

Sally A. Nickelson,¹ Paul S. Anderson,² Point No Point Treaty Council, 7999 NE Salish Lane, Kingston, Washington 98346

Bryan L. Murphie, and Greg Schirato, Washington Department of Fish and Wildlife, 48B Devonshire Road, Montesano, Washington 98563

Translocating Roosevelt Elk for Site Specific Herd Augmentation: Two Case Studies

Abstract

The state of Washington and four Native American tribes on the east Olympic Peninsula cooperatively conducted single translocations of 17 Roosevelt elk into the Dosewallips drainage in 1995 and 24 elk into the Skokomish drainage in 1997, in attempts to augment the small resident herds. Three of the elk translocated into the Dosewallips and 12 of those translocated into the Skokomish were fitted with radio-collars and monitored for 3 yr post-translocation for survival and movement. Survival of elk translocated into the Dosewallips could not be calculated due to insufficient sample size, but survival of elk translocated into the Skokomish averaged 0.65 ± 0.04 for the first 2 yr and was 0.80 the third year post-translocation. This compares with survival of 0.91 ± 0.02 for 43 resident elk from six herds in the east Olympics from 1993-2000. Of the elk translocated into the Dosewallips, 41% remained with the resident herd for at least 1 yr, while only 4% of the translocated elk remained with the Skokomish herd for 1 yr. All radio-collared elk translocated into the Skokomish dispersed singly or in small groups an average of 20 km in the general direction of the source herd. The population in the Dosewallips herd increased from 26 to 46 within 1 yr of the translocation, and has remained stable at the higher level. The Skokomish herd increased from 17 to 25 after the translocation, but subsequently declined to 15.

Introduction

Translocation is a commonly used method for reestablishing wildlife populations. Many species, including elk (*Cervus elaphus*) (Harper 1987), wolves (*Canis lupus*) (Bangs and Fritts 1996), and cougar (*Felis concolor*) (Ruth et al. 1998) have been successfully reintroduced to their former range via translocation. Over 1,200 Roosevelt (*C. e. roosevelti*) and Rocky Mountain elk (*C. e. nelsoni*) have been released at more than 50 sites throughout the Cascade Mountains in Washington and Oregon since 1947, primarily to reestablish herds that were eliminated by overhunting (Harper 1987). Data on number of elk released at a time, survival, or movement after translocation are not available from these early translocations. The goal of most translocations has been to reestablish extirpated herds or to supplement populations at a Game Management Unit (GMU) or larger scale. We know of no reported studies in which translocation was used specifically to supple-

ment a small existing elk herd in a single drainage within a GMU.

Elk dispersing from small, reintroduced populations have been reported to be subject to high rates of mortality (Geist 1982, Witmer 1990). Survival of translocated elk in Oregon was 0.77, compared with resident elk survival of 0.89 in Oregon from 1984-1990, 0.89 in Idaho from 1986-1991, and 0.86 in Washington from 1989-1993 (Unsworth et al. 1993, Stussy et al. 1994, Smith et al. 1994). Successful population augmentation, especially at the small river drainage scale, depends not only on survival of translocated individuals, but also on their developing site fidelity. Few studies, however, have addressed movement of translocated elk.

Roosevelt elk within the Dosewallips River drainage on the east Olympic Peninsula, Washington (Figure 1), declined from an estimated 150 animals in the 1930s to 47 elk in 1985, and 24 animals by 1990 (Schwartz and Mitchell 1945, Schroer 1986). Elk population declines are often related to changes in habitat. However, elk in the Dosewallips drainage spent most of their time foraging in agricultural fields and riparian areas, which have not changed in size since 1985. Despite the availability of high quality forage in the Dosewallips, the population declined. State and

¹Author to whom correspondence should be addressed.

Current address: Seattle Public Utilities, 19901 Cedar Falls Road SE, North Bend, Washington 98045.

E-mail: sally.nickelson@seattle.gov

²Current address: Foster Wheeler Environmental Corporation, 12100 NE 195th St., Suite 200 Bothell, Washington 98011

