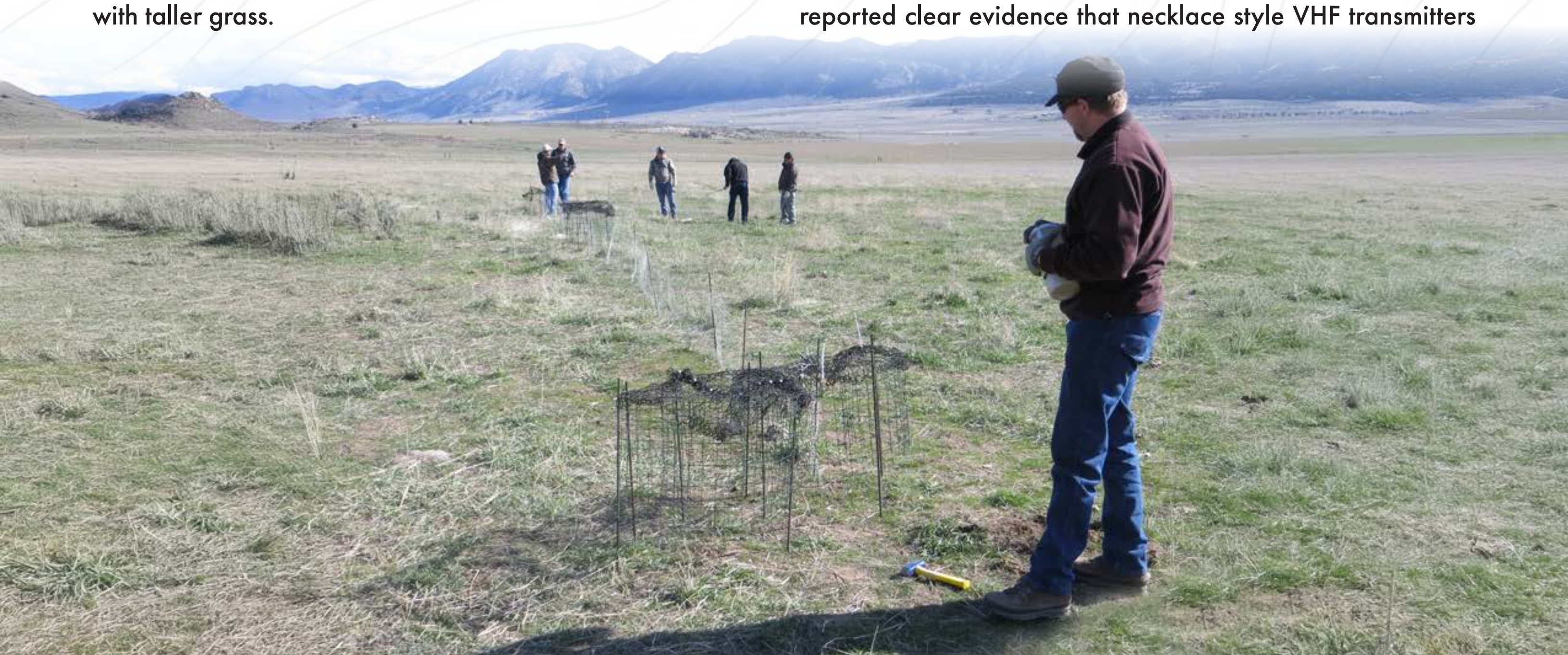
Translocated sage-grouse often have reduced survival and nesting rates compared to the resident population, at least in their first-year post-release. Reduced survival may be due to increased movement and lack of familiarity with the release area (Toepfer et al. 1990, Cope 1992, Gardner 1997, Mathews et al. 2016, Picardi et al. 2021b); releasing large numbers at once also could attract predators. Baxter et al. (2013) reported survival of residents was 1.5 times that of translocated sage-grouse. However, Ebenhoch (2017) reported translocated sage-grouse on the Yakima Training Center in Washington were less likely to nest than resident birds, but survival rate was not different. Similarly, Bell and George (2012) did not observe different survival rates for translocated versus resident sage-grouse released in northern California. Both male and female sage-grouse translocated to the Crab Creek Management Unit in Lincoln County, Washington had lower survival in the first year and predominantly in the first three months post- release (Schroeder et al 2020). When a small number of birds are released (e.g., 10), the success of the translocation relies on high survival and good reproductive output which is often not experienced in the first year. Because of this, managers should focus their efforts on obtaining their desired number of birds over multiple years, depending on project objectives, to account for lower survival and reproductive rates often experienced in the first-year post-release.

Duvuvuei et al. (2017) reported translocated adult female sage-grouse were more likely to raise a brood than translocated yearlings and suggested translocating more adults than yearlings. Conversely, Mathews et al. (2016) reported greater survival of translocated yearling sharp-tailed grouse than adults, even though there was no difference in survival between ages in the source population. They suggested adults may spend more time searching for a familiar lek, whereas yearlings may still be in a 'dispersal phase' during which they do not search for familiar leks, conspecifics, and surroundings, and are less prone to translocation-induced chronic stress or are better able to recover from stress (Mathews et al. 2016). In translocations to North Dakota and the Bi-state populations, sage-grouse hens translocated with broods reared more chicks to 50 days post hatch than hens translocated in the spring. Sage-grouse broods survived translocations best if the chicks were ≥10 days old (Meyerpeter et al. 2021).

Marking and transmitters. Banding birds with metal bands is standard practice to identify mortalities, and any birds recaptured later. Some research or monitoring projects that need resight data for individuals may add unique combinations of colored, and sometimes numbered, bands that can be observed on males at the lek. Schroeder et al. (2016) placed unique color band combinations on translocated and resident sage-grouse. The color bands allowed individual identification during lek observations from a blind and using trail cameras on the lek to distinguish locally recruited birds from those recently released. Color bands may be less effective for sharp-tailed grouse as bands would be more difficult to see, with shorter legs and occupying areas with taller grass.

