Beetle Capture at Artificially Created Snags in Harvested Stands

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ABSTRACT

In north-central Idaho, a stand was harvested leaving artificially created snags that were cut by a single grip cut-to-length harvester 4-7m above ground. Beetle populations were monitored on two species of snags, *Pseudotsuga menziesii* var *glauca* ((Beissn.) Franco) and *Abies grandis* ((Dougl. Ex. D.Don) Lindl.), using 12-unit Lindgren funnel traps. There was a significant difference ($p<.05$) between the two host species in the overall abundance (more beetles were captured near Douglas-fir snags), but family diversity and richness remained relatively constant throughout the trapping dates. . Five families were selected for closer examination (Scolytidae, Curculionidae, Buprestidae, Cerambycidae, and Cleridae). Identified abundance of the selected families was not significantly different between snag species except for the Scolytidae, which were captured in significantly higher number near the Douglas-fir snags. The scolytid population was largely comprised of a single species, *Hylastes nigrinus* Mannerheim. Thus, while abundance is greater on Douglas-fir versus grand fir for the scolytids, the other families were similarly distributed between the two tree species.

CHAPTER 1

INTRODUCTION

Snags are dead standing trees that are naturally killed by fire, wind, lightning, insects/disease, drought or flooding. Snags are a natural component of forest ecosystems. They provide foraging areas and nesting and roosting cavities for many vertebrate species from primary and secondary cavity-nesting birds to bats and squirrels. The value of snags has become recognized over the past few decades as illustrated in the following excerpt from Bull et al. (1986):

> "In the beginning there were dead trees—snags—throughout the unmanaged forest. And he who was given charge to protect the forest, looked upon the forest and said: 'Let snags be bad. They are fire and safety hazards that harbor insects and, when rotten, furnish no marketable product.' After a time, the caretakers considered snags more closely and found that many creatures of feather, fur, and scale took refuge and raised their young in their dead boles, and he said: 'Henceforth, snags are good. Let snags and the animals they sustain, be part of the managed forest.'"

Cavity-nesting birds comprise about 25% of the bird species present in the Rocky Mountains (McClelland 1979). Primary cavity-nesting birds require snags in a specific stage of decay and diameter to be able to create nesting and roosting cavities (Morrison et al. 1986). Most of these primary cavity-nesters create new nest holes each spring (McClelland 1979). Secondary cavity-nesters are dependent upon the primary cavity-nesters to excavate and abandon these cavities (Morrison et al. 1986). Cavity-nesting birds use or create three main types of cavities (Chambers et al. 1997). A natural cavity is a hole that occurred from a limb breaking off the bole. A foraging cavity is a hole with a jagged opening that is too small (<7.5cm in diameter) to be used for nesting. Excavated cavities are any circular or rectangular opening with sufficient depth for a small cavity-nesting bird to nest in that is created by a woodpecker.

Cavity-nesting birds are not the only vertebrate species to use snags. Various small mammals use them as well for foraging and nesting, although their existence is not as dependent upon snags (Loeb 1996). Bats are the primary mammalian users of snags, mainly using the area behind the loose bark for shelter from daylight. Although bats are insect feeders, they do most of their foraging while flying. Other mammalian snag users are raccoons, squirrels, opossums, and chipmunks. In addition, semi-arboreal predatory mammals, such as weasels, scavenge eggs and other small mammalian young from nests in snags as a food source.

Snags are often removed during timber harvest for safety concerns as a result of their instability (Cambers et al. 1997). However, snags can also be harvested for fiber to produce wood products. After fires, salvage logging usually occurs which involves removing the burnt, dead standing timber. Furthermore, snags are removed during the process of mop-up (extended extinguishment of small fires within the fire area after a fire) to reduce the chance of someone being injured by a weak, falling snag. Firewood cutters also remove numerous snags primarily because the law limits them to removing dead trees only.

