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STUDIES OF ECOLOGICAL FACTORS THAT AFFECT THE
POPULATION AND DISTRIBUTION OF THE WESTERN GRAY SQUIRREL
IN NORTHCENTRAL OREGON

by

SUSAN ANN FOSTER

A dissertation submitted in partial fulfillment
of the requirements for the degree of

DOCTOR OF PHILOSOPHY
in
ENVIRONMENTAL SCIENCES AND RESOURCES:
BIOLOGY

Portland State University
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TO THE OFFICE OF GRADUATE STUDIES:

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presented January 10, 1992.

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Philosophy in Environmental Sciences and Resources: Biology, presented January 10,
1992.

Title: Studies of Ecological Factors That Affect the Population and Distribution of
the Western Gray Squirrel in Northcentral Oregon

APPROVED BY MEMBERS OF THE DISSERTATION COMMITTEE:

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The western gray squirrel (*Sciurus griseus griseus* Ord) occur only in the Pacific states and in a small corner of extreme western Nevada. Field studies of aspects of the ecology of the most widely distributed subspecies of western gray squirrel (*S. griseus*) were conducted at three sites in the ponderosa pine–Oregon white oak zone on the eastern slopes of Mt. Hood, Wasco County, Oregon, between 1981 and 1989. From 1981 through 1987, a Hunter Cooperation Program provided remains of squirrels shot during the annual late summer–early autumn hunting season. Other data were gathered through capture and release studies, radiotelemetry, and habitat analysis.

The age structure of these populations, as revealed by examination of squirrels killed by hunters, is predominantly mature animals. Also, the population as estimated by hunter success during the Hunter Cooperation Program and by field observations appears to be declining.

In the sites studied, western gray squirrels have two seasons of reproductive activity annually. Some individuals mate from January through March; their young emerge from the nest in May and June. Other individuals mate during May and June; their young emerge in August and September. The latter matings are usually the most productive.

Analysis of nest trees and their surroundings revealed that nests are most likely to be located in mature trees that have well-developed crowns and occur in stands with a high degree of canopy closure. Nest trees were usually located within

approximately 180 meters of permanent water and on sites with a south-southeasterly exposure.

Home ranges of squirrels examined in this study were usually large compared to home ranges reported for this species elsewhere in its range. Given the cost of having large home ranges, it seems possible that the squirrels at these study sites exist in less than optimal ecological circumstances.

Human factors that may have contributed to the decline of the populations in this study may include the nature of logging activities and the timing of the annual hunting season. Limiting factors other than human activities may include competition with other mast-consuming animals (mule deer, elk, wild turkeys, and three other species of squirrels) for limited and variable mast crops.

CHAPTER I

INTRODUCTION

The western gray squirrel, *Sciurus griseus griseus* Ord, is the largest native tree squirrel in the western United States, yet little is known of its habitat requirements, life history, or population biology. The various subspecies of this squirrel occur in the western forested regions of the mountains and lowlands of the Pacific Coastal States (E. R. Hall, 1981). Its range extends from the northern Cascades in Washington through the Cascade and Coast ranges in Oregon and through the coastal and Sierra Nevada mountains of California. *S. griseus*, which is associated with a variety of conifers throughout its range, is also found in the ponderosa pine–Oregon white oak association on the eastern slopes of Mt. Hood.

The management status of the western gray squirrel population in northcentral Oregon is mixed. The Oregon Department of Fish and Wildlife has classified *S. griseus* as a game animal, and it is hunted in the fall. The Mt. Hood National Forest has classified it as a management indicator species for ponderosa pine–Oregon white oak associations. As an indicator species, the status and health of populations of *S. griseus* presumably indicate the quality of the habitat within which it lives. This presents a dilemma in management practices for the western gray squirrel, as it is difficult to set bag limits and hunting season dates with little information of the animal's reproductive biology. It is also difficult to provide adequate nesting sites,

food sources, space, and to monitor an indicator species when little is known of its habitat requirements. This study was designed to answer certain questions on the food habits and competitors, habitat requirements for nesting, cover and water, nest tree requirements, population structure and reproductive activities of the western gray squirrel in northcentral Oregon.

The study began in 1981 with a preliminary survey of the western gray squirrel habitats along a transect from Oregon southward to the limit of the range of the species in southern California. This permitted comparisons of prime and peripheral western gray squirrel habitats along a substantial latitudinal gradient and under a variety of different habitat types—tanoak (*Lithocarpus densiflora* var. *echinoides*),¹ pinyon pine (*Pinus monophylla*), California live oak (*Quercus chrysolepis*), Pacific madrone (*Arbutus menziesii*), and various hardwood riparian species. The regions observed included the coastal mountains of both Oregon and California, the eastern slopes of the Sierra Nevada mountains, and the mountains of southern Oregon.

Following this brief survey of western gray squirrel habitats, a study area was selected in the ponderosa pine–Oregon white oak (*Pinus ponderosa*–*Quercus garryana*) association located in Wasco County, Oregon. The study area extends from The Dalles south to the White River, on the eastern slope of Mt. Hood. This area supports a number of western gray squirrels and is open to hunting of that species from late August to early November annually.

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¹Scientific names and common names of plants are from Hitchcock and Cronquist (1973), mammals are from E. R. Hall (1981) and birds are from Peterson (1991).

The status of the western gray squirrel differs throughout its range. In Washington, the species is presently classified as a sensitive species, and an application has been made to upgrade this classification to threatened (Rodrick, 1987). In Oregon, the western gray squirrel is regarded as a pest in the agricultural areas of walnut and filbert orchards of northwestern Oregon, as a game animal in southwestern and northcentral Oregon, and as a non-game species in the remainder of its range. In California the western gray squirrel is a valued game animal over most of its range.

Much of the range of this species is on multiple-use land, and prime habitat for these squirrels is being lost or seriously altered through ignorance of basic information relevant to management of the species. Merriam's wild turkey (*Meleagris gallopavo*), mule deer (*Odocoileus hemionus*) and Rocky Mountain elk (*Cervus elaphus*) have also been listed as management indicator species for the ponderosa pine-Oregon white oak association of the Mt. Hood National Forest (Topik, Halverson & High, 1988).

The western gray squirrel is one of several species of small mammals that are important in the dispersal of hypogeous fungal spores. This role may be critical in the growth, health and survival of coniferous forests (Fogel & Trappe, 1978; Maser, Trappe, & Ure, 1978). Because western gray squirrels bury nuts singly, the squirrels are also considered important vectors for the dispersal of seeds from several species of trees, in particular various species of oaks.

This study, therefore, should be valuable in two ways. It provides information worthwhile to science in general and wildlife management in particular concerning

factors limiting the occurrence and abundance of a native northwestern species whose ecological distribution and numbers are little known. Secondly, based on information acquired in this study and in the literature, management recommendations for western gray squirrels were formulated with particular reference to their specific habitat requirements.

CHAPTER II

REVIEW OF THE LITERATURE

A number of studies have dealt with aspects of history, ecology and populations of various tree squirrels. Seton (1928) published accounts of the habits of various game animals, including eastern gray squirrel (*Sciurus carolinensis*), fox squirrel (*Sciurus niger*), red squirrel (*Tamiasciurus hudsonicus*), Douglas' squirrel (*Tamiasciurus douglasii*), and the western gray squirrel). The western gray squirrel is often considered to be sufficiently like the eastern gray squirrel in the length and nature of the reproductive cycle, the trees required for den trees, the construction and use of nest boxes, and food habits so that the information gathered from eastern gray squirrels has been used as a guide for management of western gray squirrels (Seton, 1928).

Taxonomically, however, the western gray squirrel is placed in its own subgenus, *Hesperosciurus*, while the eastern gray squirrel is in the subgenus *Neosciurus* (E. R. Hall, 1981). Studies of the bacula of squirrels (Pocock, 1923; Wade & Gilbert, 1940) indicate that there is a close phylogenetic relationship between the eastern gray squirrel, the fox squirrel, and the red squirrel, while the western gray squirrel and Abert's squirrel (*Sciurus aberti*) have similar bacula. Recent studies of both Abert's squirrel (Patton, 1984) and Kaibab squirrel (*Sciurus aberti kaibabensis*) (J. G. Hall, 1981) indicate similarities to the western gray squirrel in nest tree

selection, habitat utilization and food habits. The western gray squirrel is generally thought to have habits similar to those of the eastern gray squirrel in their respective niches, but no genetic interchange would have been possible between these species until recently when eastern gray squirrels were introduced into western gray squirrel habitat. The only tree squirrels native to the western United States are Douglas' squirrel, red squirrel, northern flying squirrel (*Glaucomys sabrinus*), Abert's squirrel, Arizona gray squirrel (*Sciurus arizonensis*) and western gray squirrel (Barnum, 1975; Brown, 1984).

HABITAT REQUIREMENTS

Habitat suitability indices produced for the Forest Service by Miller (1984) and additional work by Rodrick (1987), Cross (1969), Gilman (1986), Byrne (1979) and Asserson (1974) show that western gray squirrels need a mix of mast-producing trees to provide both food, cover and nesting sites in their habitat. The ecological range of the western gray squirrel includes a variety of habitat types with mixed conifer-oak forests. The species of oaks vary considerably within the range. Generally, the squirrels require trees of a size sufficient to produce an interconnected canopy for aerial travel, as the squirrels are extremely wary and secretive (Hall, 1980b; Miller, 1984; Rodrick, 1987). Cross (1969) gathered information on the daily activity patterns, nest sites, nest trees, and habits of the western gray squirrel in southern Oregon from 1965 to 1968. The study included a discussion of the habitat types used by the squirrels. Vegetation types included areas of primarily oaks with scattered

ponderosa pines and Douglas-fir (*Pseudotsuga menziesii*), and areas with a higher density of ponderosa pine, Douglas-fir, Oregon white oak, California black oak (*Quercus kelloggii*), and Pacific madrone. Byrne (1979), in a study of the interactions of eastern gray squirrels and fox squirrels with western gray squirrels in California, concluded that displacement of western gray squirrels by the two introduced species occurred due to habitat changes from plantings of cultivated fruits and nuts and the production of two litters per year by fox and eastern gray squirrels as opposed to one litter per year by the western gray squirrels. These differences allowed the two introduced species to replace the western gray squirrels when population numbers of the latter were low rather than displacing them through competition for available habitat or food.

Timber harvest represents an intensive habitat disruption by humans. Studies of Abert's squirrel populations and their habitats show that these squirrels are negatively influenced by forest management practices that lead to even-age stands of ponderosa pine (Patton, 1984). Asserson (1974) concluded that clear-cutting of merchantable timber involved the eradication of mast-bearing trees in the habitat of the western gray squirrel. The same results were noted following a fire in part of the study area. Observations of the burn showed little use of the area by tree squirrels. Asserson's study also noted that various age classes of oaks, including old live and dead trees, were needed to provide both food and cover, and different age categories of conifers were important for year-round cover and seasonally important food. The distribution of trees, size of trees and the patchiness of the environment appear to be factors

affecting abundance of and habitat selection by Abert's squirrels (Farentinos, 1972; J. G. Hall, 1981; Keith, 1965; Patton, Wadleigh, & Hudak, 1985; Pederson, Hasenyager, & Heggenet, 1976; Vahle & Patton, 1983).

NESTS AND NEST TREES

Nest boxes have been utilized in different forest types in an attempt to increase the availability of dens in areas lacking sufficient den trees. In the eastern and southern forests occupied by eastern gray and fox squirrels, nest boxes have been helpful in increasing squirrel populations (McComb & Noble, 1981). Several investigators have suggested that western gray squirrels utilize den trees for winter nesting or for rearing of young, although this appears to vary over the species' range (Asserson, 1974; Barnum, 1975; Cross, 1969; Ingles, 1947; Maser, Mate, Franklin, & Dyrness, 1981).

Nests built by western gray squirrels are generally of two types: large twig and leaf nests constructed with a roof of varying thickness for winter use and rearing of young, and looser leaf nests or "drays" constructed as temporary nests, summer nests or alternative nests (Cross, 1969; Ingles, 1947). Winter and rearing nests were usually built in conifers, while drays were often built in various species of deciduous trees. The selection of a nest tree for the winter or rearing nest is relatively dependant upon tree size and species (Asserson, 1974; Barnum, 1975; Cross, 1969; Rodrick, 1987) throughout the western gray squirrel's range. This is in agreement

with the information available for both Abert and Kaibab squirrels (J. G. Hall, 1981; Keith, 1965; Patton, 1984).

FOOD HABITS

Barnum (1975) indicated that western gray squirrels were not present in areas where there were only single sources of food. Stienecker and Browning (1970) analyzed the stomach contents of 310 western gray squirrels collected from 1963 to 1968. This study was updated in 1977 with the addition of 207 samples collected between 1968 and 1970 from five more counties to supplement the data from seven counties originally studied (Stienecker, 1977). Food patterns were found to be similar through the seven years of the study, although some variations were noted in species of fungus eaten in different forest associations. These studies found that one of the major components of the squirrels' diet was hypogeous fungi. Studies of the implications of mycophagy by small mammals have highlighted the importance of hypogeous fungi in the diet of western gray squirrels (Maser, Trappe, & Nussbaum, 1978; Maser, Trappe, & Ure, 1978; Stienecker, 1977). These studies have emphasized the importance of the interrelation of mycophagous mammals and the coniferous forests within which they live. The hypogeous fungi eaten by these squirrels and other small mammals are mycorrhiza-forming fungi upon which coniferous trees depend for the uptake of nonmobile minerals from the soil, while the fungi depend upon the trees for photosynthetic products. This mutualistic relationship allows for extensively increased surface area for absorption of these soil nutrients.

The Pinaceae, to which ponderosa pine belongs, are particularly dependent upon these fungi. In addition to their absorptive function, these fungi produce growth regulators that increase both the life of the rootlets and the number of root tips, and increase disease resistance (Maser, Trappe, & Ure, 1978). The hypogeous fungi depend upon mycophagous small mammals for dissemination of spores. As the squirrels travel and defecate, undigested fungal spores are shed on the soil. Eventually, the spores wash down to the roots of seedlings (J. G. Hall, 1981; Maser, Trappe, & Nussbaum, 1978). Hypogeous fungi have a higher food value, including salts, phosphorus and protein, than epigeous fungi although the hypogeous fungi are lower in water content (Stienecker, 1977; Stienecker & Browning, 1970). The foods of the introduced eastern gray and fox squirrels in California apparently do not include hypogeous fungi, although epigeous fungi were found in their diets. These two squirrels were more dependent upon human-introduced food sources such as nut orchards and cultivated foods (Byrne, 1979). Pine mast appears to be critically important in the diet of the western gray squirrel, especially in the summer and fall when the seeds have reached the milk stage. Pine seeds are high in iron and carbohydrates and contribute to the deposition of fat for winter (Stienecker, 1977; Stienecker & Browning, 1970). Cross (1969) found that pine and fir seeds were eaten all year and were eaten almost exclusively in late summer and early fall. Acorns were eaten from late fall through winter. Hypogeous fungi formed a major portion of the spring and early summer diet and were probably utilized all year. Unlike Abert's squirrels, western gray squirrels cache winter food stores. The mast is buried individually in

holes in the ground. Most of the foraging by western gray squirrels occurs on the ground except in the fall when they cut green cones for food and for winter storage.

The western gray squirrel is considered to be a pest in areas of Oregon where its natural habitat is abutted by nut groves and pear orchards. Squirrels may cause a great deal of damage to these crops (Byrne, 1979; Rodrick, 1987). Western gray squirrels and Abert's squirrels are known also to feed upon the cambial layer of twigs of the ponderosa pine trees. The squirrels utilize this rich food layer in winter and early spring when sap is running. Abert's squirrel, the diet of which is much more dependent upon ponderosa pine due to a lack of other mast in its range, also feeds upon the cambial layer, but the damage is not considered sufficient to label the animal a pest. It was noted that although an individual tree may slow its growth for a season or two, the overall growth of the tree was not significantly different from nonfeeding trees (J. G. Hall, 1981). The problem with western gray squirrels' use of cambium is localized but may cause significant damage to individual trees (Baldwin, 1980; Cross, 1969; Swift, 1977).

HOME RANGE

All animals have minimum requirements for food, cover and other necessities to sustain life. These requirements are met in that area called the habitat of the animal. The suitability of habitat is determined in part by the amount of space required to meet the animal's food, cover, nesting and reproductive needs. This space is referred to as the home range of the animal. Home range information for western gray

squirrels has been obtained by visual observation (Ingles, 1947), use of trapping grids (Asserson, 1974; Barnum, 1975; Hall, 1980a), and by radiotelemetry (Cross, 1969; Gilman, 1986). Rodrick (1987) used track stations in an attempt to determine presence of squirrels in Washington.

AGE DETERMINATION

Determination of the age structure of a population requires that a method exist to determine the age of individuals in the population. Many methods have been used for this purpose. Eye lenses of many mammals grow continuously throughout their lives. Lord (1959) used this fact to construct a graph of eye lens weights for animals of known ages. The presence and amount of epiphyseal cartilage permits separation of mammals into three classes: juveniles have a wide band of cartilage, subadults have a narrow band, and adults have no epiphyseal cartilage remaining (Carson, 1961). Asserson (1974) used this method to determine relative ages of western gray squirrels. Eruption, replacement, and wear pattern of the molariform teeth of the mandible permits separation of mammals into juvenile, subadult, adult and old adult age classes (Forbes, 1966; Hench, Kirkland, Setzer, & Douglass, 1984; Nellis, 1969).

Other methods used to determine ages of squirrels include the color and condition of genitals and mammae (Allen, 1952; Barrier & Barkalow, 1967), dried lens weight (Fisher & Perry, 1970), degree of epiphyseal closure in long bones (Petrides, 1951) and pelage coloration (Sharp, 1958).

