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Translocations of sage grouse *Centrocercus urophasianus* in North America

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Sage grouse *Centrocercus urophasianus* have been translocated in at least seven states and one Canadian province, but little published information documents the success of these attempts. Historical and recent efforts at translocations are reviewed, their success evaluated and recommendations for future translocations are provided. Over 7,200 sage grouse have been translocated in at least 56 attempts to augment or reestablish populations since 1933. Only efforts in Colorado, Idaho, and Utah appear successful, however, breeding populations in these areas remain small. Common features of successful sage grouse translocations are: 1) reproductively-active birds were captured on leks at night in March and April, 2) birds were transported rapidly and released the morning following capture, and 3) release sites were isolated, islands of habitat surrounded by inhospitable cover distant from capture areas. Translocation of sage grouse is recommended only after careful evaluation of the release area for year-round habitat, and only if agencies commit resources adequate to monitor birds immediately post-release to assess short-term survival, and to monitor long-term population abundance to assess continued fate of the translocation. Translocations presently should be viewed as experimental and not as a viable strategy to restore extirpated populations of sage grouse.

Key words: *Centrocercus urophasianus*, management, North America, sage grouse, translocation

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The sage grouse *Centrocercus urophasianus* is an important game bird and symbol of healthy sagebrush *Artemisia* spp. rangelands. Sage grouse populations have declined range-wide over the last several decades, and the current trend is downward (Braun, Martin, Remington & Young 1994). Once occurring in at least 15 states and three Canadian provinces, the species now exists in 11 states and two provinces (Braun 1995). Habitat loss, habitat degradation, and habitat fragmentation are blamed for population reductions (Braun et al. 1994, Braun 1995).

Efforts to translocate sage grouse to augment low-

density populations or to reestablish populations in suitable, but unoccupied, habitat have been attempted in at least seven states and one province. However, little published information is available documenting the methods or success of the attempts. Therefore, we review historical and recent attempts at translocating sage grouse (attempt defined as an effort to establish birds in one site through one or more years of translocations), evaluate the success of these attempts, and provide recommendations for future translocations of the species.

Historical translocations

Sage grouse are known to have been translocated in New Mexico, Oregon, Montana, Wyoming, Utah, Colorado, Idaho, and British Columbia. Most of these efforts involved moving birds within individual states, and were not well-documented.

New Mexico initiated the earliest documented sage grouse translocations in 1933 (Allred 1946, J.P. Hubbard 1991, unpubl. letter) after the species was extirpated from the state in 1912. Two hundred forty-six birds (120 males, 126 females) from Wyoming were transported in four attempts to reestablish birds in the state; in November 1933 and October 1934 in Taos County, October 1934 and October 1936 in Rio Arriba County, November 1936 in Taos County, and September 1941 in Taos County (Allred 1946, J.P. Hubbard 1991, unpubl. letter). Birds were later imported from South Dakota in August 1949 (7 males, 8 females), from Washington in March 1958 (11 males, 6 females), and from Nevada in September 1969 (20 males, 28 females). In total, from 1933 to 1969, seven separate efforts in New Mexico resulted in release of 326 birds into San Juan, Rio Arriba, and Taos counties. There were reports of birds persisting in Taos County into the 1980s, but there are no specific records (J.P. Hubbard 1991, unpubl. letter). In spring 1986, a female was reported in San Juan County (Am. Birds 1986, 40:509-510), and another female was reported in Rio Arriba County in June 1989 (Am. Birds 1989, 43:1352). Hamerstrom & Hamerstrom (1961:292) stated that "New Mexico successfully reintroduced sage grouse on a small scale by transplantings." However, J.P. Hubbard (1991, unpubl. letter) indicated that translocations of sage grouse into New Mexico "failed to resuscitate the species".

Oregon translocated sage grouse within the state in the 1940s (Batterson & Morse 1948) and 1950s (K.R. Durbin, pers. comm.). In 1941 and 1942, grouse were captured in Harney County in late August, September, and October using a walk-in trap developed in Wyoming. Birds were moved up to 483 km. No mortality occurred in 47 grouse trapped in 1941, but two of 157 died in 1942. In 1941, 15 birds were moved to Umatilla County, 21 to Malheur County, and eight to Baker County (K.R. Durbin, unpubl. letter). No information is available on the number of birds moved to each location in 1942. Batterson & Morse (1948:25) concluded that "when populations are high, . . . transplanting offers a relatively cheap and simple method

of restocking ranges where grouse have been eliminated". However, there are no surviving grouse in Umatilla County. Birds currently exist in Baker and Malheur counties (K.R. Durbin, pers. comm.), but the impact of the translocations is unknown because sage grouse resided in the release areas during the translocations.

