HABITAT ASSESSMENT OF THE ENDANGERED OREGON FORESTSNAIL, *ALLOGONA TOWNSENDIANA*, IN THE LOWER FRASER VALLEY OF BRITISH COLUMBIA

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Abstract

The endangered Oregon forestsnail (*Allogona townsendiana*) is restricted to low elevations of the lower Fraser Valley and Vancouver Island in British Columbia, and several regions in Washington and Oregon. Although research on the life cycle and microhabitat requirements of the snail has occurred in recent years, little is known about its distribution and ecology.

Field surveys were conducted by Taara Environmental over an eight month period of 2006 to collect data on the habitat requirements and distribution of the snail. The survey resulted in data collection from 535 sample plots in several locations throughout the lower Fraser Valley. Data were analyzed to determine a variety of ecological and physical site factors of preferred snail habitat. Analysis included physical conditions such as slope, elevation, and substrate, as well as ecological descriptions of dominant vegetation and associations of trees, shrubs, and herbs.

From these data it was found that the most common habitat type in which the Oregon forestsnail occurs are broadleaf forests with moderate canopy covers dominated by big leaf maple (*Acer macrophyllum*) and lesser occurrences of red alder (*Alnus rubra*). Shrubs are generally lacking, but may include red elderberry (*Sambucus racemosa*) and salmonberry (*Rubus spectabilis*). A thick cover of stinging nettle (*Urtica dioica*) is common, often in combination with sword fern (*Polystichum munitum*). Moss is generally sparse to absent. Habitat is more often natural, although a reasonably high degree of disturbance can be tolerated if intact habitat is retained in close proximity to allow for re-colonization. Topography is generally slightly sloping to the southwest. Surface substrate is normally five to ten centimeter deep leaf litter with less than five pieces of coarse woody debris.

It is hoped that this research will be used assess potential development sites and other areas for important habitat and to aid in decisions regarding conservation of the highest value habitat.

Acknowledgements

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1.0 Introduction

The endangered Oregon forestsnail (*Allogona townsendiana*) is one of the largest land snails of southwestern British Columbia. Mature individuals have shell diameters of 28-35 mm and occur in a variety of colours from pale browns to light yellows and greens. It often has a tattered look, almost as if the shell is shedding. Shells are hairless and have large, extended aperture lips that typically have a globular appearance. Parietal denticles are absent. (COSEWIC, 2002)

In Canada the Oregon forestsnail is restricted to lowland areas of the lower Fraser Valley and a single locale on Vancouver Island. While most occurrences of the species have been from the Mission to Chilliwack region, the expected habitat ranges from Langley to Harrison Hot Springs (South Coast Conservation Program, 2006). The species also occurs in the Cascade Range, Puget Trough and portions of the Olympic Peninsula in the United States (COSEWIC, 2002) (Figure 1). The actual distribution and population size in British Columbia are unknown. Development pressure throughout the lower Fraser Valley is likely fragmenting and reducing potential and existing habitat.

Figure 1. Known Distribution of the Oregon Forestsnail

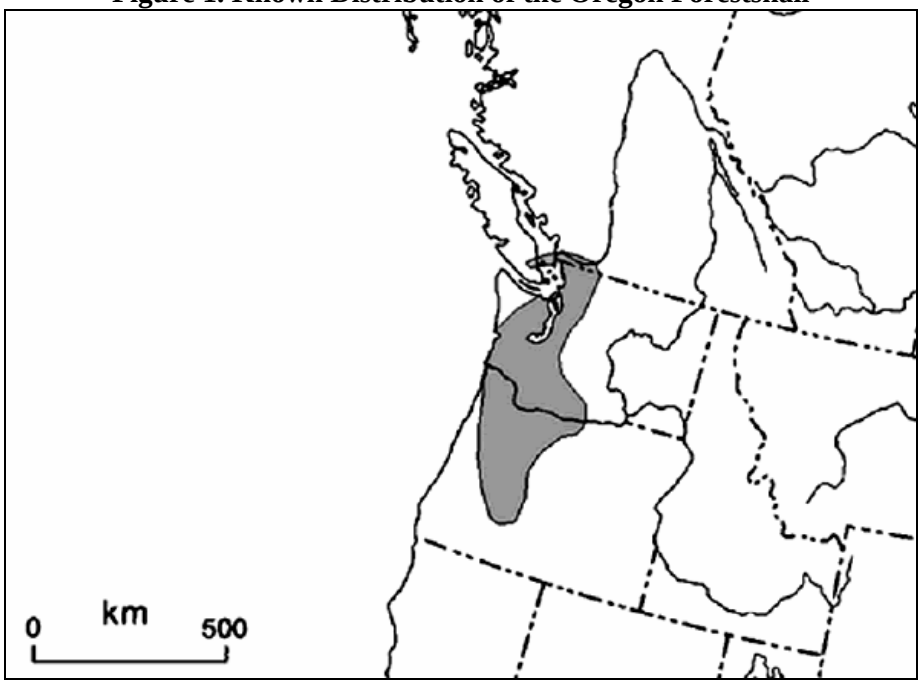

Figure 1 was adapted from the distribution map contained within the 2002 COSEWIC status report.

The ecology and life history of the Oregon forestsnail has been poorly studied (COSEWIC, 2002). Recent research at Trinity Western University has begun to provide information on the species' life cycle and microhabitat requirements (Zandberg, 2006). While this research has also focused on the macrohabitat of the species, it has been limited to the university grounds and may differ from the full range of the species.

In order to address some of the information gaps on the Oregon forestsnail, the purpose of this research project was twofold. First, an attempt has been made to determine the

macrohabitat requirements of the snail. Second, the habitat data has been analyzed to determine what site factors should be considered when assessing areas for potential habitat, impacts to habitat, and conservation of habitat. It is hoped that this information will be used by interested parties to assess development sites and other areas to identify critical habitat and to develop measures to protect the species and its habitat.

2.0 Methodology

Data collection did not follow an established protocol. Most of the data were collected during Sensitive Habitat Inventory Mapping (SHIM) projects for the City of Abbotsford and the Fraser Valley Regional District. Additional data were collected from incidental sightings during other studies and activities.