With the addition of more recent studies involving ossification, tuberosities, and adhesion lines in the mandibles, some controversy has arisen over the use of tooth eruption and wear patterns (Sullins, McKay, & Verts, 1976). The other methods are also controversial. For example, Colburn (1986) studied the degree of long bone ossification and the correlation of this to the development of suspensory tuberosities on the ischial arches of the innominate bones in eastern gray, fox, and red squirrels and eastern chipmunks. The suspensory tuberosities serve as attachment points for the ligaments that support the penis. The method is useful only up to 10-13 months of age and only in male animals. Recent studies suggest the presence of darkly stained adhesion lines in the mandible of various mammals is a method of promise, although there are some animals that show no such lines and are known to be the young of the previous year (Costain & Verts, 1982; Fiero & Verts, 1986; Livezey & Verts, 1979; Sullins, et al., 1976). Although these methods are useful for differentiating between juveniles and adults, they are not sufficient to separate animals into more than these two age classes.

REPRODUCTION

Several investigators have noted the presence of two major reproductive peaks during a single long breeding season that begins in January among western gray squirrels (Bailey, 1936; Byrne, 1979; Cross, 1969; Ingles, 1947; Swift, 1977). In these studies the major production and recruitment of young into the population occurs from the summer litter or second major reproductive peak.

Asserson (1974) studied reproductive cycles and parturition of the western gray squirrel in Kern County, California, from 1968 to 1976. He found evidence of spring and summer litters. He used information from Game Take Hunter Surveys to show that less than 5% of the population was taken by hunters each season.

Cross (1969) noted that western gray squirrel females become sexually mature at 10 to 11 months of age, and that older females could potentially have two litters a year. Other studies, however, have produced little evidence that any individual female produced more than one litter a year (Asserson, 1974; Bryne, 1979; Rodrick, 1987; Swift, 1977).

CHAPTER III

STUDY AREA

This study was conducted on the east slopes of Mt. Hood in the ponderosa pine-Oregon white oak zone (Franklin & Dymess, 1973). Integrated into this zone are Douglas-fir, western hemlock (*Tsuga occidentalis*), black cottonwood (*Populus nigricans*), and grand fir (*Abies grandis*). The area is generally characterized by dry, warm summers and moist, cold winters with most of the precipitation falling as snow during winter. Average annual precipitation ranged from 7.77 in. (19.7 cm) to 27.6 in. (70.2 cm) for 1981–1989. Average annual temperature ranged from 7.78°C to 10.56°C for 1981–1989 (U.S. Department of Commerce, National Weather Service, Portland, Oregon). Frost is possible during any season of the year.

The study area was approximately 80.5 KM². It extended from Fifteen Mile Creek in the north to the White River in the south, and included lands in the Barlow Ranger District of the Mt. Hood National Forest, the White River Game Management area of the Oregon Department of Fish and Wildlife, and private lands. The range in elevation was from 460 to 1070 m. Studies were concentrated in three primary areas: Bear Gulch–Jordan Creek, located within the Oregon Department of Fish and Wildlife land; Onion Flats, located on Mountain Fir Lumber Company land; and the Out Timber Sale, located on U. S. Forest Service land (see Figure 1).

Figure 1. Study area.

Bear Gulch-Jordan Creek is located in sections 10 and 15 of T3S, R12E. At this site, water is available throughout the year from Jordan Creek and from a seasonal creek in Bear Gulch. Trees are primarily ponderosa pine and Oregon white oak, with occasional Douglas-fir. Conifers have been thinned to promote increased forage for large mammals, and the lands are managed to provide a sustained yield of merchantable timber (L. Cooper, Manager, White River Game Management Area, personal communication, October 19, 1991).

Onion Flats is located on the North-South Road (FS 25) in sections 19 and 20 of T3S, R12E. This area is located next to a timber harvest mitigation pond that provides a year-round source of water. Trees are primarily ponderosa pine and Oregon white oak with occasional Douglas-fir and eastern hemlock. This area was logged in the early 1970s.

Out Timber Sale is located in sections 25, 26, 35 and 36 of T3S, R11E. Water is available from two mitigation ponds, two springs and Badger Creek. The vegetation type is similar to that of the other two major study areas but includes more Douglas-fir. Out Timber Sale, sold in 1976, had not been logged when this study started in 1981, but it was logged from the spring of 1985 through 1990.

A feeding station was maintained in the study area at Friend, Oregon (section 35 of T2S, R12E), for the duration of the study in a grove of ponderosa pine in order to observe behaviors of wild squirrels and released orphaned squirrels. Two large old Oregon white oaks were also in the observation area. The site, located on private land, was off limits to hunting; consequently, it provided a safe site for the

reintroduction of hand-raised squirrels into a relatively natural area occasionally occupied by wild squirrels. Water was available in a pan below a hand pump.

CHAPTER IV

METHODS AND MATERIALS

FOOD HABITS

Hunters were asked to place unused parts of the squirrels in bags and to write on a tag information concerning the date, location where squirrel was shot, time of day the squirrel was shot, the sex of the squirrel and whether or not there were ear tags on the squirrel (see Appendix A). When ear tags were present, the numbers of those tags were requested. If any of the squirrels wore radio collars, it was requested that these also be returned (Appendix A).

Seven drop boxes were located along the major access roads used by hunters. Notices of the study were posted at stores and crossroads throughout the general area (Appendix A). Hunters were personally contacted during the first 2 weeks of the season by personnel of the Dalles office of the Oregon Department of Fish and Wildlife, by Oregon State Police game officers, and by me. Articles were included in both the local and statewide newspapers. Drop locations were checked each day during the beginning of the season and during the weekends throughout the season. Response was variable, and not all parts requested were always obtained (Appendix B).

Observations of feeding habits and partial analysis of contents of stomachs collected from the Hunter Cooperation Program of 1981–1987 provided information on the squirrels' diets. Stomachs were separated from the rest of the viscera collected and placed in 10% formalin until they could be examined to ascertain the content of starchy material, fungal spores, insect parts and other identifiable materials. Specifically identified materials other than fungal spores will not be reported in this study. Zane Maser of the Forest Research Lab in Corvallis, Oregon, provided the methodology, instruction, and identification of fungal spores by percentage and type in a sample of the stomachs of the squirrels.

LIVE TRAPPING

Populations of western gray squirrels were initially censused by observation of marked individuals from live trapping. Animals were live trapped throughout the year except during the hunting season from late August through early November. Numbers, densities, sex ratios, reproductive activity, and age structure of the population were determined and monitored with the help of a Hunter Cooperation Program begun in the fall 1981 hunting season and continued for each hunting season through 1987. Quantitative information was gathered on home range by radio telemetry and correlated with observations from live trapping.

The traps used in this study were Tomahawk traps of two sizes. One was 26x9x9 in.; the other was 32x10x12 in. Traps were placed where there was evidence of squirrel activity such as sightings, nest sites, and cone cuttings. One trap was set

at each promising location. Bait consisted of whole kernel corn, cracked and whole walnuts, filberts and other nuts as available. Trap grids were not utilized because of the inherent limitation caused by trap interference with movements, lack of personnel to accomplish the task, and the relatively large home ranges utilized by western gray squirrels (Cross, 1969). The trap pattern in each area was roughly a transect through the area, but distances between traps varied. Traps were checked in the morning and evening. Trapping was conducted at Bear Gulch and Jordan Creek sites during all seasons of the year. In the Out Timber Sale area, Onion Flats, and the area between Badger Creek and Little Badger Creek, trapping was irregular throughout the study from October 1981 through August 1986.

Each squirrel trapped was marked with ear tags. Number one wing bands from National Band and Tag Co. were used. A tag was applied to each ear. The squirrel was released from the trap into a fishnet drawstring bag sewn from $\frac{3}{4}$ -in. mesh. The bag facilitated handling the squirrel and allowed for efficient weighing, ear tagging, and measurement of tail, head and body, ear, and hind foot (E. R. Hall, 1981). The squirrel's sex, reproductive condition, and general condition were noted. Squirrels were weighed on an Ohaus model 8014 spring scale, measured with a Dean plastic centimeter/inch tape, and then released.

HOME RANGE

Radiotelemetry and trap data were used to determine home range of selected squirrels in the Bear Gulch/Jordan Creek and Out Timber Sale sites. Six adjustable

radio collars (MP 14-40), a Yagi folding directional antennae (YA4-1), and a six channel receiver (DTR—6) from Wildlife Materials, Inc. were used. Animals were released from the live traps into a 3/4-in. mesh fishnet bag. A 1:1 dilution of sterile water and Ketamine (hydrochloride) from Parke-Davis Company was injected intramuscularly into each squirrel. The dose was based on weight (Donald Crimmins, DVM, personal communication, September 1981). Squirrels were conscious during the placing of the collar although slowed in their movements. After the collar was in place, each squirrel was placed back into the live trap and covered with a coat or dark cloth until the animal appeared to have recovered sufficiently to be able to run and climb normally. This usually required 1.5 to 2 hours from the time of injection. The collared squirrel was then released. Squirrels were not followed and located until 2 hours after release. Monitoring of locations of squirrels occurred at different times of the day for each radio-collared squirrel as long as the squirrel was collared. Squirrels were specifically located and mapped. Triangulation was not used, as each squirrel was located in a specific tree which was flagged. A 15T Ranger Silva compass and binoculars were used to locate and observe each squirrel. Location points were mapped with reference to the capture site. Radiotelemetry data were used to generate home ranges with the help of AUTO-CAD software.

AGE DETERMINATION

Squirrels were assigned to relative age classes using the skulls, eye lenses and forearms of the squirrels collected from the Hunter Cooperation Program from August

1981 to November 1987. Skulls were partially cleaned, left to dry, and later cleaned thoroughly. Relative age classes were based on the following criteria:

1. Juveniles: Until M^3 and m_3 are at occlusal level, or 3 to 5 months.
2. Subadults: M^3 and m_3 are at occlusal level, but P^4 and p_4 are not at occlusal level, or 5 to 15-18 months;
3. Adults: All permanent teeth in and at occlusal level, enamel wear minimal, or 18 months to 3 or 4 years.
4. Old adults: Significant wear obvious on surface of molars, dentine is obvious and fully visible, older than 3 to 4 years (Forbes, 1966; Nichols, 1958)

The bones of the forearms were scraped clean by hand and left to dry. They were later x-rayed using Ektaspeed film 15 ma—90 KVP x-ray film in the Dental Clinic at Mt. Hood Community College. These x-rays were later examined for the presence or absence of the epiphyseal cartilage.

The eye lenses were fixed in 10% formalin then dried at 80°C for 36 to 48 hours in glass vials plugged with cotton. When dried, they were removed and immediately weighed on a Mettler balance to the nearest 0.0001 g. Each lens was weighed separately and weights recorded. The stomachs were separated from the rest of the viscera and preserved in formalin for later study.

The reproductive condition of each animal was noted, and the reproductive tracts of the females and the testes of the males isolated and preserved in formalin for a future study. Tails were to be used in developing a field method for aging squirrels.

HABITAT REQUIREMENTS

Twenty-two nest tree sites and three non-nest tree sites were analyzed. Sites were chosen to represent a wide range of conditions under which squirrels' nests were found on private land, U.S. Forest Service land, and Oregon Department of Fish and Wildlife land. Nest trees were analyzed to ascertain the factors that affect the sites at which nests were built. Analysis of nest trees included a one-fifth acre fixed area circular plot with the nest tree at its center. The radius of the plot was 52.7 ft (16.06 m) (see Figure 2). Diameter of the tree at breast height (DBH), species, and crown class were recorded for each tree in the plot. The categories of crown class used were (Daniel, Helms & Baker, 1979):

1. D = dominant tree within the plot
2. CO = codominant trees within the plot
3. I = intermediate trees within the plot
4. S = suppressed trees within the plot (those that will probably die before reaching maturity or be thinned)
5. OG = open grown (the canopy of the tree does not touch the canopy of any of the surrounding trees in the plot).

Height of the nest tree, height of the nest, and age of the nest tree were also measured. Four variable plots were measured with a five-gauge prism. These plots were at the four cardinal compass points, 100 ft (30.48 m) from the nest tree. In addition to the above measurements, each tree within the fixed area plot (FAP) was also mapped with compass, clinometer, and tape measure to generate a map of each

KEY:

- + = Nest Tree
- = PIPO
- △ = QUGA
- = PSME
- ⬡ = ABCO
- * = ALIN

Figure 2. Site measurements of nest tree sites. Note: PIPO = ponderosa pine; QUGA = Oregon white oak; PSME = Douglas-fir; ABCO = Grand fir; ALIN = mountain alder; CC = % canopy closure; and BA = basal area.

nest tree site. The frequency of vegetation types was measured in terms of percentage frequency in the following categories within the FAP:

1. Percentage mature tree cover (TREEM—trees over 12' in height).
2. Percentage immature tree cover (TREER—those trees under 12')
3. Percentage tall shrub (SHRBT)
4. Percentage low shrub (SHRBL)
5. Percentage rock and percentage exposed bed rock (ROCK)
6. Percentage herb and moss covered rock (HERB) duff depth (DUFF).

Duff depth is related to the presence of hypogeous and epigeous fungi which constitute a significant portion of the squirrel's diet at certain times of the year (Stienecker, 1977; Stienecker & Browning, 1970). Distance to water (DIST) was either measured or extrapolated from a map. Within each of the quadrants formed by the four cardinal compass directions, the percentage canopy cover was estimated to the nearest 5%. The quadrants were measured from northeast, southeast, southwest, and northwest.

The range and mean of the various factors considered for each nest tree site were calculated. Other statistical methods were not used, as the sites were not chosen at random but were chosen to present the widest range of variables found during an initial survey of 60 nest tree sites. Non-nest tree sites were also chosen as representative of those areas left for wildlife following timber harvest.

CHAPTER V

RESULTS

FOOD HABITS

Stomachs of 14 squirrels obtained through the Hunter Cooperation Program between 1981 and 1984 were analyzed for fungal and starchy material. Analysis was done in the winter of 1985. Fungal spores were identified to genus. The category "starchy material" was used to represent all other food types such as residue from pine seeds, acorns, and so on. The analysis was done by Zane Maser at the Forest Research Laboratory in Corvallis, Oregon, and by me (see Table I).

The fungal spores present in the stomachs represented both hypogeous and epigeous fungi. Observations of squirrels' activities from April 1981 through September 1989 included numerous records of squirrels digging in the ground to obtain the fruiting bodies of hypogeous fungi. This activity occurred from spring through fall of each year. Squirrels were also observed picking, eating and storing the fruiting bodies of epigeous fungi. These fungi were not identified to species.

Squirrels were also observed cutting green ponderosa pine cones in the late summer and fall of each year. The terminal portion of the branch containing cones was cut as were individual cones. The individual bracts of the cones were then

TABLE I

STOMACH CONTENT ANALYSIS OF 14 WESTERN GRAY SQUIRRELS, 1981-1984

WGS # ^a	Date	Age ^b	Sex	Location	Content ^c	ID ^d
004	8/29/81	AD	F	Rock Creek	<i>Elaphomyces</i> 5% <i>Octavianina</i> T <i>Tuber rufum</i> T-1% Pollen grain Starchy material 94%	ZM
056	9/6/81	AD	F	School House Ridge	<i>Rhizopogon</i> 40% Epigeous spore 50% (<i>Gastroboletus</i> type) <i>Genea</i> T	ZM
067	9/12/91	OA	F	Badger Creek	<i>Genea</i> 3% Starchy material 97%	SF
103	10/11/81	AD	F	White River	<i>Rhizopogon</i> T Starchy material 100%	ZM
106	11/3/81	--	M	Bonney Crossing	<i>Rhizopogon</i> 85-87% <i>Geopora</i> 8-10% Starchy material 5%	SF
112	8/29/82	AD	M	Tygh Ranch	<i>Rhizopogon</i> T Starchy material 100%	ZM
115	8/29/82	AD	F	Badger Lake	<i>Rhizopogon</i> T <i>Elaphomyces</i> 5% <i>Leucogaster</i> T <i>Gautieria</i> T Starchy material 95%	SF
156	9/12/82	OA	M	Little Badger	Total fungi 0% Starchy material 100%	ZM
213	10/30/82	AD	M	Happy Ridge	<i>Rhizopogon</i> 2% Starchy material 98%	ZM
237	9/3/83	AD	M	Rock Creek	<i>Rhizopogon</i> 71% <i>Tuber rufum</i> 10% <i>Balsamia</i> or <i>Geopora</i> 9% <i>Genea</i> T Epigeous (2 spp.) T	ZM

TABLE I
STOMACH CONTENT ANALYSIS OF 14 WESTERN GRAY SQUIRRELS, 1981-1984
(continued)

WGS # ^a	Date	Age/Sex	Location	Content	ID
341	10/16/83	- F	Jordan Creek	<i>Rhizopogon</i> 65% <i>Corinarius</i> or related genera 3% <i>Geopora</i> 3% Epigeous spore T	ZM
354	11/1/83	AD F	Happy Ridge	<i>Rhizopogon</i> T Starchy material 100%	ZM
363	9/1/84	AD ^c F	Tygh Ranch	Total fungi 0% Starchy material 100%	ZM
410	10/5/84	AD F	Badger Creek	<i>Tuber rufum</i> 1% (in ascus) Starchy material 99% Pollen grain (2)	ZM

^aWestern gray squirrel Hunter Cooperation Program identification number.

^bAD = adult; OA = old adult.

^cT = trace.

^dID = Identification by; ZM = Zane Maser; SF = Susan Foster.

^eLactating female.

removed and the seeds eaten. Acorns from Oregon white oak were eaten in the diet primarily during the winter and early spring.

Additional foods taken included nectar from honeysuckle (*Lonicera coliosa*) and the foliage of miner's lettuce (*Montia perfoliata*). Both of these were eaten between late spring and midsummer.

At a feeding station located in the study site at Friend, various commercially available nuts such as English walnut, black walnut, hazelnut, pecans, almonds,

pistachios and peanuts were offered. Squirrels showed a preference for all these nuts over sunflower seeds, with a particular preference for pistachios as indicated by the order in which they fed on the nuts. Quantitative measurements of preference were not recorded. Squirrels buried these nuts, as well as acorns, singly.

SIZE

Data on body size, tail length and weight were obtained from 17 male and 36 female squirrels captured in live traps. Although the body size of the males was significantly greater than that of the females, there was no significant difference between the sexes in tail lengths. Weights were similar for both sexes unless females were pregnant. Pregnant females were heavier than other squirrels (Table II). Relative age of live-trapped squirrels could not be accurately ascertained.

