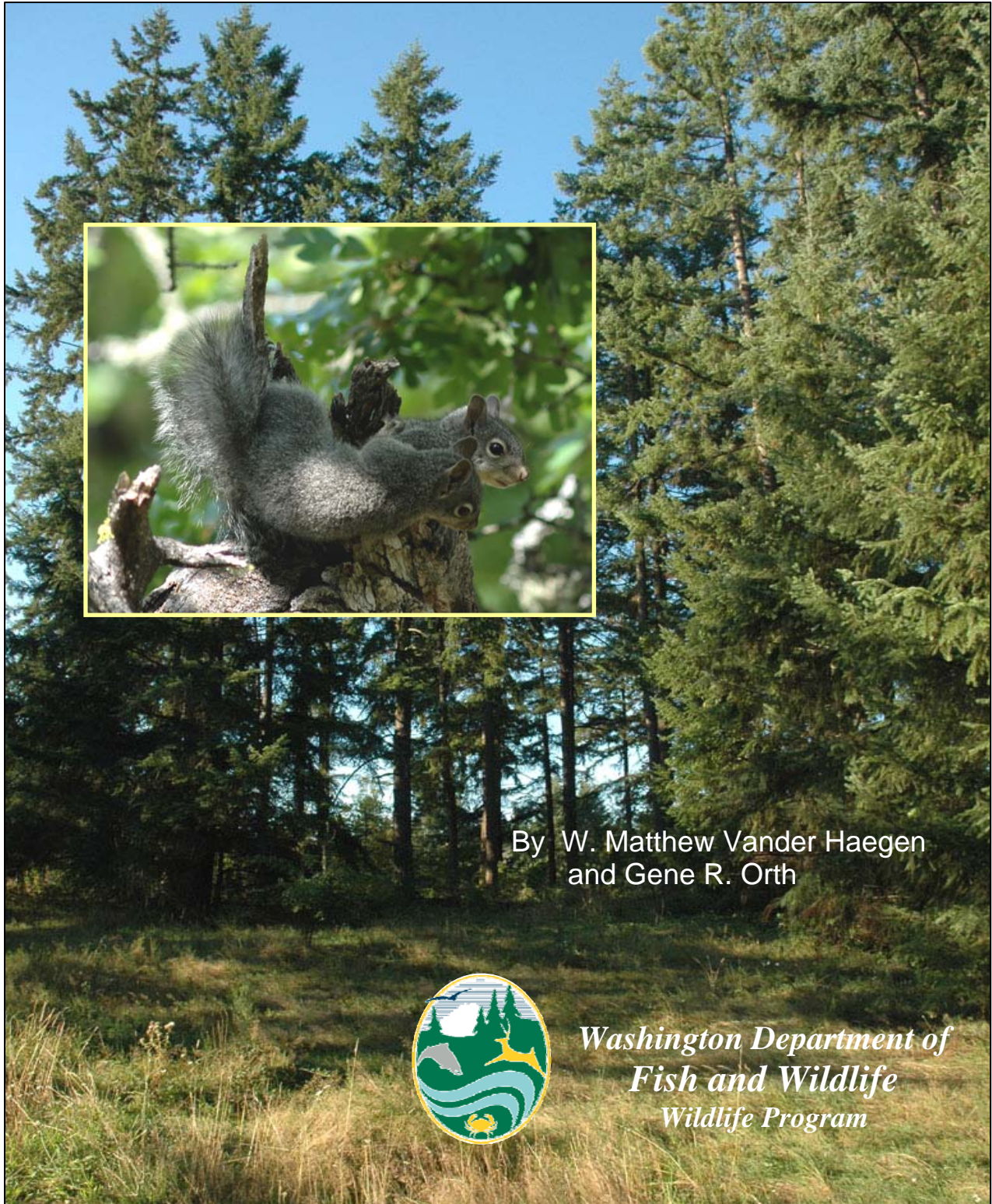


# Western gray squirrel ecology and augmentation of the population in the South Puget Trough



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*Washington Department of  
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Wildlife Program*

