



3

Structural Conditions and Habitat Elements of Oregon and Washington

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Introduction

Wildlife habitat is a concept that describes attributes in the environment that serve as life requisites for wildlife allowing them to survive and reproduce. An overt assumption is that wildlife use habitats that are arranged or comprised of vital components; these arrangements result in healthy and viable wildlife populations. However, the wildlife habitat concept does not address demographic (survival and reproduction of individuals), environmental (food supply, predators, weather), natural catastrophe (flood, drought, fire), or genetic (genetic drift or inbreeding) uncertainties. These uncertainties, though important, are difficult to determine, predict, and manage. Nonetheless, we have studied and assessed wildlife life history and how species use their habitat(s) for quite some time. Thus, the wildlife habitat concept does address features in the environment that we can manipulate to enhance or discourage wildlife use of an area.

The principal purpose of this chapter is to report what we know or surmise about wildlife and its use of the landscape into features that land managers can understand, recognize, and strive to achieve. Describing and defining these features allows us to begin to establish a common understanding for management so that we can affect and influence the landscape to meet wildlife needs. What follows is an expansion of our wildlife habitats; two major features that also service wildlife species needs are structural conditions and specific habitat elements of a site. These two features should be viewed in a hierarchical manner, with structural conditions occurring on tracts of land such as at a forest stand or watershed level, whereby habitat elements are described at a site-specific or local level, like within a forest stand. Knowing something about structural conditions of an area along with the habitat elements occurring at a site will allow us to better predict what kinds of wildlife may use the site, as well as predict, if enhancements or modifications were made what wildlife might continue to use the site or area.

The collective set of environmental conditions provided by wildlife habitats, structural conditions, and habitat elements constitutes a species' overall habitat. Hence, from an ecological perspective, we are striving to determine the current and potential ecological conditions of a landscape

or site. We achieve this knowledge by interpolating ecological condition from assessing wildlife habitats hierarchically, that is, from knowing something about the wildlife habitats, structural conditions, and habitat elements from area or site. Thus, current and desired ecological conditions can be assessed for wildlife and written:

Wildlife Habitats = wildlife cover type(s) + structural condition(s) + habitat element(s)

Structural Conditions

Structure is what a natural resource manager can manipulate to achieve various objectives. After all, manipulating the structural features of a forest stand is what silviculture is all about.¹⁰ Structural conditions are often thought to follow the plant succession series. That is, if a stand, say in a forest, is left alone and given enough time it will achieve a climax or old-growth state. So the continuum starts with the earliest stages, and given a forest example, this would be at grass/forb, and then progressing through shrub/seedling; sapling/pole; small, medium, and large trees; and eventually achieving giant trees. Catastrophic events along with some management prescriptions can reset the succession stages (fire burning a tract of land mimics in many ways the effect of a clearcut). So several key structural elements for forest and shrubland/grasslands habitats are a wide range in tree and shrub sizes, a wide range in tree diameters and tree and shrub heights, and varying amounts of tree and shrub canopies. Multiple canopy layers are also considered to be significant and this includes the continuous distribution of foliar surface from the top of the crown to the ground. Such canopy distributions are thought to create greater quantities and greater diversity of animal habitats.^{10,13} That is, canopies are important not only for their physical characteristics, such as thermal qualities that influence stream temperatures and ground conditions (i.e. shade, shelter from precipitation) but also for their abiotic abilities such as fixating CO₂ or nitrogen from the atmosphere.^{2,11,17} Finally, plant and tree understories may or may not be present depending on the structural condition of the stand;

however, their presence can influence the kind and number of species that use the stand.

Defining Structural Conditions

Knowing the wildlife-habitat type(s) of an area will allow a person to predict a list of species that may be found at that site. To refine the prediction, however, requires further information, like knowing a species range extent and condition of the habitat in the area of concern. The term condition implies, knowing the types and amounts of different structural stages and habitat elements. The condition of the habitat can predispose a species to use an area, and thus can serve as a driver for its occurrence.

Definitions of structural conditions were determined by the Species Habitat Team that was formed from multiple organizations to help clarify terms, represent field ecologist and biologist needs, and to help ensure a usable end-product. The definitions are divided into four major categories: Forest, Shrubland/Grassland, Agriculture, and Urban. The definitions for the first two categories are based on describing the characteristics of trees, shrubs, and grasses. The last two categories are based on describing land use/land cover types. This was done because of the difficulty in describing these categories from a plant community perspective and because there is very little literature available that would allow a more detailed breakdown. Table 1 was created to depict those wildlife habitats that are associated with each structural condition or land use/land cover type. A computer simulation that represents each Forest and Shrubland/Grassland structural condition can be found by reviewing the color photographs that accompany this chapter. The following are the definitions for structural conditions:

Forest Structural Conditions

The forest structural conditions are based on the following attributes: (1) tree size diameter at breast height (dbh); (2) percent canopy cover (or percent grass/forb cover); and, (3) number of canopy layers. These attributes have the following values:

Tree size (dbh)

| | | |
|----------------|--------------|-----------|
| shrub/seedling | <1 inch | <2.5 cm |
| sapling/pole | 1-9 inches | 2.5-24 cm |
| small tree | 10-14 inches | 25-37 cm |
| medium tree | 15-19 inches | 38-49 cm |
| large tree | 20-29 inches | 50-75 cm |
| giant tree | ≥30 inches | ≥76 cm |

Percent canopy cover

| | |
|----------|---------|
| open | 10-39% |
| moderate | 40-69% |
| closed | 70-100% |

Number of canopy layers

| | |
|--------------|-----------|
| single story | 1 stratum |
| multi-story | ≥2 strata |

The above attributes have been combined into the following structural conditions:

1. Grass/Forb–Open

Grass/Forb dominated with <70% coverage by grasses and forbs. Shrubs and small seedlings may be present, but do not dominate stand, (seedlings <10% canopy cover), and there may be remnant trees (trees remaining from the previous stand) that provide <10% canopy cover (Figure 1).

2. Grass/Forb–Closed

Grass/forb dominated with >70% coverage by grasses and forbs. Shrubs and small seedlings may be present, but do not dominate stand, (seedlings <10% canopy cover), and there may be remnant trees (trees remaining from the previous stand) that provide <10% canopy cover (Figure 2).

3. Shrub/Seedling–Open

Seedlings are large enough to add structure to the stand but are small enough that the structure is similar to shrubs and may have remnant trees (trees remaining from the previous stand) that provide <10% canopy cover. There is <70% cover of shrubs or seedlings. Tree size is <1 inch dbh, and there is 1 canopy stratum (Figure 3).

4. Shrub/Seedling–Closed

Seedlings are large enough to add structure to the stand but are small enough that the structure is similar to shrubs. Remnant trees (trees remaining from the previous stand) may provide <10% canopy cover. There is >70% cover of shrubs or seedlings. Tree size is <1 inch dbh, and there is 1 canopy stratum (Figure 4).

5. Sapling/Pole–Open

The canopy is open enough that understory vegetation may be abundant. Remnant trees (trees remaining from the previous stand) may provide <10% canopy cover. There is 10-39% cover of sapling and pole-sized trees. Tree size is 1-9 inches dbh, and there is 1 canopy stratum (Figure 5).

6. Sapling/Pole–Moderate

Understory development is hampered by available light and moisture. Remnant trees (trees remaining from the previous stand) may provide <10% canopy cover. There is 40-69% cover of sapling and pole-sized trees. Tree size is 1-9 inches dbh, and there is 1 canopy stratum (Figure 6).

7. Sapling/Pole–Closed

The understory is depauperate or absent. Remnant trees (trees remaining from the previous stand) may provide <10% canopy cover. There is >70% cover of sapling and pole-sized trees. Tree size is 1-9 inches dbh and there is 1 canopy stratum (Figure 7).

8. Small Tree–Single Story–Open

A grass/forb or shrub understory may be present. Remnant trees (trees remaining from the previous stand) may provide <10% canopy cover. There is 10-39% cover of small trees, with <10% cover of other tree sizes. Tree size is 10-14 inches dbh, and there is 1 canopy stratum (Figure 8).

Table 1. Matrix for wildlife habitats that are associated with structural conditions or land use/land cover types.

| Wildlife habitats | Forest Structural Conditions ¹ | Grassland/Shrubland Structural Conditions | | | | Land Use/Land Cover Conditions | |
|--|---|---|-----------|--------------|------------|--------------------------------|--------------------------|
| | | Grass/Forb | Low shrub | Medium shrub | Tall shrub | Urban ² | Agriculture ³ |
| Westside lowlands conifer-hardwood forest | X | — | — | — | — | — | — |
| Westside oak & Douglas-fir forest & woodlands | X | — | — | — | — | — | — |
| Southwest Oregon mixed conifer-hardwood forest | X | — | — | — | — | — | — |
| Montane mixed conifer forest | X | — | — | — | — | — | — |
| Eastside (Interior) mixed conifer forest | X | — | — | — | — | — | — |
| Lodgepole pine forest & woodlands | X | — | — | — | — | — | — |
| Ponderosa pine forests & woodlands | X | — | — | — | — | — | — |
| Upland aspen forest | X | — | — | — | — | — | — |
| Subalpine parklands | X | — | — | — | — | — | — |
| Alpine grasslands & shrublands | — | X | X | — | — | — | — |
| Westside grasslands | — | X | — | — | — | — | — |
| Ceanothus/manzanita shrublands | — | — | — | — | X | — | — |
| Western juniper & mountain mahogany woodlands | X | — | — | — | — | — | — |
| Eastside (Interior) canyon shrublands | — | — | — | X | X | — | — |
| Eastside (Interior) grasslands | — | X | — | — | — | — | — |
| Shrub-steppe | — | — | — | X | — | — | — |
| Dwarf shrub-steppe | — | — | X | — | — | — | — |
| Desert playa & salt scrub | — | — | — | X | — | — | — |
| Agriculture, pasture, and mixed environs | — | — | — | — | — | — | X |
| Urban and mixed environs | — | — | — | — | — | X | — |
| Open water—lakes, rivers, streams | — | — | — | — | — | — | — |
| Herbaceous wetlands | — | — | — | — | — | — | — |
| Westside riparian/wetlands | X | — | — | — | X | — | — |
| Montane coniferous wetlands | X | — | — | — | — | — | — |
| Eastside (Interior) riparian/wetlands | X | — | — | — | X | — | — |
| Coastal dunes & beaches | — | X | — | X | X | — | — |
| Coastal headlands & islets | — | X | — | X | X | — | — |
| Bays & estuaries | — | — | — | — | — | — | — |
| Inland marine deeper waters | — | — | — | — | — | — | — |
| Marine nearshore | — | — | — | — | — | — | — |
| Marine shelf | — | — | — | — | — | — | — |
| Oceanic | — | — | — | — | — | — | — |

¹Includes a variety of tree sizes and canopies²Includes low, medium, and high densities of impervious areas.³Includes areas like croplands, orchards, and pastures

9. Small Tree—Single Story—Moderate

Some grass/forb or shrub understory may be present. Remnant trees (green trees remaining from the previous stand) may provide <10% canopy cover. There is 40-69% cover of small trees with <10% cover of other sized trees. Tree size is 10-14 inches dbh, and there is 1 canopy stratum (Figure 9).