REPRODUCTION AND GROWTH

Live-trapped female squirrels displayed periods of estrous and pregnancy from January through March and lactation from April through July (Table III). Non-breeding females were trapped in the spring (March 1982, 1984 and 1985), in the fall (August 1983 and 1984), and in the winter (November 1984, December 1982 and January 1983).

Live-trapped males exhibited scrotal testes (breeding condition) in the spring (March 1982, 1984 and 1985), in the summer (June 1984), and in the winter (November 1984, December 1982, and January 1983) as shown in Table IV. Males

TABLE II
SIZE OF LIVE-TRAPPED SQUIRRELS

	Females $\bar{x} \pm 2 \text{ SE}$ (n) Range	Males $\bar{x} \pm 2 \text{ SE}$ (n) Range
Body length	307 ± 2 (36) 27 - 35	329 ± 19 (17) 27 - 39
Tail length	313 ± 1 (36) 24 - 38	318 ± 20 (17) 24 - 38
Weight	781 ± 31.5 (36) 500 - 950	806 ± 55.6 (17) 525 - 925

Note. Linear measurements are in millimeters; weights are in grams.

appeared to be in a breeding state in the winter (November through January) and in the spring (March through June). These periods coincided with the peak breeding periods of the females.

Data from the Hunter Cooperation Program showed lactating females present as late as mid-October each year from 1981 to 1986. No lactating females were found in the sample from 1987. Three females classified as lactating had nipples which did not produce milk when squeezed, but were greatly enlarged indicating recent nursing by young (see Table V).

TABLE III
DATA ON REPRODUCTIVE STATUS OF
LIVE-TRAPPED FEMALE SQUIRRELS

Non-breeding		Estrous		Pregnant		Lactating	
Date	#	Date	#	Date	#	Date	#
March 1982	3	Feb. 1982	1	March 1982	3	Apr. 1982	1
Dec. 1982	1	March 1982	1	Jan. 1983	1	May 1982	1
Jan. 1983	1	Jan. 1983	1	Feb. 1983	1	July 1983	2
Aug. 1983	2			Feb. 1984	2		
March 1984	2						
Aug. 1984	1						
Nov. 1984	2						
March 1985	1						
Total	13		3		7		4

Three female squirrels trapped repeatedly were initially non-breeding, then in succeeding trapping periods were in estrous, pregnant and lactating. These females showed weight gains of 130-250 g.

Young squirrels weighing 500 g or less could not be used in home range studies, as their head and neck circumferences were so similar that a radio collar could not be securely attached to them. All of the young squirrels I observed weighed about 500 g. Observation of hand-raised squirrels indicated that head sizes increased to adult proportions at approximately 18 months of age. Young squirrels were also observed to have more white on the hair at the ends of the tails, and they carried their

TABLE IV
DATA ON REPRODUCTIVE STATUS OF
LIVE-TRAPPED MALE SQUIRRELS

Non-breeding		Scrotal (breeding)	
March 1982	4	March 1982	2
May 1982	1	Dec. 1982	1
Dec. 1982	1	Jan. 1983	3
Feb. 1983	4	March 1984	4
March 1983	5	June 1984	2
June 1983	3	Nov. 1984	1
Nov. 1983	3	March 1985	1
Jan. 1984	1		
Feb. 1984	2		
Apr. 1985	2		
Total	26	Total	14

heads at a higher angle than adults. I did not quantify these observations which were made over 7 years of field research. The only reliable method for distinguishing sex in free-ranging squirrels is to observe evidence of nipples or external genitalia, which are visible at a distance due to color differences. Both appear dark on the white underside of the squirrels.

TABLE V
DATA ON LACTATING FEMALE SQUIRRELS TAKEN IN
THE HUNTER COOPERATION PROGRAM,
AUGUST-NOVEMBER, 1981-1987

Year/day	Age ^a	HCP # ^b
1981		
31 August	AD	029
26 August	AD	030
1982		
29 August	AD	120
29 August	OA	124
31 August	OA	128
28 August	OA	133
2 September	AD	134
4 September	AD	137
8 September	AD	144
10 September	OA	149
12 September	SA	158
2 September	SA	178
14 October	AD	197
26 September	AD	184

TABLE V
 DATA ON LACTATING FEMALE SQUIRRELS TAKEN IN
 THE HUNTER COOPERATION PROGRAM,
 AUGUST-NOVEMBER, 1981-1987
 (continued)

Year/day	Age ^a	HCP # ^b
1983		
4 September	AD	269
13 September	AD	325 ^c
13 September	AD	328
13 September	--	336
7 July	AD	350
1984		
1 September	AD	362
3 September	AD	373
3 September	AD	379
3 September	AD	380
4 September	AD	383
13 September	AD	395
13 September	OA	396
8 September	AD	407

TABLE V
DATA ON LACTATING FEMALE SQUIRRELS TAKEN IN
THE HUNTER COOPERATION PROGRAM,
AUGUST-NOVEMBER, 1981-1987
(continued)

Year/day	Age ^a	HCP # ^b
1985		
1 September	AD	446
1 September	AD	447
1 September	AD	448
1 September	--	450
2 September	OA	460
8 September	AD	468
12 September ^c	OA	472 ^d
1986		
30 August	--	484
6 September	AD	502 ^d
1987		
None		

^aSA = Subadult, AD = Adult, OA = Older adult.

^bWestern gray squirrel Hunter Cooperation Program identification number.

^cEar tag 38/39.

^dIndicates cessation of lactation.

LIVE-TRAPPING RESULTS

Seventy-nine squirrels were live trapped in seasonal trap sessions from November 1981 through April 1988 (see Table VI). Of the 77 on which data were taken, 16 were multiple captures as shown by the ear tags. Nine of these animals were trapped twice, two were trapped three times, four were trapped four times and one was trapped five times (see Table VII). Two of the live-trapped squirrels were not included in the study, as insufficient data were available on them. Trapping sessions varied in length and consisted of periods when classes were not in session² (see Table VIII).

Five ear-tagged squirrels were returned in the Hunter Cooperation Program during the fall hunting season (see Table VII). Three were obtained in 1983 and one each in 1985 and 1986. Determination of the ages of these five squirrels from their teeth shows that one was a subadult, two were adults and two were old adults.

Fifty-two males and 25 females were trapped (see Table VIII). The most productive trap period of this study was spring with 21 males and 11 females trapped during March-April. November through February was the second most successful trap period with 18 males and 9 females trapped. The summer period of June-August had the least success of the three major trap periods with 13 males and 5 females captured. Trapping was not conducted during the hunting season from late August through the first week of November each year. Trap days per squirrel averaged 21.6

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²I am a full-time member of the faculty at Mt. Hood Community College.

TABLE VI
RESULTS OF LIVE TRAPPING, 1981-1986

Year	Period(s)	Number trapped	Trap days	Trap days/squirrel
1981	Oct.-Nov.	2	491	245.5
1982	Feb.-May, Dec.	22	273	12.4
1983	Jan.-Feb. June-Aug., Nov.	29	481	16.59
1984	Jan.-March, Nov.	18	235	13.06
1985	March-April	4	145	36.25
1986	Aug.	4	82	20.5

with the inclusion of 1981 when small squirrel traps were used. These traps were Tomahawk live traps measuring 6x6x18 inches. From 1982 through 1986, raccoon and dog traps were used, and western gray squirrels were more frequently captured. Trap days per squirrel captured dropped to 15.8. These larger traps were 9x9x24 in. and 11x11x36 in. in size, respectively.

The other animals captured most frequently were California ground squirrels (*Spermophilus beecheyi*) and Steller's jays (*Cyanocitta stelleri*) (see Table IX), and Douglas' squirrels, and northern flying squirrels (*Glaucomys sabrinus*) (see Table X). Yellow pine chipmunks (*Tamias amoenus*) were observed in the larger traps but were able to escape through the mesh of the trap.

TABLE VII
RECAPTURED WESTERN GRAY SQUIRRELS

WGS # ^a	Date	Sex	Breeding Condition ^b	Location	Weight (g)
13/14	2/20/82	F	Estrous	Bear Gulch	725
	3/6/82		Pregnant		725
15/16	3/7/82	M	ST	Bear Gulch	725
	3/24/82		ST		800
40/41	12/12/82	M	ST	Bear Gulch	850
45/41	1/30/83	M	ST		800
43/42	1/29/83	F	--	Bear Gulch	800
43/-	2/12/84		Pregnant	Bear Gulch	800
46/44	1/30/83	M	ST	Bear Gulch	800
	2/26/83		--		800
83/79	8/2/82	M	--	Out Timber Sale	600
	3/19/84		--		825
84/78 ^c	2/11/84	M	ST	Bear Gulch	850
84/- ^d	3/19/84		ST		
106/105 ^{de}	6/27/84	M	ST	Bear Gulch	
	3/25/85		ST		800
58/59 ^f	2/26/82	M	--	Bear Gulch	750
	3/24/83		--		700
	6/19/83		--		800
52/53 ^{gh}	2/27/83	M	--	Bear Gulch	750
	3/23/83		--		775
	11/19/83		--		850

TABLE VII
RECAPTURED WESTERN GRAY SQUIRRELS
(continued)

WGS # ^a	Date	Sex	Breeding Condition ^b	Location	Weight (g)
126/127	8/14/86	M	NB	Onion Flat	500
	8/16/86		NB		500
	8/17/86		NB		500
30/31 ⁱⁱ	3/28/82	F	Pregnant	Bear Gulch	925
	4/10/82		Lactating		650
	3/22/84		Pregnant		780
	11/23/84		NB		850
56/57	3/22/83	M	NB	Bear Gulch	800
	6/19/83		NB		850
	2/11/84		ST		850
	3/20/84		ST		860
38/39 ⁱⁱⁱ	12/11/82	F	NB	Bear Gulch	750
	2/27/83		Pregnant		900
	3/22/84		--		760
	11/23/84		NB		825
80/92	1/14/84	M	--	Bear Gulch	650
	3/20/84		ST		600
	11/23/84		NB		750
	4/14/85		NB		775
17/18	3/15/82	F	NB	Bear Gulch	800
	3/24/82		Estrous	Morning	800
	3/24/82		Estrous	Evening	800
	3/25/82		--		
	5/16/82		Lactating		

TABLE VII
RECAPTURED WESTERN GRAY SQUIRRELS
(continued)

Returned by Hunter Cooperation Program			
WGS # ^a	Date tagged	Date killed	Location
81/	8/20/83	10/9/83	Out Timber Sale
66/89	3/22/83	10/10/83	Bear Gulch
58/49	3/24/83	10/10/83	Bear Gulch
38/39	12/11/82	10/12/85	Bear Gulch
128/129	8/17/86	8/30/86	Onion Flat

^aWestern Gray Squirrel ear tag numbers.

^bST = Testes in scrotal position. NB = Not in breeding condition.

^cChannel V squirrel.

^dNo collar when recaptured.

^eChannel II squirrel.

^fSquirrel killed and returned from Hunter Cooperation Program 10/10/83.

^gChannel III squirrel.

^hKilled by bobcat 12/22/83.

ⁱChannel VI squirrel.

^jRemoved collar on 11/23/84.

^kChannel IV squirrel.

^lKilled and returned from Hunter Cooperation Program 10/12/85.

^mChannel III-2 squirrel.

ⁿRemoved collar on 3/20/84.

TABLE VIII
SEX RATIOS AND CAPTURE RATES FOR LIVE-TRAPPED
WESTERN GRAY SQUIRRELS

Month	Number		Trap days	Trap days/WGS ^a
	Males	Females		
January	4	2	62	10.3/WGS
February	6	4	54	5.4/WGS
March	17	10	330	12.4/WGS
April	3	0	67	26.5/WGS
May	1	1	55	40.7/WGS
June	5	0	64	20.9/WGS
July	1	2	113	44.6/WGS
August	7	3	460	46.0/WGS
September	0	0	HS ^b	
October	0	0	HS ^b	
November	6	2	92	11.5/WGS
December	2	1	52	11.3/WGS
Total	52	25		

^aWGS = Western gray squirrels.

^bHS = Hunting season.

TABLE IX
MAIN TRAP COMPETITORS, 1981-1986

Year	California ground squirrel	Steller's Jay	Other ^a
1981	29	112	14
1982	56	27	0
1983	47	1	9
1984	40	4	5
1985	13	0	0
1986	4	0	1

^aSee Table 10 for the list of species included in this category.

Observations of trap sites revealed a high frequency of mule deer, elk and Merriam's turkeys stealing the bait. Douglas' squirrels and California ground squirrels were both observed chasing western gray squirrels from bait at trap sites. On one occasion both a western gray squirrel and a California ground squirrel were found in the same trap. The western gray squirrel died from injuries shortly after removal from the trap, while the smaller ground squirrel was unharmed.

HOME RANGE

From 1983 through 1985, three female and five male western gray squirrels were equipped with radio collars to measure home ranges. The first squirrel was a

TABLE X
OTHER SPECIES TRAPPED, 1981-1986

Species	Number trapped
<i>Spermophilus beecheyi</i>	188
<i>Cyanocitta stelleri</i>	140
<i>Tamiasciurus douglasii</i>	12
<i>Glaucomys sabrinus</i>	5
<i>Tamias amoenus</i>	3
Northern Flicker (<i>Colaptes auratus</i>)	3
Bushy-tailed woodrat (<i>Neotoma cinerea</i>)	2
Northern pocket gopher (<i>Thomomys talpoides</i>)	1
Nuttall cottontail (<i>Sylvilagus nuttallii</i>)	1
White-breasted nuthatch (<i>Sitta carolinensis</i>)	1

lactating female collared in the Out Timber Sale in an area on table land between Little Badger Creek to the north and Badger Creek to the south. The squirrel used four nests within her range. No transmissions were received after the week of September 8 during the 1983 hunting season. If the animal was taken by a hunter, the collar was not returned. Her range consisted of flat land in a precommercial thin and a long draw that led towards Little Badger Creek. No other water was located in the home range. Her home range area encompassed 1.68 ha. Two other females tracked

from March to November 1984 used home ranges of 3.94 and 6.47 ha, respectively (see Table XI).

Two males collared in November 1983 were both tracked for 1 month. The home range of one was 5.09 ha.; that of the other was 2.98 ha. One male tracked from January to March 1984 used a 4.60 ha home range. A second male tracked from February to September 1984 used a 4.86 ha home range.

TABLE XI
HOME RANGES OF EIGHT WESTERN GRAY SQUIRRELS

Channel number	Sex	Location	Dates	Season(s)	Size
1	F	Out Timber Sale	7/9/83-9/24/83	Summer/fall	1.68 ha
2-1	M	Bear Gulch	11/19/83-12/16/83	Winter	5.09 ha
3-1	M	Bear Gulch	11/19/83-12/18/83	Winter	2.98 ha
3-2	M	Bear Gulch	1/15/84-3/20/84	Winter	4.60 ha
5	M	Bear Gulch	2/11/84-9/8/84	Spring/Summer	4.86 ha
6	F	Bear Gulch/ Jordan Creek	3/22/84-11/23/84	Spring/Summer/ Fall	3.94 ha
4	F	Bear Gulch	3/24/84-11/23/84	Spring/Summer/ Fall	6.47 ha
2-2	M	Bear Gulch/ Jordan Creek	6/27/84-3/25/85	Summer/Fall/ Spring/Winter	Linear

A third male tracked for 3 months from June to September 1984 had a linear home range within my study area. His primary nest was more than 800 m from where he was trapped. The nest was located in a tree on the canyon wall on the north slope of Jordan Creek. The signal disappeared within three months, and when the squirrel was recaptured nine months later, he had no collar. His appearance in my study area coincided with the period of estrous for female squirrels.

AGE DETERMINATION

Age structure data for this population of western gray squirrels was assembled from information collected during the Hunter Cooperation Program from 1981 through 1987 (see Table XII). Not all animals were represented by parts appropriate to determine their age and/or sex. Tooth eruption, replacement of teeth and wear patterns of molars in whole skulls, partial skulls, and lower jaws were examined to separate the animals into four age categories—old adult, subadult, adult, and juvenile (see Table XII and Figure 3). The majority of the animals obtained over the period of the study were adults (43.5%; $n = 224$) and subadults (22.3%; $n = 115$). Juveniles ($n = 58$) and old adults ($n = 39$) were least represented at 11.3% and 7.6%, respectively. The age of 15.3% of the sample could not be determined (see Table XII).

Two measurements were taken on the whole skulls of squirrels of known age for comparison. The greatest length of skull and the least interorbital breadth

TABLE XII
SQUIRRELS FROM HUNTER COOPERATION PROGRAM
ARRANGED BY SEX AND AGE

Year	n	Sex						Age ^a															
		Male			Female			Unknown			Lactating		JUV		SA		AD		OA		Unknown		
		#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
1981	106	45	42.4	46	43.8	15	14.1	2	1.9	4	3.8	21	19.8	67	63.0	8	7.5	6	5.6				
1982	109	47	43.1	46	42.2	16	14.7	10	9.2	28	25.7	28	25.7	24	22.0	10	9.2	19	17.4				
1983	144	68	47.2	66	45.8	10	6.9	5	7.0	3	7.0	21	14.6	80	55.6	8	5.6	32	22.2				
1984	57	29	50.9	26	45.6	2	3.5	11	19.3	9	15.8	20	35.1	20	35.1	5	8.8	32	22.2				
1985	34	18	52.9	15	44.1	1	2.9	7	20.6	8	23.5	11	32.9	10	29.4	4	11.8	1	2.29				
1986	45	28	62.2	14	31.1	2	4.4	4	8.9	4	8.9	9	20.0	18	40.0	3	6.7	11	24.4				
1987	20	10	50.0	10	50.0	--	--	1	5.0	2	10.0	5	25.0	5	25.0	1	5.0	7	35.0				
Total		245	47.6	223	43.3	46	8.9	40	17.9	58	11.3	115	22.0	224	43.0	39	8.0	79	15.0				

^aJUV = juvenile; SA = subadult; AD = adult; OAD = old adult.