Progress Report

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**Annual Progress Report**

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## ABSTRACT

Western gray squirrel (*Sciurus griseus*) populations in Washington have declined over the last century and their range has diminished. Of the three disjunct populations of western gray squirrel remaining in Washington, the Puget Trough population faces the greatest risk of extinction. The majority of the Puget Trough population occurs on Fort Lewis and the adjoining McChord Air Force Base; combined, these military reservations include over 35,000 ha and contain some of the last patches of oak-pine forest in western Washington. The Recovery Plan for this State-threatened species lists augmentation of the population in the Puget Trough as a high priority. In 2007, Washington Department of Fish and Wildlife and the Department of Defense—Fort Lewis, engaged in a cooperative study of the ecology of western gray squirrels on the Fort and implemented a plan to augment this endangered population. Research on the resident population has focused on quantifying population parameters including survival, causes of mortality, productivity, habitat use, and movements. This information will be critical for assessing why the Puget Trough population has contracted over the last few decades and for focusing management efforts to allow the population to recover. Augmentation has focused on bringing animals from other populations in Washington in order to increase the genetic diversity of the resident population and expand the occupied area. From January through December 2008 we captured a total of 29 new resident western gray squirrels during routine and grid trapping. This brings to 59 the total number of resident western gray squirrels captured on the study area since October 2006. Of the squirrels captured in 2008, 15 were fitted with radio-collars and 14 were ear-tagged only and released. We collected 2624 telemetry locations of 36 radio-collared western gray squirrels in 2008 and we documented 114 nests. Eight western gray squirrels died during 2008; 5 were depredated and 3 animals died from tularemia. Twelve of 13 females tracked through the breeding period attempted to rear young; litter size varied from 2 to 4. Nineteen animals were translocated from the Methow valley and from Klickitat County to Fort Lewis in September 2008. As of 31 December, 13 translocated animals were known to be alive, 3 confirmed mortalities, and 3 animals with unknown fate due to failure of their radio-collars. One of the 9 animals translocated in 2007 was known to be alive, 4 were confirmed mortalities, and 4 animals had unknown fate due to failure of the radio-collars. Plans for 2009 include continued monitoring of radio-collared animals, vegetation sampling within core-use areas, intensified monitoring of reproductive success, and further documenting the extent of tularemia in the both the eastern and western gray squirrel populations. Additional translocations will take place in fall 2009 as part of the species recovery effort.

## INTRODUCTION

The western gray squirrel (*Sciurus griseus*) inhabits oak/conifer forests in the western United States from southern California to north-central Washington (Verts and Carraway 1998). Throughout their range, western gray squirrels are most frequently associated with pines (*Pinus* spp.) that provide nesting cover and food, and oaks (*Quercus* spp.) that provide natal den sites and acorns for food (Verts and Carraway 1998). Both tree genera also are associated with hypogeous fungi, another staple food of western gray squirrels. Populations of western gray squirrels are considered stable in much of California, where they are considered a game species (California Department of Fish and Game 2000) and where their habitat contains numerous species of both oak and pine. From mid-Oregon north through Washington, oak/pine communities are simpler, containing primarily ponderosa pine (*P. ponderosa*) and Oregon oak (*Q. garryana*). Both species are intermittent producers of mast, possibly making food resources less reliable than in more southern parts of the species' range. Although classified as a game species in Oregon, the western gray squirrel has shown evidence of declines in its population in the north-central part of the state (Foster 1992), and the Oregon Department of Fish and Wildlife lists the squirrel as “undetermined” on the State Sensitive Species List. While once hunted in Washington, the western gray squirrel has been protected since 1944 and was listed as threatened by the Washington Department of Fish and Wildlife (WDFW) in 1993 (Washington Department of Wildlife 1993).

Western gray squirrel populations in Washington have declined over the last century and their range has diminished (Washington Department of Wildlife 1993). Western gray squirrels currently exist in only 3 locations: south Puget Trough, north-central Washington (Chelan and Okanogan Counties), and south-central Washington (primarily Klickitat County). Of the three disjunct populations of western gray squirrel in Washington, the Puget Trough population faces the greatest extinction risk (Linders and Stinson 2006). Already at a low point in the early 1990s (Ryan and Carey 1995), available evidence suggests that the Puget Trough population has declined dramatically since then and may be dangerously low (Bayrakci et al. 2001). Causes for the decline in the Puget Trough population likely include habitat loss, habitat alteration, and increased mortality related to vehicle traffic (Ryan and Carey 1995).

The majority of the Puget Trough population occurs on Fort Lewis and the adjoining McChord Air Force Base (AFB); combined, these military reservations include over 35,000 ha and contain some of the last patches of oak-pine forest in western Washington (Linders and Stinson 2006). The Recovery Plan for this State-threatened species lists augmentation of the population in the Puget Trough as a high priority. In 2007, WDFW and Department of Defense—Fort Lewis, engaged in a cooperative study of the ecology of western gray squirrels on the Fort and implemented a plan to augment this endangered population (Vander Haegen et al. 2007). Research on the resident population has focused on quantifying population parameters including survival, causes of mortality, productivity, habitat use, and movements. This information will be critical for assessing why the Puget Trough population has contracted over the last few decades and for focusing management efforts to allow the population to recover. Augmentation has focused on bringing animals from other populations

in Washington in order to increase the genetic diversity of the Puget Trough population and provide a demographic boost to this small population. This report summarizes the achievements of the project for 2008 and outlines planned work for 2009.