Translocation attempts continued within Oregon from 1948 to 1951. In 1948, nine birds from Malheur County were released in Crook County during fall; in 1949, 38 birds were trapped in September in Malheur County and moved to Sherman County; and 86 birds captured in August 1950 and 85 captured in October 1951 were moved from Malheur County to Wasco County. The success of birds released into Crook County is equivocal because sage grouse resided in the county at the time of the release and post-release monitoring was minimal. There are no surviving birds in the other translocation areas from releases in 1949, 1950, or 1951 (K.R. Durbin, pers. comm.).

In 1942, Montana attempted to restore sage grouse to several regions with suitable habitat but decimated populations (Thompson 1946, Wallestad 1975). In October, 242 birds were captured, held in crates for up to 30 hours until a 'sufficient number' was obtained, and transported for up to another 30 hours in captivity prior to release. Sixty to 70 hours was the limit of confinement that did not result in mortality (Thompson 1946). Birds were released in seven counties at eight locations and some were observed in release areas as late as 1946 (Thompson 1946). However, these attempts at reestablishment ultimately were not successful (Wallestad 1975).

In August 1958, 57 sage grouse, mainly young of the year captured on summer range in Malheur County, Oregon, were translocated into British Columbia north of Richter Lake (Cannings, Cannings & Cannings 1987:150, K.R. Durbin, unpubl. letter). These were the birds mentioned by Hamerstrom & Hamerstrom (1961) when they wrote that, in 1960, British Columbia was attempting to restore sage grouse through translocations. Four unverified reports placed sage grouse in the vicinity of Richter Pass and Osoyoos as late as 1966 (Cannings et al. 1987:150). No sage grouse have been reported since then and the species has been extirpated in the province (T.J. Ethier, pers. comm.).

Translocation of sage grouse in Wyoming began in 1940. Allred (1946) reported on early efforts to move birds from Eden Valley in Sweetwater County in southwest Wyoming where they were damaging

fields of alfalfa *Medicago sativa* to areas of suitable habitat with depleted populations. Birds were captured August through October, maintained in crates or padded wire coops for no more than three days, and released in 18 of Wyoming's 23 counties. From 1940 to 1943, 2,362 grouse were trapped and 2,165 translocated, but no further information on their fate was provided (Allred 1946, Patterson 1952:213). Translocations of sage grouse within Wyoming continued from 1946 through 1951. In total, from 1940 to 1951, 6,147 sage grouse were captured in summer and early fall, and 34 males trapped on leks. Of these, 5,881 were moved up to 483 km in 30 translocation attempts into 19 counties in the state (Patterson 1952:212-213). Injuries kept 185 (3%) birds from being released.

Information on movements and survival of translocated sage grouse in Wyoming was obtained primarily from birds released in 1949 and 1950. In 1950, 500 birds were banded and moved during summer into areas open for hunting in late August and September. Band recoveries indicated that 55% of adult males and 80% of adult females, released from 32 to 64 km south of the trapping site, returned to the capture area within seven weeks of release (Patterson 1952:230-231). Adult birds quickly dispersed from release sites and many returned to the exact area of capture. Other birds were harvested at locations 32-48 km from the release site, but not at the capture site.

Establishment of translocated sage grouse in Wyoming into resident populations indicated behavioural differences between age classes of males. In August 1948 and 1949, 346 birds were banded and moved into Jackson Hole, where approximately 500 birds resided. Leks were observed during the following two springs. In 1950, 11 banded males were seen on two leks containing 117 other males, and in 1951, 10 banded males and a banded female were observed on four leks containing 89 males and at least 10 hens (Patterson 1952:234-235). At least nine of these banded males were released as juveniles. Few males released as adults were incorporated into the breeding population. Patterson (1952:237) concluded that "mature age classes were highly intolerant to establishing themselves in the locality of a transplant site, regardless of its apparent suitability", and that we should expect little success if translocations involve adults.

Movements of immature birds upon release were largely unknown. There were no significant band recoveries during the 1950 and 1951 hunting seasons

from several hundred immature sage grouse released simultaneously with adults. Patterson (1952:300) cautioned that, although trapping and translocation of sage grouse received credit for an increase in numbers in Wyoming, "there is little factual data to indicate that this program accomplished anything more than token results".