Figure 3. Numbers of squirrels of each age category taken in the Hunter Cooperation Program, 1981-1987.

characterize the size of a given skull. Each of these measurements showed a positive correlation with age (see Table XIII, Figures 4 and 5).

The sex of a squirrel cannot be determined from its skull. Information concerning the sex of the animals relied on either the presence of gonads in remains or on information returned by the hunters. Males constituted 47.6% and females 43.3% of the total sample. Sex could not be determined for 17.9% of the sample.

Lactating females comprised 7.8% of the total sample (see Table XII); 27 of the 37 lactating females in the sample were taken during September (see Table V).

Although males with enlarged testes were noted among squirrels taken in the Hunter Cooperation Program, no quantitative evaluation was completed.

NEST TREES

An initial survey of the study area located 60 nest trees sites on private, federal and state lands. A random sample of these sites did not indicate the wide range of variability of sites in which western gray squirrels nest, so the sample was discarded. Then, 21 of the 60 sites were chosen for analysis because of their variety of tree types, number of trees, size of trees, height of trees and habitats within which they were located. Three non-nest tree sites were also chosen for analysis as representative of the types of trees and sites often left for wildlife use. Statistical analysis of the sites was not possible, as they were not randomly selected. Of the 21 nest tree sites and 3 non-nest tree sites utilized in this study, 14 were located in the White River Game Management Area, and 10 were located within the Barlow Ranger

TABLE XIII
SKULL MEASUREMENTS OF KNOWN-AGE SQUIRRELS

Sample Size	Age	Greatest skull length	Least interorbital breadth (mm)
		$\bar{x} \pm 2 \text{ SE (n)}$ Range	$\bar{x} \pm 2 \text{ SE (n)}$ Range
31	Older Adult	$67.9 \pm .44$ 65.3 – 69.7	$21.4 \pm .22$ 20.0 – 22.9
207	Adult	$67.3 \pm .16$ 64.3 – 69.9	$20.8 \pm .12$ 18.0 – 23.1
82	Subadult	$64.6 \pm .46$ 59.6 – 69.3	$19.6 \pm .22$ 17.5 – 21.9
21	Juvenile	59.7 ± 1.3 52.8 – 65.0	$17.9 \pm .41$ 15.7 – 21.0

District of the Mt. Hood National Forest (see Table XIV). Site analysis was conducted occurred during the summers of 1985 and 1987. Measurements were taken of both site characteristics (see Table XIV) and nest tree characteristics (see Table XV). Comparisons of nest tree sites and non-nest tree sites showed that the components chosen for analysis were sufficient to discriminate between nest trees and non-nest trees 100% of the time. The most important components of the nest tree sites were high percentage of canopy closure (indicating degree of closeness or relatedness of adjacent trees) and being within 180 m of water. Nest tree age and diameter at breast height, relative to the nature of the site, appeared to be the most important determinants of the tree chosen. All nest trees noted in the study were

Figure 4. Mean, standard deviation, and range of greatest skull length of squirrels taken in the Hunter Cooperation Program, 1981–1987.

Figure 5. Mean, standard deviation, and range of least interorbital breadth of squirrels by age taken in the Hunter Cooperation Program, 1981–1987.

TABLE XIV
SITE CHARACTERISTICS

Tree #	Location ^a	Ownership ^b	# of trees	Species of trees				Percentage canopy closure					Aspect	TBA ^c	Comments
				PIPO	QUGA	PSME	Other	NE	SE	SW	NW	Slope			
72	BG/JC	ODFW	116	104	7	0	5	55	80	60	50	-13	west	330	Pole stand
74	BG/JC	ODFW	213	162	49	0	2	60	60	80	75	17	west	400	Turkey blind tree
77	BG	ODFW	107	70	37	0	0	20	25	85	90	14	south	305	Bobcat tree
78	BG	ODFW	67	47	20	0	0	70	60	70	30	21	south	360	Prime site—draw/BG
81	BG/JC	ODFW	34	34	0	0	0	50	35	20	40	-20	south	540	East turkey blind
87	BG	ODFW	81	28	53	0	0	70	30	20	50	15	west	260	BG-CH III
88	BG	ODFW	85	46	39	0	0	50	40	80	80	20	east	435	Kamikazi tree
89	BG	ODFW	167	52	103	12	0	80	60	30	45	45	north	355	Prime site—CH V
90	BG	ODFW	101	6	95	0	0	50	80	20	90	40	south-west	490	CH II
91	JC	ODFW	15	12	0	1	2	75	20	5	10	0	flat	370	Island site
92	Out	USFS	44	21	0	23	0	55	80	50	30	-12	south	430	CH I
93	Out	USFS	32	7	1	24	0	25	65	60	60	10	east	420	
941	Onion Flats	Mtn. Fir	108	96	10	2	0	20	15	60	90	3	flat	390	Mitigation pond
942	Out	USFS	43	9	10	24	0	25	55	25	55	14	east	340	Rd. 2710020

TABLE XIV
SITE CHARACTERISTICS
(continued)

Tree #	Location ^a	Ownership ^b	# of trees	Species of trees			Percentage canopy closure								Aspect	TBA ^c	Comments
				PIPO	QUGA	PSME	Other	NE	SE	SW	NW	Slope					
951	3-Mile	Mtn. Fir	124	61	56	0	0	25	30	40	75	3	flat	380	Oak leaf nest-pine		
952	Lutz	ODFW	22	11	8	3	0	65	65	55	70	-4	north-east	320	Highland ditch		
96	Out	USFS	25	5	6	14	0	35	5	65	50	0	south-west	510	Lunch nest		
97	3-Mile	ODFW	168	48	27	92	0	50	35	65	80	0	flat	565			
98	3-Mile	ODFW	41	21	20	0	0	10	5	5	40	18	south	280	Cattle guard		
99	Rock Creek	USFS	30	17	9	5	0	50	75	25	30	3	north-east	345	Rd. 4820012		
100	Rock Creek	USFS	48	43	5	0	0	85	25	5	80	0	flat	470	Rock Creek Old Road		
NNT1	BG	ODFW	1	1	0	0	0	10	10	10	120	-12	south-west	70	Elk trap		
NNT2	Out	USFS	5	5	0	0	0	5	5	10	5	6	south	130	Mitigation pond		
NNT3	Little Badger	USFS	15	13	2	0	0	25	10	25	25	27	south	460	S. Little Badger Campground		

^aBG = Bear Gulch; JC = Jordan Creek; Out = Out Timber Sale; Lutz = Highland Ditch; 3-Mile = 3-Mile Creek by Wamic.

^bODFW = Oregon Department of Fish and Wildlife; USFS = U.S. Forest Service; Mtn. Fir = Mountain Fir Lumber Company.

^cTotal Basal Area.

TABLE XV

NEST TREE AND NON-NEST TREE CHARACTERISTICS

Tree #	Nest Tree Height (m)	Diameter at breast height (cm)	Age	Species	Crown class	Nest height	Ratio of nest height to tree height	Distance to water (m)
72	17.1	32.0	86	PIPO	CO	11.3	0.66	61.0
74	11.9	20.8	94	PIPO	CO	8.2	0.69	15.6
77	22.3	40.6	73	PIPO	D	17.7	0.79	15.6
78	19.5	42.2	78	PIPO	D	9.5	0.48	57.3
81	27.1	58.4	77	PIPO	D	18.0	0.66	322.0
87	12.8	25.9	73	PIPO	CO	7.6	0.60	89.0
88	19.8	33.3	79	PIPO	D	15.2	0.77	13.4
89	17.4	48.3	186	PIPO	D	13.7	0.79	61.0
90	25.0	42.9	90	PIPO	CO	16.8	0.76	33.2
91	35.4	52.6	97	PIPO	CO	23.2	0.66	24.4
92	21.6	27.7	80	PIPO	CO	14.9	0.69	550.0
93	23.8	43.7	151	PIPO	CO	14.3	0.60	458.2
941	17.4	52.7	75	PIPO	D	11.3	0.60	43.9
942	19.2	32.8	104	PIPO	CO	13.7	0.71	804.9
951	18.3	33.3	79	PIPO	CO	13.7	0.75	39.6

TABLE XV
NEST TREE AND NON-NEST TREE CHARACTERISTICS
(continued)

Tree #	Nest Tree Height (m)	Diameter at breast height (cm)	Age	Species	Crown class	Nest height	Ratio of nest height to tree height	Distance to water (m)
952	26.8	57.9	239	PIPO	CO	14.9	0.56	102.7
96	23.2	44.2	275	PIPO	CO	14.0	0.61	308.5
97	18.9	42.2	108	PIPO	D	13.4	0.71	164.0
98	18.3	45.2	69	PIPO	D	11.6	0.63	112.5
99	18.0	40.4	108	PIPO	CO	12.2	0.68	122.0
100	14.0	23.9	79	PIPO	CO	7.6	0.54	457.3
NNT1	14.3	70.4	79	PIPO	OG	--	--	603.7
NNT2	32.0	61.7	178	PIPO	D	--	--	563.4
NNT3	29.9	55.1	219	PIPO	CO	--	--	111.0

ponderosa pine. One nest not included in the analysis was in a Douglas-fir. This nest was used by a male during the summer and was located on a north-facing slope in Bear Gulch. The only other tree species in which nests were found were *Q. garryana*. These were “drays” or leaf nests constructed for short duration use or loafing.

Age of the nest trees ranged from 69 to 275 years with a mean of 108 years. The range of DBH of the trees within each 0.08 ha plot for nest trees was 20.8–58.4 cm ($\bar{x}$ = 21.6 cm). The crown class of the trees within the plot was categorized into five classes: (a) dominant–8 nest trees and 1 non-nest tree; (b) codominant–13 nest trees and 1 non-nest tree; (c) intermediate–no nest trees; (d) suppressed–no nest trees; and (e) open grown (having no contiguous trees)–no nest trees and one non-nest tree.

Nest tree height for the 21 sites ranged from 12.7 m to 35.1 m ($\bar{x}$ = 20.2 m). Nests were located approximately one-third the way down from the top of the tree next to the trunk on or within two adjacent branches. The ratio of the height of the nest tree to the height of the nest ranged from 0.48 to 0.79 m ($\bar{x}$ = 0.63 m).

Site characteristics (see Table XIV) included measurement of the percentage of canopy closure in quadrants formed from the four cardinal directions. Observations of the percentage canopy closure estimated for the northeast, southeast, southwest, and northwest quadrants revealed that one quadrant tended to be more open than the other three. Both of the south-facing quadrants were more commonly open than the north-facing quadrants (58%). From ground observations these more open canopy

quadrants frequently faced onto a meadow, a road, a creek or other open area.

Aspect and slope were measured for each site and were highly variable (see Table XIV). Further characterization of each site included an estimation of the percentage occurrence of a variety of habitat components (see Table XVI). At each of the four cardinal compass directions, a variable plot (VP) (Dillworth & Bell, 1982) was located 30.2 m from the nest tree. In each variable plot, the total basal area was measured with a five-gauge prism. The resulting data revealed the number of trees

TABLE XVI
PERCENTAGE OF COVER IN ONE-FIFTH ACRE PLOT
OF NEST TREE SITES

Characteristic	Mean	Range
Mature trees > 12 ft	59.86%	35 - 85
Reproduction trees < 12 ft	3.80%	0 - 10
Tall shrubs	5.70%	0 - 20
Low shrubs	17.30%	0 - 60
Herb cover	43.40%	3 - 95
Exposed bare rock	12.20%	0 - 45
Total trees	79.60%	15 - 213
Height tallest trees	77.3 ft	42 - 120 ft

surrounding each nest tree and each non-nest tree site and served to characterize the stand within which the nest tree site was located (see Table XVII).

Maps of five representative nest tree sites are included (Figures 6 through 10). Maps of the other sites can be found in Appendix C. Nest Tree Site 072 (see Figure 6) contained a total of 116 trees and represented a pole stand in terms of the density and size of the trees. The predominant species was ponderosa pine; the other 11 trees were Oregon white oak (see Table XIV). A second nest tree was located within the FAP as indicated by a + sign in Figure 6. The canopy cover in all quadrants was 50% or greater. Distance to water was 15.6 m measured with a tape. Nest Tree Site 081 (see Figure 7), represented a site that contained 34 ponderosa pine and no other species of trees inside the FAP. There were 88 trees in the four variable plots that were also ponderosa pine. This site contained another nest tree represented by a + on the map. Canopy closure ranged from 20-50%. Distance to water was calculated to be 322 m.

Nest Tree Site 089 (see Figure 8) contained a total of 167 trees: 52 ponderosa pine, 103 Oregon white oak, 12 Douglas-fir. Many of the oaks were small diameter trees with a DBH of 2.5 cm to 12.7 cm. This contributed to a low mean DBH of 10.5 cm for the site (range 1.5 to 48.3 cm). Canopy closure was high with an average of 53.8% for the three most densely covered quadrants and 30% for the most open quadrant. The site was located on the north side of Bear Gulch on a 45° slope and was a continually occupied nest for the duration of this study. A continually occupied site was considered to be a prime site for this study. The nest at this site

TABLE XVII
BASAL AREA OF NEST TREE SITES

Site #	Total	VP-N	VP-E	VP-S	VP-W	# of trees
072	330	30	60	50	70	66
074	400	100	30	75	45	80
077	395	60	30	90	70	79
078	360	45	100	55	60	72
081	540	135	65	135	105	105
087	260	15	75	10	40	52
088	435	70	125	35	65	87
089	355	85	85	25	75	71
090	490	150	120	70	35	98
091	370	55	145	30	65	75
092	430	90	80	95	90	86
093	420	60	85	110	60	86
941	390	100	35	05	55	78
942	340	60	65	115	10	68
951	380	55	30	45	110	76
952	320	5	95	85	55	64
096	510	105	110	100	90	102

TABLE XVII
 BASAL AREA OF NEST TREE SITES
 (continued)

Site #	Total	VP-N	VP-E	VP-S	VP-W	# of trees
097	565	90	100	125	135	113
098	280	70	10	130	30	56
099	345	40	85	55	95	69
100	470	70	195	40	40	94
NN1	75	10	30	30	5	15
NN2	130	35	55	30	10	26
NN3	460	115	90	75	70	80

was also frequently used by the Channel V squirrel and was located in the center of his winter home range. Nest Tree Site 091 (see Figure 9) was located in Jordan Creek on an island between two branches of the creek. This was also a prime site. It contained a few very tall, large diameter trees. The total number of trees was 15, but the species variety was 4, with 12 ponderosa pine, no Oregon white oak, 1 Douglas-fir, 1 Grand fir (*Abies concolor*), and 1 mountain alder (*Alnus incana*). The average DBH was 48.9 cm with a range of 13.3–71.5 cm. This represented the largest diameter of trees found in nest trees during the study. Distance to water was

KEY:

+ = Nest Tree

○ = PIPO

△ = QUGA

Figure 6. Nest tree site 072. Note: Abbreviations as in Figure 2.

KEY:

+ = Nest Tree

○ = PIPO

Figure 7. Nest tree site 081. Note: Abbreviations as in Figure 2.

KEY:

- + = Nest Tree
- = PIPO
- △ = QUGA
- = PSME

Figure 8. Nest tree site 089. Note: Abbreviations as in Figure 2.

KEY:

- + = Nest Tree
- = PIPO
- △ = QUGA
- = PSME
- ⬡ = ABCO
- * = ALIN

Figure 9. Nest tree site 091. Note: Abbreviations as in Figure 2.

KEY:

+ = Nest Tree

○ = PIPO

△ = QUGA

□ = PSME

Figure 10. Nest tree site 092. Note: Abbreviations as in Figure 2.

24.4 m. Canopy closure for the least open quadrants averaged 27.5%; the most open quadrant had 5% canopy closure.

The last figure mentioned here, Figure 10, represents a site (092) with more Douglas-fir than usual. This site was located in the Out Timber Sale on the flat above Badger Creek. It included the major nest of Channel I squirrel of the home range study. The total tree count was 44 with 21 ponderosa pine, no Oregon white oak, and 23 Douglas-fir. DBH ranged from 10.5 to 42.2 cm with an average of 24.5 cm. Canopy closure averaged 53.8% for the three most closed quadrants and 30% for the most open quadrant. The measurements were made in the summer, and the nearest water was mapped at 550 m; however, a deep ravine was located 152.3 m from the nest tree and could have contained water during most of the year. The high number of Douglas-fir was unusual for the sites mapped in this study.

A nest that was occupied continually for 5 years was removed from the tree after it was observed and photographed from nest height by Oregon Department of Fish and Wildlife biologist John Beck. The nest (see Figure 11) was 92 cm long, 46 cm high and consisted of two parts: a large round ball, which was the enclosed nest of about 46 cm in outside diameter; and a resting platform beside the nest that was also 46 cm in length. The nest itself was constructed of pine boughs and needles for the outer 8 cm. The spacing between the boughs was solid with packed soil. Perhaps dirt had blown into the outer part of the nest, because squirrels have not been reported to carry soil. The soil gave great strength to the nest, making it difficult to

Figure 11. Cutaway side view of a western gray squirrel nest taken from a prime nest site.

open. The inner cavity of the nest was 25 cm in diameter and lined with shredded grasses, lichens and moss.

Observation of the construction of nests by both juvenile and adult squirrels revealed that the squirrels cut pine boughs and carried them to a tree with two or more branches arising from the trunk at the same point, providing the foundation for a platform on which to build the nest. In addition to pine boughs, oak branches with leaves were often used. When the outside had been completed, squirrels carried large mouthfuls of shredded grass into the nest. The squirrel's age may influence the quality of nest construction. In one 45-minute period, an adult squirrel was observed building a nest that remained in place for a year. In contrast, two immature animals spent 2 hours in nest construction with marginal success, as the first branches fell to the ground as succeeding branches were added. This process continued throughout the observation period.