All data were collected digitally using a Trimble Pathfinder XR Pro GPS with real-time differential correction (1 to 5 metre accuracy). This method allowed for the efficient collection of data that included spatial references of all sample plots. Two different data sets were created as more ecological and site information was desired as the project progressed. The initial data set (n=453) included the collection of:

- Species
- Habitat Description (dominant vegetation)
- Number of individuals observed (living or shells)
- General comments (site descriptions, abnormal observations, etc.)

The second data set (n=82) was significantly expanded in order to collect information in a more consistent manner and to collect additional information. Data collection involved the use of pre-defined drop down menus and open fields where text and numeric data were entered. Data fields included (descriptions of drop-down menu options in parentheses):

- Date
- Species
- Number Observed
- Live/Dead (live, dead, shell)
- Distance to Stinging Nettle (< 5m, 5 to 10m, >10m)
- Slope
- Aspect
- Substrate (CWD, leaf litter, mud, talus, etc.)
- LFH Depth (< 5cm, 5 to 10cm, >10cm)
- Coarse Woody Debris Count (0, <5, 5-10, or >10)
- Forest Type (conifer, broadleaf, shrubs, etc.)
- Qualifier (natural, disturbed, urban residential, etc.)
- General Site Comments
- Canopy Cover (<5%, 5-33%, 34-66%, 67-100%)
- Tree Species

- Shrub Cover (<5%, 5-33%, 34-66%, 67-100%)
- Shrub Species
- Herb Cover (<5%, 5-33%, 34-66%, 67-100%)
- Herb Species
- Moss and Lichen Cover (<5%, 5-33%, 34-66%, 67-100%)

For the purposes of the study, the following definitions of Forest Type from the SHIM protocol (Mason & Knight, 2001) were used:

- "Coniferous forest - This area has a natural tree crown cover of 20% or more of the total polygon area, and at least 80% of the trees are conifers.

- Broadleaf forest VBF This area has a natural tree crown cover of 20% or more of the total polygon area, and at least 65% of the trees are broadleaf.

- Mixed forest - This area has a natural tree crown cover of 20% or more of the total polygon area, but of the total trees no more then 80% can be conifer and no more then 65% can be broadleaf.

- Shrubs - The area has less than 10% tree crown cover and natural shrubs constitute 20% or more of the ground cover. Shrubs are defined as multi-stemmed woody perennial plants, both evergreen and deciduous.

- Herbs/grasses - The area has less than 20% tree cover, less than 20 % shrub cover, and 20% or more natural herbaceous cover. Herbs for this classification are defined as grass-like vascular plants, including ferns and forbs, without a woody stem. Some dwarf woody plants may be included in this category."

Data were collected from plots centered on live snails or snail shells. The plots did not have fixed areas; rather they were based on visual areas of homogenous forest type, disturbance, vegetation species, etc. This method was chosen as the Oregon forestsnail has been shown to have variable habitat patch sizes from as little as $4m^2$ to as large as $70m^2$ (Zandberg, 2006). As the habitat patch size of the species is not well known, it was thought that a fixed plot size may not accurately describe the actual habitat of the species. Therefore, the variable plots size was considered to be a more appropriate assessment of the habitat being used by the snail at the time of the survey.

In each plot the number of live snails and shells were counted. These data were not considered to be accurate counts of the total number of snails in the plot. Counting was typically undertaken by one crew member while the other entered data and fixed a GPS location. Counting stopped when the data were collected, regardless of how much of the plot was surveyed.

3.0 Results

Field surveys were conducted from mid January to early August of 2006. In total, 535 plots were surveyed in six locations. The majority of the plots were located on McKee Peak and lower Sumas Mountain within the City of Abbotsford. Additional plots were located in the City of Abbotsford, Hatzic Prairie, Little Mountain (Chilliwack) and the lower Ryder Creek watershed in the Chilliwack River Valley. Due to the sensitivity of the species and the large number of plots that were located on private property, the specific locations will not be made public.

As the survey methodology was not standardized and did not use fixed plots, statistical analysis of the results has been kept to a minimum.

3.1 Number Observed

From the 535 plots a total of 872 live snails and 599 shells were observed. Counts of live snails per plots ranged from 0 to 40 with an average of 1.6. Shell counts per plot ranged from 0 to 14 with an average of 1.2. As previously mentioned, these counts are not considered to be an accurate representation of the number of individuals or shells per plot.

3.2 Vegetation

Extensive data on the vascular vegetation present at each site was collected. Tree and shrub species were well inventoried, but herbaceous species were limited to common occurrences and do not represent the true diversity of species. Moss and lichens were not inventoried. Due to the length of the field survey, the following results were influenced by seasonal changes which affected the number and type of herbaceous species recorded.

3.2.1 Forest Cover

The forest cover of all 535 plots was assessed (Table 1). Broadleaf forests were the most common type accounting for 72% of the plots, followed by mixed forests at 20.4%. All other types accounted for 7.7% of the plots.

Table 1. Forest Cover

Forest Cover	# Plots	Percent
Broadleaf Forest	385	72.0%
Mixed Forest	109	20.4%
Wetland	12	2.2%
Shrubs	11	2.1%
Exposed Soil	10	1.9%
Herbs/Grass	6	1.1%
Coniferous Forest	2	0.4%
TOTAL	**535**	**100%**

While broadleaf and mixed forests were expected, the other forest cover types were interesting observations (Figures 2 to 7). The other forest cover types are described in greater detail in the next sections.

One of the two recorded occurrences in a coniferous forest contained deciduous species, but not enough to classify it as mixed. The second occurrence did not contain any deciduous tree species or stinging nettle. The only recorded herbaceous species was sword fern.

Shrub dominated plots lacked any tree species and were generally classified as natural areas. Although not recorded, general observations indicate that most of these areas occurred adjacent to broadleaf or mixed forest stands.

Herb and grass dominated plots generally occurred along road and trail margins, and all but two were classified as disturbed sites. Interestingly, these areas contained some of the highest numbers of live snails.