### **Objectives—Research**

1. Document population parameters of the resident (and augmented) western gray squirrel population, including: survival rates, causes of mortality, and reproductive success.
2. Document movements of resident (and augmented) western gray squirrels, including home range, core use areas, seasonal movements, and juvenile dispersal.
3. Document habitat use at coarse and fine spatial scales.
4. Document patterns of nest use and nest tree selection.
5. Document interactions with non-native eastern gray squirrels (*S. carolinensis*) and differential patterns of habitat, nest, and space use (UW graduate study).

### **Objectives—Augmentation**

1. Increase the genetic diversity of the Puget Trough population of western gray squirrels by bringing in animals from other populations.
2. Increase the area occupied by western gray squirrels on Fort Lewis.
3. Investigate the potential of non-DOD lands as reintroduction sites in the south Puget Trough and, if practicable, initiate reintroductions.

### **Methods**

Resident animals as well as animals captured for translocation were captured and handled using similar methods as described by Vander Haegen et al. (2005). Wire-mesh live traps were placed near the base of trees in likely habitat and pre-baited with English walnuts. Squirrels were forced out of the traps into a cloth handling cone (Koprowski 2002) that allowed us to weigh, measure, and inspect the animal. Most adult animals and juveniles of sufficient size (> 600g) were fitted with VHF radio-transmitter collars (Holohil Systems, Inc., Carp, Ontario) weighing approx. 15g and with a projected battery life of 18mo. Collars were made of multi-strand wire contained within plastic Tygon tubing and attached with a brass crimp. All squirrels were marked with numbered, metal ear tags (National Band and Tag Co., no.1005-3) attached to both ears.

We obtained animal locations using telemetry “homing”, a technique where the animal is approached using a telemetry receiver and Yagi antenna until a visual observation is achieved, or until the animal is determined either to be in a nest or otherwise hidden in a tree. On occasion, animal locations were derived using triangulation from 3 points. Animal and nest locations were recorded in data-logging GPS receivers (Trimble Navigation Ltd., Westminster, CO) and were differentially corrected to an accuracy of <5m.

Females were monitored intensively through spring and summer in order to document reproductive behavior. Nests suspected to contain young were climbed and inspected by hand; cavity dens were inspected with a remote video camera lowered into the cavity. We used both visual observation and remote video cameras to obtain “emergence counts”, documenting the number of advanced-age young active around a natal den or nest. All mortalities were investigated in order to determine cause of death. Animals that died from no apparent cause were sent to the Washington Animal Disease Diagnostic Laboratory at Washington State University (WSU) for analysis.

## RESULTS

### Resident Squirrels

From January through December 2008 we captured a total of 29 new resident western gray squirrels during routine and grid trapping. This brings to 59 the total number of resident western gray squirrels captured on the study area since October 2006. Of the animals captured in 2008, 15 were fitted with radio-collars and 14 were ear-tagged only and released. A full account of animals handled on the study area since October of 2006 is presented in Table 1. As of 31 December we were monitoring 25 resident western gray squirrels (8 males and 17 females) on the study area.

Table 1. Number of western gray squirrels radio-collared or ear-tagged on Fort Lewis, by age, sex, and origin, October 2006-December 2008.

Origin/Marking	Adult_M	Adult_F	Subadult_M	Subadult_F	Total
Resident/Collared	21	18	1	5	45
Resident/Ear-tagged only	5	2	4	3	14
Augmentation/Collared	10	10	1	7	28

*Animal locations.*—We collected 2624 telemetry locations of 36 radio-collared western gray squirrels in 2008 and documented each location with a GPS receiver. For most locations the following information also was collected: date, time, accuracy, substrate, activity, and general characteristics of the vegetation at the site. All telemetry locations of resident animals recorded in our database from October 2006 through December 2008 are displayed in Figure 1.

*Causes of Mortality.*—Eight western gray squirrels died during 2008. Five were depredated, with most kills attributed to mammalian predators based on remains found at the kill sites. Three animals died from infection with *Francisella tularensis*, a bacteria and the causative agent for the disease tularemia. These animals died between 7 April and 23 June and were found with no apparent cause of death and sent to WSU for analysis. Findings from these 3 animals prompted us to submit 3 additional carcasses of animals that had died of unknown cause in 2007 and frozen. Two animals (one western and one eastern gray squirrel) were determined to have died from tularemia; the third (an eastern gray squirrel) died from poisoning. The 2 tularemia deaths in 2007 occurred in September and October.