Twenty nest boxes constructed by Centennial High School biology students were placed in the Out Timber Sale area between Badger and Jordan Creek 1 year before timber was removed. The design of the boxes was provided by the Oregon Department of Fish and Wildlife (see Appendix D). None of the boxes were ever observed to be occupied in the field. Two nest boxes were also placed at Friend, the squirrel release site and feeding station. One was occupied by an adult squirrel. The squirrel was afflicted with scabies and eventually was no longer observed. The same nest box was then occupied by a recently released juvenile male. This squirrel also developed scabies, so the box was removed for cleaning. When the box was emptied,

it was noted that the previous occupant had filled the box half full of branches, leaves and needles, and was dead in the box. The juvenile squirrel had been nesting on top of both vegetation and dead squirrel, so the box was replaced with a new one. The juvenile tried once to use it, slid to the bottom of it, climbed out and did not again return to the nest box.

CHAPTER VI

DISCUSSION

Although habitat preference in animals appears to be innate (Robinson & Bolen, 1989), habitat selection depends upon the available critical resources, such as food, water, cover and space. As noted, western gray squirrels occur from northern Washington to southern California. The specific vegetational components of the squirrel's habitats change with climate and latitude; however, throughout their range these squirrels require large mast-producing trees, a fungal food source, trees of sufficient size and arrangement for nests, and access to water.

When this study began in 1981, squirrels were easily observed and trapped in my study areas. The animals continued to be evident and trapable through 1982 and 1983. Returns from the Hunter Cooperation Program indicated a relatively stable population, with sample sizes of 106 in 1981, 109 in 1982, and 144 in 1983. The large number in 1983 may have been directly due to an article published in an issue of Field and Stream entitled "Hunt For Silver" (Park, 1983). Hunters reported that they were hunting in the area because of the information in the article about the northcentral Oregon western gray squirrel population and about this study.

Following the winter of 1983-1984, fewer western gray squirrels were observed, and the Hunter Cooperation Program produced fewer individuals. Fifty-seven squirrels were obtained in 1984, 34 in 1985, and 45 in 1986 (see Table XII). A

number of hunters who had contributed each year to the study reported in 1985 and 1986 that they would not be hunting until the population increased again. Only 20 squirrels were returned through the Hunter Cooperation Program in 1987. Trap success also indicated a decline in the population, as shown by the increase in the number of trap days per squirrel captured in 1985 and 1986 (see Table VI).

The sex ratio of the squirrels taken in the Hunter Cooperation Program show a relatively even balance between males and females, with 245 (47.6%) males to 223 (43.3%) females over the 7-year period. Barnum (1975) collected 96 western gray squirrels over a 17-month period for a study of their reproductive patterns. Forty-six of the squirrels were male and 50 were female, but Barnum did not state whether this sample was representative of the population. Of 63 squirrels captured by Cross (1969) in Southern Oregon, 39 were male and 24 were female. Hall (1980b) live-trapped western gray squirrels in the Geysers area of California, live-trapped western gray squirrels during the spring and fall of 1978. Sex ratios were similar to mine and those reported by Cross (1969), with more males than females in the spring and approximately equal numbers of males and females in the fall. Sex ratios are not specifically mentioned in other studies. These data all suggest that males are more catchable during the spring, but by fall the population has shifted toward more females than males. The shift is not large, but the lower number of females seen and taken in the spring could reflect females spending more time in the nest because of gestation and early lactation.

The body weights of squirrels in this study ranged from 525–925 g with an average of 806 g for males, and 500–950 g with an average of 781 g. for females. Pregnant females weighed the most at 950 g. These weights were slightly lower than those reported by other investigators. For example, Asserson (1974) reported that in Kern County, California, adult squirrels weighed 709–963 g ($\bar{x}$ = 811 g); males weighed 709–907 g ($\bar{x}$ = 794 g), and females weighed 652–963 g ($\bar{x}$ = 828 g). Data from Swift (1977) in Butte County, California, showed a broader range of weights for adult males and females.

The body lengths of the squirrels in this study ranged from 27–39 cm ($\bar{x}$ = 32.9) for males and 27–35 cm ($\bar{x}$ = 30.8) for females. Tail lengths were not significantly different between the sexes, although the average for males was 31.8 cm and for females it was 31.3 cm. Body lengths for squirrels in this study were larger than those reported by Swift (1977), although the same squirrels' body weights were slightly smaller.

Data on the food habits of western gray squirrels from this study support the data from other investigators such as Bailey (1936), Ingles (1947), Stienecker and Browning (1970), Stienecker (1977), and Cross (1969). Each of these investigators have discussed the reliance of the squirrels upon pine seeds of various species during late summer depending upon their location and the use of acorns, when they are available, to supplement the winter diet. In the habitat of the western gray squirrel in north-central Oregon, reliance on large mast is restricted to that of ponderosa pine trees. There is extensive competition for acorns from other birds, deer and other

sciurids. A preliminary sample of stomachs collected in the study area indicate the same strong reliance of the squirrel upon hypogeous and epigeous fungus as other investigators have found (Bailey, 1936; Cross, 1969; Ingles, 1947; Stienecker, 1977; Stienecker & Browning, 1970). More recent work by Maser, Trappe, and Nussbaum (1978), Fogel and Trappe (1978), Byrne (1979), McIntire (1984) and Maser, Maser, and Trappe (1985) reported the heavy utilization of hypogeous and epigeous fungi by western gray squirrels. *Rhizopogon* is the predominant genus of hypogeous fungi in the above-mentioned studies and also in the small sample of stomachs examined in this study. *Rhizopogon* is one of the most common hypogeous fungi in mixed coniferous forests. This genus occurs specifically in association with species of Pinaceae. Species of *Rhizopogon* fruit most commonly from early fall through early winter, but the sporocarps can be found through the year (Castellano, Trappe, Maser, & Maser, 1989). Nine of the 14 stomachs examined in this study included *Rhizopogon*. Reports in the literature of the importance of small mammals as disseminators of fungal spores tends to support the importance of the western gray squirrel's role in this activity. Only two of the 14 stomachs examined here did not contain fungal spores. When one considers that acorns are produced in sufficient quantities to be a staple food on the average of only once in 7 years (U.S. Department of Agriculture, 1965) and that a number of competitors for this fall and winter food source were observed during this study, the reliance of the western gray squirrels upon fungi, and especially hypogeous fungi, becomes more apparent. Competition for acorns comes from Merriam's turkeys, California ground squirrels, yellow-pine

chipmunks, Douglas' squirrels, northern flying squirrels, mule deer and elk. Byrne (1979) considered the reliance of western gray squirrels on hypogeous fungi to be the main factor accounting for the different distributions of eastern gray and fox squirrels as contrasted with western gray squirrels in Northern California. Eastern gray squirrels and fox squirrels relied more upon domestically produced nuts from orchards.

Several references have been made in the literature to squirrels eating the cambium of conifers during some seasons. Western gray squirrels have been seen stripping bark from the upper sections of redwoods, (Fritz, 1932, cited in Ingles, 1947), and ponderosa pine, (Baldwin, 1980; Cross, 1969). This activity was not observed in the present study.

My analysis of the contents of 14 stomachs involved less than 1% of the stomachs provided through the Hunter Cooperation Program. The analysis requires considerable time and a reference collection from which to work. Even this small sample size, however, provided supporting information about the intermittent availability of acorns, as the primary source of starchy material as a late fall and winter supplemental food (see Table I). In several years during this study (e.g., 1982, 1983, 1985, and 1986) Oregon white oaks produced few if any acorns. This failure of mast production is a characteristic of this tree species. The reason for the lack of production is unknown (U.S. Department of Agricultural, 1965). Failure of the acorn crop causes the animals that depend on this food to seek other food resources. Pine seeds in the late summer and early fall provide a valuable supplement

for the accumulation of winter fat, but cannot compensate for the loss of acorns, because the squirrels eat pine seeds in the cones when they are green.

In an ideal year, the annual diet of the western gray squirrel is: acorns from winter through early spring; fungi, both hypogeous and epigeous, from early spring through late fall; ponderosa pine seeds from late summer through fall; and succulent vegetation from late spring through early summer.

The habitat of the western gray squirrel at the sites studied is characterized primarily by ponderosa pine and Oregon white oak. With erratic production of acorns being characteristic of Oregon white oak, pine seeds become increasingly important in the squirrel's diet. Pine seeds are at best a seasonally limited food. When they are also in low supply, the result is the loss of much of the population of squirrels. This loss comes as a result of the poor physical condition of the squirrels from insufficient food. Squirrels are then more susceptible to endemic parasites such as skin mites that cause scabies. Scabies results in the loss of hair and, consequently, diminished thermoregulation, which leads to death.

A study by Smith (1970), on the co-evolution of *Tamiasciurus* species and pine trees, indicate that over time pine trees evolve mechanisms that prevent high levels of predation on the cones by squirrels. These adaptations include: (a) producing cones that have few seeds, (b) producing cones that are hard to open, (c) increased thickness of the seed coat, (d) less nutritious seeds, and (e) cones that drop the seeds early in the season before the young squirrels are out of the nest. Although no information is available on the ability of ponderosa pine to minimize seed loss due to predation by

squirrels, many of the ponderosa pines in the study area produced few seeds per cone or cones with no seeds in 1983.

In northcentral Oregon and in my study area specifically, trees that produce large-sized mast are limited to ponderosa pine and Oregon white oak. In other areas of the squirrel's range there is a greater variety of mast-producing trees, such as madrone, Oregon white oak, California black oak, and sugar pine (*Pinus lambertiana*). With the continued and accelerated loss of the large cone-producing ponderosa pine throughout much of the western gray squirrel's habitat from timber harvest, and the difficulty in growing oak trees, western gray squirrel populations are probably increasingly prone to rapid decreases in population size, as are Kaibab and Abert's squirrels (Patton, 1984). Both of these squirrels have a close dependence upon ponderosa pine for food, cover and nesting. Abert's squirrel does not store food for winter use, but feeds on the inner bark of twigs, pollen from staminate cones, seeds from ovulate cones, and hypogeous fungi associated with the roots (Patton, 1984).

Size of home ranges can be directly associated with the space needed to find sufficient food. Larger home ranges require greater energy expenditure for the squirrels, as they cover a greater area to meet their food requirements. The large home ranges of the squirrels I studied suggests extensive competition with conspecifics and other species, for acorns, pine seeds in fall and winter, and for hypogeous fungi throughout the year. Males averaged 4.38 ha per squirrel, and females averaged 4.03 ha (see Table XI). Cross (1969) in southern Oregon found

average home ranges of 0.74–7.09 ha. Sizes of the ranges changed seasonally.

Summer home ranges were smaller than those in early fall, with the upper end of the range occurring at the times of the year when food was scarce. Ingles (1947) found home ranges of 1.15–1.85 acres for males and 0.300–0.85 acres for females in central California. Gilman (1986) found that males in northern California used home ranges of 2.3–3.6 ha ($\bar{x}$ = 2.5 ha), and females used home ranges of 2.0–4.2 ha ($\bar{x}$ = 2.6 ha). Hall (1980b), working in the Geysers area of central California, found that home ranges differed in various habitats but averaged less than one hectare. In knobcone pine areas western gray squirrels occurred at a density of 2.5 per ha, in yellow pine at 2.9 per ha and in mixed coniferous forests at 3.3 per ha. He concluded that the increase in numbers of squirrels per hectare was due to the increase in mast in the habitat. Asserson (1974), in Kern County, California, described home ranges for males that averaged 0.15 ha and females that averaged 0.14 ha. Although the home ranges reported in this study are considerably larger than those further south, they are close in size to those reported for other *Sciurus* species in southwestern United States. Perhaps in both cases the habitat is of marginal quality for *Sciurus* species.

The quality of the habitat is influenced by the number of mast-bearing tree species in and near the nest tree sites, and age and size of the trees. In a relatively undisturbed stand when the number of trees was smallest, the trees were largest and had broad interconnected canopies. Nests were always located about one-third of the distance down from the top of the tree. The nest was located at a juncture of

branches large enough to support a nest. There did not appear to be a preferred branch size or configuration other than having two or three branches protruding from the bole at the same location of sufficient closeness to support twigs and branches used as the base of the nest.

An important feature associated with all nest trees was the contiguous crowns of neighboring trees providing aerial routes of travel for some distance from the nest tree. Squirrels are cautious in their approach to the nest, possibly to avoid predators and nest competitors. Neither hand-raised nor wild squirrels would return to the nest directly, but would instead enter the canopy several trees from the nest and work their way through the canopy to their nests. Squirrels would not move into the nest tree if I was watching them. However, if I turned my back, they would quickly enter the nest.

Several sites that were continuously occupied throughout the first 6 years of the study were termed "prime" sites. These sites were close to permanent water, had a number of conifers with contiguous canopies, and were in mixed pine-oak stands. At one of these prime sites, on two occasions the occupying western gray squirrel was killed by a bobcat. The first kill occurred after a 2.54 cm snowfall. The tracks of both animals revealed the progression of stalking, chase and kill. In neither case did the bobcat eat the tail, large intestine, gall bladder or radio-collar of the squirrel. In contrast, a squirrel killed by a coyote was apparently devoured except for some fur. The nest of squirrel killed by the bobcat was occupied within 2 weeks by another squirrel. The nest was maintained at least through 1989.

Reproductive activity in western gray squirrels occurs during much of the year. Estrous was recorded from January through March and again in June. Pregnancies were recorded from January through March and again in August. Lactation was recorded from March and April and again in July through October. Nonbreeding individuals were also found from March through January. These data are consistent with those of other researchers in that there are two periods of time during which litters are produced. Each female produces one litter per year with the majority of production occurring in what is termed the summer litter or the second peak of reproduction. These second (summer) litters contribute most successfully to population recruitment.

Disruptions in the food supply, lack of areas for dispersal, and hunting of squirrels during the late summer cause population decline. A female squirrel that does not have an adequate winter food supply will have few reserves from which to sustain herself and a litter if she should become pregnant in the first part of the breeding season. This would favor a larger number of breeding females in the later period of estrous of May through July. Onset of the first breeding season appears to be related to the onset of the second period in that both may be influenced by severe weather early in the year. When spring is delayed by inclement weather, the onset of the peaks of breeding are also delayed. This results in the taking of lactating females during the first part of the fall hunting season. The timing of the fall hunt appears to be important in maintaining a viable squirrel population. Data from the Hunter Cooperation Program show that the majority of western gray squirrels taken during

the hunting season are adults and old adults. These are the animals that are the major producers of young in the population. The continued loss of these members from the population and the taking of lactating females whose young are not likely to survive, together with the loss of useable habitat to logging and occurrence of harsh weather will have profound effects on population size, stability, durability and possibly genetic composition of the squirrel population. It is reasonable to argue that removal of adults and old adults in greater proportion than the subadults or juveniles presents a problem in the timing of the hunting season.

Logging most often removes ponderosa pine from the habitat. These large, mature trees are needed by western gray squirrels for food and cover within the habitat. In unmanaged tree stands, a squirrel can select from a wide variety of combinations of tree size, form, and density to meet its needs (Patton, 1984). Under natural conditions, ponderosa pine tends to grow in stands of uneven age, with even-aged groups within the stand. To date, over 50% of the nest trees and sites used in this study have been logged.

The decline of the western gray squirrel population in northcentral Oregon can be attributed to both natural and human-caused activities. It is possible that changes in long-term weather pattern have affected the area and its precipitation. The range of the western gray squirrel at one time extended northward through central Washington. The squirrel's status in Washington is listed as "sensitive." The Non-Game Division of the Washington Department of Game has proposed that the status of the western gray squirrel be changed to threatened. The squirrel has

suffered extensive habitat loss in much of its range, but that does not explain its disappearance over most of its previous range in Washington.

In northcentral Oregon the western gray squirrel populations appear to occupy marginal habitats. The increase in logging, the difficulty with which ponderosa pine can be regenerated after cutting, the pattern of "leave-trees" in clear cuts, the unpredictable food supplies, the variable precipitation patterns, and the impact of the early hunting season on the species have combined to produce a habitat that is not favorable to continued survival of the western gray squirrels. These factors have been compounded by the introduction of Merriam's turkeys which I observed competing with western gray squirrels for winter food.

CHAPTER VII

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

Northcentral Oregon is, under natural conditions, marginal habitat for western gray squirrels. Due to habitat changes resulting from both natural and human causes, the squirrel population began to decline in the winter of 1983–1984. The decline is correlated with the loss of their major fall food supply, ponderosa pine seeds due to inclement weather. In the spring of 1983, rain interfered with good pollination in ponderosa pine; thus, the cones in 1984 were largely empty. The spring of 1983 was also delayed by late freezes when the acorns would have been setting on the trees. This led to a lack of acorns over much of the forest. With the loss of two of the major foods needed to produce fat accumulation sufficient to offset the shortages of winter, the squirrels were stressed. Endemic in the population is scabies, a skin condition caused by the mite, *Notoedras douglasi*, which became widespread in the squirrel population in 1984. Due to resulting hair loss and to food shortage, many squirrels died of hypothermia, starvation, or both. The population probably could have recovered from this outbreak within a few years, but with the accelerated rate of logging in the Barlow Ranger District, available habitat and resources for western

gray squirrels was reduced. Continued squirrel hunting during the period of greatest reproductive potential—late August through mid-September—accentuated the losses.

The habitats investigated in this study are larger than for other populations of this squirrel in southern Oregon and California, as a result of the squirrels having to travel further to meet their needs for food, water and nest sites. Some changes in home range occur between summer and winter. Summer ranges include north-facing slopes while winter ranges tend to include south-facing slopes.

Field observations suggest that competition for nest sites, food, and space is increased in this area by the large number of other squirrel species present, the foraging of deer on acorns, and the introduction of Merriam's turkey into the area. The turkeys and deer compete with the squirrel for winter food.

Nest tree sites are located in habitats including a predominant mix of ponderosa pine and Oregon white oak. The stands within which the nests are located range from open, sparse stands to dense clusters of pole-sized trees which include a few larger pines. At least one to a few large mast-producing oaks are also present. Winter and breeding nests are located in codominant ponderosa pine trees. Nest sites are never in large, single pines, but rather in clusters of trees with interconnected canopy. This canopy is utilized by the squirrel for cover and travel.