The wetland plots were all classified as natural and generally occurred in broadleaf forests. Most plots contained stinging nettle and skunk cabbage (Figure 8). These areas generally occurred on the banks of streams in seepage areas. Only one plot had standing water and the single snail was observed on large woody debris.

All but three of the exposed soil plots occurred in disturbed sites, generally trails, slides, ditches or old roads. Many of the occurrences were bordered by broadleaf or mixed forest and it is assumed that the snails were temporary inhabitants of the exposed soil areas.

3.2.2 Trees

507 of the 535 plots contained tree species. Of those, canopy cover was estimated for 82 plots. The assessment determined that 59.8% of the plots of a canopy cover of 34-66%, 31.7% had a cover of 67-100%, and 8.5% had a cover of 5-33% (Table 2).

Table 2. Canopy Cover

Canopy Cover	# Plots	Percent
5-33%	7	8.5%
34-66%	49	59.8%
67-100%	26	31.7%
TOTAL	**82**	**100.0%**

In order to determine which tree species and associations of species are most commonly associated with OFS, the data were analyzed. Table 3 presents a breakdown of the number of plots that contain given tree species. It shows that big leaf maple (*Acer macrophyllum*) was found in 84.1% of the plots, along with red alder (*Alnus rubra*) at 33.8%, and western red cedar (*Thuja plicata*) at 20.0%. Five other species made up the remainder of the plot composition. Although not a recorded attribute, general observations during the survey found that the age or size of trees did not appear to significantly influence the number or presence of snails. Large numbers were found in pole/sapling forests, young forests, and stands with veteran trees.

Table 3. Tree Species

Species	# Plots	Percent
Big leaf maple (*Acer macrophyllum*)	450	84.1%
Red alder (*Alnus rubra*)	181	33.8%
Western red cedar (*Thuja plicata*)	107	20.0%
Paper birch (*Betula papyrifera*).	84	15.7%
Western hemlock (*Tsuga heterophylla*)	29	5.4%
No trees	28	5.2%
Douglas-fir (*Pseudotsuga Menziesii*)	22	4.1%
Black cottonwood (*Populus balsamifera* ssp. *Trichocarpa*)	6	1.1%
Other[1]	3	0.6%
TOTAL	**535**	

In order to determine the most common association of tree species, the data were analyzed to determine the number of species per plot. Tree composition ranged from zero to four species per plot (Table 4). Single species plots were the most common, accounting for 45.0% of the plots, followed by two species plots with 32.0%.

Table 4. Number of Tree Species per Plot

# Species/Plot	# Plots	Percent
Zero	28	5.2%
One	241	45.0%
Two	171	32.0%
Three	83	15.5%
Four	12	2.2%
TOTAL	**535**	**100.0%**

The most common single species plot was dominated by big leaf maple with 77.6% of the plots, followed by red alder with 19.9%. Three other species also occurred in single species plots (Table 5).

Table 5. Number of Plots and Type of Species with One Tree Species

Species	# Plots	Percent
Maple	187	77.6%
Alder	48	19.9%
Cedar	4	1.7%
Birch	1	0.4%
Fir	1	0.4%
Cottonwood	0	0.0%
Hemlock	0	0.0%

[1] Other species included one occurrence each of grand fir (*Abies grandis*), cascara (*Rhamnus pushiana*), and an introduced oak (*Quercus* sp.).

TOTAL	**241**	**100%**

Plots that contained two tree species contained several different compositions. Big leaf maple / red alder was the most common with 38.0% (this was also the most common multi tree species association of all plots), followed by big leaf maple / western red cedar with 28.7%, and big leaf maple / paper birch with 21.1%. Six other combinations of two species plots were observed (Table 6). Note that these statistics do not include plots that had more than two tree species. If these data are included then the numbers of two species combinations would increase and the subsequent percent of the total plots would change. The main change to the statistics in the following table would be an increase in the number and percent that contained the maple / alder, maple / birch, and birch / alder combinations.

Table 6. Number of Plots and Type of Species with Two Tree Species

Species	Maple	Percent
Maple/Alder	65	38.0%
Maple/Cedar	49	28.7%
Maple/Birch	36	21.1%
Maple/Hemlock	8	4.7%
Maple/Fir	7	4.1%
Maple/Cottonwood	3	1.8%
Maple/Birch	1	0.6%
Birch/Alder	1	0.6%
Cedar/Hemlock	1	0.6%
TOTAL	**171**	**100%**

Plots that contained three tree species were dominated by big leaf maple / red alder / western red cedar with 33.7% and big leaf maple / red alder / paper birch with 31.3%. The remainder of the plots contained various combinations of all seven main species and the three other tree species (Table 7).

Table 7. Number of Plots and Type of Species with Three Tree Species

Species Composition	# Plots	Percent
Maple/Alder/Cedar	28	33.7%
Maple/Alder/Birch	26	31.3%
Other	24	28.9%
Maple/Cedar/Hemlock	5	6.0%
TOTAL	**83**	**100.0%**

Only 12 plots contained four species of trees. All but two of the plots contained big leaf maple and red alder and none contained black cottonwood. The remaining species were distributed randomly with no dominant combinations.

3.2.3 Shrubs

265 of the 535 plots contained shrubs species. Of those, percent cover was estimated for 82 plots. The assessment determined that 47.6% of the plots had a percent cover of 34-

66%, 35.4% had a cover of 67-100%, 14.6% had a cover of 5-33%, and 2.4% had a cover of less than 5% (Table 8).

Table 8. Percent Cover of Shrubs

Canopy Cover	# Plots	Percent
<5%	2	2.4%
5-33%	12	14.6%
34-66%	39	47.6%
67-100%	29	35.4%
TOTAL	**82**	**100%**

In order to determine which shrub species and associations of species are most commonly associated with OFS, the data were analyzed. Table 9 presents a breakdown of the number of plots that contain given species. It shows that salmonberry was found in 22.8% of the plots, along with red elderberry at 19.1%, and thimbleberry at 13.1%. 16 other species made up the remainder of the plot composition. No shrubs were recorded for 50.5% of the plots.