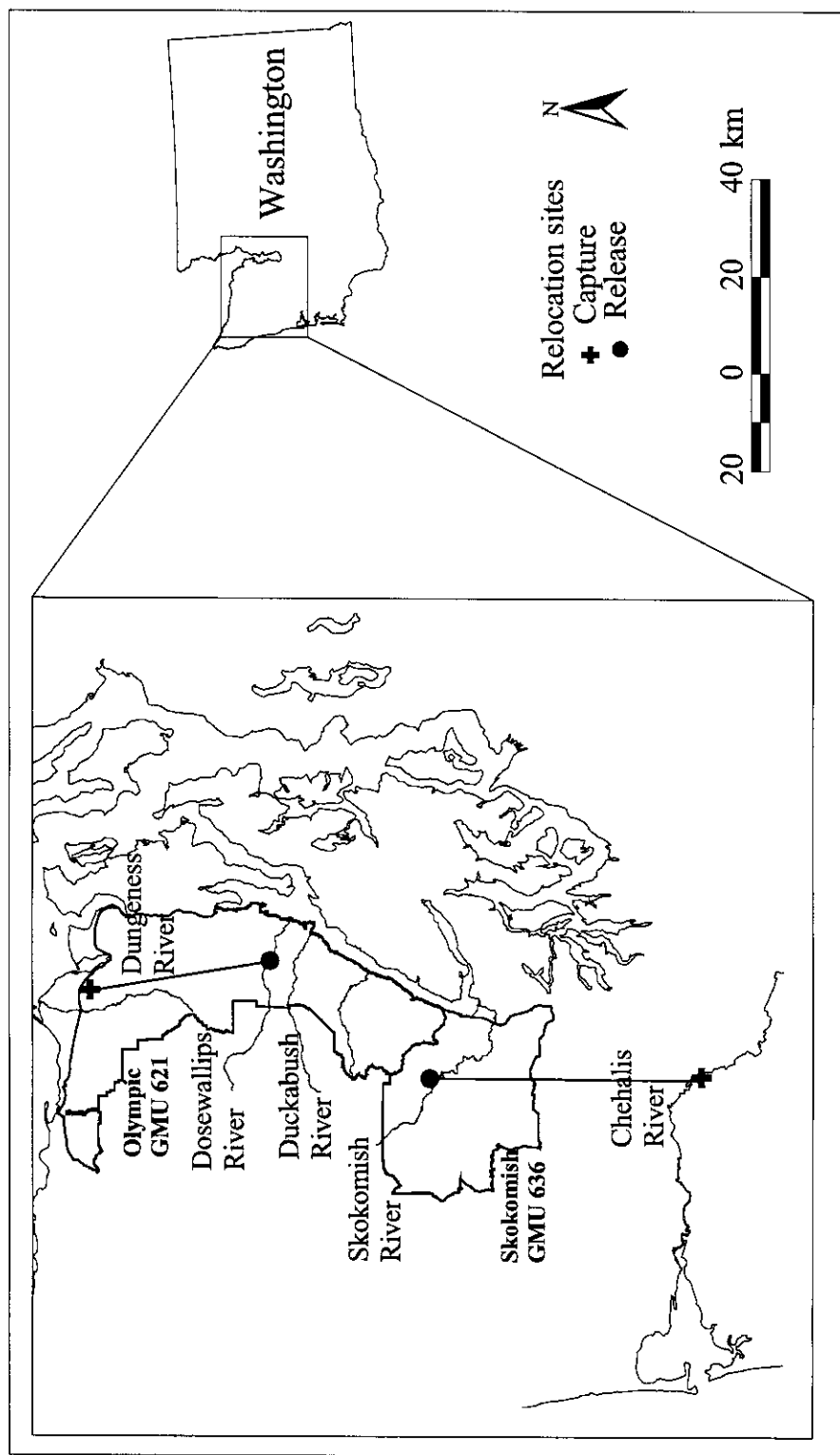


Figure 1. Capture and release sites for Roosevelt elk translocated to the Dosewallips drainage (Olympic GMU 621) in 1995 and to the Skokomish drainage (Skokomish GMU 636) in 1997, Olympic Peninsula, Washington.

tribal harvest data indicate that cow harvest in the 1980s was sufficient to cause the decline since 1985. The cause of the population decline from the 1930-1985 is unknown, but may be related to timber harvest patterns, the increase in human population in the drainage, and elk harvest.

To facilitate population recovery, the four Point No Point Treaty Council (PNPTC) tribes, consisting of the Skokomish, Port Gamble S'Klallam, Jamestown S'Klallam and Lower Elwha Klallam tribes, closed tribal hunting on the Dosewallips herd in 1990. The elk population remained unchanged however, and in 1993 the Washington State Department of Fish and Wildlife (WDFW) and the PNPTC tribes closed the entire Olympic GMU to elk hunting. The Dosewallips herd remained static at about 24 animals despite the hunting ban.

A similar situation occurred in the Skokomish GMU in the southeast Olympics. The herd in the Skokomish River drainage dropped from an estimated 250 elk in the 1940s to ~25 animals in 1995 (Schwartz and Mitchell 1945). State and tribal cow harvest since 1980 was sufficient to cause recent population declines, though the decline seen from 1940-1980 was likely related to changes in habitat, primarily timber harvest patterns and resultant forage availability, as well as elk harvest. The PNPTC tribes closed tribal elk hunting in the Skokomish drainage in 1995, and in 1996 both WDFW and the tribes closed the entire GMU to elk hunting. As with the Dosewallips, the Skokomish herd remained static despite the hunting ban.