RECOMMENDATIONS

Several practices would either maintain or enhance western gray squirrel habitat. These include the following:

1. Maintain corridors of travel on the ground as well as in the canopy. When providing snags in timber removal areas, cluster the green trees left for future snags to provide both contiguous routes for travel and connect the clusters of snags to the side of a sale area.
2. Alter logging practices so as to maintain an interconnected canopy that would allow for aerial routes of travel for a distance of at least 60 m around nest trees which also need to be adjacent to or within interconnected arboreal corridors.
3. Provide a mix of both large Oregon white oak and ponderosa pine trees within the habitat for food, cover, and nest tree sites.
4. Maintain the above sites within 180 m of water, and enhance other potential nest tree sites by construction of water holding facilities.
5. Enhance habitat from which timber has been removed by planting mast-bearing trees such as California hazel and more Oregon white oak.
6. Clear-cuts or timber sale areas should be no larger than 60 m in width. If larger sizes are required, the sale area should be designed to provide for distances no more than 60.0 m from adjacent cover.
7. Areas within western gray squirrel habitat in which regeneration of ponderosa pine is difficult or impossible should be protected from timber removal.
8. Change the time of the fall hunt to the first of October to decrease the taking of lactating females in the hunt.
9. The bag limit should remain at low levels while the squirrel population levels are low. Recovery of the population should be carefully monitored until

population recovery can be documented. Following recovery, bag limit should be set according to hunter pressure and the potential for naturally caused (e.g., available food) population decline.

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APPENDIX A

**HUNTER COOPERATION PROGRAM
INFORMATION SHEET**

SILVERGRAY SQUIRREL STUDY

NON-EDIBLE PARTS NEEDED

1. SKULL (HEAD)
2. FOREARM OR ONE WHOLE ARM
3. REPRODUCTIVE TRACT AND STOMACH (GUTS)
4. TAIL (OPTIONAL)

The information derived from this study will be used to help determine population, size, age structure, and reproductive status of Silvergray Squirrels.

Follow-up information will be mailed to you that participate in the study if you so desire. Please indicate on the tag if you wish such information.

Thank you for your cooperation!

Susan Foster, Graduate Student
Portland State University
P.O. Box 335
Gresham, Oregon 97030

INSTRUCTIONS

1. FILL OUT TAG AND PLACE IN LARGE PLASTIC BAG PROVIDED.
2. PLACE GUTS ONLY IN THE SMALLER BAG, SEAL, AND PLACE IN LARGE BAG.
3. PLACE HEAD, ARM, AND TAIL IN THE SAME LARGE BAG.
4. SEAL BAG AND LEAVE IN DROP BOX.
5. RECORD TAG NUMBERS (EAR TAGS) ON THE TAG IN THE PLASTIC BAG.

DROP BOX LOCATIONS

1. ROCK CREEK RESERVOIR CAMPGROUND
2. BONNEY CROSSING CAMPGROUND
3. LITTLE BADGER CAMPGROUND ON S-308 (2511)
4. JORDAN CREEK CAMPGROUND
5. BARLOW RANGER DISTRICT OFFICE (OUTSIDE)
6. STATE FISH AND WILDLIFE OFFICE (OUTSIDE)
7. ROAD INTO FRIEND

HUNTER COOPERATION REQUESTED

APPENDIX B

**RAW DATA FROM HUNTER COOPERATION PROGRAM INCLUDING
HUNTING SEASON ROADKILLS AND ANIMALS OBTAINED FROM
OREGON DEPARTMENT OF FISH AND WILDLIFE AND
OREGON STATE POLICE PERSONNEL
FOR STOMACH CONTENT ANALYSIS**

#	Age ^a	Sex ^b	1981	Location	Parts
001	AD	F	29 Aug.	308/341	forearm, head, eyes, tail
002	AD	M	29 Aug.		
003	SA	F	29 Aug.	Jordan Creek Campground	guts, eyes, arm, skull, tail
004	AD	F	29 Aug.	Rock Creek Res. Area	guts, eyes, arm, skull
005	AD	F	29 Aug.	Waterhole on 3012A	
006	AD	F	29 Aug.	S. of JCC 6	tail, eyes, guts, arm
007	AD	M	29 Aug.	308/341	
008	SA	F	29 Aug.	Tygh Creek	tail, arm
009	AD	F	29 Aug.	S341	
010		M	29 Aug.	308-341	
011			29 Aug.		
012	JV	M	30 Aug.	McCubbin Gulch/508	skull, eye, guts, tail, arm
013	OA	M	30 Aug.	Bear Springs RS 216	eyes, tail, arm, guts
014	AD	M	29 Aug.	Gate Creek 5408	eyes, skull
015	AD	F	30 Aug.	Bonney Crossing	eyes, skull, guts, arm
016	SA	M	30 Aug.	Gate Creek	skull, eyes, arm, guts
017	AD	F	30 Aug.	Gate Creek	eyes, arm, guts
018	JV	M	30 Aug.	Waterhole 3012A	skull, eyes, tail, guts
019	OA	M	29 Aug.	Bonney Crossing	skull, leg, eyes, guts
020	SA	M	30 Aug.	Bonney Crossing	skull, leg, eyes, guts
021	AD	F	30 Aug.	Bonney Crossing	skull, eye, arm

#	Age ^a	Sex ^b	1981	Location	Parts
022	OA	F	30 Aug.	Bonney Crossing	skull, eye, arm, guts
023	OA	F	29 Aug.	Bonney Crossing	skull, eye, arm
024	AD	F	30 Aug.	Highland Ditch	skull, eyes, guts, tail
025	SA	M	30 Aug.	Gate Creek	skull, arm, eye, guts
026	AD	M	31 Aug.	White River	guts, leg, tail, eyes
027	AD	F	31 Aug.	On ridge north of Tygh Creek/Old Friend Road.	skull, guts, arm, tail, eyes
028	AD	M	31 Aug.	3012A - waterhole	skull, arm, tail, eyes, guts
029	AD	F Lact.	31 Aug.	3012A - ½ mile from Badger Pond	skull, arm, tail, eyes, skin w/stain + old wounds
030	AD	F Lact.	26 Aug.	Odell Creek at treatment plant	skull, eyes, tail, stomach, reprod., arm
031	AD				skull, eyes, stomach, arm
032	AD	F			skull, guts
033	AD	F			skull
034	JV	F	1 Sept.	White River Game Management Area	skull, eyes, guts, tail
035	AD	F	1 Sept.		skull, eyes, guts, tail
036	OA	F	3 Sept.		skull, eyes, guts (all four feet)
037	AD	F	3 Sept.	Roadkill - Camp Baldwin - S44	tail, arm
038	AD	M	5 Sept.	Smock Prairie	skull, guts, arm, eyes, tail, reprod.

#	Age ^a	Sex ^b	1981	Location	Parts
039	AD	M	31 Aug.	Jordan Creek Bear Gulch	skull, arm, eyes, tail
040	AD	F	31 Aug.	Jordan Creek Bear Gulch	skull, eyes, reprod.?, guts, arm
041	SA	F	31 Aug.	Jordan Creek Bear Gulch	skull, eyes, arm, stomach
042	AD	F	1 Sept.	Jordan Creek Bear Gulch	skull, eyes, arm, tail, stomach
043	SA	F	4 Sept.	Mill Creek	skull, eyes, arm, stomach, tail
044	AD	F	5 Sept.	Smock Prairie	skull, eyes, stomach, arm, tail
045	AD	M	4 Sept.	Rock Creek	skull, eyes, stomach, arm
046	AD	M	5 Sept.	Rock Creek	skull, eyes, arm
047	OA				skull, eyes
048	AD		4 Sept.		skull, eyes
049	AD	M	5 Sept.	Above Bonney Crossing	skull, eyes, stomach, reproductive organs
050	SA		5 Sept.	School Canyon, Tygh Creek	skull, eyes, tail
051	SA		5 Sept.	School Canyon, Tygh Creek	skull, eyes, tail
052	AD		5 Sept.	School Canyon, Tygh Creek	skull, eyes, tail
053	SA		5 Sept.	School Canyon, Tygh Creek	skull, eyes, tail
054	SA	M	6 Sept.	Bonney's Crossing	eyes, stomach, part foot (round worms)
055	AD	M	6 Sept.	Bonney's Crossing	skull, stomach, arm, leg, tail, reprod.

#	Age ^a	Sex ^b	1981	Location	Parts
056	AD	F	6 Sept.	School House Ridge	skull, eyes, stomach, arm, reprod., tail
057	AD	M	6 Sept.	School House Ridge	skull, eyes, stomach, reprod. tail
058	AD	M		Little Badger	stomach, reprod.
059	AD	M		Little Badger	stomach, skull, penis, eyes
060	AD			Little Badger	stomach, eyes, skull
061	AD			Little Badger	stomach, eyes, skull
062	AD			Little Badger	stomach, eye
063	AD			Little Badger	stomach, skull, eyes
064	SA	M	6 Sept.	Rock Creek	stomach, eyes, skull
065	SA	F	6 Sept.	Highland ditch above Bonney Crossing	stomach, eyes, skull
066	SA	M		picked up at Rock Creek	skull, eyes, lens, arm
067	AD	F	12 Sept.	1st pond east of Junction 207/308	skull, one eye, arms, tail, reprod., stomach
068	AD	M	12 Sept.	Tygh Creek, just off 207	tail, stomach, arm, skull, eye
069	AD	M			skull, tail, arm, gut, reprod., eye
070	AD	M			skull, tail, arm, gut, eye
071	OA	F	13 Sept.	Old North-South before Tygh Creek	skull, eye, gut, reprod., tail, arm
072	SA	M	7 Sept.	Mill Creek Ridge	arm, head, tail

#	Age ^a	Sex ^b	1981	Location	Parts
073	SA	F	7 Sept.	Mill Creek Ridge	
074	AD	F	5 Sept.	15-mile ditch	
075	SA	M	5 Sept.	15-mile ditch	
076	AD	F	5 Sept.	15-mile ditch	
077	AD	M	18 Sept.	Bonney Crossing	tail, arm, skull, eyes, reprod.
078	AD	F	19 Sept.	Penn Creek	tail, arm, skull, reprod., eyes
079	AD	F	13 Sept.	near Rock Creek Reservoir	skull, eyes, arm, guts
080	AD	F	14 Sept.	Smock Prairie	tail, skull, eyes, guts, arm
081	AD	F	14 Sept.	S-408A	tail, guts, arm, skull, eyes
082	AD	F			skull, eyes, guts
083	SA				skull, eyes, guts
084	AD	M	13 Sept.	Barlow Road	skull, eyes, guts, reprod.
085	AD	F	7 Sept.	3-Mile Creek	skull, eyes, guts
086		F	12 Sept.	Barlow Road near Smock Prairie	skull, eye, guts
087	SA	M	8 Sept.	White River Road	guts, skull, eyes, reprod.
088	JV	M	16 Sept.	Gate Creek area	guts, reprod.
089	AD	F	14 Sept.	Barlow Road	tail, guts, skull, eyes
090	AD	F	12 Sept.	Barlow Road near Smock Prairie	guts, skull, eyes
091		F	22 Sept.	¼ mi. west of Jordan Camp	guts, tail

#	Age ^a	Sex ^b	1981	Location	Parts
092	SA	F	25 Sept.	Jordan Butte	guts, skull, eyes, arm, reprod.
093	SA	F	25 Sept.	Jordan Butte	guts, arm, skull, eyes
094	AD	M	26 Sept.	Ramsey Park area	skull, eyes, arm, tail
095	AD	M	17 Sept.	White River Game Management Area	skull, tail, arm, guts, reprod.
096	SA	M	27 Sept.	Old 207 Road	skull eyes, stomach
097	AD	F	27 Sept.		stomach
098	AD	F	9 Oct.	Ramsey Creek	skull, eyes, foot, guts
099		M	9 Oct.	Friend area	guts only
100	AD	M	8 Oct.		
101	SAD	F	4 Oct.		
102	AD	F	11 Oct.	Jordan Creek	skull, eyes, guts
103	AD	F	11 Oct.	Road 408-T	skull, eyes, guts
104	AD	M	24 Oct.	McCubbins Gulch	skull, 1 eyes, guts, arm, testes
105	AD	M	29 Oct.	Old 207-North-South Road	skull, eyes
106		M	3 Nov.	Near Bonney Crossing	arm, stomach, testes, 1 eye

^aOA = Old adult; AD = Adult; SA = Subadult; JV = Juvenile.

^bLact. = Lactating; Preg. = Pregnant.

#	Age ^a	Sex ^b	1982	Location	Parts
107		M	18 July	Junction 408/403 by Rock Creek	testes, arm, tail
108	SA		28 Aug.	3-Mile Creek	tail
109	SA	M	28 Aug.	Little Badger Trail	stomach, arm, skull, eyes
110	SA	F	28 Aug.	S. of Friend near Clark Mill Road	tail, skull, 1 lens, stomach, reprod., arm
111	AD	M	28 Aug.	Tygh Ranch	tail, stomach, skull, lens, testes, arm
112	AD	M	29 Aug.	Tygh Ranch	tail, stomach, skull, lens, arm
113	AD	M	29 Aug.	Tygh Ranch	tail, skull, eyes, arm, testes
114	SA	F	29 Aug.	Tygh Ranch	skull, eyes, arm, tail, stomach
115	AD	F	29 Aug.	Badger Lake Road 3010A	skull, eyes, arm, tail, stomach, ovaries
116	JV	M	28 Aug.	Rock Creek Reservoir	stomach, arm, eye
117	OA	M	28 Aug.	Rock Creek Reservoir	skull, eyes, 2 arms, stomach
118	SA	M	29 Aug.	3012A	skull, eyes, arm, stomach, testes
119	JV	M	28 Aug.	308—2 mi. n. Bonny Crossing	
120	AD	F Lact.	29 Aug.		
121	SA	M	28 Aug.	off Road 3010	skull, eye, stomach, testes

#	Age ^a	Sex ^b	1982	Location	Parts
122	SA	F	28 Aug.	Bonny Crossing	1 eye, tail, $\frac{1}{2}$ lower jaw, $\frac{1}{2}$ upper jaw, arm, stomach
123	OA	M	30 Aug.	Tygh Ranch	testes, baculum, stomach, arm, skull, eye, tail
124	OA	F Lact.	29 Aug.	Tygh Ranch	arm, skull, tail, stomach, eye
125	AD	M	30 Aug.		stomach, testes
126	SA	M	30 Aug.	A55	stomach, testes, arm, skull, eye
127	OA	F	29 Aug.	Rock Creek—Road 4810-180	arm, stomach, skull, eyes
128	OA	F Lact.	31 Aug.	$\frac{1}{2}$ mi. east of waterhole, 3012 (140)	ovary, nipple, stomach, arm, skull, eye, tail
129	AD	F	31 Aug.	waterhole 3012 (140)	arm, stomach, skull, eye, tail
130	JV	F	1 Sept.	1 $\frac{1}{2}$ mi. post N.E. boundary on M308	arm, stomach, tail, skull, eye
131	SA	M	31 Aug.	waterhole, N.E. boundary on 308	testes, baculum, skull, arm, eyes, tail, stomach
132	AD	F	1 Sept.	off Road 3010	stomach, ovary, nipples, arm, tail, skull, eye
133	OA	F Lact.	28 Aug.	Badger	arm, skull, tail, stomach, trachea, larynx, eyes
134	AD	F Lact.	2 Sept.		skull, eyes, arm, stomach
135	AD	M	4 Sept.		testes, skull, eyes, stomach, baculum

#	Age ^a	Sex ^b	1982	Location	Parts
136	JV	M	3 Sept.	North-South Road—School Canyon	stomach, arm, eyes
137	AD	F Lact.	4 Sept.		tail, arm, stomach, ovaries and uterus, skull, eyes
138	AD	M	3 Sept.	Red Rock Road—Road 2710-190	arm, baculum, arm, skull, eyes
139	OA	F	3 Sept.	North-South Road/School Canyon	
140	SA		4 Sept.	White River Game Management Area—Campbell Lane	arm, skull, eyes, (no gut, no sex)
141	AD	M	4 Sept.	White River Game Management Area	stomach, skull, eye
142	AD	M	5 Sept.	Jordon Creek	skull, lens, arm, testis
143	SA	F	5 Sept.	Middle Jordon Creek (scabies)	skull, lens, arm
144		F Lact.	8 Sept.	Junction of S-125 & S-16 Pollywog Spring	ovary, arm, tail
145		M	6 Sept.	No map	
146		F	10 Sept.	Jordan Creek	tail, arm, stomach
147	JV	M	11 Sept.	Penn Creek	tail, stomach, eyes, jaw/teeth
148	AD	F	11 Sept.	Penn Creek	tail, stomach, eyes, jaw/teeth
149	OA	F Lact.	10 Sept.	West branch Mosier Creek	tail, eyes, skull, stomach, arm

#	Age ^a	Sex ^b	1982	Location		Parts
150	JV	F	10 Sept.	West branch Mosier Creek		tail, eyes, skull, stomach, arm
151	AD	F	12 Sept.	308H—Red Rock Road		tail, stomach, eye, skull
152	JV	F	11 Sept.	Red Rock on S308		tail, stomach, skull, eye
153	AD	F	11 Sept.	Red Rock on S308		tail, stomach, skull, eye, ovaries
154	AD	F	11 Sept.	Red Rock on S308		tail, stomach, skull, eye, ovaries
155	SA	F	12 Sept.	Red Rock		tail, stomach, skull, eye, ovaries
156	OA	M	12 Sept.	Little Badger		arm, head, stomach, testes
157	AD	M	12 Sept.	Near C-2 Pond		arm, head, stomach, testes
158	SA	F Lact.	12 Sept.			arm, head, stomach, reprod.
159	OA	M	12 Sept.			arm, head, stomach, testes
160	AD	F	4 Sept.	S308		ovaries, stomach, eyes, skull
161	AD	F	18 Sept.	Rock Creek		tail, leg, stomach, ovaries, skull, eyes
162	SA	M	18 Sept.	Rock Creek		tail, testes, stomach, eyes, skull
163	JV	M	18 Sept.	Rock Creek		testes, stomach, tail, eyes, skull
164	JV	M	18 Sept.	Rock Creek		tail, skull, stomach, testes, eyes