10. Small Tree—Single Story—Closed

Grass/Forb or shrub understory minor or absent. Remnant trees (trees remaining from the previous stand) may provide <10% canopy cover. There is >70% cover of small trees, with <10% cover of other-sized trees. Tree size is 10-14 inches dbh, and there is 1 canopy stratum (Figure 10).

11. Medium Tree—Single Story—Open

A grass/forb or shrub understory may be present. Remnant trees (trees remaining from the previous stand) may provide <10% canopy cover. There is 10-39% cover of medium trees, with <10% cover of other-sized trees. Tree size is 15-19 inches dbh, and there is 1 canopy stratum (Figure 11).

12. Medium Tree—Single Story—Moderate

Grass/Forb or shrub understory may be present. Remnant trees (trees remaining from the previous stand) may provide <10% canopy cover. There is 40-69% cover of medium trees with <10% cover of other-sized trees. Tree size is 15-19 inches dbh, and there is 1 canopy stratum (Figure 12).

13. Medium Tree—Single Story—Closed

A grass/forb or shrub understory may be present. Remnant trees (trees remaining from the previous stand) may provide <10% canopy cover. There is >70% cover of medium trees with <10% cover of other-sized trees. Tree size is 15-19 inches dbh, and there is 1 canopy stratum (Figure 13).

14. Large Tree—Single Story—Open

Grasses, shrubs, and/or seedlings may occur in the understory. There is 10-39% cover of large and/or giant size trees with <10% cover of other-sized trees. Tree size is 20-29 inches dbh, and there is 1 canopy stratum (Figure 14).

15. Large Tree—Single Story—Moderate

Some grass/forb or shrub understory may be present. There is 40-69% cover of large and/or giant trees with <10% cover of other-sized trees. Tree size is 20-29 inches dbh, and there is 1 canopy stratum (Figure 15).

16. Large Tree—Single Story—Closed

Grasses, shrubs, and/or seedlings may occur in the understory. There is >70% cover of large and/or giant trees with <10% cover of other-sized trees. Tree size is 20-29 inches dbh, and there is 1 canopy stratum (Figure 16).

17. Small Tree—Multi-story—Open

These stands have an overstory of small trees with a distinct subcanopy of saplings and/or poles. Scattered larger trees may be present but make up $\leq 10\%$ canopy cover. Grass/forb or shrub understory may be present. There is 10-39% total canopy cover dominated by small trees, $\geq 10\%$ canopy cover of ≥ 1 other smaller tree sizes. Tree size is 10-14 inches dbh, and there are ≥ 2 canopy strata (Figure 17).

18. Small Tree—Multi-story—Moderate

These stands have an overstory of small trees with a distinct subcanopy of saplings and/or poles. Scattered larger trees may be present but make up $\leq 10\%$ canopy cover. Grass/forb or shrub understory may be present, but is probably limited. There is 40-69% total canopy cover dominated by small trees, $\geq 10\%$ canopy cover of ≥ 1 or more other smaller tree sizes. Tree size is 10-14 inches dbh, and there are ≥ 2 canopy strata (Figure 18).

19. Small Tree—Multi-story—Closed

These stands have an overstory of small trees with a distinct subcanopy of saplings and/or poles. Scattered larger trees may be present but make up $\leq 10\%$ canopy cover. Grass/forb or shrub understory extremely limited or absent. There is >70% total canopy cover dominated by small trees, $\geq 10\%$ canopy cover of ≥ 1 other smaller tree sizes. Tree size is 10-14 inches dbh, and there are ≥ 2 canopy strata (Figure 19).

20. Medium Tree—Multi-story—Open

These stands have an overstory of medium trees with a distinct subcanopy of smaller trees. Scattered larger trees may be present but make up $\leq 10\%$ canopy cover. Grass/forb or shrub understory may be present, but is probably limited. There is 10-39% total canopy cover dominated by medium trees, $\geq 10\%$ or more canopy cover of ≥ 1 other smaller tree sizes. Tree size is 15-19 inches dbh, and there are ≥ 2 canopy strata (Figure 20).

21. Medium Tree—Multi-story—Moderate

These stands have an overstory of medium trees with a distinct subcanopy of smaller trees. Scattered larger trees may be present but make up $\leq 10\%$ canopy cover. Grass/forb or shrub understory may be present, but is probably limited. There is 40-69% total canopy cover dominated by medium trees, $\geq 10\%$ or more canopy cover of 1 or more smaller tree sizes. Tree size is 15-19 inches dbh, and there are ≥ 2 canopy strata (Figure 21).

22. Medium Tree—Multi-story—Closed

These stands have an overstory of medium trees with a distinct subcanopy of smaller trees. Scattered larger trees may be present but make up $\leq 10\%$ canopy cover. Grass/forb understory may be present, but is probably limited. There is >70% total canopy cover dominated by medium trees, $\geq 10\%$ or more canopy cover of ≥ 1 smaller tree sizes. Tree size is 15-19 inches dbh, and there are ≥ 2 canopy strata (Figure 22).

23. Large Tree—Multi-story—Open

These stands have an overstory of large or giant-sized trees with one or more distinct canopy layers of smaller trees. Stands with >40% cover of giant trees are classified in the Giant, multi-storied stage. In westside forests, stands dominated by large trees usually have giant trees scattered in the stand, with fewer in eastside forests. A grass/forb or shrub understory is often present, especially in canopy gaps. There is 10-39 % total canopy cover, with ≥10% or more canopy cover from large and/or giant trees and another ≥10% canopy cover from ≥1 or more smaller tree size classes. Tree size is 20-29 inches dbh, and there are ≥2 canopy strata (Figure 23)

24. Large Tree—Multi-story—Moderate

These stands have an overstory of large or giant-sized trees with ≥1 distinct canopy layers of smaller trees. Stands with >40% cover of giant trees are classified in the giant, multi-storied stage. In westside forests, stands dominated by large trees usually have giant trees scattered in the stand, with fewer in eastside forests. Grass/Forb or shrub understory is often present, especially in canopy gaps. There is 40-69% total canopy cover, ≥10% canopy cover from large trees with another ≥10% canopy cover from ≥1 smaller tree size classes. Tree size is 20-29 inches dbh, and there are ≥2 canopy strata (Figure 24).

25. Large Tree—Multi-story—Closed

These stands have an overstory of large or giant-sized trees with ≥1 distinct canopy layers of smaller trees. Stands with > 40% cover of giant trees are classified in the giant, multi-storied stage. In westside forests, stands dominated by large trees usually have giant trees scattered in the stand, with fewer in eastside forests. A grass/forb or shrub understory is often present, especially in canopy gaps. There is >70% total canopy cover, ≥10% or more canopy cover from large trees with another ≥10% canopy cover from ≥1 smaller tree size classes. Tree size is 20- 29 inches dbh, and there are ≥2 canopy strata (Figure 25).

26. Giant Tree—Multi-story

These stands have an overstory of giant-sized trees with ≥1 distinct canopy layers of smaller trees. Stands with <40% canopy cover are classified in the large tree multi-story open stage. There is >40% canopy cover. Tree size is >30 inches dbh, and there are ≥2 canopy strata (Figure 26a and b).

Shrubland and Grassland Structural Conditions

The shrubland and grassland structural conditions are based on the following attributes: (1) shrub height, (2) percent shrub cover (or percent grass/forb cover), and (3) shrub age class. These attributes have the following values:

Shrub height

| | | |
|--------|-----------------|--------------|
| low | <1.6 ft | <0.5 m |
| medium | 1.6-6.5 ft | 0.5-2.0 m |
| tall | >6.5 ft-16.5 ft | >2.0 m-5.0 m |

Percent shrub cover

| | |
|--------|---------------------|
| open | 10-69% shrub cover |
| closed | 70-100% shrub cover |

Shrub age class

| | |
|----------------|----------------------------|
| seedling/young | negligible crown decadence |
| mature | ≤ 25% crown decadence |
| old | 26-100% crown decadence |

The above attributes have been combined into the following structural conditions:

1. Grass/Forb—Open

Grasslands that have <10% shrub cover and <10% tree canopy cover. Grasses and forbs cover are <70% of the ground, and bare ground is evident (Figure 27).

2. Grass/Forb—Closed

Grasslands that have <10% shrub cover and <10% tree canopy cover. Grasses and forbs cover >70% of the ground (Figure 28).

3. Low Shrub—Open Shrub Overstory—Seedling/Young

Shrublands with shrubs <1.6 ft tall, shrub canopy cover 10-69% and may have <10% tree canopy cover. Areas with <10% shrub cover are categorized as Grass/Forb. These are post-disturbance regenerating shrublands dominated by seedlings or young shrubs. Mature, legacy shrubs may persist from before the disturbance, but occur as scattered singles or widely scattered clumps. Crown decadence is negligible (Figure 29).

4. Low Shrub—Open Shrub Overstory—Mature

Shrublands with shrubs <1.6 ft tall, shrub canopy cover 10-69% and may have <10% tree canopy cover. Areas with <10% shrub cover are categorized as Grass/Forb. Crown decadence is ≤25% (Figure 30).