Table 9. Shrub Species

Species	# Plots	Percent
No shrubs	270	50.5%
Salmonberry (*Rubus spectabilis*)	122	22.8%
Red elderberry (*Sambucus racemosa* ssp. *Pubens*)	102	19.1%
Thimbleberry (*Rubus parviflorus*)	70	13.1%
Vine maple (*Acer circinatum)*	37	6.9%
Devil's club (*Oplopanax horridus*)	27	5.0%
Indian plum (*Oemleria cerasiformis*)	27	5.0%
Snowberry (*Symphoricarpos albus*)	25	4.7%
Other	14	2.6%
Trailing blackberry (*Rubus ursinus*)	12	2.2%
Himalayan blackberry (*Rubus discolour*)	10	1.9%
Beaked hazelnut (*Corylus cornuta*)	7	1.3%
Dull Oregon grape (*Mahonia nervosa*)	5	0.9%
Red huckleberry (*Vaccinium parvifolium*)	3	0.6%
TOTAL	**535**	

Other shrub species include trailing black currant (*Ribes laxiflorum*), hardhack (*Spiraea douglasii*), mountain ash (*Sorbus sitchensis*), ninebark (*Physocarpus capitatus*), goatsbeard (*Aruncus dioicus*), oceanspray (*Holodiscus discolor*) and willow (*Salix* spp.).

In order to determine the most common association of shrub species, the data were analyzed to determine the number of species per plot. Shrub composition ranged from zero to five species per plot (Table 10). Plots with no shrubs were the most common, accounting for 50.5% of the plots. Plots with one species of shrub accounted for 26.7%, followed by two species plots with 14.2%. Three to five species plots accounted for only 8.7%.

Table 10. Number of Shrub Species per Plot

# Species/Plot	# Plots	Percent
Zero	270	50.5%
One	143	26.7%
Two	76	14.2%
Three	27	5.1%
Four	10	1.9%
Five	9	1.7%
TOTAL	**535**	**100.00%**

The most common single species plot was dominated by salmonberry with 28.0%, thimbleberry with 23.1% and red elderberry with 18.2%. Each of the remainder of the shrub species accounted for less than 10% of the total plots (Table 11).

Table 11. Number of Plots and Type of Species with One Shrub Species

Species	# Plots	Percent
Salmonberry	40	28.0%
Thimbleberry	33	23.1%
Red elderberry	26	18.2%
Devil's club	13	9.1%
Other	6	4.2%
Snowberry	6	4.2%
Trailing blackberry	6	4.2%
Indian plum	5	3.5%
Vine maple	3	2.1%
Himalayan blackberry	3	2.1%
Dull Oregon grape	2	1.4%
Beaked hazelnut	0	0.0%
Red huckleberry	0	0.0%
TOTAL	**143**	**100%**

Plots with two species of shrubs had 24 combinations. The most common combination was red elderberry / salmonberry at 36.8%. Each of the remaining combinations accounted for less than 10% of the total plots (Table 12).

Table 12. Number of Plots and Type of Species with Two Shrub Species

Species	# Plots	Percent
Red elderberry / Salmonberry	28	36.8%
Salmonberry / Thimbleberry	7	9.2%
Red elderberry / Vine maple	5	6.6%
Salmonberry / Devil's club	5	6.6%
Red elderberry / Thimbleberry	4	5.3%
Red elderberry / Snowberry	3	3.9%
Salmonberry / Vine maple	3	3.9%
Red elderberry / Other	2	2.6%

Salmonberry / Indian plum	2	2.6%
Thimbleberry / Indian plum	2	2.6%
Vine maple / Snowberry	2	2.6%
Red elderberry / Himalayan blackberry	1	1.3%
Red elderberry / Indian plum	1	1.3%
Red elderberry / dull Oregon grape	1	1.3%
Salmonberry / Trailing blackberry	1	1.3%
Salmonberry / dull Oregon grape	1	1.3%
Thimbleberry / Vine maple	1	1.3%
Thimbleberry / Trailing blackberry	1	1.3%
Vine maple / Indian plum	1	1.3%
Vine maple / Beaked hazelnut	1	1.3%
Vine maple / Himalayan blackberry	1	1.3%
Indian plum / Snowberry	1	1.3%
Indian plum / Other	1	1.3%
Snowberry / Himalayan blackberry	1	1.3%
TOTAL	**76**	**100%**

Three species combinations had few dominant combinations. 14.8% of the three species plots contained the red elderberry / salmonberry / vine maple combination, another 14.8% contained the red elderberry / salmonberry / thimbleberry combination, while the remainder has various combinations.

Only one combination, red elderberry / salmonberry / thimbleberry / trailing blackberry, occurred more than once (20%) in the plots that contained four species. No dominant combinations were found in the five species plots.

As with the tree species, if the three, four and five species combinations are added to the two species combinations, then the most common shrub associations would change. The expanded selection would still be dominated by combinations of red elderberry, salmonberry, thimbleberry, and vine maple.

3.2.4 Herbs

421 of the 535 plots contained at least one herbaceous species. Of those, percent cover was estimated for 82 plots. The assessment determined that 73.2% of the plots had a percent cover of 67-100%, 20.7% had a cover of 34-67%, 4.9% had a cover of 5-33%, and 1.2% had a cover of less than 5% (Table 13).

Table 13. Percent Cover of Herbs

Percent Cover	# Plots	Percent
<5%	1	1.2%
5-33%	4	4.9%
34-66%	17	20.7%
67-100%	60	73.2%
TOTAL	**82**	**100%**

In order to determine which shrub species and associations of species are most commonly associated with OFS, the data were analyzed. Table 14 presents a breakdown of the

number of plots that contain given species. It shows that stinging nettle (*Urtica dioica*) was the most common species accounting for 66.2% of the plots, while sword fern (*Polystichum munitum)* was found in 27.5%, and fringecup (*Tellima grandiflora*) in 10.5%. 15 other species that occurred in less than 10% of the plots made up the remainder of the plot composition. 21.1% of the plots did not contain herbaceous vegetation.