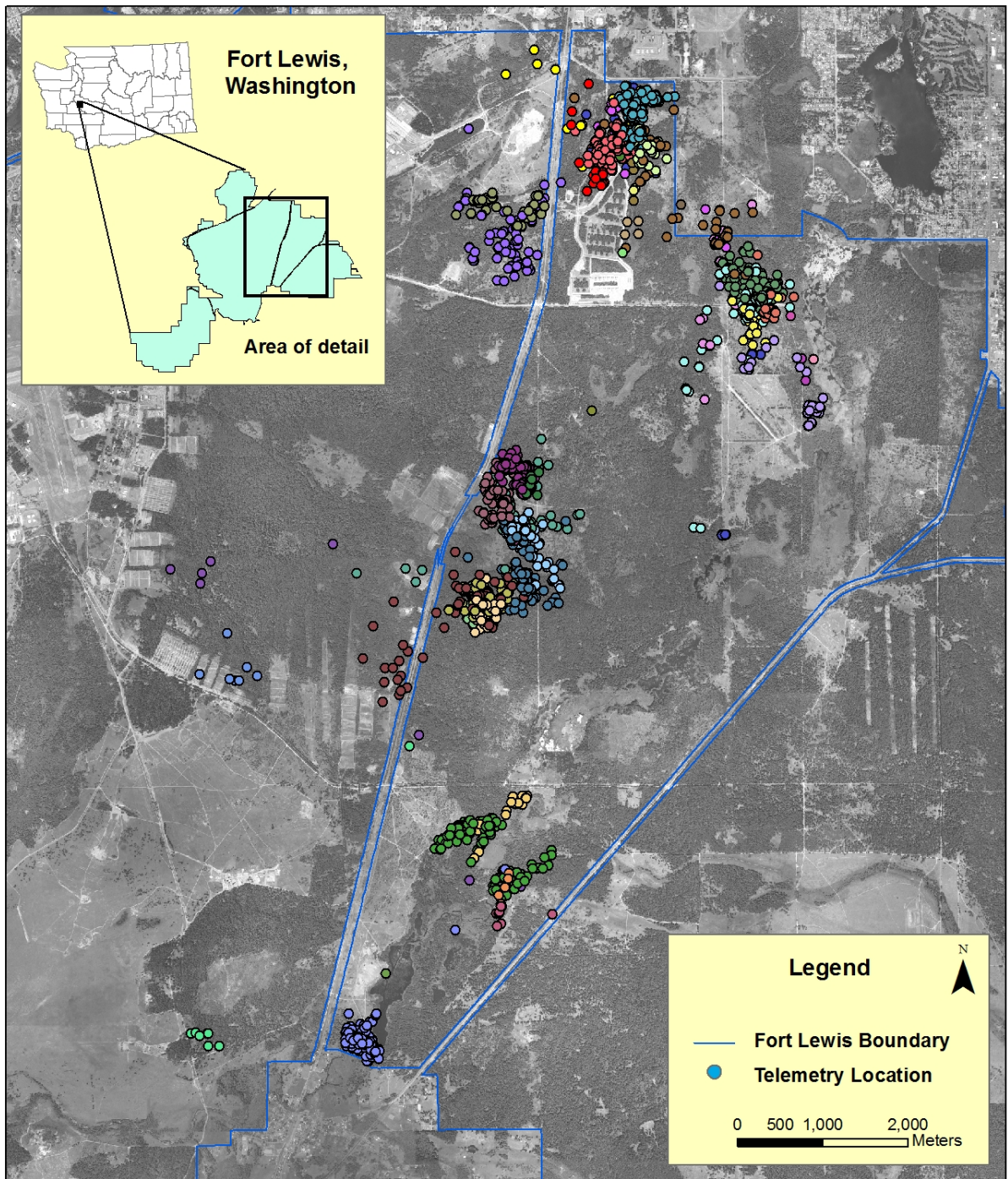


Figure 1. Telemetry locations of resident western gray squirrels on Fort Lewis, Washington, 2006-2008. Symbol colors are unique for each animal.

*Reproduction.*—Thirteen females were monitored from late winter through summer for indications of breeding activity. Unlike females that we studied in Klickitat County and the North Cascades, females on Fort Lewis seldom focused activity on one particular nest prior to parturition. We used target-trapping during summer to document breeding status. All but one female showed definite indications of breeding, exhibiting enlarged teats, nuzzle marks, or both. Counts of young were possible for 7 females and ranged from 1 to 4; litter sizes for females where we believe the count to be definitive were 2 for one female and 4 for 3 females. No females showed evidence of attempting a second litter in one breeding season.