Because elk harvest appeared to be the proximate factor in recent population declines, and habitat in both drainages seemed sufficient to support higher elk populations, a management decision to augment the small herds with translocated elk was made. Our goal was to evaluate the success of single augmentations of 17 elk translocated into the Dosewallips in 1995, and 24 elk translocated into the Skokomish in 1997. State and tribal managers agreed that the criteria for success was to increase each herd to ≥ 50 animals during the spring count. Monitoring of radio-collared cow elk from six herds on the east side of the Olympic Peninsula (referred to in this paper as resident elk) began in 1993 and provided baseline survival data needed for comparison (Smith et al. 1994). Our specific objectives were to 1) compare annual survival rates of resident and translocated elk, 2) evaluate movements of translocated

elk, and 3) document the population response of the small herds in the Dosewallips and Skokomish drainages to the translocation.

Study Area

The study area was located on the eastern portion of the Olympic Peninsula in northwest Washington, and consisted of portions of the Olympic (168,976 ha) and Skokomish (97,073 ha) GMUs (Figure 1). The source herd for the Dosewallips translocation was the non-migratory Dungeness herd located near Sequim, 37 km north of the Dosewallips River. The source herd used in the Skokomish translocation was a migratory herd that wintered near the Chehalis River, 56 km south of the Skokomish River.

Climate on the Olympic Peninsula is maritime, with dry summers and mild, wet winters. Annual precipitation averages 128 cm in the east, 63 cm in the north and 250 cm in the south Olympics, with differences due to the rain shadow effect of the Olympic Mountains (Henderson et al. 1989). Below 600 m snows are intermittent and fleeting with most precipitation falling as rain. Above 600 m snow is more persistent, and as a result, east Olympic elk winter below 600 m.

The study area was within the Western Hemlock (*Tsuga heterophylla*) Zone and included the western hemlock/salal (*Gaultheria shallon*), western hemlock/salal/sword fern (*Polystichum munitum*), western hemlock/salal-Oregongrape (*Berberis nervosa*), and western hemlock/sword fern-oxalis (*Oxalis oregana*) associations (Henderson et al. 1989). Land ownership was mixed, with lower elevations primarily held by large industrial timber companies and small private landowners. Higher elevations were in U.S. Forest Service and National Park Service ownership. Valley floors were largely residential or agricultural, often with pastures seeded in grasses, and the foothills were generally forested. Much of the forest in the lower valleys was clearcut harvested from the 1960s through the 1990s, and in 1995 there was a patchwork of recent clearcuts and young even-aged regeneration stands aged 10-40 yr. A limited number of late-successional patches were in the Forest Service ownership, primarily located in the Skokomish drainage.

Topography of both the Dungeness and Chehalis Rivers drainages, where the source herds were located, included relatively flat valley bottoms and

gently rolling hills. Elevation ranged from 6-15 m for the wintering Chehalis herd and 24-640 m for the resident herd at Dungeness. Habitat was chiefly grassy fields, riparian areas, wetlands, and some coniferous and deciduous forestland in various stages from recent clearcut to mature forest. The elk herds spent much of the time in agricultural fields and damage complaints were high in both drainages. However, hunting access was limited due to the proximity of residential areas, which precluded the use of state and tribal harvest as an effective method to reduce the elk herds.

Topography at the release sites in the Dosewallips and Skokomish drainages was characterized by steep valley walls and narrow valley floors. Elevations used by the resident herds ranged from sea level to 533 m in the Dosewallips and from 209-274 m in the Skokomish. The Skokomish differed from the capture sites and the Dosewallips because the resident herd did not occupy any residential or agricultural land.

Methods

Capture and Processing

We immobilized resident cow elk from six herds throughout the eastern Olympics using a dart rifle fired either from the ground or a helicopter. We collected canine tooth samples for age estimation using the cementum annuli technique, and attached Advanced Telemetry Systems (ATS) radio collars to cow elk (Hamlin et al. 2000). Each collar was equipped with a motion-sensitive mortality sensor. We placed numbered colored ear tags in all translocated elk, while resident elk did not receive ear tags. We processed resident elk at the site of capture, while translocated elk were transported to a processing station via helicopter. We released resident elk on site, and drove translocated elk in darkened stock trailers to the release site, where they were released as a group as close as possible to either the Dosewallips or Skokomish herd.