#	Age ^a	Sex ^b	1982	Location	Parts
165	AD	F	18 Sept.	Rock Creek	tail, stomach, ovaries, eyes, skull
166	AD	F	18 Sept.	School Canyon	tail, stomach, ovaries, eyes, skull, arm
167	OA	M	18 Sept.	School Canyon	tail, stomach, testes, lower jaw, arm
168	AD	M	18 Sept.	School Canyon	tail, stomach, testes, eyes, arm, skull
169	JV	F	19 Sept.	Jordan Creek Campground	stomach, arm, skull, eyes
170	SA	M	19 Sept.	School Canyon	3 stomachs, 6 eyes, 3 tails, 3 testes, 1 head, lower jaw
171	OA	M	19 Sept.	School Canyon	
172	SA	M	19 Sept.	School Canyon	
173	AD	F	19 Sept.	School Canyon	tail, arm, eyes, stomach, jaw
174	SA	M	12 Sept.	Jordan Creek	tail, arms, eyes, stomach, skull, testes
175	AD	F	14 Sept.	Fir Mountain	tail, arms, eyes, stomach, skull, no ovaries
176	SA	M	12 Sept.	Jordan Creek	tail, arms, eyes, stomach, skull, 2 testes
177	SA	M	14 Sept.	Fir Mountain	tail, arms, eyes, stomach, skull, testes, no lens
178	SA	F Lost			
179	JV	M	25 Sept.	Jordan Creek camp	

#	Age ^a	Sex ^b	1982	Location	Parts
180	AD		25 Sept.		skull
181	AD		25 Sept.		skull
182	SA		25 Sept.		skull
183	AD		25 Sept.		skull
184	AD	F Lact.	26 Sept.		skull, eyes
185	SA	M	26 Sept.		testes, eyes
186	JV	M	3 Oct.	Head trail #469	head, testes
187	AD	M	7 Oct.	Friend	skull, eyes, stomach, testes
188	SA	M	7 Oct.	Friend	skull, eyes, stomach, testes
189	JV	M	9 Oct.	5 Mile Creek	tail, hindleg
190	AD	F	9 Oct.	5 Mile Creek	tail, arm, ovaries, lens, skull
191	AD	F	10 Oct.	Smock Prairie	tail, stomach, eye, arm, skull
192	AD	M	10 Oct.	Smock Prairie	tail, stomach, eye, arm, skull
193	JV	F	10 Oct.	Smock Prairie	stomach, ovaries, arm, tail
194	AD	M	9 Oct.	South White River	arm, testes, stomach, lens, skull
195	AD	M	9 Oct.	South White River	arm, testes, stomach, lens, skull
196	SA	F	9 Oct.	South White River	arm, stomach, eye, skull

#	Age ^a	Sex ^b	1982	Location	Parts
197	SA	F Lact.	14 Oct.	School Canyon	ovaries, stomach, forearm, lenses, skull, skin
198	SA	F	14 Oct.	School Canyon	skin, forearm, ovaries, stomach, lens, skull
199	AD	F	14 Oct.	School Canyon	skin, forearm, lens, ovaries, skull, stomach
200	ASA	M	27 Sept.	Badger Creek	skin, forearms, stomach, testes, lens, skull
201	OA	F	24 Sept.	Trail #447	stomach, pelt, skull, lenses
202			16 Oct.	Bear Gulch	arm
203 a	AD	M	24 Oct.	Onion Flat between cattle guards S207	skull, tail, hindleg, lens,
203 b	AD		24 Oct	Onion Flat between cattle guards S207	skull, lens, tail
204	AD		24 Oct	Onion Flat between cattle guards S207	tail, skull, 2 lens
205 a			24 Oct.	Onion Flat between cattle guards S207	tail
205 b			24 Oct.	Onion Flat between cattle guards S207	tail
205 c			24 Oct.	Onion Flat between cattle guards S207	tail
206			24 Oct.	Onion Flat between cattle guards S207	tail
207			24 Oct.	Onion Flat between cattle guards S207	tail

#	Age ^a	Sex ^b	1982	Location	Parts
208		M	24 Oct.	Onion Flat between cattle guards S207	tail
209	OA		24 Oct.	Onion Flat between cattle guards S207	tail, skull
210	OA			Onion Flat between cattle guards S207	tail, skull, lens
211 a	JV		24 Oct.	Onion Flat between cattle guards S207	tail
211 b	AD		24 Oct.	Onion Flat between cattle guards S207	tail skull
212	SA		24 Oct.		tail, skull
213	AD	F	30 Oct.	Happy Ridge (308) ½ mile east of Forest Service Boundary	all
214	AD	M	8 Dec.	Pine Hollow rESERVOIR	all
215				Rock Creek Res. Road. 48	
216	AD				
217	AD				

#	Age ^a	Sex ^b	1983	Location	Parts
218	AD	F	1 Sept.		eye, skull, stomach, ovaries, arm, skin
219	AD	M	2 Sept.	Rock Creek	stomach, skull, eyes, testis
220	SA		2 Sept.	Rock Creek	stomach, skull, eye
221	AD	M	2 Sept.	Rock Creek	stomach, testis, skull, eye
222	AD	M	2 Sept.	Rock Creek	arm, skull, eye, stomach, baculum
223	AD		2 Sept.	Rock Creek	stomach, arm, eye, skull
224	AD	M	2 Sept.		stomach, testis, eye, arm, skull, tail
225	AD	F	2 Sept.	Out timber sale	stomach, ovaries, eye, arm, skull
226	AD	F	2 Sept.	Little Badger	arm, skull, eye
227	JV	M	2 Sept.	Little Badger	skull, eye, stomach, testis
228		M	1 Sept.	Little Badger	stomach, testis
229	AD	M	1 Sept.		arm, eye, skull, tail
230		F	1 Sept.	Friend Road	stomach, ovaries
231	AD	F	1 Sept.		tail, arm, eyes, skull
232	AD	F	1 Sept.		tail, arm, eyes, skull
233	AD	M	2 Sept.	Rock Creek Reservoir	arm, tail, skull, eye
234	AD	F	2 Sept.	South Rock Creek Reservoir	arm, skull, eye, tail
235		F	2 Sept.	South Rock Creek Reservoir	arm, skull, eye, tail
236		F	2 Sept.	South Rock Creek Reservoir	

#	Age ^a	Sex ^b	1983	Location	Parts
237	AD	M	3 Sept.		arm, eye, skull, stomach
238	SA	F	3 Sept.	Rock Creek	tail, eye, skull, arm
239	AD	F	3 Sept.	Rock Creek	tail, eye, skull
240	AD	F	2 Sept.	WRMA	arm, skull, eye
241		F	2 Sept.	Jordon Creek	eye, arm
242	AD	F	2 Sept.	Tygh Creek	skull, eye
243	SA	F	2 Sept.	WRMA	arm, skull, eye
244		M	2 Sept.	Tygh Ranch	skull, eye, tail, arm
245	AD	F	2 Sept.		arm, skull, eye
246	AD	M	2 Sept.	WRMA	arm, skull, eye, stomach, testes
247	AD	F	2 Sept.	WRMA	arm, skull, eyes
248		F?	1-4 Sept.		tail
249	OA	F	2-4 Sept.	Redborn	tail, backleg, eye, lower jaw
250	AD	M	2 Sept.	Road 22	skull, arm, eye
251	OA	M	3 Sept.	Road 22	tail, arm, skull, eye
252	AD	F	1-4 Sept.	Schoolhouse Road	skull, arm, eye
253		M	3 Sept.	Road 22	skull, eye
254	AD	F	3-4 Sept.		skull, arm

#	Age ^a	Sex ^b	1983	Location	Parts
255	SA	F	3-4 Sept.		arm, skull
256	AD		3-4 Sept.		arm, skull, eye
257	AD	M?	3-4 Sept.		arm, skull, eye
258	AD	M?	3-4 Sept.		arm, skull, eye
259	JV	M?	3-4 Sept.		arm, skull, eye
260		M?	3-4 Sept.		arm, skull, eye
261	AD	M?	3-4 Sept.		arm, skull, eye, testes
262	AD	F?	3-4 Sept.		skull, 1 eye, arm
263	AD	M?	3-4 Sept.		arm, skull, eye
265	AD	M?	3-4 Sept.		arm, skull, eye
265	AD	M?	3 Sept.		arm, skull, eye
266		M?	4 Sept.		arm, skull, eye, demolished
267	SA	F?	4 Sept.		arm, eye, skull
268	AD	M?	3-4 Sept.		arm, eye, skull

#	Age ^a	Sex ^b	1983	Location		Parts
269	AD	F Lact.	4 Sept.	Gate Creek		arm, tail, skull, eye, stomach, ovaries
270	SA	M	3 Sept.			arm, skull, stomach
271		M	3 Sept.	Below (south) Rock Creek Reservoir		skull, eye
272	AD	M	3 Sept.	Below (south) Rock Creek Reservoir		skull, eye
273	AD	M	3 Sept.	Below (south) Rock Creek Reservoir		skull, eye
274	SA		4 Sept.			skull, arm, eye
275	AD	F	4 Sept.	Sportsman Park		skull, arm, eye, tail
276	SA	F	4 Sept.	Sportsman Park		skull, eye, tail, arm
277	AD	F	4 Sept.	Sportsman Park		skull, eye, tail, arm
278	AD	F	4 Sept.	North-South Road		skull, eye, arm
279	SA	M	5 Sept.	South of Sportsman Park		skull, eye, tail, arm
280	AD	M	5 Sept.	South of Sportsman Park		skull, arm
281	AD	F	5 Sept.	Jordan Creek		skull, eye
282	SA	M	5 Sept.	North-South Road		skull, eye, arm
283	AD	M?	5 Sept.			skull, eye
284	AD	M	4 Sept.	North-South Road		arm, skull, eye
285	SA	M	4 Sept.	Old Barlow Road		arm, skull, eye
286	AD	M	4 Sept.	North-South Road		arm, skull, eye
287	AD	F	4 Sept.	7000-131		skull, arm, eye

#	Age ^a	Sex ^b	1983	Location	Parts
288	SA	M	4 Sept.	Tygh Ranch	skull, eye, tail
289	SA	M	4 Sept.	Tygh Ranch	skull, eye, tail
290	SA	F	4 Sept.	Tygh Ranch	skull, eye, arm, tail
291	SA	F	4 Sept.	Tygh Ranch	tail, skull, eye
292	AD	M	4 Sept.	Tygh Ranch	tail, skull, eye, arm
293	AD	F	4 Sept.	Tygh Ranch	tail, skull, eye
294	AD	M	4 Sept.	R12 T3 Sect. 9	tail, skull, testis, eye
295	AD	M	4 Sept.	R11 T3 Sect. 1	tail, testes, eye, skull
296	AD	F	3 Sept.	R12 T3 Sect. 7	tail, skull, eye, ovaries
297		F	3 Sept.	R12 T3 Sect. 7	tail, skull, eye, ovaries
298	AD	F	3 Sept.	R12 T3 Sect. 7	tail, skull, eye
299	AD	M	3 Sept.	R12 T3 Sect. 7	tail, skull, eye, arm
300	SA	M	3 Sept.	R12 T3 Sect. 7	tail, skull, eye, arm
301	SA	M	3 Sept.	R12 T3 Sect. 7	tail, skull, eye
302	JV	M	8 Sept.	Ketchum Ridge above The Dalles	tail, skull, arm, testes
303	AD	M	8 Sept.	Neil Creek above The Dalles	tail, skull, arm, testes
304	OA	F	5 Sept.	Road to Friend	skull—broken, eyes, brain
305	AD	M	6 Sept.	Road 27—south end	skull, eye
306	AD	F	10 Sept.	S-205 above cattleguard	skull, eye, arm, testes, stomach
307	AD	M	6 Sept.	Road 27	arm, eye, skull

#	Age ^a	Sex ^b	1983	Location	Parts
308	AD	F	5 Sept.	Road to Friend	skull, eye
309	AD	M	5 Sept.	1 mile west Little Badger Campground	skull--broken, eye
310	OA	F	7 Sept.	Chenowith Creek	skull, eye, tail, arm, ovaries
311		M	16 Sept.	Bonney Crossing	tail, arm
312		M	16 Sept.	Bonney Crossing	arm
313	AD	F	16 Sept.	Bonney Crossing	lower jaw, arm, 3 eyes
314	AD	F	16 Sept.	Bonney Crossing	lower jaw, 3 eyes
315	AD	F	11 Sept.	Friend area	skull, arm, tail, eyes, ovaries
316	OA	F	11 Sept.	Friend area	skull, arm, tail, eyes, ovaries
317	SA	F	11 Sept.	Five-Mile Creek Road	skull, arm, eyes, ovaries
318		M	9 Sept.	Douglas Cabin Road	arm, eye, skull, testes
319	AD	F	11 Sept.	Badger Creek	arm, skull, eye
320	AD	?	10 Sept.	Union Flats between the cattle guards	
321	AD	?	10 Sept.	Union Flats between the cattle guards	
322		?	10 Sept.	Union Flats between the cattle guards	
323		?	10 Sept.	Union Flats between the cattle guards	

#	Age ^a	Sex ^b	1983	Location	Parts
324		?	10 Sept.	Union Flats between the cattle guards	
325	AD	F	13 Sept.	4820-120 near Rock Creek Reservoir	tail, skull, lens
326		M	13 Sept.	4820-120 near Rock Creek Reservoir	arm, tail, lens, lower jaw
327		M	13 Sept.	4820-120 near Rock Creek Reservoir	tail, arm, lower jaw, lens
328	AD	F Lact.	13 Sept.	Hood River County	all
329	AD	M	18 Sept.	R11 T2 S25	tail, arm, skull, eyes
330	AD	M	18 Sept.	R11 T2 S26	skull, eyes
331	AD	M	18 Sept.	R11 T2 534	
332	SA		19 Sept.	Bonney Crossing	
333	AD		19 Sept.		
334	OA		19 Sept.		
335	AD		19 Sept.		
336		F Lact.	13 Sept.		all
337			24 Sept.	roadkill—R48-2 miles Rock Creek	tail, arm, lower jaw
338		F	24 Sept.	roadkill—R2510 near Gravel Pit Point	tail, arm
339		F	8 Oct.	Little Badger Camp	arm

#	Age ^a	Sex ^b	1983	Location	Parts
340	AD	F	11 Oct.	1½ miles northeast of Bonney Crossing	arm, skull, eye
341		F	16 Oct.	Roadkill	all
342	AD	M	29 Oct.	upper 5-mile	arm, skull, eye, tail, hide, stomach, testes
343	AD	F	29 Oct.	upper 15-mile	
344	AD	F	29 Oct.	upper 5-mile	
345	AD	F	4 Sept.	Camp Baldwin	arm, jaw
346	SA	M	4 Sept.	Camp Baldwin	arm, skull, eye
347		F	4 Sept.		arm
348	AD	F	9 Oct	Junction S308 & 3012A	skull, 1 eye, tail, arm
349	OA	M	4 Sept.	Camp Baldwin	skull, eye, arm
350	AD	F Lact.	7 July	Out Timber sale	skull, eye, tail, arm, ovaries, uterus, stomach
351		M		Hwy. 26 Brightwood	arm, tail
352	AD	F	5 Nov.	Jordan Campground	skull, tail, eye
353	SA	F			arm, skull, tail, eye
354	AD	F	1 Nov.	Happy Ridge	arm, skull, eyes, stomach, ovaries, uterus
355	JV	M			arm, tail, jaw
356	AD	M	10 Oct.	Roadkill—on Eight Mile	baculum, skull, eye, arm, tail
357	OA	M	10 Oct.		eye, skull

#	Age ^a	Sex ^b	1983	Location	Parts
358	AD	M	10 Oct.		arm, skull, eye
359	AD	M	10 Oct.		arm, tail, skull, eye
360			29 Sept.	Roadkill--Hood River Dee Highway	arm, tail, jaw
361		M	29 Sept.	Roadkill--Hood River Dee Highway	arm, jaw

^aOA = Old adult; AD = Adult; SA = Subadult; JV = Juvenile.

^bLact. = Lactating; Preg. = Pregnant.