5. Low Shrub—Open Shrub Overstory—Old

Shrublands with shrubs <1.6 ft tall, shrub canopy cover 10-69% and may have <10% tree canopy cover. Areas with <10% shrub cover are categorized as Grass/Forb. Crown decadence is >25% (Figure 31).

6. Low Shrub—Closed Shrub Overstory—Seedling/Young

Shrublands with shrubs <1.6 ft tall, shrub canopy cover >70%, and may have <10% tree canopy cover. These are post-disturbance regenerating shrublands dominated by seedlings or young shrubs. Mature, legacy shrubs may persist from before the disturbance, but occur as scattered singles or widely scattered clumps. Crown decadence is negligible (Figure 32).

7. Low Shrub—Closed Shrub Overstory—Mature

Shrublands with shrubs <1.6 ft tall and shrub canopy cover >70%, and may have <10% tree canopy cover. Crown decadence is ≤25% (Figure 33).

8. Low Shrub—Closed Shrub Overstory—Old

Shrublands with shrubs <1.6 ft tall, shrub canopy cover >70%, and may have <10% tree canopy cover. Crown decadence is >25% (Figure 34).

9. Medium Shrub—Open Shrub Overstory—Seedling/Young

Shrublands with shrubs 1.6 - 6.5 ft tall, shrub canopy cover >10% and <70%, and may have <10% tree canopy cover. Areas with <10% shrub cover are categorized as Grass/Forb. These are post-disturbance regenerating shrublands dominated by seedlings or young shrubs. Mature, legacy shrubs may persist from before the disturbance, but occur as scattered singles or widely scattered clumps. Crown decadence is negligible (Figure 35).

10. Medium Shrub—Open Shrub Overstory—Mature

Shrublands with shrubs 1.6 - 6.5 ft tall, shrub canopy cover >10% and <70%, and may have <10% tree canopy cover. Areas with <10% shrub cover are categorized as Grass/Forb. Crown decadence is ≤25% (Figure 36).

11. Medium Shrub—Open Shrub Overstory—Old

Shrublands with shrubs 1.6 - 6.5 ft tall, shrub canopy cover >10% and <70%, and may have <10% tree canopy cover. Areas with <10% shrub cover are categorized as Grass/Forb. Crown decadence is >25% (Figure 37).

12. Medium Shrub—Closed Shrub Overstory—Seedling/Young

Shrublands with shrubs 1.6 - 6.5 ft tall, shrub canopy cover >70%, and may have <10% tree canopy cover. These are post-disturbance regenerating shrublands dominated by seedlings or young shrubs. Mature, legacy shrubs may persist from before the disturbance, but occur as scattered singles or widely scattered clumps. Crown decadence is negligible (Figure 38).

13. Medium Shrub—Closed Shrub Overstory—Mature

Shrublands with shrubs 1.6 - 6.5 ft tall, shrub canopy cover >70%, and may have <10% tree canopy cover. Crown decadence is ≤25% (Figure 39).

14. Medium Shrub—Closed Shrub Overstory—Old

Shrublands with shrubs 1.6 - 6.5 ft tall, shrub canopy cover >70%, and may have <10% tree canopy cover. Crown decadence is >25% (Figure 40).

15. Tall Shrub—Open Shrub Overstory—Seedling/Young

Shrublands with shrubs >6.5ft tall, shrub canopy cover >10% and <70%, and may have <10% tree canopy cover. Areas with <10% shrub cover are categorized as Grass/Forb. These are post-disturbance regenerating shrublands dominated by seedlings or young shrubs. Mature, legacy shrubs may persist from before the disturbance, but occur as scattered singles or widely scattered clumps. Crown decadence is negligible (Figure 41).

16. Tall Shrub—Open Shrub Overstory—Mature

Shrublands with shrubs >6.5 ft tall, shrub canopy cover >10% and <70% and may have <10% tree canopy cover. Areas with <10% shrub cover are categorized as Grass/Forb. Crown decadence is ≤25% (Figure 42).

17. Tall Shrub—Open Shrub Overstory—Old

Shrublands with shrubs >6.5 ft tall, shrub canopy cover >10% and <70%, and may have tree canopy cover <10%. Areas with <10% shrub cover are categorized as Grass/Forb. Crown decadence is >25% (Figure 43).

18. Tall Shrub—Closed Shrub Overstory—Seedling/Young

Shrublands with shrubs >6.5 ft tall, shrub canopy cover >70%, and may have tree canopy cover <10%. These are post-disturbance regenerating shrublands dominated by seedlings or young shrubs. Mature, legacy shrubs may persist from before the disturbance, but occur as scattered singles or widely scattered clumps. Crown decadence is negligible (Figure 44).

19. Tall Shrub—Closed Shrub Overstory—Mature

Shrublands with shrubs >6.5 ft tall, shrub canopy cover >70%, and may have tree canopy cover <10%. Crown decadence is ≤25% (Figure 45).

20. Tall Shrub—Closed Shrub Overstory—Old

Shrublands with shrubs >6.5 ft tall, shrub canopy cover >70%, and may have <10% tree canopy cover. Crown decadence is >25% (Figure 46).

Urban Land Use/Land Cover Conditions

The Urban land use/land cover conditions are based on the level of urban development as determined by the percent of land surface covered by impervious materials.

The Urban land use/land cover classification consists of the following conditions:

1. Low Density

Surfaces that are covered with 10-29% of impervious material. Examples would include rural residential areas, suburban housing with large lots (≥1 acre [2.4 ha]).

2. Medium Density

Surfaces that are covered by 30-59% of impervious material. Examples would include single family housing areas (lot size >1 acre [2.4 ha]), suburban development.

3. High Density

Surfaces that are covered by 60-100% of impervious material. Examples would include core downtown areas within cities (e.g., Seattle, Portland), commercial areas (e.g., shopping malls), industrial areas, high density housing (e.g., apartment buildings), and transportation corridors (e.g., highways).

Agricultural Land Use/Land Cover Conditions

1. Cultivated Cropland

Farmland used for production of annual crops such as vegetables and herbs is characterized by bare soil, and plant debris either in the field or along the periphery. The location tends to be along bottomland areas of streams and rivers and areas with a sufficient source of irrigation. Farmland used for production of annual grasses such as wheat, oats, barley, and rye is characterized by upland and rolling hill terrain, generally without irrigation. This agricultural division has similar pesticide use and/or irrigation requirements. That is, row crops are treated the same way in regard to the general application of pesticides and cultural techniques in land preparation and harvest. There is a wide range of soil conservation practices in this category.

2. Improved Pasture

Farmland used for the production of perennial grass such as grass seed and hay. Perennial grass is generally grown without irrigation. Perennial crops are treated the same way in regard to the general application of pesticides and cultural techniques.

3. Orchards/Vineyards/Nursery

Farmland used for production of tree fruits (apples, peaches, pears, hazelnuts), vineyards (grapes), berries (strawberries, raspberries, blueberries, blackberries), Christmas trees, and nursery stock (ornamental container and greenhouse operations). This cover type is generally located in upland areas with access to a high volume of irrigation. Christmas trees are characterized by upland areas, poorer soils and no irrigation. The use of chemicals in non-food crops, such as Christmas trees and nursery stock, is considerably different both in materials and time of applications.

4. Modified Grasslands

Annual or introduced perennial grasslands, including cheatgrass (*Bromus tectorum*), medusahead (*Taeniatherum caput-medusae*), and other annual bromes; moist environments, including riparian bottomlands, are often dominated by Kentucky bluegrass. Annual grasslands (and areas of introduced forbs) are usually dominated by one or two introduced annuals which comprise most of the vegetation cover. Perennial grasslands are usually dominated by a single planted bunchgrass with introduced annuals and weedy forbs between the bunches. Some environments support rhizomatous perennial grasses. These areas occur mostly on uplands but also includes riparian bottomlands that are dominated by non-native grasses. Modified grasslands can be found throughout the steppe and grasslands areas of eastern Oregon and Washington and at low elevation sites in southwestern Oregon.

5. Unimproved Pasture

Farmland that seems to have no active management such as fertilizer application, irrigation or weed control. This

land might be grazed by livestock, but shows no evidence of irrigation. It can also be characterized by uncut hay, organic debris from the previous season, uncut standing dead grass, exotic plants like tansy ragwort (*Senecio jacobea*), thistle (*Cirsium* spp.), Himalaya blackberry (*Rubus discolor*) and their debris, patches of shrubs such as hawthorn (*Crataegus* spp.), snowberry (*Symphoricarpos* spp.), spirea (*Spirea* spp.), poison oak (*Rhus diversiloba*), and encroachment by various tree species. This land has usually been cleared and farmed intensively in the past. This category also includes lands that are designated within the Conservation Reserve Program (CRP) and areas planted with crested wheatgrass (*Agropyron cristatum*). Land owners use unimproved pasture for grazing livestock, otherwise it lies dormant. Thus, those lands that are not grazed either revert to brushy field or volunteer forest.

Structural Conditions Data Matrix

To maximize the utility of wildlife-habitat relationship information, a digital database that links wildlife with its structural conditions can be found on the CD-ROM included with this book. Wildlife occurrence within a particular structural condition type was determined through an expert panel process held during the fall of 1998. Table 1 was created to assist the expert panel in identifying what wildlife habitats are associated with what structural conditions. The categories that depict a wildlife species occurrence with a particular structural condition are Y—Yes the species occurs, H—Historically occurred, and U—Unsure. Alongside the occurrence category, we identify the types of activity that the species does while using the structural condition. The activity codes for the wildlife species within a particular condition are: B—Both feeds and breeds, F/R-HE—Feeds and Reproduces when a specific habitat element is present, F—Feeds only, R—Reproduces only, and O—Other. The Other category reflects activities such as roosting/resting, hibernating, or using the habitat for cover (thermal and hiding) purposes.

Defining the Level of Associations Between Wildlife and Structural Conditions

As mentioned in Chapter 1, we continue to embrace the new concept of degree of association between wildlife species and their habitats.¹⁹ For the purposes of this project, we used the following categories for characterizing the degree of association.