In Colorado in April 1971 and 1972, between 20 and 30 sage grouse were captured at night in Gunnison County, transported 129 km to a sagebrush habitat of approximately 2,600 ha in northeastern Saguache County, and released the following morning from burlap sacks (C.E. Braun, unpubl. letter). There were no birds in the release area and the nearest birds to the release site were 48-64 km across a 3,300 to 3,650 m high, forested mountain range. This range also separated the capture site from the release site. Although no additional records exist of the release, the translocation appears successful because presently birds occupy an area of <1,550 ha. Approximately 50 breeding birds existed in the area in spring 1996 (C.E. Braun, pers. comm.).

Recent translocations

In attempts to reestablish sage grouse populations in suitable, but unoccupied range, two translocations were conducted in Utah (J.F. Karpowitz, pers. comm.). During August 1976, 48 hens and chicks from a non-migratory population in Wayne County were captured using net guns and released the following morning in adjacent San Juan County. The release site is a low-elevation, sagebrush mesa where catchment ponds for pronghorn *Antilocapra americana* and guzzlers (gamebird watering device) had been constructed prior to the release. Sage grouse appeared constrained to areas around water developments because the surrounding habitat was hot, dry sagebrush rangeland. Translocated birds established a lek which has been monitored annually since 1976. Although the population persisted for a number of years, recent drought has reduced numbers until only a single male attended the lek in 1996 (J.F. Karpowitz, pers. comm.).

Utah's second translocation was conducted from 1987 to 1990, when 43 birds from non-migratory populations were released into Sevier County. Twenty-seven hens and juveniles were captured in summer from Uintah County in 1987 and 1989, and 14 males and 2 females were trapped at night from

leks in Carbon County in 1988 and 1990. All birds were released the day following capture after being held in sacks. The release area, over 100 km from the capture sites, was a high-elevation, sagebrush bench surrounded by marginal cover. Guzzlers were also established in the area prior to the translocation. One lek has been observed and 20 males were present in 1996 (J.F. Karpowitz, pers. comm.).

The only translocation of sage grouse using radio-equipped birds to monitor success occurred within Idaho in 1986 and 1987 (Musil 1989, Musil, Connelly & Reese 1993, Musil, Reese & Connelly 1994). The Sawtooth Valley in central Idaho's Custer County (30 km long, 3-5 km wide, and 1,960-2,250 m a.s.l. in elevation) supported a population of sage grouse with at least six active leks prior to 1980. The number of leks declined until 1986 when one male attended one lek (Musil et al. 1993).

By 1986, biologists believed the vegetation had again become suitable for sage grouse because of changes in livestock management practices and natural sagebrush revegetation. The grouse population, however, may have been too low in the early 1980s for recovery even with improving habitat. In an attempt to augment the remnant population, 196 sage grouse were trapped at night on leks in March and April from non-migratory populations at similar elevations approximately 144 km from the Sawtooth Valley. Males were moved in wooden crates and females were moved individually in cardboard boxes to reduce injuries (Musil et al. 1993). All birds were released the morning following capture. Forty-four (22%) grouse (31 females, 13 males) were equipped with radio-transmitters (Musil et al. 1993).

Sage grouse released into the Sawtooth Valley made extensive movements up to 37 km from the release site in the initial 3-6 weeks post-release, similar to other translocated upland game birds (Miller, Major & Backs 1985, Kurzejeski & Root 1988). Birds that survived this period returned to summer near the release site becoming more sedentary. No translocated birds, radio-equipped or banded, were known to return to capture sites (Musil et al. 1993).

Contrary to movements of birds translocated in summer within Wyoming, sage grouse released into the Sawtooth Valley during the breeding season remained near (within a mean of 4.2 km) the release site during the summer following release. High, forested mountains surrounding the valley may have effectively deterred permanent dispersal (Musil et al. 1993).

Translocated males did not display with the lone resident male on the last active lek in 1986, but displayed on three other areas in 1987 and at two additional leks in 1988. Both marked and unmarked birds attended leks, with mean lek size averaging 3.9 birds in 1987 and 2.8 birds in 1988 (Musil et al. 1993). Currently, there are three active leks in the valley with 1-3 males per lek (G.W. Gadwa, pers. comm.).

Survival of sage grouse translocated into the Sawtooth Valley was lowest in the first three weeks after release (daily survival = 0.9560 in 1986 and 0.9786 in 1987). Survival was higher during the sedentary period of the summer, 4-22 weeks post-release (daily survival = 0.9986 in 1986 and 0.9982 in 1987; Musil et al. 1993).