Transmitter design for translocations should be given critical thought given the objective of the project is survival of individual birds, and the considerable time, effort, and funds that are invested into each bird. Translocated birds are often equipped with necklace-mounted, battery- powered Very High Frequency (VHF) radio transmitters (<3% of bird's body weight) to monitor survival and movements (Duvuvuei et al. 2017, Baxter et al. 2013). Global Positioning System tracking devices available with Platform Transmitter Terminal (GPS PTT) are also commonly used. These heavier rump-mounted transmitters provide downloadable data on location at frequent intervals and can provide excellent data on use of habitat types and movements (Schroeder et al. 2016). However, Severson et al. (2019) reported marking sage-grouse with currently available GPS PTT devices increased mortality compared to those marked with VHF transmitters. Post hoc analysis suggested a possible combination of attachment type, reflective solar panel, device weight, and device positioning as a likely cause of decreased survival. Advances in technology have yielded lighter and smaller transmitters, but issues of transmitter attachment remain a concern. Current solar-powered models are <20 g, on par with battery-powered VHF transmitters. Additional techniques that can reduce weight include "store-on-board" technology (Kauth et al. 2020), but the bird must be recaptured so that data can be recovered.

Studies using telemetry assume behavior, reproduction, and survival of radio marked birds is representative of the population. Marks and Marks (1987) reported lower survival of radio marked sharp-tailed grouse, but at a time before improvements in transmitters and attachments were made. Connelly et al. (2003) briefly reviewed the changes in VHF transmitter attachment practices for sage-grouse; transmitters have become lighter, and attachment methods have improved over the years. Hagen et al. (2006) detected no effect of VHF transmitters on summer or winter survival of male lesser prairie-chickens. However, Gibson et al. (2013) reported clear evidence that necklace style VHF transmitters



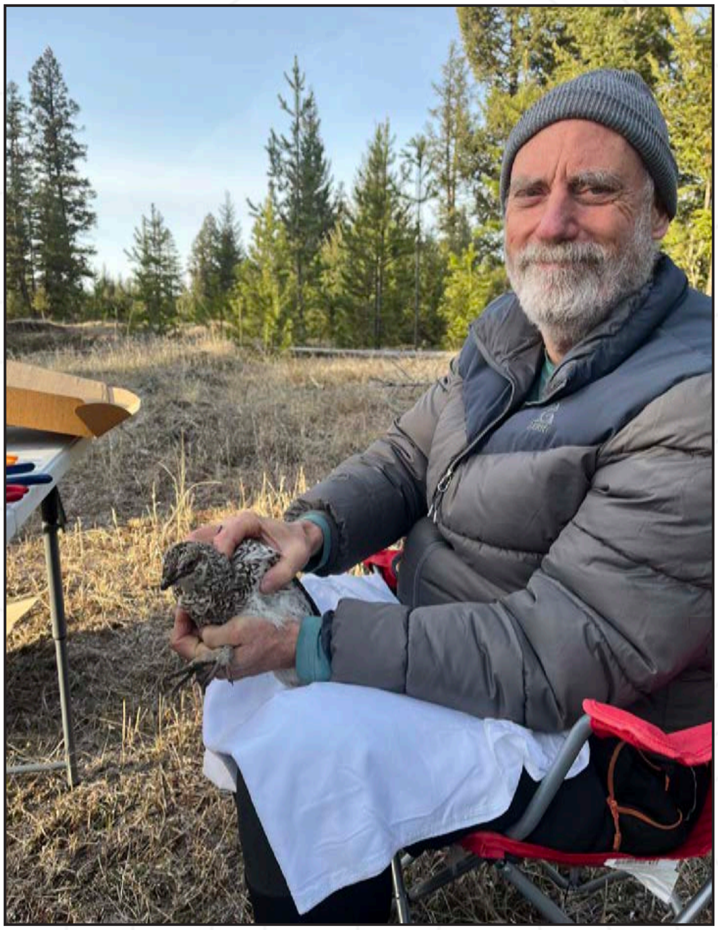
affected lek attendance rates and/or behavior on leks of male sage-grouse. Their model suggested radio packages reduced the likelihood of males attending a lek during a season, or reduced apparent survival, this despite the use of small radio packages (<1% of body weight) less tightly attached than recommended by Connelly et al. (2003). Gibson et al. (2013) cited other studies reporting lower breeding success of collared individuals in black grouse, lower survival in rock ptarmigan, and lower breeding success and survival of female ring-necked pheasants. This suggests a need to balance the desire for close monitoring with the need to minimize negative effects of radio packages. Hoffman et al. (2015) recommended radio-collaring sharp-tailed grouse early during a reintroduction (>50% of males in an initial fall release) so the location of a lek is known, and movements and nesting location of females can help guide subsequent releases, as suggested by Coates et al. (2006). Hoffman et al. (2015) suggested that a lower proportion of birds may be collared in later releases and during reinforcement.

Disease and genetic testing. Translocations may risk moving pathogens to novel environments and uninfected populations, as well as the risk of placing uninfected translocated animals into a landscape with pathogens to which they are naïve. In addition, states, provinces, and countries have varying regulations regarding movement of wildlife. The "WAFWA Guidelines for Health Screening and Sampling of Galliformes" should be followed and a veterinarian, ideally specializing in wildlife, should be consulted in the planning phase of all translocations (Burco et al. 2018).

The "WAFWA Guidelines for Health Screening and Sampling of Galliformes" (Burco et al. 2018) are summarized here. Intrastate and intra-provincial translocations typically require approval of the respective wildlife or natural resource agency, unless disease testing and surveillance are mandated by law. Cross-border translocations generally require disease screening to comply with entry requirements of the recipient state and issuance of an entry permit from an accredited veterinarian within the donor state. Screening generally includes an inspection by a veterinarian for overall health and potential ectoparasites issues, along with lab tests for additional pathogens of concern. Screening required by the recipient state's department of agriculture typically include pathogens of concern to the poultry industry; however, required tests may change due to emerging diseases and recommendations by a local veterinarian.