Monitoring

We monitored resident and translocated elk with a combination of aerial and ground telemetry. For the first 2 mo after translocation, ground locations were gathered by triangulation (without direct observation) to minimize disturbance to the translocated elk. Subsequent ground locations consisted of either triangulation or direct obser-

vation to record location, total number of elk, herd composition, and number of ear-tagged elk in the herd. All locations were plotted on U.S. Geographical Survey 1:24,000 scale topographical maps. We replaced collars in each of the six resident herds as needed to maintain a minimum of two per herd, but collars on translocated elk were not replaced. Once a mortality signal was detected, we determined cause of death.

We collared 43 resident cow elk from the east Olympics and monitored them for survival 1993-2000. We conducted biweekly flights of these radio-collared elk from 1993-1995. Resident elk were relocated monthly from 1995-2000, either from the ground or air. Overall, we averaged 108 relocations/herd. We relocated elk translocated to the Dosewallips approximately biweekly from date of translocation to date of mortality (an average of 10 relocations) or until they joined the resident herd. We relocated elk released in the Skokomish weekly from April through June 1997 using ground telemetry and approximately once per month from June 1997 through September 1999 with aerial telemetry, averaging 32 relocations/elk.

Data Analysis

We calculated annual survival rates for both the resident and translocated elk using a staggered-entry Kaplan-Meier survival estimator (Pollock et al. 1989). We used a 1-tailed z-test to test whether the annual survival rate of translocated cow elk was less than that of residents, using a minimum sample of five (Pollock et al. 1989). We calculated annual survival based on a 1 April to 31 March time period. Cause of mortality was placed into 4 categories: 1) predation (clear evidence of predation present), 2) unknown natural (no evidence of either predation or human-caused mortality), 3) human caused (evidence of bullets or arrows present), and 4) unknown (the carcass was too decomposed to reveal evidence of cause of mortality) (Smith et al. 1994). Significance levels for all tests were set at $P=0.05$.

We used ARCVIEW 3.0a (Environmental Systems Research Institute, Redlands, California) to analyze movements of translocated elk, and determined direction and distance of travel from release site to end point (either the mortality location or arithmetic center of the new home range) (White and Garrott 1990, Ruth et al. 1998, Zar 1999). Home range was calculated using a fixed

kernal estimator, using the least square cross validation method for the smoothing parameter (Worton 1989, Seaman et al. 1999). To test for possible homing behavior, we placed the end points of the translocated elk within one of four 90° quadrants centered on due north, south, east, and west from the release point. We then used chi-square to compare actual endpoints with expected non-directional dispersal from the release site.

We used the composition counts of the Dosewallips and Skokomish herds, obtained from ground surveys when herds were sighted in open habitat in February through April of each year, to document the minimum number in the herd. Because multiple counts from each herd were within 0-3 animals, we used the highest count as the minimum number present for each herd. Total population was not estimated because we had no reliable sightability factor. We also documented minimum spring numbers for the Dungeness herd (source population for the Dosewallips translocation), and as a comparison, the Duckabush herd, in the adjacent drainage located 2 km south of the Dosewallips. Both of these herds were also sighted in open fields, and had consistent multiple counts within 0-3 animals. We used a 1-tailed Mann Whitney U test to compare the minimum spring counts in the Dosewallips and Duckabush herds for 4 yr before and 5 yr after the translocation. We also compared spring counts from 3 yr prior and 5 yr post-translocation in the Dungeness herd and 4 yr prior and 2 yr post-translocation in the Skokomish herd.

Results

Survival

Seventeen elk (12 cows and 5 bulls) were translocated into the Dosewallips in April 1995, with no mortalities associated with the translocation procedure itself. Of the 17 translocated elk, three cows had a radio-collar attached. Two of the three radio-collared cows translocated to the Dosewallips died within the first 7 mo post-translocation. The small sample size precluded calculation of survival rates.

Twelve cows of 24 elk translocated into the Skokomish (20 cows and 4 bulls) in March 1997 were fitted with radio-collars. The collared cows had an average age of 5.4 yr (SE = 1.0), with a range from 2-14. Four mortalities occurred during the capture, which we did not include in the

survival estimations because we were interested solely in survival post-translocation. No capture myopathy mortality was documented within the first month after the translocation. Annual survival rates for the 12 radioed cows translocated to the Skokomish averaged 0.65 (SE = 0.04) for the first 2 yr post-translocation (Table 1), and were significantly lower than resident elk in both years (1997-98: $P = 0.015$; 1998-99: $P = 0.003$). Survival in the third year did not differ significantly from that of residents.

Eleven of 15 (73%) translocated radio-collared elk (data combined from both the Dosewallips and Skokomish translocations) died from 1995-

TABLE 1. Annual survival (April-March) for adult Roosevelt cow elk, from six resident herds in the east Olympics, 1993-2000, and 12 collared elk translocated into the Skokomish drainage, eastern Olympic Peninsula, Washington, 1997-2000. Non-significant differences in survival between resident and translocated elk during the same year are denoted by the same superscript letter.