One hen translocated in 1986 nested, while six nests (five from radio-marked hens) were found in 1987. Nest success was 43% (3 of 7) and 14 chicks were produced (Musil et al. 1993). Nesting and summering habitat selected by translocated grouse exhibited characteristics generally similar to those reported for resident sage grouse populations (Musil et al. 1994). Reproduction continues in the same areas of the valley nine years after the last release, with a total breeding population of approximately 20 birds (G.W. Gadwa, pers. comm.). This translocation of sage grouse into the Sawtooth Valley remains successful on a small scale.

As part of the translocation of sage grouse into the Sawtooth Valley, Idaho, survival of birds released using three techniques was compared. First, single birds were released by hand into the air or onto the ground (hard release); second, groups of 3-10 males and females were released together from a holding pen opened from a remote location (soft release); and third, 3-5 birds were simultaneously anesthetized, placed in sagebrush cover and allowed to recover and leave the area (soft release, Musil 1989).

Birds released by hand either flushed or walked from the release site alone. Of five releases from the holding pen, birds flushed as a group on three occasions. Although six anesthetized groups were released, only four were observed from concealment. Fourteen of 17 birds walked from the site and two flushed together (Musil 1989).

There was no difference in grouse daily survival up to 22 weeks post-release between soft release techniques (pen-released = 0.9954, anesthetized release = 0.9953), but survival was higher ($P = 0.094$) for soft-released birds (0.9954) when pooled than for hard-released birds (0.9907). There were no differences

between release techniques in distances moved post-release, but soft-released birds more quickly ($P = 0.031$) settled into appropriate habitat ($\bar{x} = 34 \pm 9$ days) than did hard-released birds ($\bar{x} = 52 \pm 13$ days; Musil 1989). Because translocated grouse released by hand exhibited lower survival and took longer to settle onto summer range than soft-released birds, Musil (1989) suggested that soft-releasing sage grouse would contribute to the success of translocations.

Translocation as a management strategy

Seven states and one province are known to have translocated sage grouse since 1933. Over 7,200 birds have been transported within and between states in 56 separate attempts to augment or reestablish sage grouse populations (Table 1). Only the more recent translocation efforts in Colorado, Idaho, and Utah appear successful. Results from Wyoming are equivocal. Common features of successful translocations are: 1) reproductively-active birds were captured on and around leks at night in March and April, 2) birds were transported rapidly and released the morning following capture, and 3) release sites were isolated, confined sagebrush habitat surrounded by inhospita-

ble cover types distant (>100 km) from capture areas.

Male grouse attending leks, and females at or near leks, captured and rapidly translocated into new habitat may be more likely to continue behaviours directed at production of offspring, i.e., males attempt to form leks and attract females, and hens seek males and search for nesting sites, than birds moved at other times of the annual cycle. The rapid transport and release of birds, regardless of the nature of the release techniques, minimizes stresses associated with capture, handling, marking, and confinement. Birds are likely in better physiological condition when released quickly into unfamiliar terrain than those confined for two or three days. Geomorphic features such as mountain ranges or waterless deserts and isolated units of habitat may prohibit translocated birds from dispersing (Musil et al. 1993, J.F. Karpowicz, pers. comm.).

The history of sage grouse translocations, especially more recent efforts (Musil et al. 1993, 1994, C.E. Braun, pers. comm., J.F. Karpowicz, pers. comm.) demonstrate that translocated birds can select habitat appropriately, reproduce, and exhibit site fidelity. If carefully planned and conducted, translocations of sage grouse into areas with adequate year-round habitat may be useful in establishing or augmenting pop-

Table 1. Sage grouse translocations in North America.

Area	Release years	No of years birds were released	Months of release	No of birds released	Successful
New Mexico	1933-34	2	Oct-Nov	85	No
	1934, 1936	2	Oct	86	No
	1936	1	Nov	27	No
	1941	1	Sep	48	No
	1949	1	Aug	15	No
	1958	1	Mar	17	No
	1969	1	Sep	48	No
Oregon	1941-42	2	Aug-Oct	199 to 3 sites	No
	1948	1	Fall	9	In ¹
	1949	1	Sep	38	No
	1950-51	2	Aug, Oct	171	No
Montana	1942	1	Oct	242 to 8 sites	No
British Columbia	1958	1	Aug	57	No
Wyoming	1940-43	4	Aug-Oct	2,165 to 18 sites	In ¹
	1946-48	3	Jul-Oct	554 to 3 sites	In ¹
	1948-49	2	Aug	346	In ¹
	1949-51	3	Jul-Oct, May	2,816 to 8 sites	In ¹
Colorado	1971-72	2	Apr	20-30	Yes ²
Utah	1976	1	Aug	48	U ³
	1987-90	4	Spring, Summer	43	Yes ⁴
Idaho	1986-87	2	Mar-Apr	196	Yes ⁵

¹ Insufficient data to determine success.