## **Nests**

During 2008 we documented 114 nests used by radio-collared western gray squirrels and recorded each location with a GPS receiver. For most nest locations the following information also was collected: date, time, accuracy, tree species and DBH, nest type, nest color, and nest condition. All nest locations recorded in our database from October 2006 through December 2008 (137 locations) are displayed in Figure 2.

Most (90 %) nests were in Douglas fir (97 shelter nests; 21 platform nests; 2 cavity dens; 3 unknown) or ponderosa pine (8%; 8 shelter nests; 2 platform nests; 1 unknown). Three nests were cavity dens in Oregon oak.

## **Translocated Squirrels**

*2007 Release.*—In October of 2007 we released 9 Western gray squirrels onto Fort Lewis (Table 2). All animals were captured in the Black Canyon Creek drainage, Okanagan National Forest, near Pateros. Seven animals (4 females, 3 males) were released 9 October 2007 near Bill Lake in Training Area (TA) 10, and 2 more animals (1 female, 1 male) were released 12 October 2007 in Holden Woods, TA 10. All were given injections of 0.15 ml Ivermectin upon capture to kill ectoparasites. The first 7 were released directly from the holding cage (trap) and allowed to run free. The latter 2 were placed in separate wood duck nest boxes approximately 7 meters above the ground, each filled with leaf litter and about 12 walnuts. A door was shut over the opening for 2 hours, and then quietly opened to allow the squirrel to exit.

Three of the original 7 animals died within the first 3 days. One juvenile female (2546) which had climbed an oak tree upon release and then fell to the ground (seemingly unharmed) and ran off was found depredated the next morning. An adult male (2550) was found the second day after release in debilitated condition and was brought in for recovery but died en route, probably from exposure. The third animal (2549), an adult female, was located the second day after release under a log at daybreak but ran off, and found there again the next morning dead, also probably from exposure.