Snag Management

Management of snags has been developed and practiced by foresters and wildlife biologists to increase snag densities in managed forest stands. Forest managers have created management guidelines to protect and maintain snags to increase habitat for snag dependent species (Cline et al. 1980). This process includes protecting existing snags and artificially creating additional snags. An artificially created snag is a live tree intentionally killed using various techniques (e.g., girdling, topping, herbicide treatment, use of pathogenic fungi, or pheromones to attract tree-killing insects) (Bull and Partridge 1986). The methods used for killing a tree require careful planning due to varying result in different rates of decay, fall, and occupancy by wildlife. The variation in results occur for various reasons including failure of herbicide treatments to always kill the tree, pheromones used to attract insects may cause outbreaks in nearby trees and stands, pathogenic fungi sometimes result in faster decay than desired and girdled trees tend to have a high rate of fall.

Artificial creation of snags is one technique that is used to increase the density of cavity nesting birds in the area. Bull and Partridge (1986) measured the cost, fall rate, occupancy by cavity-nesting birds, and the mean mortality of six different methods of killing trees. A topped tree died immediately, stood the longest, and was most frequently used by birds for foraging. However, the topping method they used was expensive and labor-intensive. Other less labor-intensive methods can be used to lower the costs and still fabricate similar results.

Chambers et al. (1997) topped trees at 17 m above ground in either patches of clumped snags or dispersed snags throughout the stand. These snags were created in stands with different management practices including group selection, clearcut, and two-story canopies. Five years after topping occurred there was no significant difference in snag height, bark cover, scorch, and number of dead limbs or lean between stands. However, decay rate appeared to have been higher in open-canopy stands. Birds rarely used any natural snags within the study area, but natural snags were not readily available in the stands.

In clearcuts, cavity-nesting birds most frequently use snags that are 78 to 102 cm in diameter at breast height (dbh) and 3.4 to 9.3 m in height (Schreiber and deCalesta 1997). However, birds can use snags as small as 30 cm in dbh (Morrison et al. 1986). Cavity-nesting birds preferred snags that had neither advanced deterioration nor were completely sound and had higher percentage of bark cover. They also favored snags with broken tops versus intact tops (McClelland 1979).

The USDA Forest Service, Pacific Northwest Region, has developed a policy to help protect snags for wildlife. The policy was written to set standards and establish guidelines for management, but still allow flexibility between districts of the National Forest to best suit that area's forest ecology (Bull et al. 1986). The latest revision, completed in 1985, states:

> "Dead and defective tree habitat includes standing dead trees (snags), standing live defective trees, dead and down trees (logs), and whips (small, standing live or dead trees that remain standing after timber harvest operations). Dead and defective tree habitat shall be managed to maintain viable populations of existing native and desired non-native vertebrate species which are dependent upon or use such habitats on the National Forests. As a minimum, dead and

defective tree habitat shall be provided in sufficient quality, quantity, and distribution so as to maintain primary cavity excavators in excess of 40 percent of their population capacity on commercial forest lands."

Insects and Snags

One important aspect of snags is their relationship with insect communities and the affect snags may have on these insect populations. Many insect groups are attracted to dead and dying trees and rarely attack healthy trees. Many scolytid species release aggregation pheromones which are produced during their digestion of plant material to signal others that they have found a suitable host (Dajoz 2000). Other insects are attracted to compounds that are released by stressed trees. A tree suffering from a wound, drought, wind breakage, lightning, or fire is a stressed tree. Normally when a tree is wounded it secretes oleoresin, which may alert other insects to the presence of a weakened, susceptible tree.

Aggregation pheromones released by insects can cause dispersed individuals of the same species to congregate in a given place for an effective attack (Dajoz 2000). Females are frequently the pioneers and are the ones to initiate mass attacks by releasing pheromones. It has also been demonstrated that in different stages of the attack different pheromones are released to either attract or deter specific sex. When the tree has been successfully attacked and eggs have been laid, some species of insects will release yet another pheromone, an anti-aggregation pheromone, to deter other invaders away from their eggs. This ensures that a suitable habitat remains for their young to develop, disperse, and reproduce.