Year	Resident			Translocated		
	n	Survival	SE	n	Survival	SE
1993-94	15	1.0	0			
1994-95	22	0.82	0.02			
1995-96	23	0.78	0.02			
1996-97	22	0.86	0.01			
1997-98	16	0.94	0.01	12	0.67	0.03
1998-99	14	1.0	0	8	0.63	0.05
1999-00	19	0.95 ^a	0.01	5	0.80 ^a	0.07
Mean 1993-00		0.91	0.02			

2000. Proximate causes of mortality for translocated elk included predation (30%), unknown natural mortality (30%), human caused (20%), and unknown (20%). Fourteen of the 43 (33%) radio-collared resident elk died from 1993-2000. Proximate causes of resident elk mortality included predation (25%), unknown natural mortality (31%), human caused (13%), and unknown (31%).

Movement

Of the 17 elk translocated to the Dosewallips, 7 (41%) remained with the target herd for ≥ 1 yr, 5 for ≥ 2 yr and 3 for ≥ 4 yr, as confirmed by multiple sightings of ear-tagged animals. One of the three radio-collared elk joined the Dosewallips herd immediately after the translocation and remained with the herd throughout the study period.

The early deaths of the other two precluded movement analysis.

None of the 12 radio-collared translocated elk joined the Skokomish herd, and only one ear-tagged bull of the 24 translocated into the drainage remained with that herd for 1 yr. Most moved out of the Skokomish drainage in the general direction of the capture site (Figure 2). These movements out of the drainage primarily occurred during the first 3 mo after translocation. Significantly more elk moved south, with 9 of the 12 elk movement endpoints located in the quadrant centered on due south ($P < 0.001$).

Elk translocated to Skokomish moved a mean distance of 20 km (range 1-42) from release site to end point. The two oldest collared elk (ages 14 and 8) died within 2 mo of the release date, and they had moved the shortest distance, remaining within the Skokomish drainage. With these elk omitted from the analysis, mean distance moved was 24 km (range 12-42 km). There was no correlation between the ages of the remaining collared elk and distance moved. By January 2000, only four of the 12 collared translocated elk survived, and each had joined a separate herd outside the Skokomish GMU. These four elk had moved the farthest, averaging 32 km to the center of their new home ranges.

Population Response

The Dosewallips herd increased ($P = 0.01$) after the translocation, from a stable spring count of 23 from 1992-1995 to a mean of 51 (range 46-56) from 1996-2000 (Figure 3). The Dungeness source herd population did not differ significantly pre and post-translocation. The herd was estimated at 60 animals pre-translocation, recovered to 53 by 1997, and had a spring count of 68 in 1999.

Spring counts in the neighboring Duckabush resident herd had been slowly increasing from 1993-1995. Similar to the Dosewallips, the Duckabush population increased after the translocation date ($P = 0.01$), from 49 in 1995 to 73 in 1996, after which the numbers stabilized (Figure 3). None of the translocated elk joined this herd.

The Skokomish herd declined from 28 elk in 1992 to 17 in spring 1997. By spring 1998, 1 yr after the translocation, 25 animals were present. Both collars in the Skokomish herd were lost within 2 wk of each other in spring 1999 before a count could be obtained, and we were unable to get

another count until fall 2000, when the herd was down to 15 animals (Figure 3). The Skokomish herd did not differ significantly before and after the translocation.

Discussion

Augmenting a small elk herd in a single drainage depends on several factors, including adequate survival, fidelity of the translocated elk to the new area, and reproduction and growth rate of the resident herd. The survival of elk translocated into the Skokomish was significantly lower than resident herds in the east Olympics for the first 2 yr after the translocation, averaging 0.65 compared with the average 0.91 survival for resident elk from 1993-2000 (Table 1). The 0.65 survival of translocated elk was lower than the 0.77 reported for translocated elk in Oregon (Stussy et al. 1994). Several studies reviewed in Jones and Witham (1990) found that translocated white-tailed deer (*Odocoileus virginianus*) had lower survival than residents. Numerous other species also had poor survival after translocation (Erickson and McCullough 1981, Griffith et al. 1989). The translocation into the Skokomish likely disrupted normal elk herd behavior and social cohesiveness of the translocated elk, which may have contributed to lower survival. The elk moved long distances through unfamiliar territory, either singly or in small groups, which may have increased their vulnerability (Figure 2).

Movements of collared elk ≤ 3 mo after the translocation were representative of the other translocated elk, as ear-tagged elk were observed in similar locations to the radio-collared elk. The movement appeared to be homing behavior, because the endpoint of 9 out of 12 radio-collared elk was in the quadrant centered on due south (Figure 2). The Skokomish drainage runs east-west, and the topography to the north and south of the drainage is equally steep. The topography to the south does not become gentler until 14.5 km south of the river.