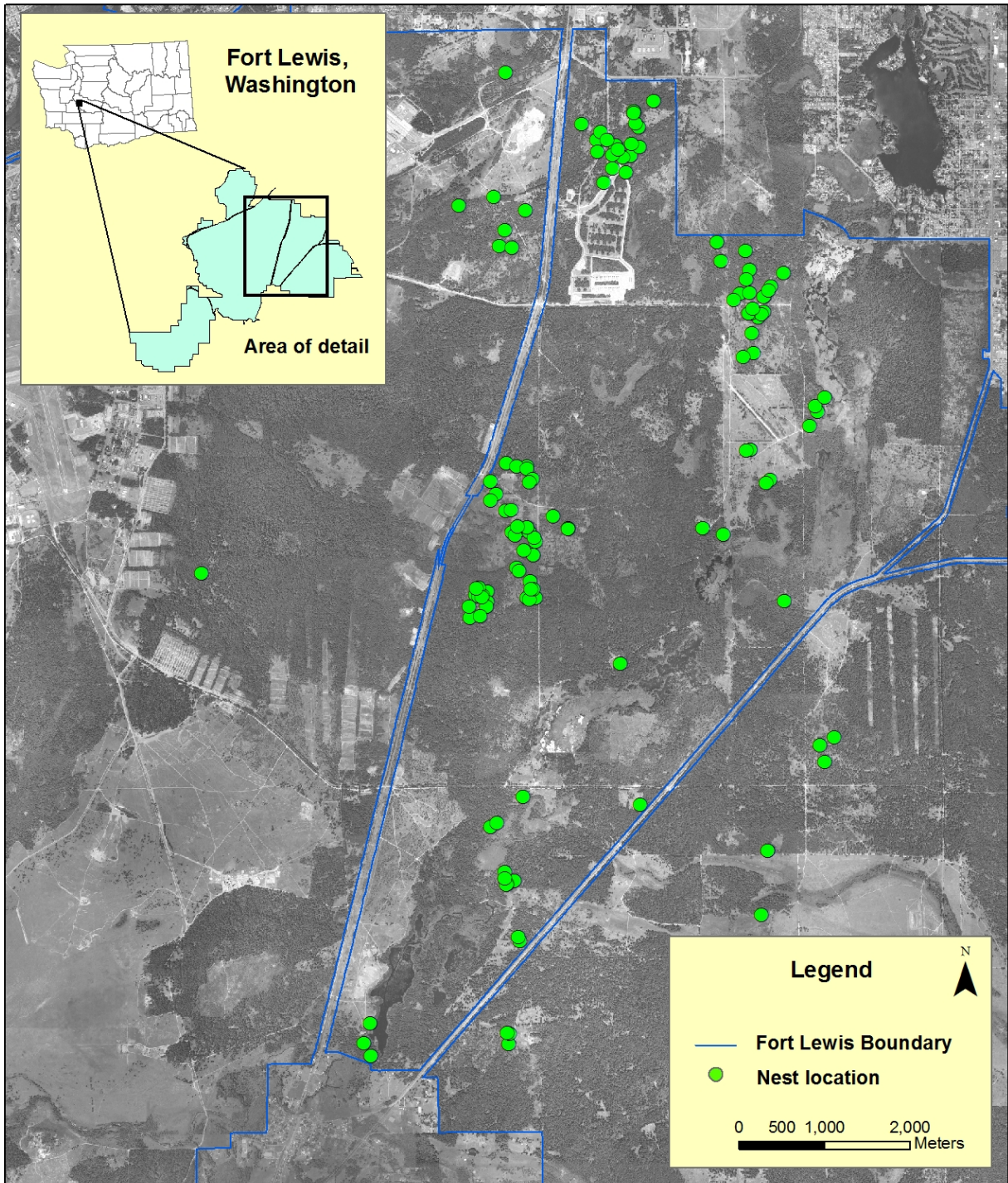


Figure 2. Nests of radio-collared western gray squirrels (both residents and translocated animals) on Fort Lewis, Washington, 2006-2007.

Table 2. Western gray squirrels translocated onto Fort Lewis in 2007 as part of ongoing efforts to augment the resident population.

<b>ID</b>	<b>Sex</b>	<b>Age</b>	<b>Survival Period</b>	<b>Release Site/Date</b>	<b>Fate</b>
2551	M	Adult	15 months +	Bill Lake/9 Oct	Alive, seemingly settled
2545	M	Adult	12 months	Holden/9 Oct	Mortality, predation
2546	F	Juvenile	One day	Holden/9 Oct	Mortality, predation
2547	F	Adult	2 months +?	Bill Lake/9 Oct	Unknown
2548	F	Juvenile	3 weeks?	Bill Lake/9 Oct	Unknown, likely slipped collar
2549	F	Adult	3 days	Holden/9 Oct	Mortality, probable exposure
2550	M	Adult	2 days	Holden/9 Oct	Mortality, probable exposure
2552	F	Subadult	6 months +?	Holden/11 Oct	Unknown
2554	M	Subadult	9 months +?	Holden/11 Oct	Unknown

Of the remaining 4 animals from the early release, one juvenile female (2548) either slipped her collar (purposely left loose to allow for growth) or was depredated; her collar was found in the Central Impact Area (CIA) 15 days after release with no remains that would indicate predation. One adult male (2547) “vanished” (radio signal disappeared suddenly and all trapping efforts for the animal were fruitless) 2 months after release. Another adult male (2545) remained alive for over one year, covering quite a bit of ground until seemingly settling in TA 11; he was killed and eaten by a predator. The last of these, an adult male (2551), was still alive 15 months after release and seems to have settled in TA 13. This animal is the all-time record-setter for distance traveled by a western gray on Fort Lewis (Figure 3).

The 3 early deaths from the first release prompted an experimental release into nest boxes for the final 2 animals, the idea being that if they needed shelter after release they would at least have these boxes available to them. Support of that theory first came when, upon opening the door to the nest box remotely from a distance, they remained inside for some time afterwards, and both remained very close to these boxes for several days before abandoning them. The male of these 2 remained in Holden Woods until disappearing over 9 months later. We tried, unsuccessfully to trap the animal, but his wide range could mean he is still alive with a non-functioning collar. An interesting note on this male is that he was trapped adjacent to 2 resident females in estrus in February 2008. The female of these 2 late-released animals moved and set up residence ~3 kilometers away, also vanishing 6 months after release. As of 31 December 2008, there was one adult male still alive and transmitting, 4 animals (1 adult female, 1 juvenile female, 1 subadult female and 1 subadult male) whose fate was unknown, and 4 confirmed mortalities (2 predation and 2 likely from exposure).

*2008 Release*—In September/October 2008 we released 19 western gray squirrels onto Fort Lewis: 16 from the Dead Canyon study site (2004-2005) in Klickitat County (private timber holding), one from just north of Lyle, Klickitat County (DNR land), and 2 from the same Black Canyon study area in the Methow as the 2007 release animals (Table 3). All were given injections of 0.15 ml Ivermectin upon capture, and all Klickitat County

animals were released at their capture sites and re-captured 2-3 weeks later and given a second injection. Our concern with animals from the Klickitat population was the known occurrence of nododric mange; a second injection was given to kill any mites that survived as eggs following the initial injection.