Temporal Distribution

Within 24 hours of being killed (severed), loblolly and Virginia pines were being colonized by bark beetles (Younan and Hain 1984). Bark beetle predators and competitors also quickly colonized the tree. Predators including *Platysoma parallelum* Say (Coleoptera: Histeridae), *Medetera bistriata* Parent (Diptera:Dolichopodidae), *Cylistix attenuata* LeConte (Coleoptera: Histeridae), and *Scoloposcelis mississippensis* (Drake and Harris) (Hemiptera: Anthocoridae) arrived within the first 24 hours of the tree being severed. The initial captures of bark beetle competitors' were also recorded within the first day after the tree was killed. Parasites did not arrive until the last 10 days of the study period (42 days) during which 73% were captured.

Stephen and Dahlsten (1976b) reported similar results in live trees under attack by the western pine beetle *Dendroctonus brevicomis* LeConte, but larval parasites were coordinated with the development of their hosts and arrived at the time suitable larvae were present. Predators respond quickly to a mass attack of *D. brevicomis*. Other correlations between bark beetles and their predators were found, such as, an increase of adult flies *Medetera aldrichii* Wheeler (Diptera: Dolichopodidae), on the bark at approximately the time bark beetle eggs hatched, thus providing a suitable larval host for developing maggots. Also, larval parasites were coordinated with the development of their hosts so they arrived at the time the suitable stage of the host was available.

Temporal distribution of beetles in trees that had been felled yielded similar results (Ohmart and Voigt 1982). However, these authors added some interesting points. Insects of the subfamily Aleocarinae (Coleoptera: Staphylinidae) and *Lasconotus trubercuatus* Kraus (Coleoptera: Colydiidae) arrived in waves. They had a quick, large number of arrivals after the tree was felled and the number of infesting insects slowly tapered off for the next 30 days. After 30 days the species again had a quick increase in population and tapered off for the next 30 days. These authors also reported that three xylophagous species, *Gnathotrichus retusus* (LeConte) (Coleoptera:Scolytidae), *Dolurgus pumulus* Mannerheim (Coleotera: Scolytidae), and *Lechriops californica* LeConte (Coleoptera: Curculionidae), did not arrive until the felled tree had dried sufficiently (approx. 30 days) to reach their moisture requirements and make the log a suitable habitat.

Spatial Distribution

The position of large woody debris is important for insect colonization (Ohmart and Voigt 1982). Therefore, on trees that are felled and horizontal, insect distribution had no noteworthy pattern because species that use vertical cues for landing cannot do so. Western pine beetle usually initiates attacks at the mid-bole region of standing trees and then spreads up and down the bole (DeMars 1970). Stephen and Dahlsten (1976b) reported that the first generation of these beetles and their associates were more abundant and primarily inhabited the region 10.5 m high on the bole, while the next generation was primarily present on the lower portion of the bole. The population of the bark beetles declined in the second generation and in response to the population decrease predators and parasites declined as well. The higher the population occurred on the bole, the lower the numbers of bark beetles in the second generation compared to the first generation (Stephen and Dahlsten 1976a). This change in spatial pattern of the beetles among generations could be an adaptive mechanism for optimizing use of the host. These mechanisms could increase survival during the winter in relation to thicker bark and preserving the phloem below the infestation for later use.

Objectives

The objective of this study was to better understand the insect use patterns of artificially created snags. More specifically, I designed the study to answer the question: Do species composition of bark beetles (Scolytidae), weevils (Curculionidae), long-horn beetles (Cerambycidae), metallic wood-boring beetles (Buprestidae), and checkered beetles (Cleridae) differ between species of artificially created snags in harvested stands?