Closely Associated. A species is widely known to depend on a habitat or structural condition for part or all of its life history requirements. Identifying this association implies that the species has an essential need for this habitat or structural condition for its maintenance and viability. Some species may be closely associated with more than one habitat or structural condition, others may be closely associated with only one habitat or structural condition. Examples of species exhibiting close associations are red-winged blackbirds to wetland habitats, and spotted owls to mature and giant tree structural conditions.

Generally Associated. A species exhibits a high degree of adaptability and may be supported by a number of habitats or structural conditions. In other words, the habitats or structural conditions play a supportive role for its maintenance and viability. Examples include the black bear's association with a variety of forested habitats or the black-tailed deer associated with a number of structural conditions.

Present. A species demonstrates occasional use of a habitat or structural condition. The habitat or structural condition provides marginal support to the species for its maintenance and viability. Examples are the rough-legged hawk in desert playa and salt scrub shrubland or the mink in a montane mixed conifer forest.

Finally, the expert panelists assigned an overall confidence rating to the occurrence and activity headings for each species within each structural condition. The confidence ratings were simply high (e.g., many peer or published accounts), moderate, and low (e.g., few or no published accounts). By assigning a confidence rating, our objective was to offer users an evaluation of the overall strength of the scientific evidence.

Habitat Elements

Site-specific habitat elements (HEs) are those components of the environment believed to most influence wildlife species' distribution, abundance, fitness, and viability (definition adapted from Marcot et al.¹⁴ and Mayer and Laudenslayer.)¹⁶ In this context, HEs include natural attributes, both biological and physical (e.g., large trees, woody debris, cliffs, and soil characteristics) as well as anthropogenic features and their effects such as roads, buildings, and pollution. Including these fine-scale attributes of an animal's environment when describing the habitat associations for a particular species expands the concept and definition of habitat, a term widely used only to characterize the vegetative community or structural condition occupied by a species. Failing to assess and inventory HEs within these communities and conditions may lead to errors of commission; species may be presumed to occur when in actuality they do not. Habitat elements that influence a species negatively may preclude occupancy or breeding despite adequate floristic or structural conditions.

Defining Habitat Elements

Traditionally defined, the term habitat is that set of environmental conditions, usually depicted as food, water, and cover, used and selected for by a given organism. Despite this broad definition, many land management agencies use the term habitat to denote merely the vegetation conditions and/or structural or seral stages used by a particular species. However, many other environmental attributes or features influence and affect the population viability of wildlife species. Marcot et al.¹⁴ in their assessment of the terrestrial species of the Columbia River Basin emphasized the importance of examining all features that exert influence on wildlife by

expanding the definition of habitat to encompass all environmental correlates, naming the entirety of these attributes Key Ecological Correlates or KECs. All environmental scales, from broad floristic communities to fine-scale within-stand features, were included in their definition of a KEC. The word Key in Key Environmental Correlate refers to the high degree of influence (either positive or negative) the environmental correlates exert on the realized fitness of a given species. Nonetheless, when this information was determined, only direct relationships between an HE and a species were identified. Most of the HE-species associations refer to on the CD-ROM are mostly a positive influence between the HE and the species. Negative influence between HE and the species may be viewed as environmental stressors; however, a comprehensive list of negative influences is not presented here. The following are HE definitions.

1. Forest, Shrubland and Grassland Habitat Elements

Biotic, naturally occurring attributes of forest and shrubland communities; the information that follows is for mostly positive relationships.

1.1 Forest/woodland vegetative elements or substrates.

Biotic components found within a forested context.

1.1.1 Down wood. Includes downed logs, branches, and rootwads.

1.1.1.1 Decay class. A system by which down wood is classified based on its deterioration.

1.1.1.1.1 hard (class 1, 2). Little wood decay evident; bark and branches present; log resting on branches, not fully in contact with ground; includes classes 1 and 2 as described in Thomas²².

1.1.1.1.2 moderate (class 3). Moderate decay present; some branches and bark missing or loose; most of log in contact with ground; includes class 3 as described in Thomas²².

1.1.1.1.3 soft (class 4, 5). Well decayed logs; bark and branches missing; fully in contact with ground; includes classes 4 and 5 as described in Thomas.²²

1.1.1.2 Down wood in riparian areas. Includes down wood in the terrestrial portion of riparian zones in forest habitats. Does not refer to in-stream woody debris.

1.1.1.3 Down wood in upland areas. Includes downed wood in upland areas of forest habitats.

1.1.2 Litter. The upper layer of loose, organic (primarily vegetative) debris on the forest floor. Decomposition may have begun, but components still recognizable.

1.1.3 Duff. The matted layer of organic debris beneath the litter layer. Decomposition more advanced than in litter layer; intergrades with uppermost humus layer of soil.

1.1.4 Shrub layer. Refers to the shrub strata within forest stands.

- 1.1.4.1 Shrub size. Refers to shrub height.
- 1.1.4.2 Percent shrub canopy cover. Percent of ground covered by vertical projection of shrub crown diameter.
- 1.1.4.3 Shrub canopy layers. Within a shrub community, differences in shrub height and growth form produce multi-layered shrub canopies in the forest understory.
- 1.1.5 Moss. Large group of green plants without flowers but with small leafy stems growing in clumps.
- 1.1.6 Flowers. A modified plant branch for the production of seeds and bearing leaves specialized into floral organs.
- 1.1.7 Lichens. Any of various lower plants made up of an alga and a fungus growing as a unit on a solid surface.
- 1.1.8 Forbs. Broad-leaved herbaceous plants. Does not include grasses, sedges, or rushes.
- 1.1.9 Cactus. Any of a large group of drought-resistant plants with fleshy, usually jointed stems and leaves replaced by scales or spines.
- 1.1.10 Fungi. Mushrooms, molds, yeasts, rusts, etc.
- 1.1.11 Roots, tubers, underground plant parts. Any underground part of a plant that functions in nutrient absorption, aeration, storage, reproduction and/or anchorage.
- 1.1.12 Ferns. Any of a group of flowerless, seedless vascular green plants.
- 1.1.13 Herbaceous layer. Understory non-woody vegetation layer beneath shrub layer (forest context). May include forbs, grasses, ferns.
- 1.1.14 Trees. Includes both coniferous and hardwood species.
- 1.1.14.1 Snags. Standing dead trees.
- 1.1.14.1.1 Decay class. A system by which snags are classified based on their deterioration.
- 1.1.14.1.1.1 hard. Little wood decay evident; bark, branches, top, present; recently dead; includes class 1 as described in Brown³.
- 1.1.14.1.1.2 moderate. Moderately decayed wood; some branches and bark missing and/or loose; top broken; includes classes 2 and 3 as described in Brown.³
- 1.1.14.1.1.3 soft. Well decayed wood; bark and branches generally absent; top broken; includes classes 4 and 5 as described in Brown.³
- 1.1.14.2 Snag size. Measured in diameter at breast height (dbh) the standard measurement for standing trees taken at 4.5 feet above the ground.
- 1.1.14.2.1 seedling <1 inch dbh
- 1.1.14.2.2 sapling/pole 1-9 inches dbh
- 1.1.14.2.3 small tree 10-14 inches dbh
- 1.1.14.2.4 medium tree 15-19 inches dbh
- 1.1.14.2.5 large tree 20-29 inches dbh
- 1.1.14.2.6 giant tree ≥30 inches dbh
- 1.1.14.3 Tree size. Measured in dbh, same as 1.1.14.2 above.
- 1.1.14.3.1 seedling <1 inch dbh
- 1.1.14.3.2 sapling/pole 1-9 inches dbh
- 1.1.14.3.3 small tree 10-14 inches dbh
- 1.1.14.3.4 medium tree 15-19 inches dbh
- 1.1.14.3.5 large tree 20-29 inches dbh
- 1.1.14.3.6 giant tree ≥30 inches dbh
- 1.1.14.4 Mistletoe brooms/witches brooms. Dense masses of deformed branches caused by any type of broom-forming parasite (fungal or plant).
- 1.1.14.5 Dead parts of live tree. Portions of live trees with rot; can include broken tops; branches with decay; tree base with rot.
- 1.1.14.6 Hollow living trees (chimney trees). Tree bole with large hollow chambers.
- 1.1.14.7 Tree cavities. Smaller chamber in a tree; can be in bole, limbs, or forks of live or dead trees. May be excavated or result from decay or damage.
- 1.1.14.8 Bark. Includes crevices or fissures, and loose or exfoliating bark.
- 1.1.14.9 Live remnant/legacy trees. A live mature or old-growth tree remaining from the previous stand. Context is remnant trees in recently harvested or burned stands up through young forested stands. See dead parts of live trees, hollow living trees, tree cavities, and bark to see which species benefit from remnant trees with these attributes.
- 1.1.14.10 Large live tree branches. Large branches often growing horizontally out from the tree bole.
- 1.1.14.11 Tree canopy layer. Refers to the strata occupied by tree crowns.
- 1.1.14.11.1 Sub-canopy. The space below the predominant tree crowns.
- 1.1.14.11.2 Above canopy. The space above the predominant tree crowns.
- 1.1.14.11.3 Tree bole. The tree trunk.
- 1.1.14.11.4 Canopy. The more or less continuous cover of branches and foliage formed collectively by the crowns of adjacent trees and other woody growth.
- 1.1.15 Fruits/seeds/nuts. Plant reproductive bodies that are used by animals.
- 1.1.16 Edges. The place where plant communities meet or where successional stages or vegetative conditions within plant communities come together.
- 1.2 Shrubland/grassland vegetative elements or substrates.