For translocations across state or federal borders, pre-translocation surveillance of the donor population may take the place of testing during a translocation to determine if the source population is disease free and suitable for translocation. For pre-translocation disease surveillance, 33% of the anticipated number to be translocated or a minimum of 30 individuals is recommended; however, larger samples may be needed based on the geographic area, the level of confidence required, and the rules of the respective agencies. It may be desirable to conduct the same testing in the recipient population to understand disease risks to translocated birds. International translocations require further planning and regulatory compliance. Import from Canada requires a health certificate from a Canadian government veterinarian and an Animal and Plant Health Inspection Service (APHIS) inspection at the border. APHIS (2019) maintains a disease list for which all translocated birds are screened. Note that blood, disease, or tissue samples from Canada also require a U.S. Department of Agriculture (USDA) import permit and an associated processing fee for each shipment. Shipping samples with the birds, or using a lab in Canada, may avoid the additional permit fee.

Tests typically include serology or Polymerase Chain Reaction (PCR) assay for Mycoplasma gallisepticum, M. synoviae, and M. meleagridis. Serologic tests are more common but have a greater probability of false positives than PCR assays. Serology requires a blood draw, and PCR can be run with choanal swabs. Although translocated species may not be susceptible to all tested strains of Mycoplasma, testing is still required by most states prior to import to ensure translocated birds are not acting as carriers of disease. Salmonella pullorum (Pullorum Disease) and S. gallinarum (Fowl Typhoid) can cause significant sickness and mortality in infected populations. Testing is conducted for Salmonella



spp. via blood draw and serological assay. Any positive individuals should be euthanized and necropsied and tissues cultured to determine type. Avian influenza viruses (AIV) are classified by subtype and may be either low pathogenic or highly pathogenic strains. Any AIV is a concern as increased circulation of low pathogenic AIV may lead to development of highly pathogenic AIV. Avian Influenza Viruses are typically tested with PCR using an oropharyngeal swab, although less accurate serological tests are available.

Any summer/early fall captures would likely also necessitate testing for West Nile Virus (WNV), which has been documented in greater sage-grouse from Idaho, Wyoming, Montana, Oregon, and Alberta. 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 (Kristen Mansfield, WDFW Veterinarian, personal communication). This is generally not a concern in spring translocations because vectors of WNV (i.e., Culex mosquitoes), are not active in early spring. In many cases, a blood sample from the translocated birds is sufficient to meet disease-testing requirements.

Parasites in the gastrointestinal tract are relatively common and can be responsible for limited mortality events. Long holding times can lead to increased parasite loads. Coccidiosis and other gastrointestinal parasites can be screened via fecal samples examined with flotation and microscopy. Other internal parasites, external parasites, bacterial disease, viral disease and fungal disease may be of local or emerging concern, and state wildlife veterinarians should be consulted. The National Poultry Improvement Plan provides a list of accredited labs for each diagnostic test. All reusable transport containers should be cleaned and disinfected between uses even if disease has not been detected. Wood shavings should not be used in transport containers as they pose a risk of aspergillosis (a fungal infection).

There must be advance planning and consideration in the event individuals, or the entire cohort, fail to pass health inspections or disease testing, and cannot be released into the recipient population. Options include: 1) retesting positive individuals if a false positive is suspected, 2) returning all birds to the capture site, 3) returning diseased individuals to the capture site, 4) culling diseased individuals, or 5) culling the entire group. If any birds are positive for Salmonella spp., no birds from the flock should be translocated. It is also recommended that genetic samples be taken from all handled birds by plucking feathers from the breast of a bird or taking a small amount of blood. Blood and feathers should be stored frozen or dried. There must be plans to assess these samples, especially if genetic goals are a basis for conducting the translocation (Small et al. 2011, Zimmerman et al. 2019)

Capture, transport, and release techniques. The details of capture, handling, transport, and release have evolved over the years (Toepfer et al. 1990, Reese and Connelly 1997, Snyder et al. 1999), but they should be outlined before the project begins.

<u>Sharp-tailed Grouse</u>

The techniques for spring capture of sharp-tailed grouse using walk-in traps on leks are standard (Toepfer et al. 1987, Haukos et al. 1990, Schroeder and Braun 1991) though many minor modifications of trap designs have been used. Traps are typically made of welded wire fencing with 2" X 4" openings, cone-shaped funnel entrances (or modified so no funnel is needed), and netting over the top to reduce injuries when birds jump. Traps are arranged on leks with 1" X 1" holed drift fencing to direct birds toward trap entrances.

<u>Sage-Grouse</u>

Sage-grouse are typically captured with long-handled nets and the aid of a spotlight (e.g., >1 million candle power), which is very effective during spring when birds are attending leks (Giesen et al. 1982, Wakkinen et al. 1992, Reese and Connelly 1997). Birds are captured at night while roosting on the ground, often in small groups on or in the general vicinity of leks. Rocket netting on leks with little or no sagebrush cover can also be effective if carefully planned (Connelly et al. 2003; A. Moser, personal communication). For brood translocations, radio-marked females were located at nocturnal roost sites using radio-telemetry, while unmarked females with broods were found by searching known brood-rearing habitat at night (Meyerpeter et al. 2021). Both were captured using similar spotlighting and netting techniques as described above.

<u>Handling and Transport</u>

Following capture, each bird should be identified to age and sex, weighed and measured, banded with a standard metal band (either numbered aluminum band or combination of aluminum and plastic), blood sample drawn for disease testing or genetic analysis (or pulled feathers for genetics), and transmitters attached (on each bird or a sub-sample) (Hines and Zwickel 1985, Marks and Marks 1987, Fremgen et al. 2017, Foster et al. 2018).