Possible explanations for the translocated elk not remaining within the Skokomish drainage include the predisposition of the source herd to migrate, disturbance from predators or people, and difference in habitat. Agricultural fields supplied a significant amount of nutrition to the highly productive Chehalis source herd, and were lacking in the Skokomish drainage. Of the four

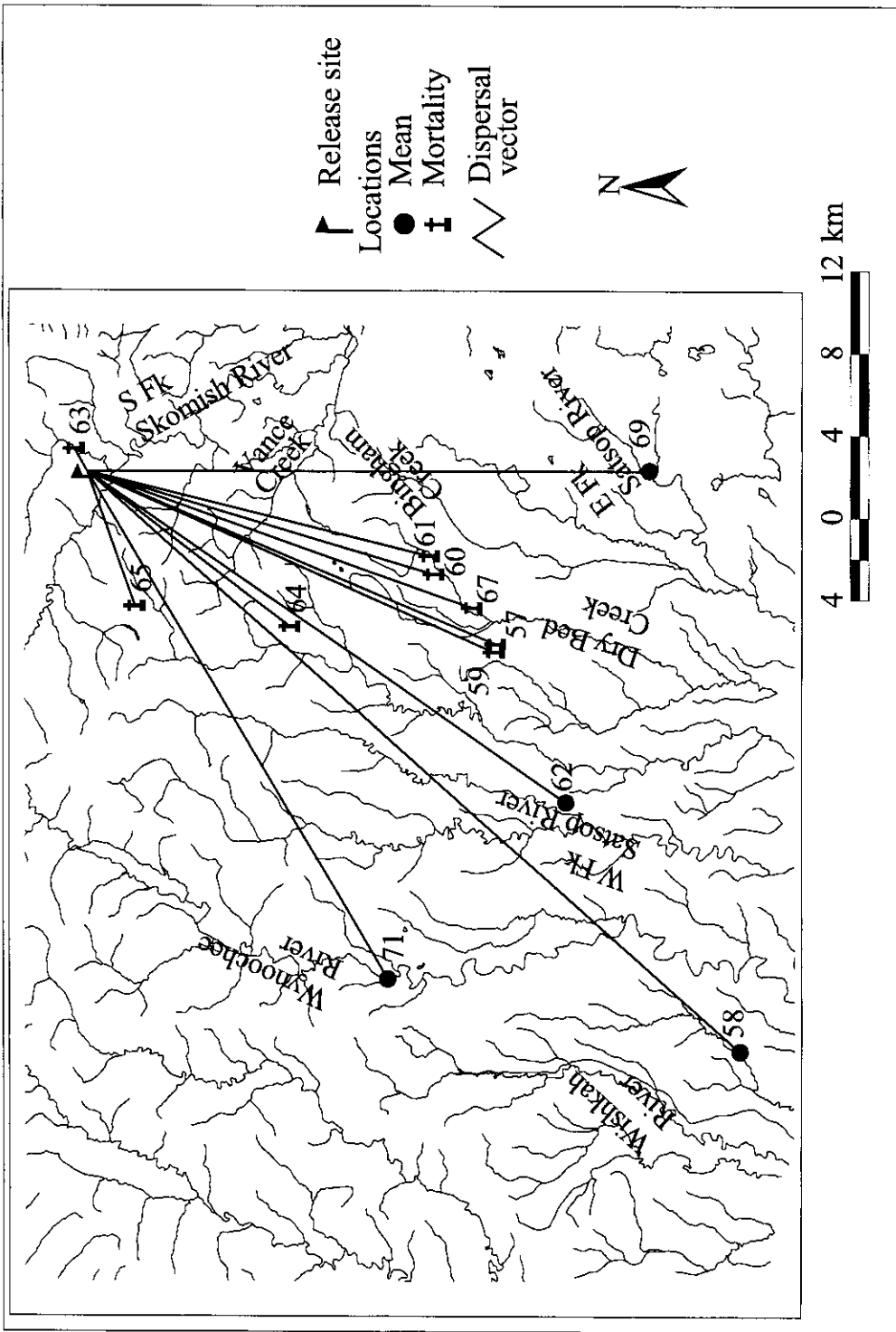


Figure 2. Direction of movement and distance traveled by translocated Roosevelt elk released in the Skokomish drainage, Olympic Peninsula, Washington, 1997.