Table 14. Herb Species

Species	# Plots	Percent
Stinging nettle (*Urtica dioica*)	354	66.2%
Sword fern (*Polystichum munitum)*	147	27.5%
No herbs	113	21.1%
Fringecup (*Tellima grandiflora*)	56	10.5%
Lady fern (*Athyrium filix-femina*)	53	9.9%
Bedstraw (*Galium spp.*)	32	6.0%
Pacific bleeding heart (*Dicentra formosa*)	29	5.4%
Other	24	4.5%
Bracken (*Pteridium aquilinum*)	18	3.4%
Vanilla leaf (*Achlys triphylla*)	9	1.7%
Skunk cabbage (*Lysichiton americanus*)	7	1.3%
TOTAL	**535**	

Other shrub species include various buttercup (*Ranunculus* spp.) and grass species, common horsetail (*Equisetum arvense*), lance leaved plantain (*Plantago lanceolata*), Pacific waterleaf (*Hydrophyllum tenuipes*), reed canarygrass (*Phalaris arundinacea*), Mexican hedge-nettle (*Stachys mexicana*), broad-leaved starflower (*Trientalis borealis*), and Siberian miner's-lettuce (*Claytonia sibirica*).

In order to determine the most common association of herbaceous species, the data were analyzed to determine the number of species per plot. Herb composition ranged from zero to six species per plot (Table 15). Plots with one species of herb accounted for 47.7%, followed by two species plots with 17.0%. Three to six species plots accounted for the remaining 13.9% of the plots. Plots with no herbs were the second most common, accounting for 21.1% of the plots.

Table 15. Number of Herb Species per Plot

# Species/Plot	# Plots	Percent
Zero	113	21.1%
One	255	47.7%
Two	91	17.0%
Three	35	6.5%
Four	20	3.7%
Five	13	2.4%
Six	7	1.3%
TOTAL	**535**	**100.0%**

The most common single species plot was dominated by stinging nettle with 80.4%, while sword fern accounted for 18.0%. Each of the remainder of the shrub species accounted for less than 0.4% of the total plots (Table 16).

Table 16. Number of Plots and Type of Species with One Herb Species

Species	# Plots	Percent
Stinging nettle	205	80.4%
Sword fern	46	18.0%
Lady fern	1	0.4%
Fringecup	1	0.4%
Vanilla leaf	1	0.4%
Skunk cabbage	1	0.4%
Pacific bleeding heart	0	0.0%
Bracken	0	0.0%
Bedstraw spp.	0	0.0%
Other	0	0.0%
TOTAL	**255**	**100%**

Plots with two species of herbs had 16 associations. The most common association was stinging nettle / sword fern at 39.6%. Each of the remaining associations accounted for less than 10% of the total plots (Table 17).

Table 17. Number of Plots and Type of Species with Two Herb Species

Species	# Plots	Percent
Stinging nettle / sword fern	36	39.6%
Stinging nettle / lady fern	9	9.9%
Stinging nettle / bedstraw spp.	8	8.8%
Stinging nettle / Pacific bleeding heart	8	8.8%
Stinging nettle / other	7	7.7%
Stinging nettle / skunk cabbage	6	6.6%
Stinging nettle / fringecup	5	5.5%
Sword fern / lady fern	3	3.3%
Sword fern / other	2	2.2%
Bracken / other	1	1.1%
Fringecup / other	1	1.1%
Stinging nettle / vanilla leaf	1	1.1%
Sword fern / vanilla leaf	1	1.1%
Stinging nettle / bracken	1	1.1%
Lady fern / fringecup	1	1.1%
Sword fern / fringecup	1	1.1%
TOTAL	**91**	**100%**

Plots with three species of herbs had seven reoccurring associations, and seven random associations. The most common associations were stinging nettle / sword fern / bedstraw

spp., stinging nettle / sword fern / bracken, and stinging nettle / sword fern / lady fern, all of which accounted for 14.3% of the plots. Each of the remaining associations accounted for 11.4% or less of the total plots (Table 18).

Table 18. Number of Plots and Type of Species with Three Herb Species

Species	# Plots	Percent
Stinging nettle / sword fern / bedstraw spp.	5	14.3%
Stinging nettle / sword fern / bracken	5	14.3%
Stinging nettle / sword fern / lady fern	5	14.3%
Stinging nettle / sword fern / fringecup	4	11.4%
Sword fern / lady fern / fringecup	4	11.4%
Stinging nettle / sword fern / other	3	8.6%
Stinging nettle / lady fern / fringecup	2	5.7%
Other combinations	7	20.0%
TOTAL	**35**	**100%**

Plots with four species of herbs had four reoccurring associations, and eight random associations. The most common association was stinging nettle / sword fern / lady fern / fringecup which accounted for 30.0% of the plots. Each of the remaining associations accounted for 10.0% or less of the total plots (Table 19).

Table 19. Number of Plots and Type of Species with Four Herb Species

Species	# Plots	Percent
Stinging nettle / sword fern / lady fern / fringecup	6	30.0%
Stinging nettle / sword fern / lady fern / other	2	10.0%
Stinging nettle / lady fern / vanilla leaf / bedstraw spp.	2	10.0%
Stinging nettle / sword fern / fringecup / Pacific bleeding heart	2	10.0%
Other combinations	8	40.0%
TOTAL	**20**	**100%**

Plots with five species of herbs had two reoccurring associations, and seven random associations. Each of the two reoccurring associations accounted for 23.1% of the plots, while the random associations comprised the remaining 53.8% (Table 20).

Table 20. Number of Plots and Type of Species with Five Herb Species

Species	# Plots	Percent
Stinging nettle / sword fern / fringecup / Pacific bleeding heart / bedstraw spp.	3	23.1%
Stinging nettle / sword fern / lady fern / fringecup / Pacific bleeding heart	3	23.1%
Other combinations	7	53.8%
TOTAL	**13**	**100%**

Plots with six species of herbs had one reoccurring association, and three random associations. Each of the two reoccurring associations accounted for 57.1% of the plots, while the random associations comprised the remaining 42.9% (Table 21).