The 2008 release occurred in 2 phases. Six animals (2 adult males, 2 adult females, 2 subadult females) were released 10 September (all from Dead Canyon). Ten animals (4 adult males, 5 adult females, 1 subadult female) were released 24 September (also from Dead Canyon). We then brought 2 animals from Black Canyon (both adult males) and released them 27 September. Finally, an additional subadult female captured near Lyle was held at a wildlife rehabilitation center for 2 weeks to allow for the second dose of Ivermectin, and was released 10 October.

All of these animals were released into wood duck nest boxes as described above, and all remained at least briefly inside the boxes. The weather was considerably warmer and dryer at this release compared to 2007, and most animals were released one month earlier. Conditions were excellent for the release, with a greater acorn crop on Fort Lewis than in 2007 and a better pine cone crop in Klickitat County. As of 31 December there were 13 animals (7 female, 6 male) still alive and transmitting, 3 confirmed mortalities (females), and 3 (2 females, 1 male) with unknown fate (Figure 3).

Table 3. Western gray squirrels translocated onto Fort Lewis in 2008 as part of ongoing efforts to augment the resident population.

<b>ID</b>	<b>Sex</b>	<b>Age</b>	<b>Survival Period</b>	<b>Release Site/Date</b>	<b>Fate</b>
2393	F	Adult	4 months +	TA 13/24 Sep	Alive, in TA 13
2468	F	Adult	4 months +	TA 11/24 Sep	Alive, TA 11
2572	F	Subadult	4 months +	TA 10/10 Sep	Alive, Johnson marsh
2575	F	Adult	4 months +	TA 11/10 Sep	Alive, Hardtack marsh
2579	F	Adult	4 months +	TA 11/24 Sep	Alive, Shaver lake area
2592	F	Adult	4 months +	TA 10/24 Sep	Alive Shaver lake area
2594	M	Adult	4 months +	TA 13/27 Sep	Alive, in TA 13
2598	M	Adult	4 months +	TA 13/ 27 Sep	Alive, near Driver's Course
2574	M	Adult	4 months +	TA 11/10 Sep	Alive, near Driver's Course
2584	M	Adult	4 months +	TA 13/24 Sep	Alive, in TA 13
2585	M	Adult	4 months +	TA 13/24 Sep	Alive, in TA 13
2591	M	Adult	4 months +	TA 10/24 Sep	Alive, Johnson marsh
2599	F	Subadult	3 months	TA 13/9 Oct	Mortality, predation
2401	F	Adult	1 month	TA 10/10 Sep	Mortality, road kill
2578	F	Adult	1 month	TA 10/10 Sep	Mortality, road kill
2576	F	Subadult	4 days +?	TA 11/10 Sep	Unknown
2586	F	Subadult	3 days +?	TA 13/24 Sep	Unknown
2589	F	Adult	4 months +?	TA 13/24 Sep	Alive, in AIA
2573	M	Adult	3 months +?	TA 11/24 Sep	Unknown