An important consideration is to minimize stress to birds, especially by reducing the length of time in captivity. Transport is typically by vehicle (by plane in a few cases) in individual cardboard boxes that allow some movement, but not enough for birds to injure themselves. The bottom of the transport boxes can be filled with a layer of unscented kitty litter (or something else that improves transport conditions) to reduce contact between feces and the birds' feet. Fine pine shavings should not be used as bedding because it can block nasal passages if inhaled. Some projects have used plywood transport boxes with separate compartments for each bird (e.g. Lazenby 2020, p. 118). If multiple birds are transported in the same box, it is important the box be kept dark to reduce potential fighting. The transport box can also be used as a settling box at the release site (see release section) and/or to release birds remotely, thus eliminating the need for birds to be handled a second time. The advantage of this strategy is diminished if a veterinarian needs to visually examine the birds. Regardless of the method of transport and release, grouse should be kept cool at all times and released as soon as possible after capture, preferably on the same day or early the next day within 26 hours if possible. Settling boxes can be placed at the edge of an active lek during the breeding season or close to cover at other times of year. Birds should not be released near fences, power/transmission lines, or in the direction of a strong wind. Reusable boxes should be cleaned and sanitized between uses.

Sharp-tailed grouse. Rodgers (1992) kept sharp-tailed grouse in captivity for an average of 40 days and fed commercial grains and lettuce before release. However, Schneider (1994) speculated an abrupt change in diet when sharp-tailed grouse are released may be stressful and cautioned reintroductions involving periods of captivity may result in higher mortality, as was reported by Gardner (1997).

Sage-grouse. Musil (1989) experimented with anesthetizing sage-grouse and placing them under a sagebrush plant as a stress reduction technique, but this did not improve daily survival of released birds (Reese and Connelly 1997). Reese and Connelly (1997) recommended sage-grouse be transported quickly. Meyerpeter et al. (2021) demonstrated a method to transport sage-grouse hens with chicks in a compartmented transport box, using a partition to separate them to prevent potential injury to the chicks during transport. Hand warmers should be placed in the chick compartment to provide a heat source while separated from the female.

Release

Snyder et al. (1999) categorized projects as either "soft release" or "hard release," based on whether birds were released from remotely operated boxes, but the term "soft release" is more commonly used in the literature for translocations involving days or weeks of transitional confinement and supplemental feeding (Griffith et al. 1989, Teixeira et al. 2007). Dickens et al. (2009) reported translocated chukars (Alectoris chukar) exhibited symptoms of chronic stress for at least 31 days post-release, and even birds captured, handled, and released back to the capture site showed some symptoms of chronic stress. Chronic stress, which may last several weeks, can result in weight loss and may result in increased mortality or reduced productivity at the release site. To minimize stress, settling boxes can be used as described below. The term "hard release" for projects involving confinement for <36 hours and no supplemental feeding, is consistent with that used in the literature. The term "modified hard release" could be applied when techniques are used to reduce panic flushing, such as remotely opened boxes, or decoys, but no prolonged confinement and/or feeding is involved.

Sharp-tailed grouse. Gardner (1997) held sharp-tailed grouse together in a pen and fed them for several days before release, but discontinued holding birds for >24 hours the third year because of concerns about weight loss and stress. Birds held in captivity exhibited greater movements and a period of lower survival for the first 3 weeks post- release, compared to birds released within 24 hours. Gardner (1997) recommended minimizing the time between capture and release, and not holding birds together.

Rodgers (1992) described a method used to re-establish a population of plains sharp-tailed grouse (T. p. jamesi) in Kansas involving an artificial lek with decoys, vocalization playbacks, and remotely opened release boxes. The mock lek was established to encourage released birds to remain at the site and prevent dispersal that caused failure of earlier projects. Crawford and Snyder (1994) experimented with this technique in the early years of a reintroduction project in northeastern Oregon. They reported decoys did not seem to retain birds at the site, but vocalization playbacks might be important, although they may also interfere with vocalizations of released birds. Coates et al. (2006) conducted a reintroduction of Columbian sharp-tailed grouse in Nevada using the mock lek technique described by Rodgers (1992) and released birds from a box with separate compartments, but they were uncertain whether the mock lek was beneficial. Sage-grouse. Reese and Connelly (1997) recommended sage-grouse be released in groups from a holding pen from a hidden location. Hennefer (2007) reported that female sage-grouse released near a lek with actively strutting males dispersed shorter distances than those released near an inactive lek. For sage-grouse brood releases, Meyerpeter et al. (2021) recommended a soft release with a pen that would allow the hen to resume brooding prior to release, so that the hen does not immediately flush and potentially abandon her brood. Furthermore, releasing broods as soon as possible following capture and arrival to the release site improves success, ideally shortly after sunrise. A delayed-release acclimation pen should be used to facilitate a gradual release, where the brood is released from the transport box into a small pen (76 cm wide by 160 cm long, 61 cm tall) to prevent immediate chick abandonment by the female. Once all chicks have exited the transport box and the hen appears calm, the acclimation pen door can be opened. Remotely operated systems for opening the transport box and pen door can be used to minimize disturbance and facilitate smoother releases. See Meyerpeter et al. (2021) and Lindenauer (2025; in prep) for more details.

Artificial insemination

The stress of translocations may cause delays in breeding and disruption of the normal mating process. As a result, translocated females may be less productive, either forgoing breeding or producing infertile eggs (Schneider et al. 2019). A possible solution to this problem is artificial insemination, first demonstrated in grouse by Stirling and Roberts (1967) but is now being considered for translocations (Schneider et al. 2019, Lazenby 2020). Another potential advantage with artificial insemination is donor semen can be selected, potentially optimizing outbreeding (Łukaszewicz and Kowalczyk 2015). However, the application of artificial insemination techniques to a translocation of Columbian sharp-tailed grouse in Nevada failed to produce positive results, whereas translocated females successfully bred with males released in previous years rather than producing chicks from the artificial insemination (Mathews et al. 2018). Artificial insemination was also used on a portion of the female greater sage-grouse translocated from Wyoming to North Dakota (Table 1; Lazenby 2020). An additional consideration is that artificial insemination will add to the handling time and stress of captured birds.