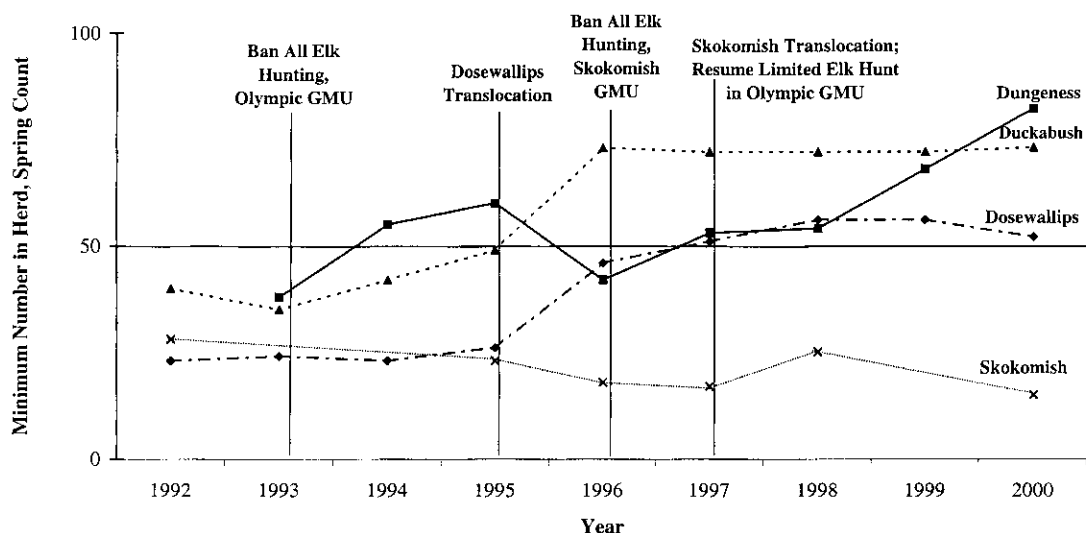


Figure 3. Minimum spring herd counts for the Dosewallips, Skokomish, Duckabush and Dungeness Roosevelt elk herds, before and after translocation, Olympic Peninsula, Washington.

surviving translocated collared elk, three remained in new home ranges that contained large fields. It is also possible that the amount of forage present in the Skokomish drainage was insufficient to support higher numbers of elk.

The Skokomish herd had a moderate increase from 17 to 25 animals 1 yr after the translocation, though only one translocated bull joined the resident herd (Figure 3). However, the count of 15 animals in 2000 is the lowest since it has been monitored, so that the single translocation was not effective in augmenting this herd and did not meet the criteria for success. The assumption that the habitat was sufficient to support higher numbers of elk may have been incorrect.

Site fidelity of the translocated Dosewallips group was greater than the Skokomish group. A possible reason may be that the habitat in the Dosewallips was not substantially different from that of the source Dungeness herd. Agricultural fields were used extensively in both drainages, and predator populations in the immediate area were likely low due to the proximity of human residences. Both of these factors probably contributed to the greater site fidelity seen in the Dosewallips group. In addition, the source herd was not migratory, so the translocated elk were not predisposed to large movements.

One year after the translocation, the Dosewallips herd, which had been stable at ≤ 25 animals prior to the translocation, almost doubled in size. How-

ever, other factors such as a high recruitment rate during the 1995-1996 season may have also played a role in the population increase. The closest neighboring herd to the Dosewallips, located in the Duckabush Valley, also had a dramatic population increase in 1995-1996 (Figure 3), indicating high recruitment in the east Olympics during that year. The increase to >50 animals in the Dosewallips herd met the criterion for success for the project developed prior to the translocation. Because both the Dosewallips and Duckabush herds have stabilized at higher numbers, the assumption that habitat could support higher numbers was supported.

Management Implications and Recommendations

There were several disadvantages to translocating elk to supplement small local herds. It was expensive, with the cost estimated at about \$450/animal moved, excluding staff time. It can cause elk mortality during the procedure and can result in lower survival after the translocation (Table 1). More importantly, the single translocation did not achieve the goal of supplementing the Skokomish herd, and other factors may have been important in the apparent success of the Dosewallips translocation.

Based on this study, we recommend: 1) complete a habitat analysis prior to a translocation effort, to ensure that sufficient habitat is available

to support additional animals, 2) habitat in the source and translocation areas must be similar, 3) the source herd should not be migratory, and 4) a large portion of the source herd should be moved, to retain herd dynamics and social cohesiveness. We also recommend that a soft release technique be considered, to increase site fidelity (Gogan and Barrett 1988, Phillips 1985). Supplemental feeding after the release may also help keep elk in the release area and reduce early dispersal (Witmer 1990). Multiple translocations may be required to supplement specific small herds that are not limited by habitat availability.