Table 21. Number of Plots and Type of Species with Six Herb Species

Species	# Plots	Percent
Stinging nettle / sword fern / lady fern / fringecup / bedstraw spp. / other	4	57.1%
Other combinations	3	42.9%
TOTAL	**7**	**100%**

As with the tree and shrub species, if the three to six species associations are added to the two species associations, then the most common associations would change. The expanded selection would still be dominated by associations of stinging nettle, sword fern, lady fern, fringecup, and bedstraw spp.

3.2.5 Moss

The percent cover of mosses was estimated for 82 plots, but species were not identified. Table 22 shows that 76.8% of the plots had less than 5% cover of moss, 19.5% has 2 to 33%, and only 3.7% had 34-66%. No plots contained more than 67% cover of moss.

Table 22. Percent Cover of Moss

Percent Cover	# Plots	Percent
<5%	63	76.8%
5-33%	16	19.5%
34-66%	3	3.7%
67-100%	0	0.0%
TOTAL	**82**	**100%**

3.2.6 Distance to Stinging Nettle

Due to the known importance of stinging nettle in the habitat requirements of the Oregon forestsnail, the distance from observed snails to nettle plants were recorded. Of the 82 plots where the distance to stinging nettles were measured, 84.1% were observed within five metres, 1.2% within five to ten metres, and 14.6% over ten metres (Table 23). On many occasions, snails were observed climbing the stalks of nettles (Figure 9 and 10).

Table 23. Distance to Stinging Nettle

Distance	# Plots	Percent
< 5m	69	84.1%
5 to 10m	1	1.2%
> 10m	12	14.6%
TOTAL	**82**	**100%**

3.3 Disturbance

All 535 plots were assessed for disturbance. The assessment found that 76.6% of the plots were considered natural with the remaining 23.4% disturbed. This was a qualitative measurement based on the general appearance of the site. A plot was considered to be disturbed if any significant disturbance had occurred within the last 20 years. Few if any sites were located in areas that have not been disturbed by human use due to their proximity to urban areas. Table 24 presents the number and percent of plots that were considered to be disturbed.

Table 24. Disturbance

Type	# Plots	Percent
Natural	410	76.6%
Disturbed	125	23.4%
TOTAL	**535**	**100**

Disturbances varied throughout the study areas. Types of disturbance observed ranged from past/current logging, agricultural, urban/residential encroachment, trails, roads, ditch maintenance, and natural events such as slides and slumps. The most common disturbance types noted were trails and urban/residential encroachment.

Three areas where snails were observed living in disturbed conditions were of great interest. The first area was a large private parcel on lower Sumas Mountain. The area had been clearcut, de-stumped, plowed, and used as horse pasture for an unknown time. At the time of the survey, the parcel was dominated by a thick canopy of pole/sapling red alder (Figure 13), with much of the bordering area containing a young to mature broadleaf forest dominated by big leaf maple. Few shrub species were present and the herbaceous layer was largely limited to patches of stinging nettle. The area had a substrate that was mainly composed of exposed mineral soil with accumulations of small woody debris from alder as the stand underwent self-thinning. Almost without exception, each patch of stinging nettle contained a small snail population. No snails were found outside of the stinging nettle patches.

The second area included several ditches and road medians along Straiton Road on lower Sumas Mountain. The area was bordered on one side by a paved road and steeply sloping broadleaf forest on the other. It was dominated by herbs and grasses and short shrubs. Regular ditch and road maintenance occurred, so all vegetation was mown and most of the ditch was exposed mineral soils (Figure 11). This area contained some of the highest concentrations of breeding snails observed during the study and included several observations of snails in the ditch and directly adjacent to the paved edge of the road.

The third area was the multitude of old dirt roads and active trails found throughout the study areas. Many of the plots considered disturbed occurred when a snail was observed in or on the edge of an active dirt trail or old road (Figure 12). The trails were used for many purposes including hiking, horse riding, dog walking, and ATV and bike riding. Numerous recently dead snails were found on trails, but many more were observed

crossing or nesting in the exposed soils. The majority of these areas were bordered by big leaf maple dominated forests.

3.4 Slope

The slope of 81 plots was measured and basic statistical analysis performed. Slope ranged from 0° to 50° with a mean of 13.3 (Table 25).

Table 25. Slope

Mean	13.3
Standard Error	1.06
Median	12
Mode	5
Standard Deviation	9.57
Sample Variance	91.63
Minimum	0
Maximum	50
Confidence Level (95.0%)	2.12

3.5 Aspect

The aspects of 77 plots were measured using a classified system of N, NE, E, SE, S, SW, W and NW. The most common aspects were SW, W, and NW accounting for 87.1% of the sites. No NE or E aspects were measured and only a single SE azimuth was measured. Table 26 presents the number and percent of aspects measured.

Table 26. Aspect

Aspect	# Plots	Percent
SW	30	39.0
W	19	24.7
NW	18	23.4
N	6	7.8
S	3	3.9
SE	1	1.3
NE	0	0.0
E	0	0.0
TOTAL	**77**	**100.0**

These data are skewed towards western slopes due to the topography in which the plots were located. Many plots where aspect was not recorded were located on southern and eastern slope (such as the southern slope of McKee Peak above Lower Sumas Mountain Road).

3.6 Elevation

The elevation of the lowest and highest plots was determined from digital topographical maps. The lowest elevation was 12 metres a.s.l. at the base of Sumas Mountain in the City of Abbotsford. The highest elevation was 390 metres a.s.l. near the summit of

McKee Peak in the City of Abbotsford. Although the elevation of all data points were not statistically analyzed, a visual inspection of the mapped occurrences indicates that no particular elevation had a concentration of species. It did appear that the number of mapped occurrences generally decreased with higher elevations; however, limited time was spent surveying areas above 300 metres a.s.l.

3.7 Substrate

Snails were observed on a variety of substrates. Substrate ranged from various types and thicknesses of leaf litter, exposed mineral soil, organic soils, large woody debris, and interspersed amongst colluvial boulders (Figures 14 to 16). The most common substrate observed was leaf litter, accounting for 88.8% of the plots (Table 27).