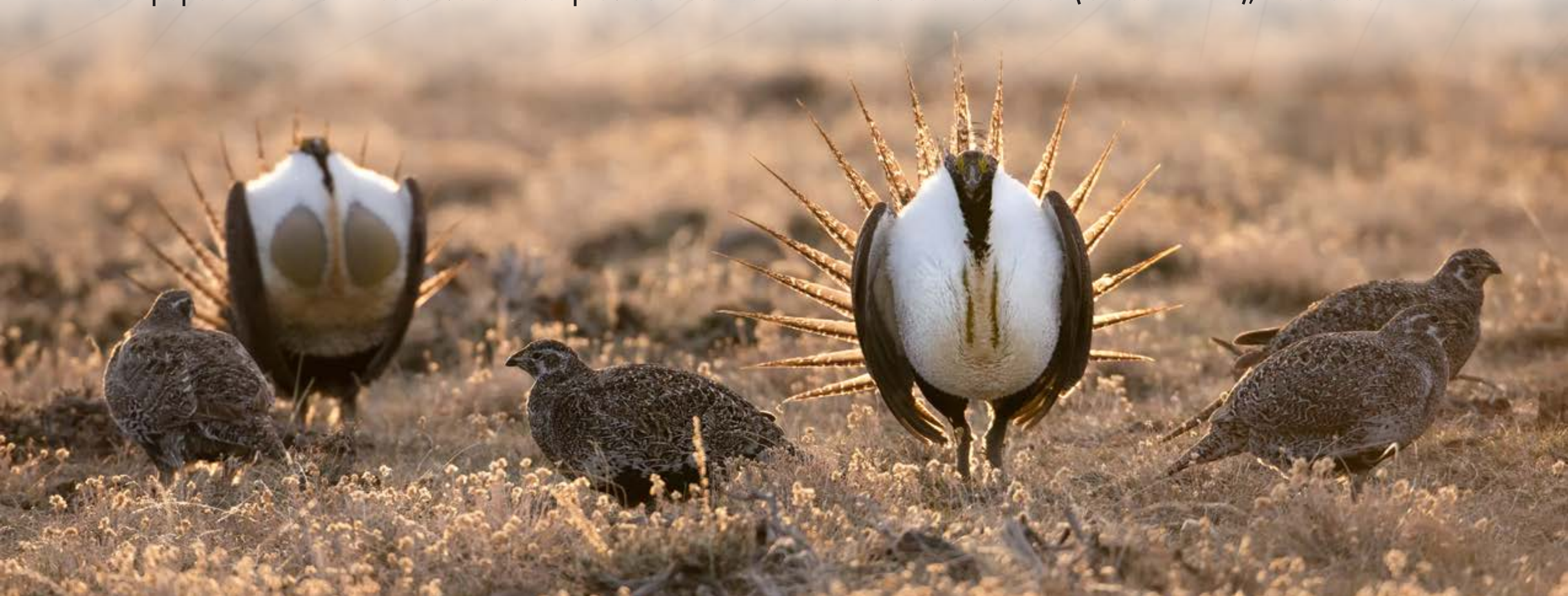
Monitoring and evaluation

Progress of a translocation should be monitored as closely as possible given the project budget and technology available, but this must be balanced with the need to minimize negative impact of disturbance and radio collars on bird behavior and survival. Specific objectives of monitoring typically include examinations of movement, habitat use, productivity, survival, and population size. These evaluations provide essential information to determine whether additional translocations, habitat improvements, or changes in release locations, and/or translocation methodologies are necessary (Toepfer et al. 1990, Reese and Connelly 1997) and can help guide future translocation efforts. Monitoring of movement patterns and lek establishment during the initial year of translocation can be used to fine-tune location of subsequent release sites (Coates et al. 2006).

Lek counts suffer from some biases but can be used to monitor trends of local populations (Connelly et al. 2003, 2004; Connelly and Schroeder 2007; Garton et al. 2011; Fedy and Aldridge 2011, Garton et al. 2015; Gruber-Hadden et al. 2016) and have been shown to be a valid index of population change (Dahlgren et al. 2016). Lek count data at translocation sites should be carefully compared to local trends to fully understand the contribution or success of the translocation. If pre-translocation genetic sampling was conducted, then post-translocation samples can be analyzed to identify improvement in genetic diversity.

Monitoring and evaluation of projects can be conducted with radio (VHF) and/or satellite (GPS) telemetry and lek surveys. Birds marked with VHF transmitters are located visually or by triangulation with portable receivers and 3-element Yagi antennas. Fixed-wing aircraft can be used to locate lost birds as needed throughout the year. Locations for birds marked with GPS transmitters are downloaded from satellite with a paid subscription, without personnel being in the field, or downloaded directly from the transmitter using a UHF antenna or computer cord in the case of store-on-board units. Disturbance of birds, particularly at nest sites, should be avoided whenever possible. Brood counts can be done when their locations are predictable, in association with a radio-marked hen via flush counts, or with the use of pointing dogs to increase detection rates (Dahlgren et al. 2012).

Additional metrics to determine short-term success may include survival and reproductive rates of translocated birds versus residents (Gruber 2012), increases in nest



propensity in the second- year post-release, number of losses to permanent dispersal, and observations of released birds with residents (Baxter et al. 2008). An evaluation should be conducted even if the translocation was believed to have failed. Monitoring source and control populations using similar telemetry methodology as translocated sites can also be critical, especially if the goal is to accurately evaluate restoration success and potential impacts to source populations. For example, Meyerpeter et al. (2025) found reinforced populations outperformed source and control populations following translocation using a before-after-control-impact design. Importantly, only through close tracking of individuals, the authors concluded that a decline in population growth at one source population was attributed to decreased survival and independent of translocation actions. Analyses of detailed telemetry data at source and control sites allows for disentanglement of potential effects of translocation from other sources of mortality.