Literature Cited

- Bangs, E. E., and S. H. Fritts. 1996. Reintroducing the gray wolf to central Idaho and Yellowstone National Park. *Wildlife Society Bulletin* 24:402-413.
- Erickson, D. W., and C. R. McCullough. 1981. Fates of translocated river otters in Missouri. *Wildlife Society Bulletin* 15:511-517.
- Geist, V. 1982. Adaptive behavioral strategies. Pages 219-277 *In* J. W. Thomas and D. E. Towell (editors). *Elk of North America*. Stackpole Books, Harrisburg, Pennsylvania.
- Gogan, P. J. P., and R. H. Barrett. 1988. Lessons in management from translocations of Tule elk. Pages 275-287 *In* L. Nielsen and R. D. Brown (editors), *Translocation of Wild Animals*. Wisconsin Humane Society, Inc. and Caesar Kleberg Wildlife Research Institute, Kingsville, Texas.
- Griffith, B. J., M. Scott, J. W. Carpenter, and C. Reed. 1989. Translocation as a species conservation tool: status and strategy. *Science* 245:477-480.
- Hamlin, K. L., D. F. Pac, C. A. Sime, R. M. DeSimone, and G. L. Dusek. 2000. Evaluating the accuracy of ages obtained by 2 methods for Montana ungulates. *Journal of Wildlife Management* 64: 441-449.
- Harper, J. A. 1987. Ecology and management of Roosevelt elk in Oregon. Unpublished report on file at Oregon Department of Fish and Wildlife, Portland, Oregon.
- Henderson, J. A., D. H. Peter, R. D. Leshner, and D. C. Shaw. 1989. Forested Plant Associations of the Olympic National Forest. USDA Forest Service R6 Ecological Technical Paper 001-88. Pacific Northwest Region, Portland, Oregon.
- Jones, J. M., and J. H. Witham. 1990. Post-translocation survival and movements of metropolitan white-tailed deer. *Wildlife Society Bulletin* 18:434-441.
- Phillips, J. A. 1985. Acclimation of reintroduced Tule elk in the Diablo Range, California. M.S. Thesis, San Jose State University, San Jose, California.
- Pollock, K. H., S. R. Winterstein, C. M. Bunck, and P. D. Curtis. 1989. Survival analysis in telemetry studies: the staggered entry design. *Journal of Wildlife Management* 53:7-15.
- Ruth, T. K., K. A. Logan, L. L. Sweanor, M. G. Hornocker, and L. J. Temple. 1998. Evaluating cougar translocation in New Mexico. *Journal of Wildlife Management* 62:1264-1275.
- Schroeder, G. L. 1986. Seasonal movements and distribution of migratory Roosevelt elk in the Olympic Mountains, Washington. M.S. Thesis, University of Washington, Seattle, Washington.
- Schwartz, J. E., II, and G. E. Mitchell. 1945. The Roosevelt elk on the Olympic Peninsula, Washington. *Journal of Wildlife Management* 9:295-319.
- Seaman, D. E., J. J. Millsbaugh, B. J. Kernohan, G. C. Brundige, K. J. Raedeke, and R. A. Gitzen. 1999. Effects of sample size on kernel home range estimates. *Journal of Wildlife Management* 63:739-747.
- Smith, J. L., W. A. Michaelis, K. Sloan, J. L. Musser, and D. J. Pierce. 1994. An analysis of elk poaching losses and other mortality sources in Washington using biotelemetry. Unpublished report on file at Washington Department of Fish and Wildlife, Olympia, Washington.
- Stussy, R. J., W. D. Edge, and T. A. O'Neil. 1994. Survival of resident and translocated female elk in the Cascade Mountains of Oregon. *Wildlife Society Bulletin* 22:242-247.
- Unsworth, J. W., L. Kuck, M. D. Scott, and E. O. Garton. 1993. Elk mortality in the Clearwater drainage of northcentral Idaho. *Journal of Wildlife Management* 57:495-502.
- White, G. C., and R. A. Garrott. 1990. *Analysis of Wildlife Radio-Tracking Data*. Academic Press, San Diego, California.
- Witmer, G. 1990. Re-introduction of elk in the United States. *Journal of the Pennsylvania Academy of Science* 64:131-135.
- Worton, B. J. 1989. Kernel methods for estimating the utilization distribution in home-range studies. *Ecology* 70:164-168.
- Zar, J. H. 1999. *Biostatistical Analysis*. Prentice-Hall, Englewood Cliffs, New Jersey.

Acknowledgments

We thank the Administration for Native Americans, Washington Department of Fish and Wildlife and Rocky Mountain Elk Foundation for funding this project. We thank J. Smith for organizing and coordinating both translocations. Weyerhaeuser supplied helicopters and experienced pilots. We thank the U.S. Forest Service for assisting in the Skokomish translocation. We thank L. Bender for valuable comments on an earlier version of this manuscript. Finally, we thank the over 100 volunteers who spent long hard hours to complete the translocations.