My objectives were to:

1. Identify and compare the species composition of insect communities captured at two species of artificially created snags, Douglas-fir and grand fir.
2. Describe and compare the temporal distribution of insect species captured at two species of artificially created snags, Douglas-fir and grand fir.
3. Measure and compare abundance of selected insect species captured at two species of artificially created snags, Douglas-fir and grand fir.
4. Describe abundance of selected insects related to the variables of the snags, including height, diameter, closest neighbor and fuel loads, captured at two species of artificially created snags, Douglas-fir and grand fir.

CHAPTER 3

EXPERIMENTAL METHODS

All experimental work was conducted on the University of Idaho Experimental Forest (UIEF) located approximately 32 km east of Moscow, Idaho. The UIEF is comprised of four major units (East Hatter Creek, West Hatter Creek, Big Meadow Creek, and Flat Creek) that cover over 2830 hectares. The forest consists of a diverse population of plants and trees, typical of the drier mountains of northern Idaho (Osborne and Applegren 1996). However, this vegetation is highly influenced by the transition of true prairie to forest. Rain and snowfall result in annual precipitation of 69 cm. Daily average temperatures range from 0°C in the winter with an average daily low at -4°C to an average daily temperature of 17°C in the summer with a average daily high of 27°C. Soils are deep at 1.5 meters and are well to moderately drained formed in volcanic ash, in loess and granitic residuum. The UIEF also has frequent harvests that are followed by prescribed burns.

There are several common tree species in the forest including grand fir (*Abies grandis* ((Dougl. Ex. D.Don) Lindl.), Douglas-fir (*Pseudotsuga menziesii* var *glauca* ((Beissn.) Franco), western redcedar (*Thuja plicata* Donn ex D.Don), ponderosa pine (*Pinus ponderosa* Dougl. Ex Laws.), western larch (*Larix occidentalis* Nutt.), western white pine (*Pinus monticola* Dougl. Ex D.Don), lodgepole pine (*Pinus contorta* Dougl. ex Loud.), Engelmann spruce (*Picea engelmannii* Parry ex Engelm.), western hemlock (*Tsuga heterophylla* (Raf.) Sarg.) and subalpine fir (*Abies lasiocarpa* (Hook.) Nutt.)

(Osborne and Applegren 1996). A shrub layer that includes ninebark (*Physocarpus capitatus* (Pursh.) Kuntze), ocean-spray (*Holodiscus discolor* (Pursh.) Maxim), willows (Salix) and red stem ceanothus (*Ceanothus sanguineus* Pursh.) can dominate some areas. Snowberry (*Symphoricarpus albus* (L.) Blake), wild rose (*Rosa woodsii* Lindl.), and thimbleberry (*Rubus parvifloris* Nutt.) are common low shrubs in the area and the understory typically consists of forbs and grasses.

A variety of wildlife occurs within the UIEF due to the many stages of plant succession that are present. Elk, white-tailed deer, and mule deer use this habitat year-round and other mammals that are present include black bears, coyotes, bobcats, mountain lions, and moose (Osborne and Applegren 1996). In addition, numerous small mammals and birds occupy and use the UIEF for nest building and foraging.

Snags of two tree species, *Pseudotsuga menziesii* var. *glauca* and *Abies grandis,* were created within harvested stands unit 5 and 6 on the East Hatter Creek unit by removing the tops from the selected trees. The area encompassing the snags in this project included approximately 25 hectares. Trees were topped by cutting the tree 4-7 m above ground, leaving the appearance of high stumps that do not have any crown or foliage that remain.

The population of high stumps was created in January of 2002 using a single grip cut-to-length harvester, while the remaining stand was clear-cut. Distance between each snag and the forest edge varied. A total of 64 Douglas-fir and 83 grand fir high stumps were made, of which 15 Douglas-fir and 15 grand fir were used in this study. The high stumps were created from trees with various diameters and the final stumps were of varying heights. Along with stumps height and diameters, various measurements were recorded at each stump (Table 3.1). These measurements included the following:

- Percent slope
- Degree of aspect of the slope
- Elevation
- Northing
- Easting
- Fuel load was measured on four sides of the snag (North, South, East, and West) and then averaged for each snag. This evaluation was based on a post burn snag evaluation created by H. Osborne, UIEF Manager. It was based on a 1 to 5 scale with 1 being the least amount of fuel and 5 the greatest. The guidelines are as follow:
    1. Light timber litter
    2. Medium timber litter
    3. Light logging slash
    4. Medium logging slash
    5. Heavy logging slash
- Distance to the forest edge (edge of the harvest unit) up to 50 meters.
- Diameter at breast height for each snag.
- Height of each snag
- Distance to closest tree greater then 20 cm up to 50 meters.
    - Species of tree
    - Diameter at breast height
    - Height

  - The degree of location from the snag

- Distance to nearest tree same species greater then 10cm up to 50 meters.
  - Diameter at breast height
  - Height
  - The degree of location form the snag

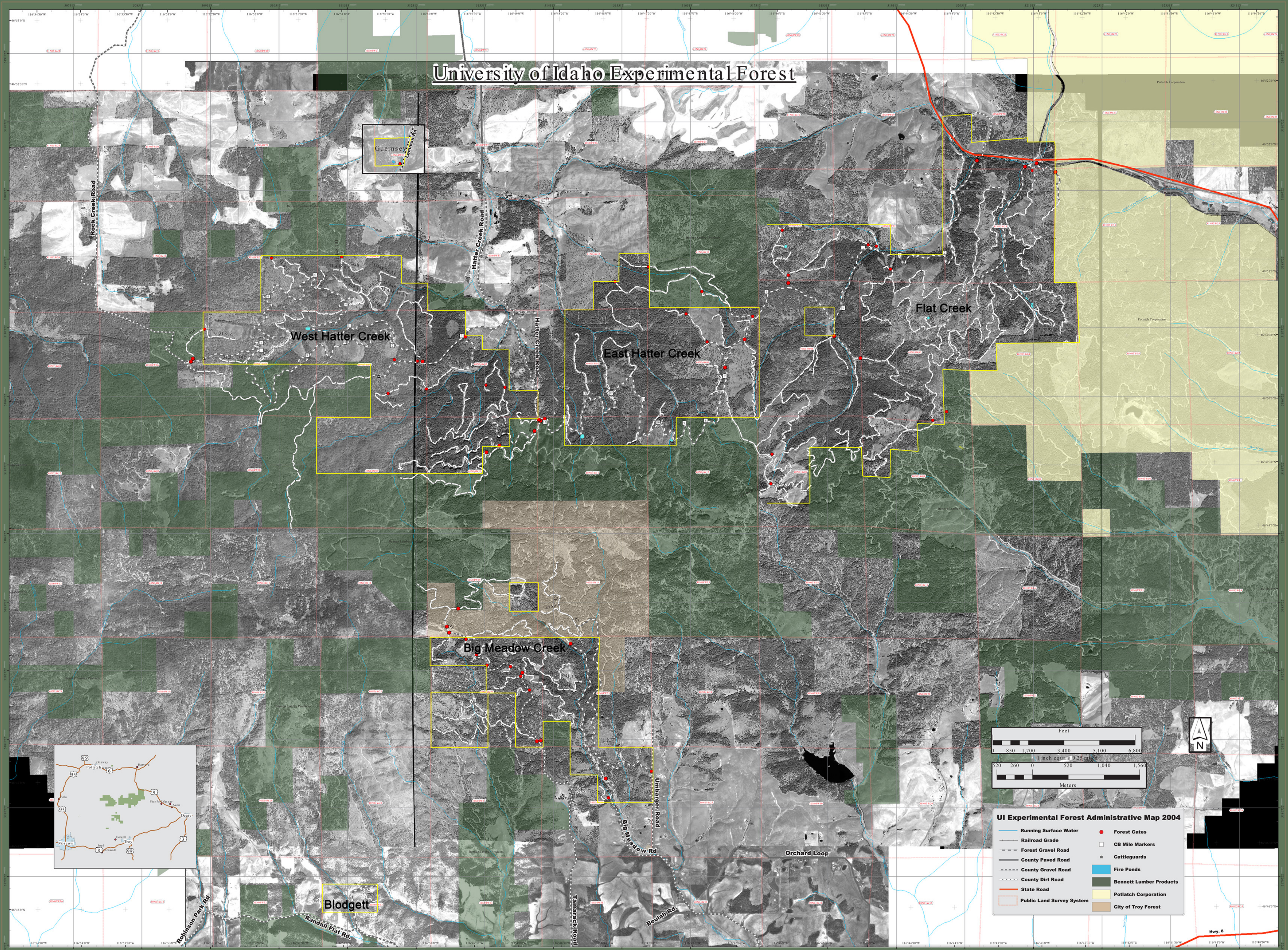
Table 3.1. The mean (± SEM) of environmental variables for the artificially created snags of Douglas-fir (n=15) and grand fir (n=15).