Projects should have annual progress reports, even if not required by a grant or contract. It is important to maintain communication with the responsible individual in the wildlife agency that granted capture permits, so they are assured birds are going to a well-run project and can provide information to their managers and public. Progress and final reports should be available to the source agency, granting agency, to wildlife managers, and interested public. Additional data or information may be required by the source agency (such as number of birds by sex, age, and specific capture location). The following key elements should be included in annual and final reports:

- Pre-release assessment of the target habitat and disturbances
- Numbers of birds by age and sex captured and released
- Identification of any capture or transport mortalities
- Movements of translocated birds
- Survival rates of translocated birds
- Nesting rates and success, brood success
- Description of modifications from original proposal
- Evaluation of trapping, transport, and release methods
- Results of disease screening
- Genetic assessments
- Future needs or planned work
- Possible impacts on the source population (if this information is available)
- Update of recipient population status (primarily in final report)
- Evaluation of the translocation effort (primarily in final report)
- Description of habitat management and maintenance plans (primarily in final report)
- Other lessons learned (primarily in final report)

Funding

A key consideration is whether adequate funding is likely to be available to complete the project. A reintroduction project requires a commitment of several years of releases and monitoring. A full-time seasonal employee and vehicles to assist with capture and conduct intensive monitoring are relatively expensive. For example, North Dakota spent approximately \$1 million to translocate and monitor ~400 sage-grouse males, females, and females with broods over a 4-year period (Jesse Kolar, personal communication). If satellite transmitters are used, managers should consider the costs of the transmitters as well as subscription costs for transmitters. As budgets and work schedules have tightened, adequate funding and careful budgeting is increasingly important. Volunteers have proven useful on past projects, but it is unlikely volunteers will be able to complete a detailed proposal or project reporting.

Official letter of request and permits

An official letter of request for translocations between states and/or provinces should be sent by the requesting agency to the wildlife agency director or bureau chief of the source state, province, or tribe. The official request letter and proposal need to be sent far enough in advance (preferably ≥4 months) of the desired translocation to allow adequate time for consideration, decision-making, and logistical preparation. If the request is from another entity, such as a federal agency, non-governmental organization or private party, the official letter of request should be sent to the wildlife agency of both the source and recipient states, provinces, and/or tribes. Any requests for assistance from the source agency, such as help with trapping, should be explicitly stated in the letter of request and proposal.

Some states, provinces, or tribes may require permits, such as a scientific collecting permit, a translocation document, and/or agriculture importation permit. Additional permitting and inspections are required if birds will be moved across the U.S.-Canadian border (e.g., U.S. Fish and Wildlife Service, U.S. Department of Agriculture, APHIS, and the Canadian Food Inspection Agency). Most permits and other required forms require time for processing, fees, and/or scheduled appointments.

Evaluation of Translocation Proposals

We recommend external evaluations of translocation proposals be conducted by the Western Association of Fish and Wildlife Agencies Sage- and Columbian Sharp-tailed Grouse Technical Committee prior to commencement of grouse translocation project. Members of the Technical Committee include representatives from state and provincial agencies who are typically program leads for management and research of these species within their respective agency. The Technical Committee is uniquely positioned to offer leadership and guidance on translocation projects, including the ability to conduct an informed review.

The Technical Committee will evaluate translocation proposals based on guidelines provided in this document, including the long-term potential for success as determined by habitat quality, size and connectivity of the target location, and improvement of limiting factors that lead to the original declines in the population. In general, federally listed populations, subspecies, and species should be considered before non-listed populations, subspecies, and species.

Reinforcements should take priority over reintroductions, given the lower probability of success for reintroductions. The Technical Committee should also give attention to an evaluation of an appropriate source population, including taxonomy, heterozygosity, population size, and environmental similarity. Although there is tremendous variation in logistical and protocol considerations, they also should be considered.

In times of declining populations range-wide, it has become increasingly difficult for states and provinces to justify donating birds to another jurisdiction. An evaluation and recommendation by the Technical Committee will assure donor agencies their wildlife resources are utilized appropriately, standard guidelines and methods are followed, and ultimately each translocation will build on our state of knowledge and experience such that success of translocations will increase in the future.

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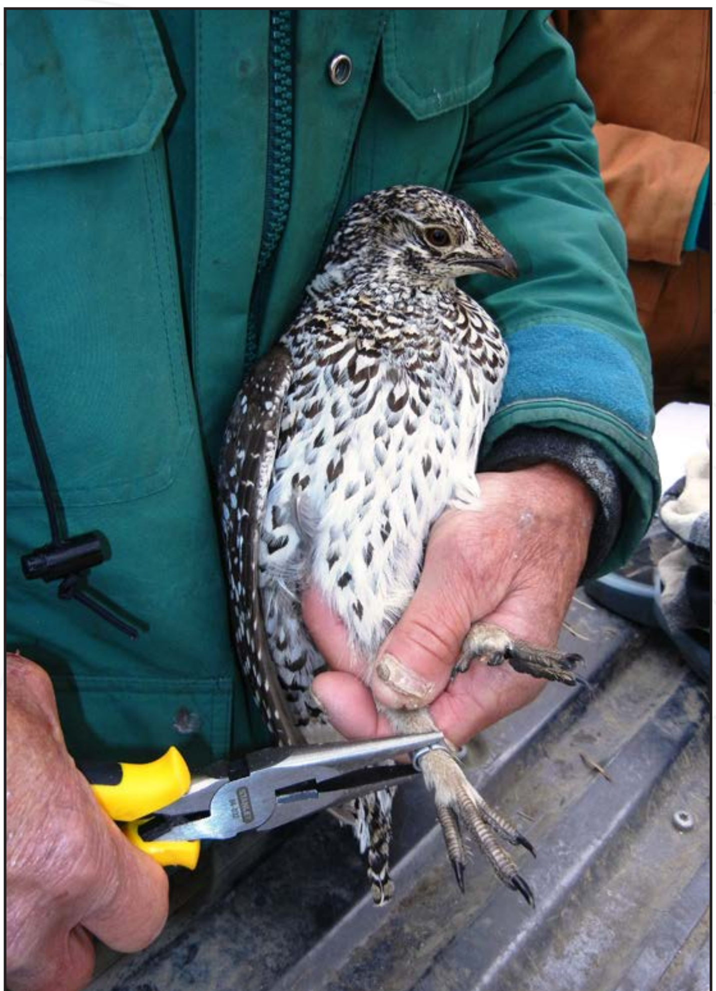

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Table 1. Known translocations of greater sage-grouse, Gunnison sage-grouse, and sharp-tailed grouse in western North America during 1876–2024.