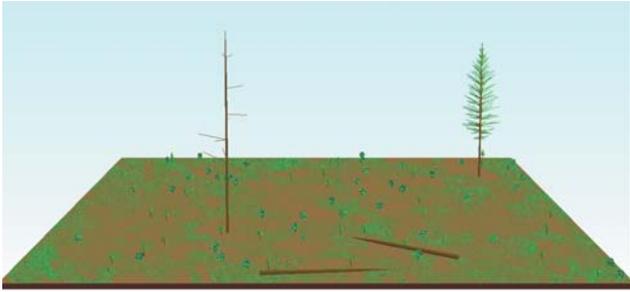


Figure 1. Grass/Forb—Open

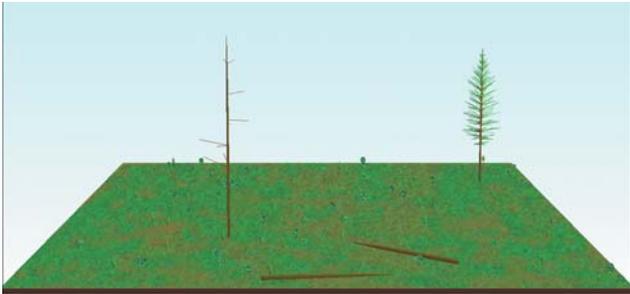


Figure 2. Grass/Forb—Closed

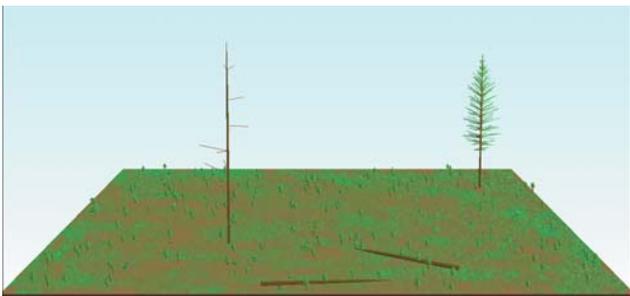


Figure 3. Shrub/Seedling—Open



Figure 4. Shrub/Seedling—Closed

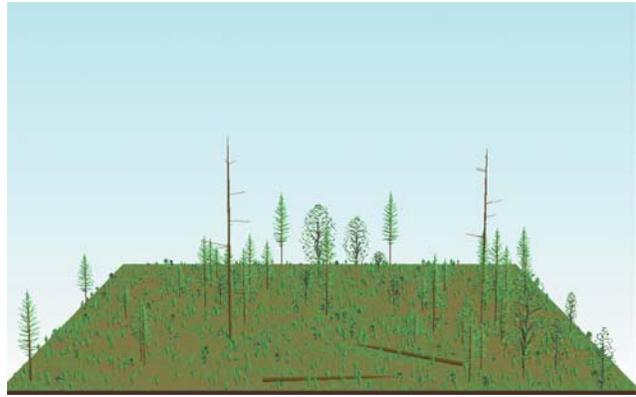


Figure 5. Sapling/Pole—Open

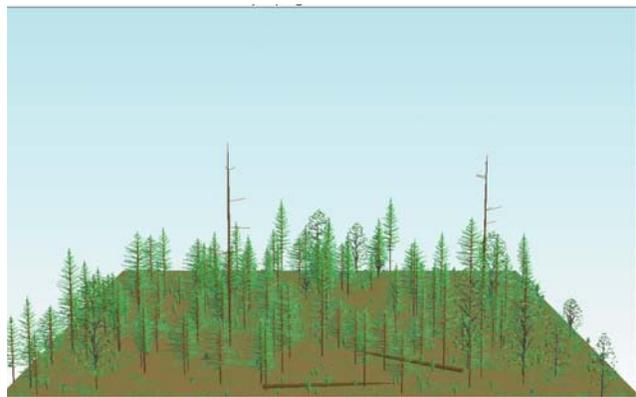


Figure 6. Sapling/Pole—Moderate

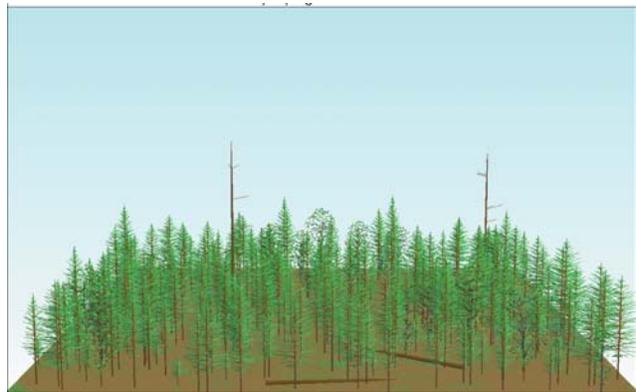


Figure 7. Sapling/Pole—Closed

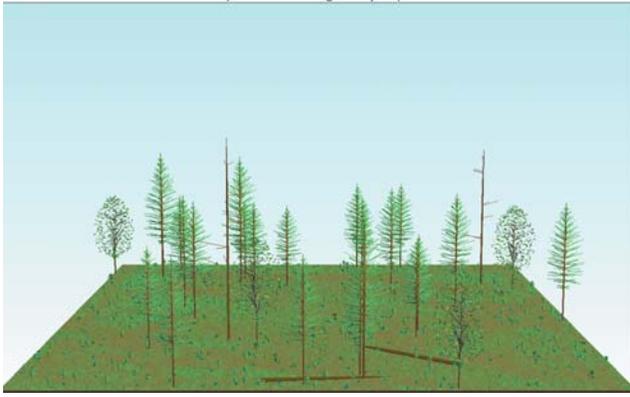


Figure 8. Small Tree—Single Story—Open

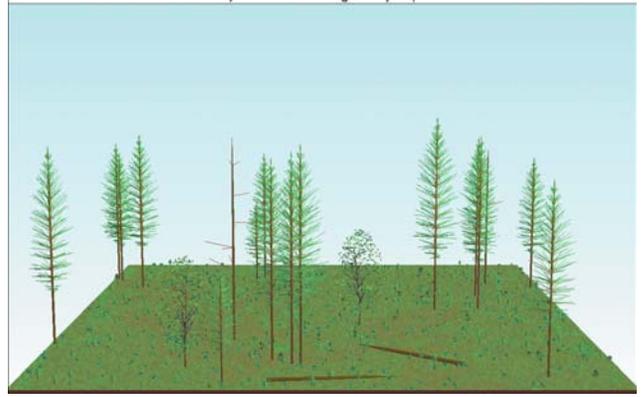


Figure 11. Medium Tree—Single Story—Open

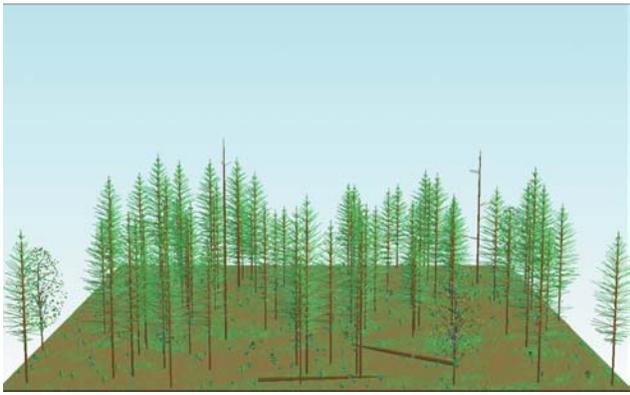


Figure 9. Small Tree—Single Story—Moderate

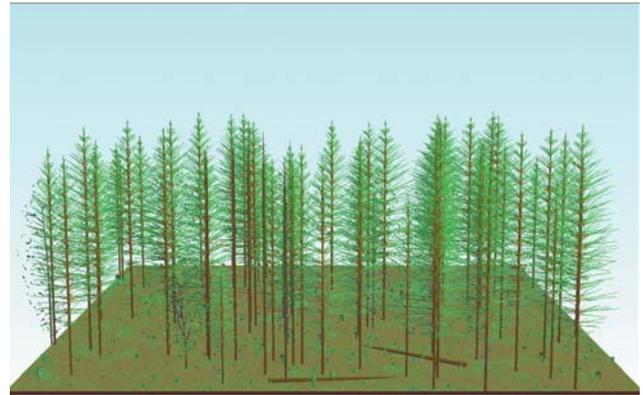


Figure 12. Medium Tree—Single Story—Moderate

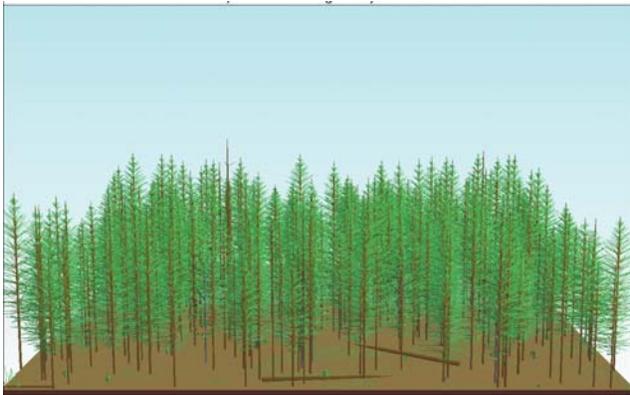


Figure 10. Small Tree—Single Story—Closed

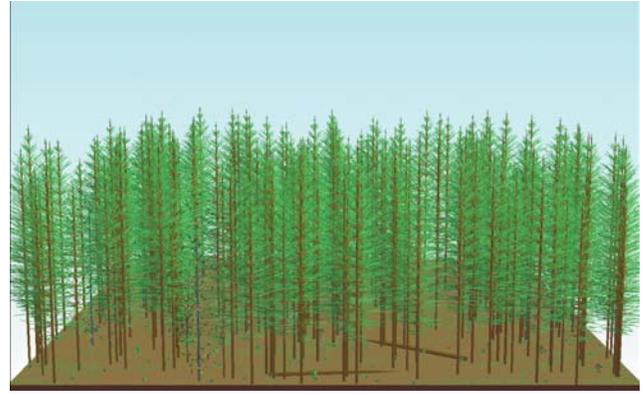


Figure 13. Medium Tree—Single Story—Closed

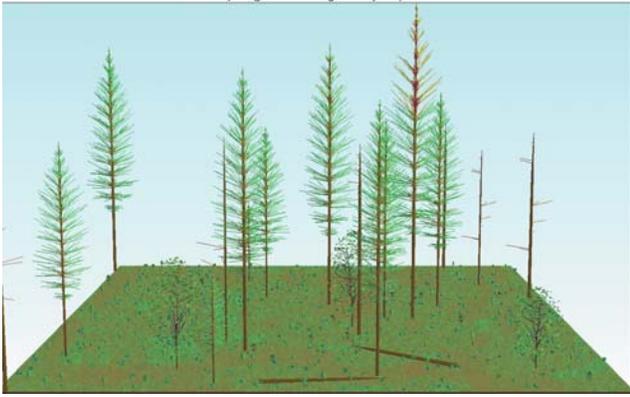


Figure 14. Large Tree—Single Story—Open