² 50 breeding birds in 1996.

³ U uncertain, one male on lek in 1996.

⁴ 20 males on one lek in 1996.

⁵ 20 breeding birds in 1996.

ulations. However, successful translocations have not produced major increases in sage grouse abundances at release sites in Colorado, Idaho, and Utah. Further monitoring of these populations, as well as additional translocation efforts in other areas, are imperative for determining the large-scale feasibility of translocations as a management option (Musil et al. 1993).

Recommendations

We recommend translocation of sage grouse only after careful evaluation of the release area for year-round habitat. Birds to be translocated should be captured on or near leks during March or April, transported quickly to the release site, and released via a soft release technique.

Musil (1989) recommended that transport crates have low, padded ceilings to reduce head injuries and that birds be separated during transport to reduce fighting. Given the cost and number of personnel needed to simultaneously anesthetize groups of birds (Musil 1989:64), we favour the release pen technique over anesthetizing birds.

Lewis, McGowan & Baskett (1968) and Woolf, Norris & Kube (1984) cautioned that translocation failures are often not sudden, but rather, populations persist and then decline. Translocation of sage grouse should be conducted only if agencies commit resources adequate to: 1) monitor bird movement, habitat use, and survival immediately post-release to assess short-term patterns of habitat use and causes of mortality; and 2) monitor long-term population abundance through lek and brood counts to assess continued success of the translocation.

The following questions should be considered prior to any translocation of sage grouse:

1. How can multiple potential release sites be evaluated and prioritized? Could development and validation of habitat suitability models be used?
2. Could habitat improvement practices prior to the translocation increase its probability of success?
3. Would pseudo-leks (Eng, Pitcher, Scott & Greene 1979, Rodgers 1992) be valuable in attracting and retaining sage grouse in the release area?
4. How does habitat fragmentation and an increasingly complex mosaic of suitable and unsuitable habitat impact success of a translocation? What is the minimum area needed in a release habitat to retain a population? Translocated sage grouse in

Idaho persist in 12,500 ha of sagebrush cover, but translocated birds in Colorado exist in approximately 1,550 ha of sagebrush (C.E. Braun, pers. comm.).

5. Which source of translocation stock, migratory or non-migratory, is better? Are subspecific differences an influence on translocation success?
6. What are minimum or optimal numbers of birds needed to maximize chances of success? What are the best sex and age ratios for success?
7. What time of year is optimal? We suggest March and April, but winter-trapped birds might be successful.
8. Does survival of birds translocated in March and April differ with severity of the preceding winter? Are birds translocated following a mild winter more likely to survive than those translocated after a severe winter? Should birds be translocated only following mild winters?
9. How will birds respond to release into an area with no resident birds or with resident birds? Patterson (1952:301) indicated that "there is little merit in promiscuously moving birds into regions which now probably support as many birds as the habitat will accommodate".
10. Does the presence of a similar species such as sharp-tailed grouse *Tympanuchus phasianellus* influence success?
11. What refinements to transport and/or release techniques could increase survival of birds?

Conclusions

Of 118 translocations of native game species in the United States, Canada, Australia, and New Zealand from 1973 to 1986, 86% were successful (Griffith, Scott, Carpenter & Reed 1989). In comparison, the success of sage grouse translocations is only 5% (3 of 56 attempts), or, if the Wyoming efforts are excluded, only 12% (3 of 26 attempts), even though many of these efforts exhibited factors associated with success, i.e. native game species, release areas with good habitat, birds translocated into the core of the species range rather than on the periphery or outside its range, herbivorous food habits, release areas free of congeneric competitors, and release stock that was wild-caught from populations of medium to high density (Griffith et al. 1989). The continued persistence of populations in low numbers following translocation of sage grouse in Colorado, Idaho, and

Utah, and the historical failure of most such translocations, suggests that future translocations of sage grouse be viewed as experimental and not a desirable, viable strategy to restore extirpated populations. Efforts must focus on maintenance and enhancement of existing habitat quantity and quality to avoid the need for problematic translocation efforts.

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