Target location	Source location	Year(s)	Number[a]	Active[b]	Reference(s)
Introductions of greater sage-grouse – translocations to locations outside original range					
NM (Taos and Rio Arriba counties)	WY (Sweetwater Co.)	1933–1934, 1936, 1941	246	No	Allred 1946
NM (Taos Co.)	SD	1949	15	No	Allred 1946
NM (Taos Co.)	WA	1958	17	No	Allred 1946
NM (Taos Co.)	NE	1969	48	No	Allred 1946
Introductions of sharp-tailed grouse – translocations to locations outside original range					
HI (Hawaii Co.)	BC	1932	30	No	Caum 1933, Swedberg 1967, Pyle and Pyle 2017
New Zealand	UT	1876	22	No	Phillips 1928
Reintroductions of greater sage-grouse – translocations to unoccupied locations inside original range					
BC (Richter Lake)	OR (Malheur Co.)	1958	57	No	Cannings et al. 1987
OR (Umatilla, Malheur, and Baker counties)	OR (Harney Co.)	1941–1942	199	No	Batterson and Morse 1948
OR (Sherman Co.)	OR (Malheur Co.)	1949	38	No	Reese and Connelly 1997
OR (Wasco Co.)	OR (Malheur Co.)	1950–1951	171	No	Reese and Connelly 1997
WA (Yakama Nation)	OR	2005–2007	55	No	Schroeder et al. 2020
WA (Yakama Nation)	WY (Wind River Indian Reservation)	2006	5	No	Schroeder et al. 2020
WA (Yakama Nation)	NV	2013–2014	68 (45/23/0)	No	Schroeder et al. 2020
WA (Lincoln Co.)	OR	2008–2015	280 (138/124/18)	Yes	Schroeder et al. 2020
Reintroductions of Gunnison sage-grouse – translocations to unoccupied locations inside original range					
CO (Poncha Pass)	CO (Gunnison Co.)	1971–1972	25 (listed as 20–25)	Yes	Reese and Connelly 1997
UT (San Juan Co.)	UT (Wayne Co.)	1976	48	No	Reese and Connelly 1997
Reintroductions of sharp-tailed grouse – translocations to unoccupied locations inside original range					
CO (Dolores Rim, Montezuma Co.)	CO (Moffat Co. & Routt Co.)	2004–2007	166 (63/103/0)	Yes	Hoffman et al. 2015
CO (Middle Park, Grand Co.)	CO (Moffat Co. & Routt Co.)	2006–2009, 2014–2016	289 (120/169/0)	Yes	Hoffman et al. 2015, Kathleen Griffin, pers. comm.
CO (Wolcott State Bridge, Grand Co.)	CO (Moffat and Routt counties)	2015–2018	173 (63/110/0)	Yes	Kathleen Griffin, pers. comm.
NV (Snake Mountains)	ID (SE)	1999–2005	227 (145/82/0)	Yes	Smith 2012
NV (Bull Run Basin)	ID (SE)	2013–2017	212 (59/153/0)	Yes	SPE, pers. Comm
OR	Unknown	1963	85	No	Snyder et al. 1999
OR (Wallowa Co.)	ID (SE) & UT (NE)	1991–1997, 2001–2002, 2006–2008	389 (221/168/0)	No	Hoffman et al. 2015
UT (Summit Co.)	UT (Box Elder Co.)	1993	34 (21/13/0)	No	Hoffman et al. 2015
UT (Antelope Island)	UT (Box Elder County)	2009–2013	82 (53/29/0)	No	Hoffman et al. 2015
WA (Eastern)	MT (Bison Range)	~1930	30	No	Philip L. Wright, pers. comm.
WA (Turnbull)	WA (Tunk Valley)	1954	25	No	MAS, unpub. data
WA (Crab Creek)	Pen-reared	1993–1994	15	No	Merker 1996
Reinforcements of greater sage-grouse – Translocations to augment existing populations					
AB (SE) and SK (SW)	Pen-reared	2018	66	Yes	Joel Nicholson, pers comm.
AB (SE)	MT	2011–2012	41	Yes	Whiklo and Nicholson 2015
CA (Clear Lake)	OR and NV	2005–2019	179	Yes	Bell and George 2012, Katherine Miller, pers. comm.