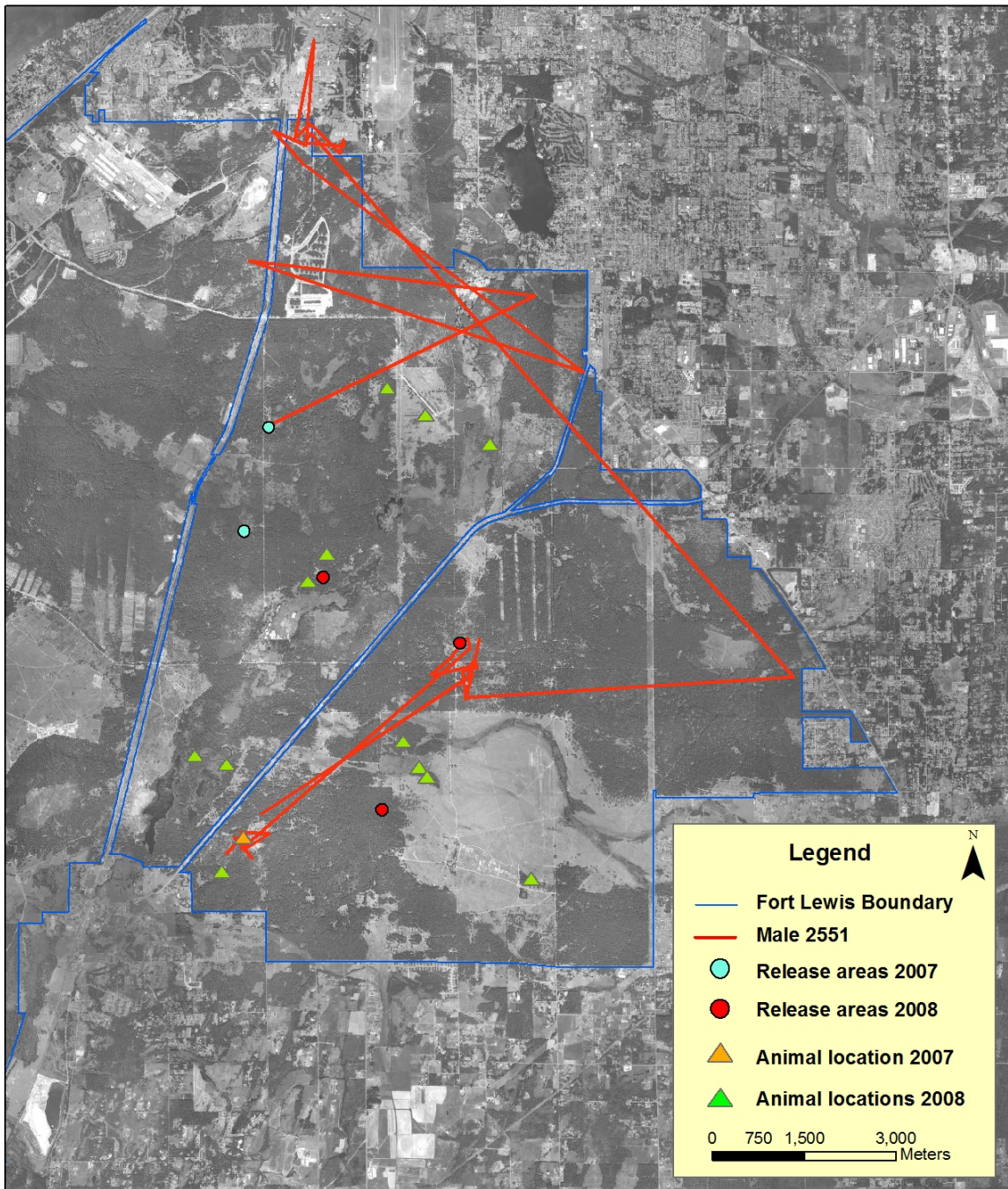


Figure 3. Release areas and current locations of western gray squirrels translocated to Fort Lewis, and movement track of 1 male squirrel for a 12- month period following his release in October 2007.

Five animals have remained fairly close to their release site; one adult female (2393) and two adult males (2585 and 2594) at TA 13, and one subadult female (2572) and one adult male (2591) at Johnson marsh. One male (2573) moved 9 km WSW to prairie's edge at the Artillery Impact Area, and now cannot be heard by ground or air. Most others have traveled from 1.5 to 6 km so far. Two animals, both adult males, have settled in a small grove of cottonwoods and oaks, most of which is now underwater. Two others, an adult male (2574) and an adult female (2592) seem to have settled several km from their release into good-looking habitat.

## **PLANS FOR 2009**

### **Research**

Monitoring of radio-collared squirrels will continue through the next reporting period. We will capture and radio-collar additional resident western gray squirrels in order to maintain a suitable sample size for ongoing research on the ecology of the species on Fort Lewis. Areas of emphasis will include: documenting all natal nests and reproductive attempts through increased monitoring; measuring the height of all nests and nest trees; initiating annual sampling of mast crop size; and sampling vegetation within animal home ranges to facilitate habitat use analyses. Further documenting the extent of tularemia in both the eastern and western gray squirrel populations will also be emphasized, with all suspicious mortalities sent for analysis.

In 2009 we plan to begin semi-annual trapping on a large (approx. 1 mile square) grid in order to provide a census of western and eastern gray squirrels within a defined area. In addition to a (nearly) complete count of animals using a site, grid trapping also will provide: 1) an opportunity to radio-collar juveniles in the fall, 2) the means to test the efficacy of hair-tubes vs. traps for detecting animal occurrence, and 3) an additional site to compare the spatial distribution of eastern and western gray squirrels (supplementing smaller grids run in 2008 as part of the UW graduate study).

### **Augmentation**

Additional western gray squirrels will be released on the Fort during fall 2009 as part of the species recovery effort. We will consider all 3 source populations identified in the augmentation plan, including populations in northern Oregon. Oregon Department of Fish and Wildlife has expressed willingness to provide western gray squirrels for this effort. Release areas will be selected in consultation with Fort Lewis staff. Potential areas identified in the augmentation plan include Training areas 3-5 and the Rainier training area. Assessment of these areas will begin early in 2009 with field visits and a thorough survey using hair tubes. Depending on survival of the 2008 release cohort, additional animals may be released in TA11 and/or TA13 to supplement these earlier releases.

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