VARIABLE	DOUGLAS-FIR	GRAND FIR
Stump diameter (cm)	38 ± 2.92	33 ± 1.63
Stump height (m)	5 ± 2.03	4.6 ± 1.21
Aspect	286° ± 9.23	248° ± 10.74
Slope %	17.3% ± 2.98	16.5 ± 2.11
Elevation (m)	888 ± 24.01	886 ± 25.82
Northing	46.50.074 ± 00.01.184	46.50.079 ± 00.01.189
Easting	116.47.771 ± 00.00.991	116.47.771 ± 00.01.036
Fuel load	2.55 ± .21	2.28 ± .22

Beetle populations were monitored using 12-unit Lindgren funnel traps (Lindgren 1983) placed directly adjacent to the 15 grand fir and 15 Douglas-fir high stumps. One trap per tree was suspended on the eastern aspect of the boles, with the top of the trap approximately 2m above ground on an iron pole directly adjacent to the snag. Twenty traps (10 adjacent to Douglas-fir and 10 adjacent to grand fir high stumps) were placed in the field on May 15 and the remaining 10 traps (5 each on Douglas-fir and grand fir) were placed in the field on May 22.

Insects were collected from each trap weekly from May through mid-August and bimonthly from mid-August through September. The final collection was made on September 26. After each collection the specimens were sorted and all beetles were identified to family. The specimens in the families Scolytidae, Curculionidae, Buprestidae, Cerambycidae, and Cleridae, were divided and where possible, identified to species with the help of F.W. Merickel in the William F. Barr Museum, College of Agricultural and Life Sciences, University of Idaho (Dodds and Ross 2002; Furniss and Carolin 1977; Furniss and Johnson 2002; Hatch 1971; Wood 1982; Linsely 1962-64).

Temporal distributions of beetle captures were plotted. The total abundance of beetles captured throughout the summer, family richness (number of families captured), and family-level diversity were calculated and compared between the two high stump species using Student's t-tests. Family diversity was calculated using the Shannon-Weaver diversity index (Price 1997). Species level comparisons of abundance, richness, diversity and evenness was conducted for the selected families. All statistical analyses were conducted using the Statistix® (2000) software package.


University of Idaho Experimental Forest
Guernsey
Rock Creek Road
Hatter Creek Road
West Hatter Creek
East Hatter Creek
Flat Creek
Big Meadow Creek
Umbarger Road
Big Meadow Rd
Orchard Loop
Tamarack Road
Beulah Rd.
Robinson Park Rd.
Randall Flat Rd.
Blodgett
Hwy. 8
Feet
0 850 1,700 3,400 5,100 6,800
1 inch equals 0.25 miles
520 260 0 520 1,040 1,560
Meters
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UI Experimental Forest Administrative Map 2004
Running Surface Water
Railroad Grade
Forest Gravel Road
County Paved Road
County Gravel Road
County Dirt Road
State Road
Public Land Survey System
Forest Gates
CB Mile Markers
Cattleguards
Fire Ponds
Bennett Lumber Products
Potlatch Corporation
City of Troy Forest