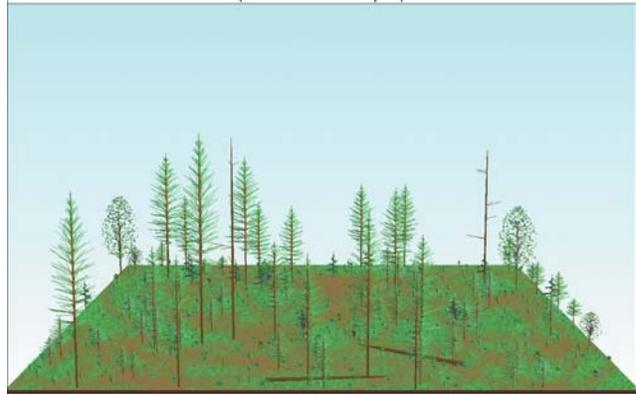


Figure 17. Small Tree—Multi-story—Open

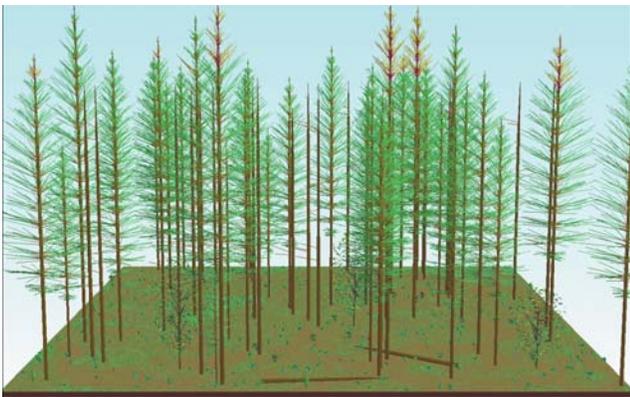


Figure 15. Large Tree—Single Story—Moderate

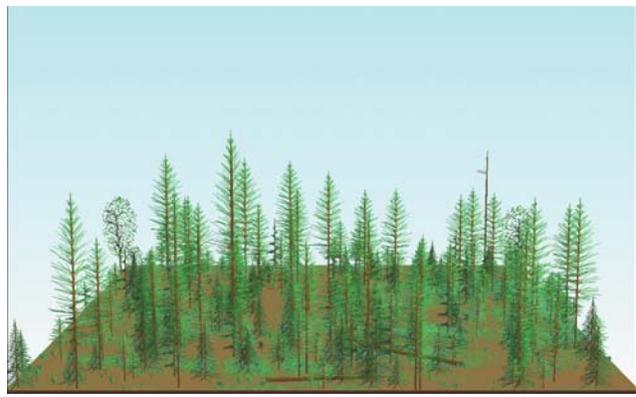


Figure 18. Small Tree—Multi-story—Moderate

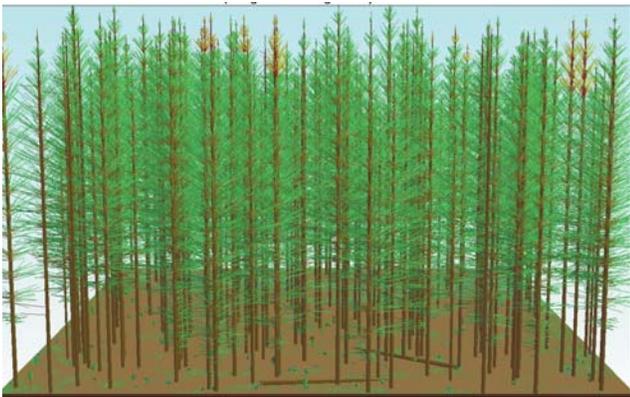


Figure 16. Large Tree—Single Story—Closed

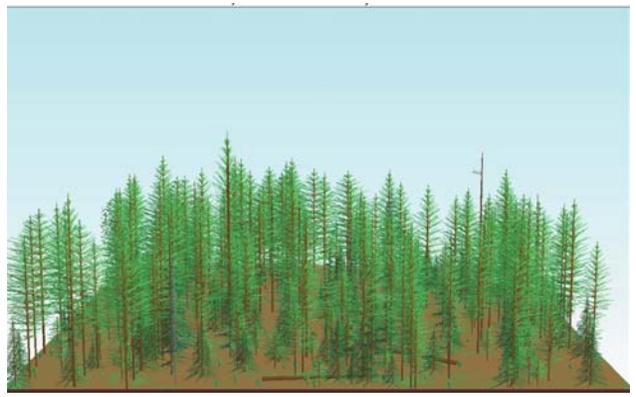


Figure 19. Small Tree—Multi-story—Closed

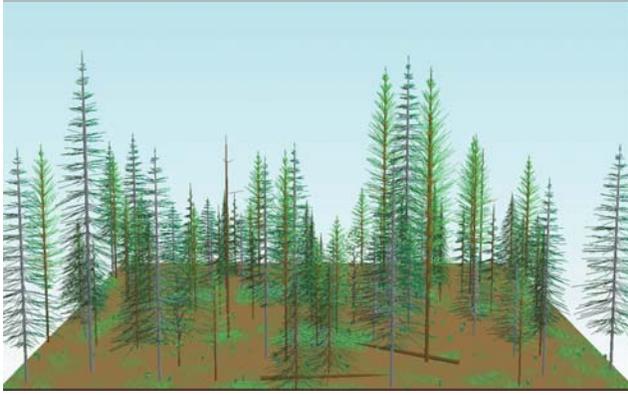


Figure 20. Medium Tree—Multi-story—Open



Figure 23. Large Tree—Multi-story—Open

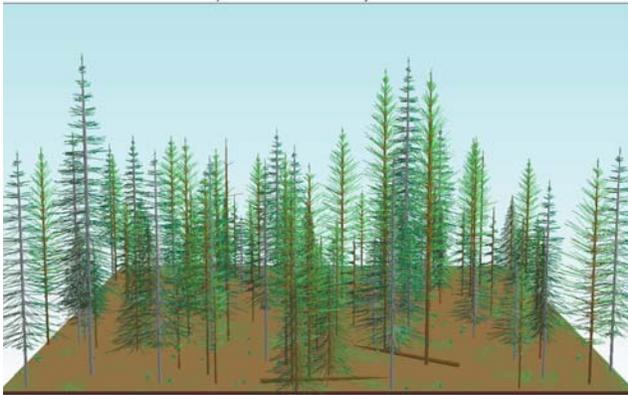


Figure 21. Medium Tree—Multi-story—Moderate



Figure 24. Large Tree—Multi-story—Moderate

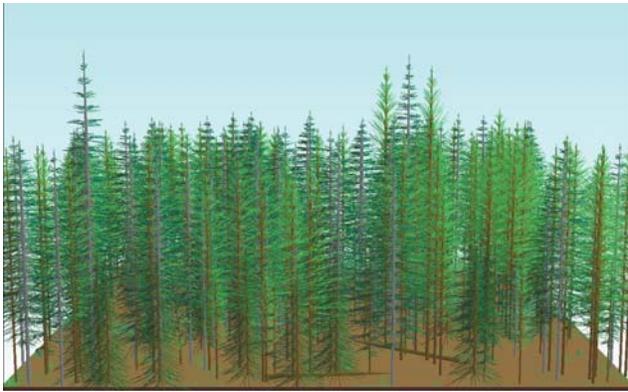


Figure 22. Medium Tree—Multi-story—Closed

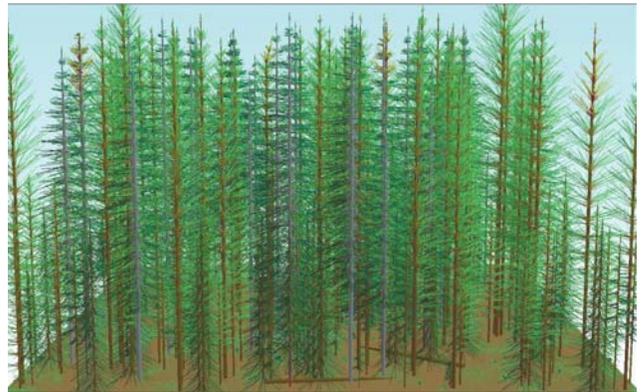


Figure 25. Large Tree—Multi-story—Closed



Figure 26a. Giant Tree—Multi-story

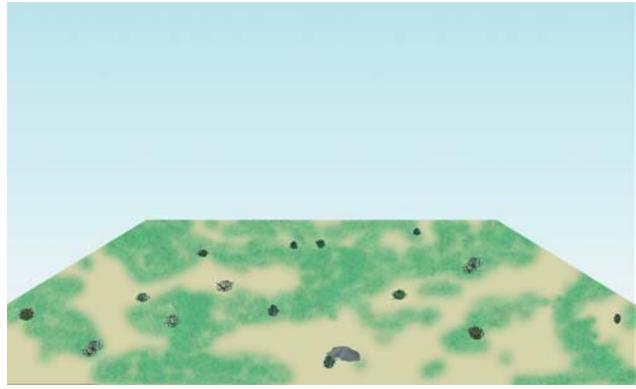


Figure 27. Grass/Forb—Open



Figure 26b. Giant Tree—Multi-story. This photograph has been included due to the limitations of the computer model.