Table 27. Substrate

Type	# Plots	Percent
Leaf litter	71	88.8%
Soil	8	9.8%
Colluvium	2	2.4%
LWD	1	1.2%
TOTAL	**82**	**100.0%**

Leaf litter depth was recorded using a classified system of <5cm, 5-10cm, and >10cm (Table 28). The most common depth measured was 5-10cm, accounting for 62.0% of the plots.

Table 28. Depth of Leaf Litter

Type	# Plots	Percent
< 5cm	10	14.1%
5-10cm	44	62.0%
>10cm	17	23.9%
TOTAL	**71**	**100%**

Coarse woody debris was recorded using a classified system of <5, 5-10, and >10 occurrences in the plot (Table 29). It was found that 86.6% of the plots contained less than 5 pieces of coarse woody debris, and none contained more than 10 pieces.

Table 29. Coarse Woody Debris Count

Type	# Plots	Percent
< 5	71	86.6%
5 to 10	11	13.4%
>10	0	0.0%
TOTAL	**82**	**100%**

4.0 Discussion

The results of this survey indicate that the Oregon forestsnail inhabits a wide variety of habitat types and disturbance levels. That said, the snail appears to have a strong preference for several specific habitats. The following table is a summary of the most common habitat types based on the highest percentage of occurrence within surveyed plots (Table 30). The three columns (A, B, and C) indicate preferred habitat types with A being the highest occurrence and B and C less common. Elevation was not included due to lack of sufficient data.

Table 30. Habitat Suitability Rating

Factor	Suitability Rating		
	A	**B**	**C**
Forest Type	Broadleaf Forest	Mixed Forest	Wetland
Canopy Cover	34-66%	67-100%	5-33%
Tree Species	Big leaf maple	Red alder	Western red cedar
Number Tree Species	1	2	3
Tree Association	Big leaf maple / red alder	Big leaf maple / western red cedar	Big leaf maple / birch
Percent Cover of Shrubs	0	34-66%	67-100%
Shrub Species	No shrubs	Salmonberry	Red elderberry
Number Shrub Species	0	1	2
Shrub Association	Red elderberry / salmonberry	Red elderberry / salmonberry / vine maple	Red elderberry / salmonberry / thimbleberry
Percent Cover of Herbs*	67-100%	34-66%	5-33%
Herb Species	Stinging nettle	Sword fern	Fringecup
Number Herb Species	1	2	3
Herb Association	Stinging nettle / sword fern	Stinging nettle / sword fern / lady fern	Stinging nettle / sword fern / fringecup
Moss Cover	<5%	5-33%	34-66%
Distance to Stinging Nettle	< 5m	> 10m	5 to 10m
Disturbance Tolerance	Natural	Natural	Natural
Slope	13	13	13
Aspect	SW	W	NW
Elevation	-	-	-
Substrate Type	Leaf litter	Soil	Colluvium
Depth of Leaf Litter	5-10cm	>10cm	< 5cm
Coarse Woody Debris Count	< 5	5 to 10	>10

* The plots that did not contain herb species were not included in the above table. The lack of herbs is considered to be due to the large number of plots that were surveyed in early spring.

The above suitability rating indicates that the most common habitat type in which the Oregon forestsnail occurs are broadleaf forests with moderate canopy covers dominated by big leaf maple and lesser occurrences of red alder Shrubs are generally lacking, but may include red elderberry and salmonberry. A thick cover of stinging nettle is common, often in combination with sword fern. Moss is generally sparse to absent. Habitat is more often natural, although a reasonably high degree of disturbance can be tolerated if intact habitat is retained in close proximity to allow for re-colonization. Topography is generally slightly sloping to the southwest. Surface substrate is normally five to ten centimeter deep leaf litter with less than five pieces of coarse woody debris.

5.0 Conclusion and Recommendations

This study attempted to describe the most common habitat in which the Oregon forest occurs. Based on the large sample size and distribution of sample plots, the results should be reasonably accurate. The calculated percentages of specific physical and ecological conditions were skewed by the time of year in which the survey was conducted, the lack of fixed plot areas, and the incomplete vegetation inventory. However, while the actual percentages may have inaccuracies, the dominant vegetation and physical descriptions were significantly more common and changes to survey methods should not affect their rankings. Even with assumed inaccuracies, the analysis of the data should assist with the identification of important habitat features when considering disruptive activities and when determining potential conservation areas.

The data could be significantly improved by the created of permanent fixed sample plots of standard sizes and the development of a standardized survey method. However, in order to determine these criteria, additional knowledge on the life cycle and microhabitat requirements of the snail is required. This study is conducive to future repetition as all the sample plots were accurately mapped. When the biology of the snail is better understood, it is recommended that a survey is conducted in a manner in which comprehensive statistical analysis can be performed.

6.0 References

COSEWIC 2002. COSEWIC assessment and status report on the Oregon forestsnail Allogona townsendiana in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vi + 20 pp.

Mason, B., and R. Knight. 2001. Sensitive Habitat Inventory and Mapping. Community Mapping Network, Vancouver, British Columbia. 315pp + viii. M. Johannes, Editor.

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Appendix A: Photo Plates

Figure 2. Broadleaf Forest and Colluvium

Figure 2 shows an uncommon habitat type; large colluvial boulders and woody debris on steep western slopes of lower Sumas Mountain, Abbotsford. While the substrate was different than many plots, these areas typically had young to mature big leaf maple, red alder, sword fern, and stinging nettle.

Figure 3. Big Leaf Maple and Stinging Nettle

Figure 3 shows mature big leaf maple stands with a dense cover of stinging nettle on flat, lowland areas of lower Sumas Mountain, Abbotsford. These areas contained the highest concentrations of snails and often extended for several hectares.

Figure 4. Steep Broadleaf Forest and Sword Fern

Figure 4 shows steep, rocky slopes western slopes of Sumas Mountain, Abbotsford. While not as frequent as lowland areas, numerous snails were mapped amongst the sword fern, stinging nettle, big leaf maple, red alder and occasional conifer.

Figure 5. Red Alder, Red Elderberry, and Stinging Nettle

Figure 5 shows typical red alder, big leaf maple, red elderberry, and stinging nettle that frequently occurs on much of lower Sumas Mountain, Abbotsford.