#	Age ^a	Sex ^b	1984	Location	Parts
362	AD	F Lact.	1 Sept.	Bonney Crossing	Skull-partial, eye, guts,
363	AD	F Lact.	1 Sept.	Tygh Ranch	guts, arm, skull, testes
364	AD	M	1 Sept.	Tygh Ranch	guts, arm, skull, testes
365	AD	M	1 Sept.	Tygh Ranch	skull, tail, eyes, arm
366	SA	M	1 Sept.	Gate Creek	tail, arm, head, stomach
367	AD	F	1 Sept.	Hazel Hollow (Smock Prairie)	tail, head, arm
368	AD	M	2 Sept.	Tygh Ranch	skull, eyes, stomach, testes
369	SA	M	1 Sept.	Tygh Ranch	skull, eyes, stomach, testes
370	JV	M	2 Sept.	Tygh Ranch	skull, eyes, guts
371	JV	M	2 Sept.	Tygh Ranch	skull, eyes, guts
372	JV	M	2 Sept.	Tygh Ranch	some teeth, stomach, arm
373	AD	F Lact.	3 Sept.	Penn Creek	skull, eye, arm, stomach
374	OA	F Lact.	3 Sept.	Tygh Ranch	skull, eye, guts
375	SA	M	3 Sept.	Tygh Ranch	skull, eye, guts
376	JV	M	3 Sept.	Tygh Ranch	skull, eye, guts
377	JV	M	2 Sept.	Tygh Ranch	skull, eye, guts
378	JV	M	2 Sept.	Tygh Ranch	skull, eye, guts
379	AD	F Lact.	3 Sept.	Picked up at Bonney Crossing	skull, eyes

#	Age ^a	Sex ^b	1984	Location	Parts
380	AD	F Lact.	3 Sept.	Picked up at Bonney Crossing	skull, eyes
381	SA		3 Sept.	Picked up at Bonney Crossing	skull, eyes
382	SA	F	2 Sept.	Tygh Ranch	all=skull, stomach, arm, lens, tail
383	AD	F Lact.	4 Sept.	Jordan Creek	arm, head, stomach
384		M	5 Sept.	Gate Creek	arm, eyes, testes, baculum
385	JV	F	5 Sept.	Gate Creek	arm, eyes, tail
386	AD	M	6 Sept.	$\frac{1}{2}$ - $\frac{3}{4}$ miles south Jct. 2710-2711	tail, arm, head, guts, testes, baculum
387	AD	M	6 Sept.	Jordan Creek	arm, stomach, testes, head
388	JV	F	6 Sept.	Jordan Creek	arm, head, guts, ovaries
389	SA		8 Sept.	Smock Prairie	tail, stomach, ovaries?
390	JV	M	8 Sept.	Jordan Creek	stomach, eyes, testes, skull
391	OA	M	8 Sept.	Jordan Creek	stomach, eyes, skull, testes
392	AD	M	13 Sept.	East of School Canyon	stomach, arm, tail, eyes, skull
393	SA	F	9 Sept.	Road 170, Barlow Road	skull, eye, guts
394	SA	M	10 Sept.	Bonney Crossing	skull, eye
395	AD	F Lact.	13 Sept.	East of School Canyon	
396	OA	F Lact.	13 Sept.	Bonney Crossing box	

#	Age ^a	Sex ^b	1984	Location	Parts
397	AD	M	13 Sept.	Barlow Road	stomach, skull, eyes
398		M	13 Sept.	Barlow Road	stomach, skull, eyes
399	AD	M	13 Sept.		skull, tail, stomach, eyes
400	AD	F	24 Sept.	S. ridge, Jordan Creek Canyon	guts
401	AD	F	20 Sept.	Gate Creek Canyon	arm, skull, lens, stomach
402	SA	M	15 Sept.	4 miles east of south end of North-South Road	tail, skull, lens, stomach, arm
403	SA	F	15 Sept.	4 miles east of south end of North-South Road	tail, skull, lens, stomach, arm
404	JV	M	9 Sept.	Jordan Creek	tail, skull, lens, stomach, arm
405	SA	M	20 Sept.	Gate Creek Canyon	arm, skull, lens, stomach
406	SA	M	1 Oct.	44 Badger Creek on S308 across from Trail 469	
407	AD	F Lact.	8 Sept.	Little Badger	all
408	SA	F	1 Oct.	S308/North-South Road	arm, lens, skull
409	SA	F	4 Oct.	Badger Creek Trail S308 at Trail 469	arm, lens, skull, stomach
410	AD	F	5 Oct.	Badger Creek campground entrance	arm, lens, skull, stomach
411	SA	F	5 Oct.	S308 Badger Creek campground entrance	arm, skull, lens, stomach,

#	Age ^a	Sex ^b	1984	Location	Parts
412	SA	M	23 Sept.	Jordan Creek Campground	eyes, tail, skull, stomach, testes, baculum
413	AD	F Lact.	23 Sept.	Jordan Creek Campground	skull, eyes, arm, guts
414	OA	F	29 Sept.	Douglas Cabin Road at start	skull, eyes, guts
415	OA	M	15 Sept.	Upper Mill Creek	tail, skull, eyes, arm, stomach, baculum
416	SA	M	15 Sept.	Upper Mill Creek	arm, skull, tail, eyes
417	SA	F	10 Oct.	1 mile south Jordan Creek campground along creek ridge	tail, arm, stomach, skull, ovaries
418	SA	M	7 Oct.	Badger Creek entrance to campground	arm, guts, eyes, jaws
421					arm
422					tail

^aOA = Old adult; AD = Adult; SA = Subadult; JV = Juvenile.

^bLact. = Lactating; Preg. = Pregnant.

#	Age ^a	Sex ^b	1985	Location	Parts
419	AD	M	25 Feb.	roadkill	tail, arm, jaw, lens
420	AD	F	25 Feb.	shot in pasture oaks @ HQ White River Wildlife Management Area	arm, skull, skin, lens, stomach, reprod. organs
423	AD	F	4 March	Pine Grove 1/4-mile north of Joyce turnoff on Rt. out to Endersby	skin, skull, eyes, ovaries, arm, stomach
424	AD	M	9 March	Shadybrook Road 300 yards east end of pavement--pipo/ pasture [scabies]	tail, skull, eyes, stomach, arm
425	OA	F	8 March	B/W Rock Gate Creek	tail, stomach, arm, eyes, skull
426	AD	F Preg.	12 March	1/2-mile north of 3 Feeder Corral	skin, skull, stomach, eyes, arm
427	SA	M		Clark Mill Road 200 yd. west of Game Fence Cattleguard	skull, arm, stomach, eye, tail
428	AD	F	14 Sept.		stomach, tail, skull, arm, eyes, ovaries
429	OA	F	24 Oct.		tail, skull, arm, ovaries, stomach, eyes
440	SA		1 Sept.	Rock Creek dumpster	skull, eyes, stomach, arm
441	AD	F	1 Sept.	Rock Creek dumpster	skull, eyes, stomach, arm, ovaries
442	SA	M	1 Sept.	Rock Creek dumpster	skull, eyes, stomach, arm

#	Age ^a	Sex ^b	1985	Location	Parts
443	JV	M	1 Sept.	Rock Creek dumpster	skull, eyes, stomach, arm, testes (2 sets—large & small)
444	JV	M	1 Sept.	Rock Creek dumpster	head, eyes
445	JV	M	1 Sept.	Rock Creek dumpster	skull, stomach, testes
446	AD	F Lact.	1 Sept.	Rock Creek dumpster	skull, stomach, testes
447	AD	F Lact.	1 Sept.	3530 Road	stomach, arm, head, eyes, ovaries
448	AD	F Lact.	1 Sept.	Barlow Road	
449	JV	F	1 Sept.	Tygh Creek	skull, eyes, arm, stomach, reprod.
450		F Lact.	1 Sept.	Tygh Creek	all (no arm)
451	SA	F	1 Sept.	Tygh Creek	all
452	JV	M	1 Sept.	Tygh Ranch	all
453	JV	M	1 Sept.	Tygh Creek	all
454	JV	M	1 Sept.	Tygh Creek	all
456	SA	F	3 Sept.	Tygh Creek	all
457	SA	M	3 Sept.	Tygh Ranch	all except arm
458	JV	F	2 Sept.	Tygh Ranch	all
459	AD	M	3 Sept.	Tygh Ranch	all but arm
460	OA	F	2 Sept.	Tygh Ranch	all

#	Age ^a	Sex ^b	1985	Location	Parts
461	AD	F	1 Sept.	North-South Road, School Canyon	all
462		M	4 Sept.	North-South Road	leg, testes
463	OA	F	4 Sept.		skull, stomach, leg
464		M	7 Sept.	Lower Little Badger Campground	
465	SA	F	7 Sept.	Friend area	skull, eye, stomach, testes, arm
466	SA	M	8 Sept.	Jordan Creek	stomach, leg, skull, eyes
467	JV	F	8 Sept.	Jordan Creek	jaws, stomach, 1 eye
468	AD	F Lact.	8 Sept.	Jordan Creek	skull, no eyes, stomach
469	AD	M	27 Oct.	Owl Hollow	skull, stomach, testes, tail, eyes
470	SA	M	27 Oct.	Owl Hollow	skull, stomach, tail, arm, eyes
471	AD	F	27 Oct.	1 mile south North-South Road	all
472	OA	F Lact.	12 Oct.	Bear Gulch	stomach, skull, lens, eartags 38/39
473	SA	M	12 Oct.	Bear Gulch	no tail, stomach, eyes, skull

^aOA = Old adult; AD = Adult; SA = Subadult; JV = Juvenile.

^bLact. = Lactating; Preg. = Pregnant.

#	Age ^a	Sex ^b	1986	Location	Parts
475	JV	M	30 Aug.	Onion Flats	arm, tail, testes, stomach, intestines
476		M	30 Aug.	Onion Flats	arm, reprod., tail, heart, stomach, intestine
477	SA	M	30 Aug.	Road above Bonney Crossing	arm, eyes, skull
478	SA	M	30 Aug.	Picked up at Barlow Road [scabies]	arm, tail, reprod., skull, stomach
479	SA	F	31 Aug.	Jordan Creek on road	eye, skull, arm, guts
480	AD	M	31 Aug.	south side Pen Creek	arm, tail, skull, eye, testes, guts
481		F	30 Aug.	Just in Forest Service boundary on F.S. 27	arm, tail, stomach
482		M	30 Aug.	intersection of pavement and dirt road, 27 & 2710	arm, tail, stomach
483		F	30 Aug.	Road 27 about 1 mile from start of pavement	arm, stomach
484		F	30 Aug.	Just past KC Pond toward pavement on Road 27	arm, stomach, tail, ovaries
485	JV	M	30 Aug.	1st cattle guard on Rd. 27	arm, stomach, testes, eartags 128/129
486	JV	M	30 Aug.	at pond by camp between two cattleguards	tail, arm, stomach
487	AD	M	30 Aug.	1 mile from Rock Creek campground	testes, eyes, lower jaw, stomach, arm
488		F	31 Aug.	upper Little Badger drop box	arm

#	Age ^a	Sex ^b	1986	Location	Parts
489	JV	M	31 Aug.	upper Little Badger drop box	no parts
490	OA	F	31 Aug.	gravel pit 3 Mile Creek	ovaries, stomach, arm, eye, skull
491	SA	M	31 Aug.	2710 above Bonney Crossing	testes, baculum, leg, eyes, skull, stomach
492	SA	M	1 Sept.	1 mile south of Jordan Creek	heart, tail, stomach, skull, testes, eye
493	SA	M	1 Sept.	2710 above Bonney Crossing	skull, eyes, arm(?), stomach
494	AD	M	4 Sept.	$\frac{1}{4}$ mil. downstream from Badger Crossing	skull, eyes, stomach, testes
495	SA	M	4 Sept.	Spur 31B campground	arm, skull, eyes, tail
496	SA	F	4 Sept.	Spur 31B campground	arm, skull, eyes, tail
497	AD	M	4 Sept.	2 miles from Bonney Crossing toward Tygh Valley	stomach, testes, legs, skull
498	AD	M	1 Sept.	White River Game Management Headquarters	lens, skull, testes, stomach
499	AD	F	1 Sept.	White River Game Management Headquarters	stomach, ovaries
500	AD	M	30 Aug.	10 Street—Chenowith	All
501	AD	M	10 Sept.	Barlow Road	eye, skull, stomach, testes
502	AD	F Lact.	6 Sept.	White River Game Management Headquarters	stomach, ovaries, skull, eye
503	OA	M	7 Sept.	Picked up Little Badger	skull, eye, stomach, testes

#	Age ^a	Sex ^b	1986	Location	Parts
504	AD	M	26 Oct.	T45, R11E, Section 35, Rd. 3530	stomach, eyes, arm, skull
505		F	25 Oct.	1½ mile N.E. Badger Crossing	jaw, eye
506	AD	M	25 Oct.	2 miles N.E. Badger Crossing	part skull, eye, stomach, testes
507	SA	M		Tygh Ranch	tail, skull, stomach
508	AD	M		School Ridge	tail, stomach, skull, eyes
509	AD	M	16 Sept.	½ mile Rock Creek Campground	skull, eyes, arm, stomach
510		M	24 Sept.	SW Jordan Creek Campground	stomach
511	AD				stomach, eye, skull
512	AD	F		Tygh Ranch	skull, eye
513		F	24 Oct.	Barlow Road	stomach
514		M	19 Oct.	Barlow Road	no pats
515	AD	M			stomach, head, eyes
516		F _{Lact.}	3 Nov.	¼ mile above Jordan Creek	stomach
517	OA	M			lower jaw
518	AD				skull, eyes, stomach
519	AD	F	25 Oct.	T45, R11E Sec. 22, 4820-120	skull, eyes, arm, stomach

^aOA = Old adult; AD = Adult; SA = Subadult; JV = Juvenile.

^bLact. = Lactating; Preg. = Pregnant.

#	Age ^a	Sex ^b	1987	Location	Parts
600	SA	M	29 Aug.	Little Badger Creek	skull, eyes, stomach
601	AD	M	29 Aug.	Rock Creek above gravel storage	skull, eyes, stomach, arm
602	AD	F	29 Aug.	Rock Creek above gravel storage	skull, eyes, stomach, arm
603	SA	M	29 Aug.	Rock Creek above gravel storage	skull, eyes, stomach, arm
604		F Lact.	29 Aug.	Friend Road	1 jar
605		F	29 Aug.	Friend Road	
606		M	29 Aug.	Friend Road	1 jar: 3 stomachs,
607		M	29 Aug.	Friend Road	1 testis, 3 baculum
608		M	29 Aug.	Friend Road	
609	SA	F	3 Sept.	Little Badger Creek by campground	leg, stomach, eyes, head, tail
610	SA	F	4 Sept.	Tygh Ranch	all
611	JV	M	20 Sept.	Badger Creek	tail, stomach
612	JV	F	20 Sept.	Badger Creek	tail, stomach
613		F	20 Sept.	Badger Creek	tail, stomach
614		M	26 Sept.	Picked up at Jordan Creek	tail, stomach, testes
615	SA	M	18 Oct.	Badger Creek Campground	tail, skull, eyes, stomach(?)
616	OA	F	18 Oct.		skull, eyes, stomach, ovaries

#	Age ^a	Sex ^b	1987	Location	Parts
617	AD	M	4 Nov.	Pine Grove	skull, eyes, arm
618	AD	M	4 Nov.		sull, eyes
619	AD	F	4 Nov.	Friend Area	skull, eyes

^aOA = Old adult; AD = Adult; SA = Subadult; JV = Juvenile.

^bLact. = Lactating; Preg. = Pregnant.

APPENDIX C

NEST TREE SITE MAPS

KEY:

- + = Nest Tree
 ○ = PIPO
 △ = QUGA

Nest tree site 074.

Note: PIPO = ponderosa pine; QUGA = Oregon white oak;
 CC = % canopy closure.

KEY:

- + = Nest Tree
 ○ = PIPO
 △ = QUGA

Nest tree site 077.

Note: PIPO = ponderosa pine; QUGA = Oregon white oak;
 CC = % canopy closure.

KEY:

+ = Nest Tree

○ = PIPO

△ = QUGA

Nest tree site 078.

Note: PIPO = ponderosa pine; QUGA = Oregon white oak;
CC = % canopy closure.

KEY:

- + = Nest Tree
○ = PIPO
△ = QUGA

Nest tree site 087.

Note: PIPO = ponderosa pine; QUGA = Oregon white oak;
CC = % canopy closure.

KEY:

- + = Nest Tree
- = PIPO
- △ = QUGA

Nest tree site 088.

Note: PIPO = ponderosa pine; QUGA = Oregon white oak;
CC = % canopy closure.

KEY:

+ = Nest Tree

○ = PIPO

△ = QUGA

Nest tree site 090.

Note: PIPO = ponderosa pine; QUGA = Oregon white oak;
CC = % canopy closure.

KEY:

- + = Nest Tree
 ○ = PIPO
 △ = QUGA
 □ = PSME

Nest tree site 093.

Note: PIPO = ponderosa pine; QUGA = Oregon white oak;
 PSME = Douglas-fir; CC = % canopy closure.

KEY:

- + = Nest Tree
 ○ = PIPO
 △ = QUGA
 □ = PSME

Nest tree site 0941.

Note: PIPO = ponderosa pine; QUGA = Oregon white oak;
 PSME = Douglas-fir; CC = % canopy closure.

KEY:

- + = Nest Tree
 ○ = PIPO
 △ = QUGA
 □ = PSME

Nest tree site 0942.

Note: PIPO = ponderosa pine; QUGA = Oregon white oak;
 PSME = Douglas-fir; CC = % canopy closure.

KEY:

+ = Nest Tree

○ = PIPO

△ = QUGA

Nest tree site 0951.

Note: PIPO = ponderosa pine; QUGA = Oregon white oak;
CC = % canopy closure.

KEY:

- + = Nest Tree
 ○ = PIPO
 △ = QUGA
 □ = PSME

Nest tree site 0952.

Note: PIPO = ponderosa pine; QUGA = Oregon white oak;
PSME = Douglas-fir; CC = % canopy closure.

KEY:

- + = Nest Tree
 ○ = PIPO
 △ = QUGA
 □ = PSME

Nest tree site 096.

Note: PIPO = ponderosa pine; QUGA = Oregon white oak;
PSME = Douglas-fir; CC = % canopy closure.

KEY:

- + = Nest Tree
- = PIPO
- △ = QUGA
- = PSME

Nest tree site 097.

Note: PIPO = ponderosa pine; QUGA = Oregon white oak;
PSME = Douglas-fir; CC = % canopy closure.

KEY:

+ = Nest Tree

○ = PIPO

△ = QUGA

Nest tree site 098.

Note: PIPO = ponderosa pine; QUGA = Oregon white oak;
CC = % canopy closure.

KEY:

- + = Nest Tree
 ○ = PIPO
 △ = QUGA
 □ = PSME

Nest tree site 099.

Note: PIPO = ponderosa pine; QUGA = Oregon white oak;
 PSME = Douglas-fir; CC = % canopy closure.

KEY:

+ = Nest Tree

○ = PIPO

△ = QUGA

Nest tree site 100.

Note: PIPO = ponderosa pine; QUGA = Oregon white oak;
CC = % canopy closure.

KEY:

+ = Nest Tree

○ = PIPO

Non-nest tree site 001.

Note: PIPO = ponderosa pine; CC = % canopy closure.

KEY:

- + = Nest Tree
○ = PIPO

Non-nest tree site 002.

Note: PIPO = ponderosa pine; CC = % canopy closure.

KEY:

- + = Nest Tree
- = PIPO
- △ = QUGA

Non-nest tree site 003.

Note: PIPO = ponderosa pine; QUGA = Oregon white oak;
CC = % canopy closure.

APPENDIX D

NEST BOX DESIGN

SQUIRREL NEST BOX PLAN

MATERIAL LIST

Rough 1" Lumber 9'-10"

Back	24" x 10"
Front	18" x 10"
Sides (2)	18" x 10"
Bottom	8" x 10"
Lid	14" x 10"
Lid Cleat	8" x 10"

Nails Galvanized	
8d	13 per side &
	3 in front = 29
6d	6 in lid = 6

Oregon Department of Fish & Wildlife
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7/75