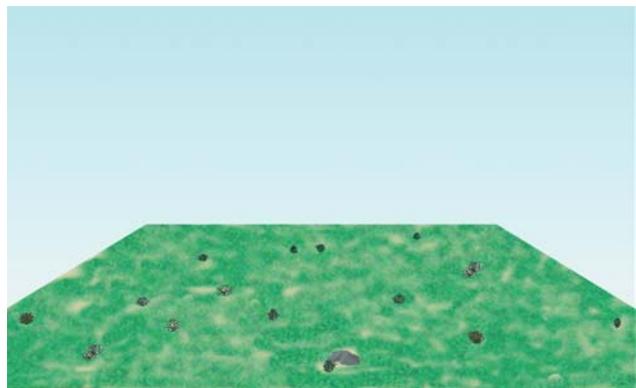


Figure 28. Grass/Forb—Closed

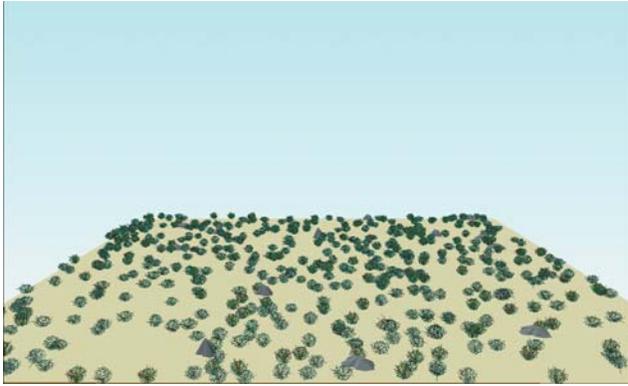


Figure 29. Low Shrub—Open Shrub Overstory—Seedling/Young

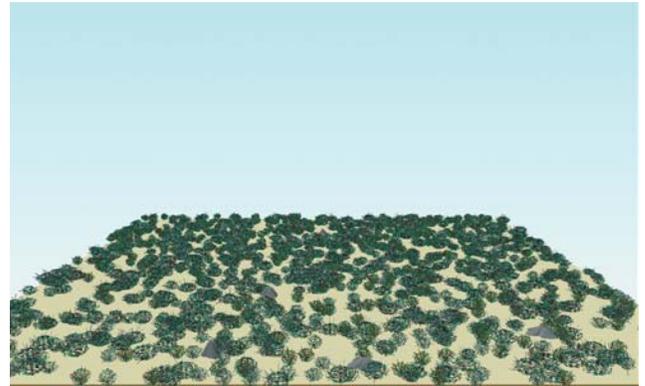


Figure 32. Low Shrub—Closed Shrub Overstory—Seedling/Young

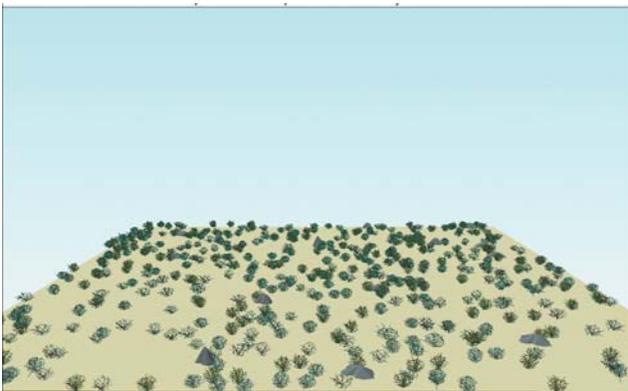


Figure 30. Low Shrub—Open Shrub Overstory—Mature

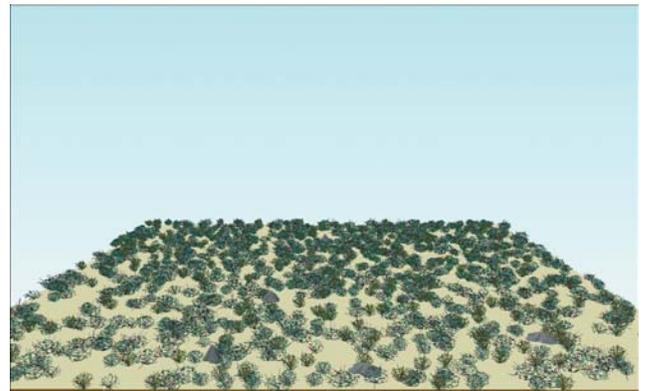


Figure 33. Low Shrub—Closed Shrub Overstory—Mature

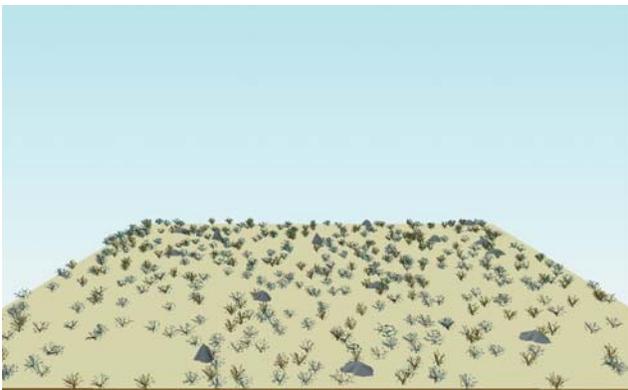


Figure 31. Low Shrub—Open Shrub Overstory—Old

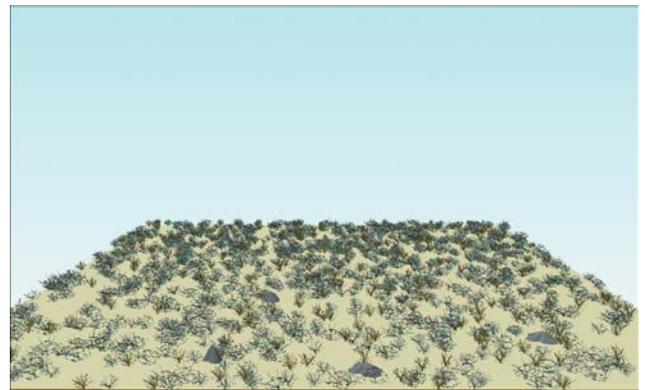


Figure 34. Low Shrub—Closed Shrub Overstory—Old

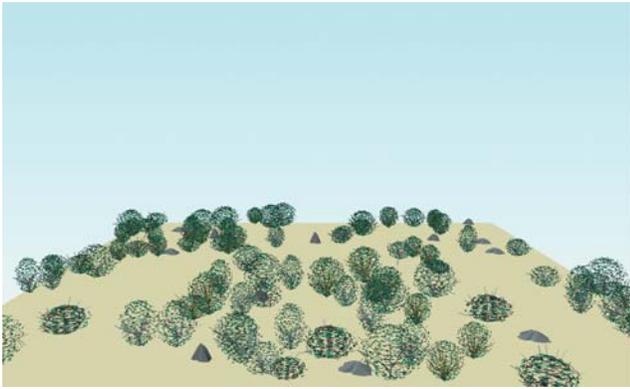


Figure 35. Medium Shrub—Open Shrub Overstory—Seedling/Young

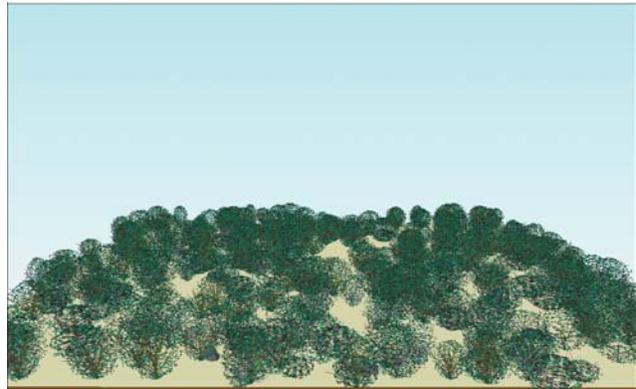


Figure 38. Medium Shrub—Closed Shrub Overstory—Seedling/Young

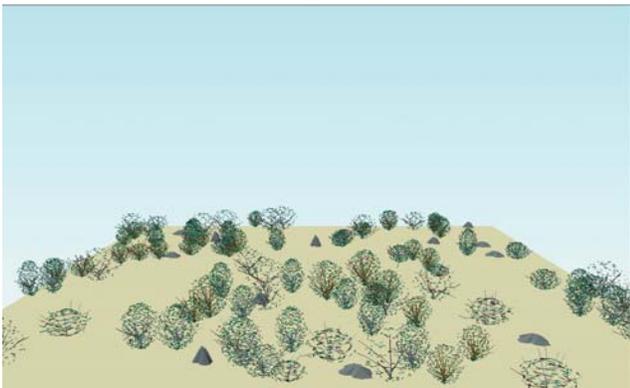


Figure 36. Medium Shrub—Open Shrub Overstory—Mature

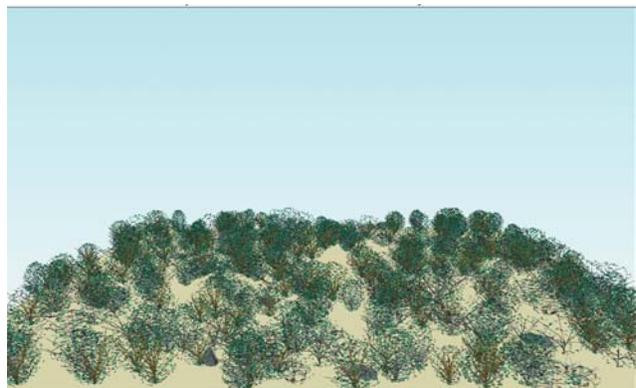


Figure 39. Medium Shrub—Closed Shrub Overstory—Mature

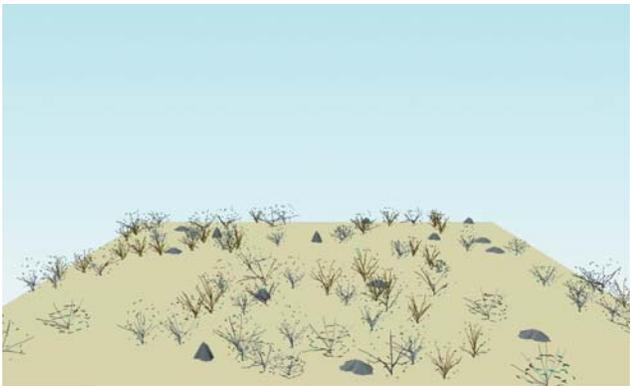


Figure 37. Medium Shrub—Open Shrub Overstory—Old

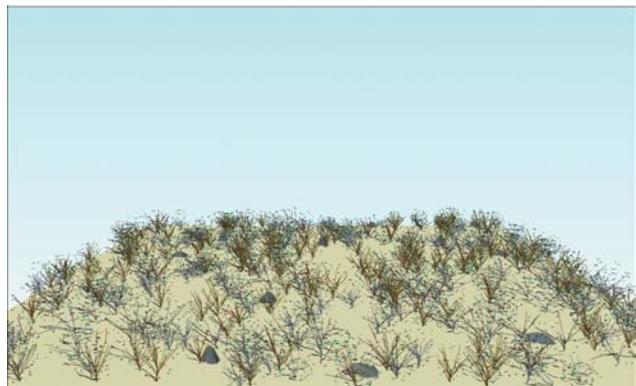


Figure 40. Medium Shrub—Closed Shrub Overstory—Old

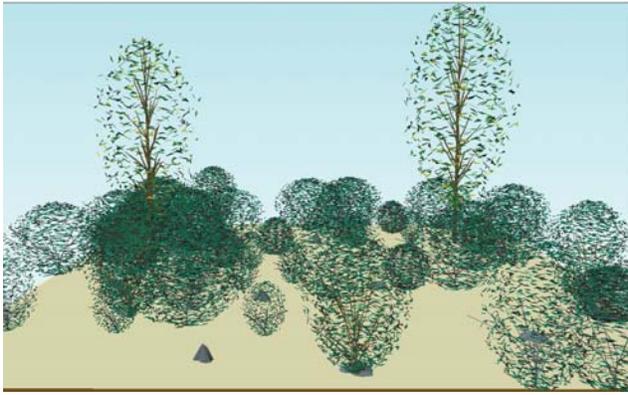


Figure 41. Tall Shrub—Open Shrub Overstory—Seedling/Young

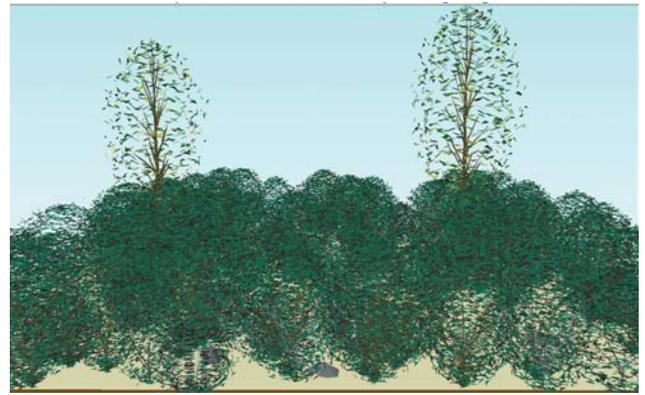


Figure 44. Tall Shrub—Closed Shrub Overstory—Seedling/Young

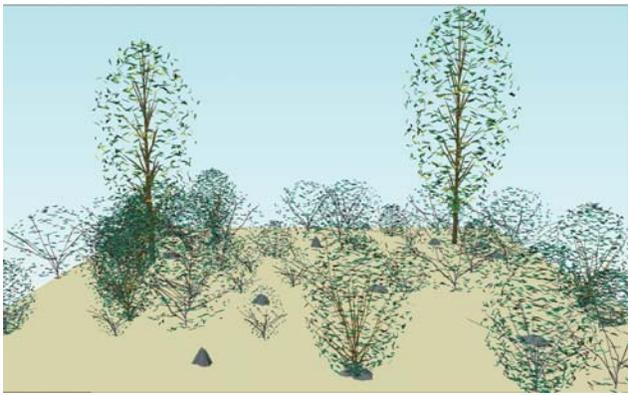


Figure 42. Tall Shrub—Open Shrub Overstory—Mature

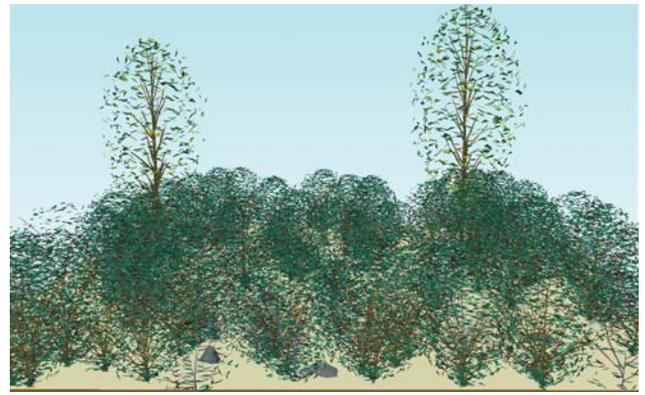


Figure 45. Tall Shrub—Closed Shrub Overstory—Mature

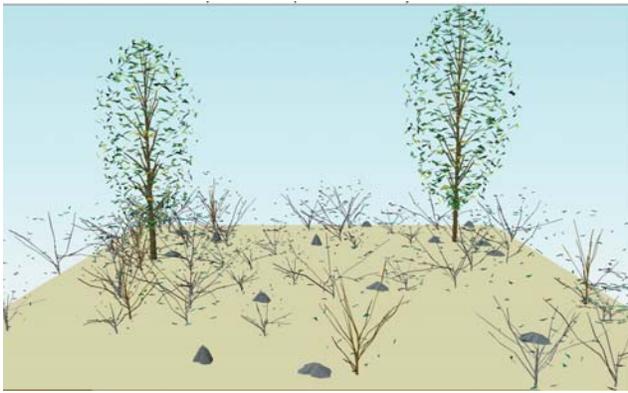


Figure 43. Tall Shrub—Open Shrub Overstory—Old



Figure 46. Tall Shrub—Closed Shrub Overstory—Old

Biotic components found within a shrubland or grassland context (these are positive influences only).

- 1.2.1 Herbaceous layer. Zone of understory nonwoody vegetation beneath shrub layer (nonforest context). May include forbs, grasses.
- 1.2.2 Fruits/seeds/nuts. Plant reproductive bodies that are used by animals.
- 1.2.3 Moss. Large group of green plants without flowers but with small leafy stems growing in clumps.
- 1.2.4 Cactus. Any of a large group of drought-resistant plants with fleshy, usually jointed stems and leaves replaced by scales or spines.
- 1.2.5 Flowers. A modified plant branch for the production of seeds and bearing leaves specialized into floral organs.
- 1.2.6 Shrubs. Plant with persistent woody stems and <16.5 feet tall; usually produces several basal shoots as opposed to a single bole.
 - 1.2.6.1 Shrub size. Refers to shrub height.
 - 1.2.6.1.1 small <2.0 feet
 - 1.2.6.1.2 medium 2.0 - 6.5 feet
 - 1.2.6.1.3 large 6.5 - 16.5 feet
 - 1.2.6.2 Percent shrub canopy cover. Percent of ground covered by vertical projection of shrub crown diameter.
 - 1.2.6.3 Shrub canopy layer. Within a shrub community, differences in shrub height and growth form produce multi-layered shrub canopies.
 - 1.2.6.3.1 Sub-canopy. The space below the predominant shrub crowns.
 - 1.2.6.3.2 Above canopy. The space above the predominant shrub crowns.