Figure 6. Western Red Cedar, Big Leaf Maple, Sword Fern and Stinging Nettle

Figure 6 shows typical habitat of big leaf maple, western red cedar, sword fern and stinging nettle that occurs on much of lower Sumas Mountain, Abbotsford. This was one of the most common habitats in which the snail was observed.

Figure 7. Oregon Grape

Figure 7 shows an example of a steep, dry slope covered in Oregon grape on Sumas Mountain, Abbotsford. Several snails were found in this unusual habitat.

Figure 8. Skunk Cabbage Wetland

Figure 8 shows a live snail found in a skunk cabbage wetland on the banks of Clayburn Creek, Abbotsford.

Figure 9. Stinging Nettle and Bedstraw

Figure 9 shows a snail upside down on a small twig in the middle of a thick stinging nettle patch on lower Sumas Mountain, Abbotsford.

Figure 10. Snail Climbing Stinging Nettle

Figure 10 shows a snails climbing the stalk of stinging nettle on lower Sumas Mountain, Abbotsford. This was a common sight in many of the thick nettle patches in the area.

Figure 11. Disturbed Ditch Habitat

Figure 11 shows an actively maintained ditch and mown edge of Straiton Road in Abbotsford. Several dozen snails were observed mating on the edge of and in the exposed soil of the ditch.

Figure 12. Habitat Disturbed by Trail

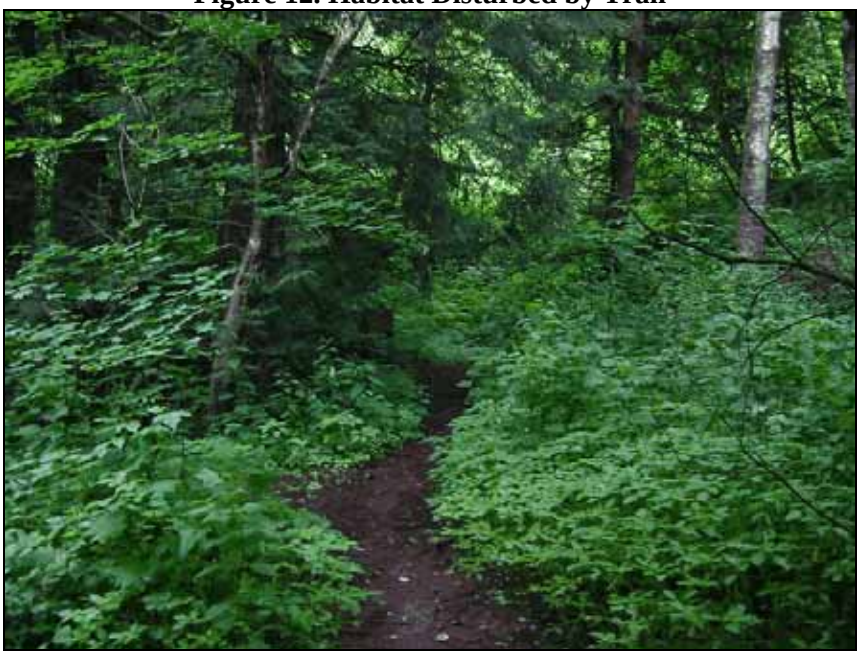

Figure 12 shows an example of a well used trail on Little Mountain, Chilliwack, through snail habitat. Large numbers of live and dead snails were observed in the soft dirt.

Figure 13. Pole/Sapling Red Alder and Stinging Nettle

Figure 13 shows an example of small habitat patches of stinging nettle in dense pole/sapling red alder on lower Sumas Mounting, Abbotsford. The area had been logged, de-stumped and used as horse pasture for many years before regeneration occurred.

Figure 14. Exposed Soil

Figure 14 shows a snail in the exposed soil of a well used trail.

Figure 15. Leaf Litter and Small Woody Debris

Figure 15 shows a snail in leaf litter and small woody debris.

Figure 16. Decaying Large Woody Debris

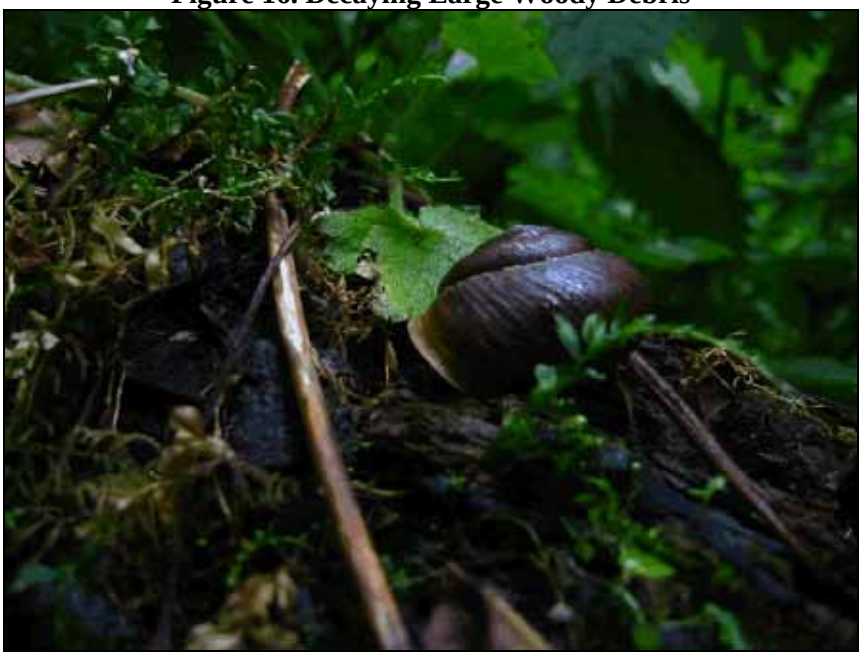

Figure 16 shows a snail on old, decaying large woody debris.

Figure 17. Large Woody Debris

Figure 17 shows an example of a snail found on the fallen trunk of a paper birch.