Target location	Source location	Year(s)	Number[a]	Active[b]	Reference(s)
CA (Parker Meadows)	CA (Bodie Hills)	2017-2023	375 (20/71/275)	Yes	Steve Abele, pers comm. Meyerpeter et al. in press, Bi-State Accomplishment Reports
CO (Routt Co.)	CO (Jackson Co.)	2018–2019	80 (20/60/0)	Yes	Kathleen Griffin, pers comm.
ID (Sawtooth Valley)	ID (SE)	1986–1987	196 (131/65/0)	No	Reese and Connelly 1997
MT (8 unspecified locations)	WY (Sweetwater Co.)	1942	242	Yes	Thompson 1946, Patterson 1952
ND (Bowman Co.)	WY	2017–2018	158 (66/66/26)	Yes	Lazenby 2020
OR (Crook Co.)	OR (Malheur Co.)	1948	9	Yes	Reese and Connelly 1997
UT (Anthro Mountain)	UT (Parker Mountain)	2009–2010	60 (0/60/0)	Yes	Gruber 2012, Duvuvuei et al. 2017
UT (Sevier County)	UT (Uintah and Carbon counties)	1987–1990	43	Yes	Reese and Connelly 1997
UT (Strawberry Valley)	UT (Diamond Mountain)	2003–2008	336 (0/336/0)	Yes	Baxter et al. 2008, 2013
UT (Sheeprock Mountains)	UT (Box Elder Garfield, Piute, and Wayne counties)	2016–2019	146 (40/106/0)	Yes	UDNR 2019
WA (Yakima Training Center)	OR & NV	2004–2006	63 (5/44/14)	Yes	Schroeder et al. 2020
WA (Yakima Training Center)	ID	2014–2016	36 (0/30/6)	Yes	Schroeder et al. 2020
WY (6 different counties)	WY (Eden Valley)	1950	405	Yes	Patterson 1952
WY (Albany Co.)	WY (Eden Valley)	1940–1943, 1947, 1949	308	Yes	Patterson 1952
WY (Big Horn Co.)	WY (Eden Valley)	1940–1943	50	Yes	Patterson 1952
WY (Campbell Co.)	WY (Eden Valley)	1940–1943	62	Yes	Patterson 1952
WY (Carbon Co.)	WY (Eden Valley)	1940–1943	19	Yes	Patterson 1952
WY (Fremont Co.)	WY (Eden Valley)	1940–1943, 1946–1948	356	Yes	Patterson 1952
WY (Goshen Co.)	WY (Eden Valley)	1940–1943	244	No	Patterson 1952
WY (Hot Springs Co.)	WY (Eden Valley)	1940–1943	119	Yes	Patterson 1952
WY (Johnson Co.)	WY (Eden Valley)	1940–1943, 1950	179	Yes	Patterson 1952
WY (Lincoln Co.)	WY (Eden Valley)	1940–1943	203	Yes	Patterson 1952
WY (Natrona Co.)	WY (Eden Valley)	1940–1943, 1950	335	Yes	Patterson 1952
WY (Niobrara Co.)	WY (Eden Valley)	1940–1943	231	Yes	Patterson 1952
WY (Park Co.)	WY (Eden Valley)	1940–1943	198	Yes	Patterson 1952
WY (Platte Co.)	WY (Eden Valley)	1940–1943	305	Yes	Patterson 1952
WY (Sheridan Co.)	WY (Eden Valley)	1940–1943, 1950	515	Yes	Patterson 1952
WY (Sublette Co.)	WY (Eden Valley)	1940–1943, 1949–1950	458	Yes	Patterson 1952
WY (Sweetwater Co.)	WY (Eden Valley)	1940–1943, 1946–1951	865	Yes	Patterson 1952
WY (Teton Co.)	WY (Eden Valley)	1940–1943, 1948–1949	397	Yes	Patterson 1952
WY (Uinta Co.)	WY (Eden Valley)	1949	514	Yes	Patterson 1952
WY (Washakie Co.)	WY (Eden Valley)	1940–1943	41	Yes	Patterson 1952
Reinforcements of Gunnison sage-grouse – Translocations to augment existing populations					

Target location	Source location	Year(s)	Number[a]	Active[b]	Reference(s)
CO (Cimarron)	CO (Gunnison Co.)	2000	6	Yes	Zimmerman et al. 2019, Kathleen Griffin, pers. comm.
CO (Crawford)	CO (Gunnison Co.)	2011–2013	72 (31/41)	Yes	Zimmerman et al. 2019, Kathleen Griffin, pers. comm.
CO (Dove Creek)	CO (Gunnison Co.)	2010–2011	42 (17/14/11)	Yes	Zimmerman et al. 2019, Kathleen Griffin, pers. comm.
CO (Pinon Mesa)	CO (Gunnison Co.)	2010–2013	93 (31/55/7)	Yes	Zimmerman et al. 2019, Kathleen Griffin, pers. comm.
CO (Poncha Pass)	CO (Gunnison Co.)	2000–2001, 2013–2014	68 (36/26/6)	Yes	Kathleen Griffin, pers. comm.
CO (San Miguel)	CO (Gunnison Co.)	2006–2014	115 (43/39/33)	Yes	Kathleen Griffin, pers. comm.
Reinforcements of sharp-tailed grouse – Translocations to augment existing populations					
BC (Fraser Plateau)	BC (Fraser Plateau)	2005	9 (5/4/0)	Yes	Hoffman et al. 2015
ID (House Creek Drainage)	ID (SE)	2003–2010	247 (160/87/0)	Yes	Smith 2012
ID (Shoshone Basin)	ID (SE)	1992–1999	359 (210/149/0)	Yes	Smith 2012
MT (Tobacco Plains)	BC (Merritt & Clinton)	1987–1991, 1996–1997	139 (104/35/0)	No	Young and Wood 2012
WA (Crab Creek)	ID (SE), BC (Fraser plateau), UT (N)	2005–2013, 2024	235 (128/107/0)	Yes	Schroeder et al. 2024
WA (Dyer Hill)	ID (SE), BC (Fraser Plateau), UT (N), WA (Nespelem)	1999, 2005–2008, 2024	94 (50/44/0)	Yes	Schroeder et al. 2024
WA (Greenaway Spring)	ID (SE), BC (Fraser Plateau), UT (N)	2005, 2011	17 (16/1/0)	Yes	Schroeder et al. 2024
WA (Nespelem)	ID (SE), BC (Fraser plateau), UT (N)	2005–2009, 2011–2012, 2022	113 (73/40/0)	Yes	Schroeder et al. 2024
WA (Scotch Creek)	ID (SE), BC (Fraser Plateau), WA (Nespelem)	1998–2000, 2019, 2022–2023	121 (64/57/0)	Yes	Schroeder et al. 2024
WA (Tunk Valley)	BC (Fraser Plateau)	2018–2019, 2023	80 (39/41/0)	Yes	Schroeder et al. 2024

[a]When the data is available, the number in parentheses includes the number of breeding-aged males, breeding-aged females, and juveniles.

[b]Active refers to sites that are believed to be active ("yes") or inactive ("no") as of 2024.

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