- 1.2.7 Fungi. Mushrooms, molds, yeasts, rusts, etc.
- 1.2.8 Forbs. Broad-leaved herbaceous plants. Does not include grasses, sedges, or rushes.
- 1.2.9 Bulbs/tubers. Any underground part of a plant that functions in nutrient absorption, aeration, storage, reproduction and/or anchorage.
- 1.2.10 Grasses. Members of the Graminae family.
- 1.2.11 Cryptogamic crusts. Non-vascular plants that grow on the soil surface. Primarily lichens, mosses, and algae. Often found in arid or semi-arid regions. May form soil surface pinnacles.
- 1.2.12 Trees (located in a shrubland/grassland context). Small groups of trees or isolated individuals.
 - 1.2.12.1 Snags. Standing dead trees.
 - 1.2.12.1.1 Decay class. System by which snags are classified based on their deterioration.
 - 1.2.12.1.1.1 hard. Little wood decay evident; bark, branches, top, present; recently dead; includes class 1 as described in Brown.³
 - 1.2.12.1.1.2 moderate. Moderately decayed wood; some branches and bark missing and/or loose; top broken; includes classes 2 and 3 as described in Brown.³
 - 1.2.12.1.1.3 soft. Well decayed wood; bark and branches generally absent; top broken; includes classes 4 and 5 as described in Brown.³

1.2.12.2 Snag size. Measured in dbh, as previously defined.

- 1.2.12.2.1 shrub/seedling <1 inch dbh
- 1.2.12.2.2 sapling/pole 1-9 inches dbh
- 1.2.12.2.3 small tree 10-14 inches dbh
- 1.2.12.2.4 medium tree 15-19 inches dbh
- 1.2.12.2.5 large tree 20-29 inches dbh
- 1.2.12.2.6 giant tree ≥30 inches dbh

1.2.12.3 Tree size. Measured in dbh, as previously defined.

- 1.2.12.3.1 shrub/seedling <1 inch dbh
- 1.2.12.3.2 sapling/pole 1-9 inches dbh
- 1.2.12.3.3 small tree 10-14 inches dbh
- 1.2.12.3.4 medium tree 15-19 inches dbh
- 1.2.12.3.5 large tree 20-29 inches dbh
- 1.2.12.3.6 giant tree ≥30 inches dbh

1.2.13 Edges The place where plant communities meet or where successional stages or vegetative conditions within plant communities come together.

2. Ecological Habitat Elements

Selected interspecies relationships within the biotic community; they include both positive and negative influences.

2.1 Exotic species. Any non-native plant or animal, including cats, dogs, and cattle.

2.1.1 Plants. This field refers to the relationship between an exotic plant species and animal species.

2.1.2 Animals. This field refers to the relationship between an exotic animal species and the animal species.

2.1.2.1 Predation. The species queried is preyed upon by or preys upon an exotic species.

2.1.2.2 Direct displacement. The species queried is physically displaced by an exotic species, either by competition or actual disturbance.

2.1.2.3 Habitat structure change. The species queried is affected by habitat structural changes caused by an exotic species, for example, cattle grazing.

2.1.2.4 Other. Any other effects of an exotic species on a native species.

2.2 Insect population irruptions. The species directly benefits from insect population irruptions (i.e., benefits from the insects themselves, not the resulting tree mortality or loss of foliage).

2.2.1 Mountain pine beetle. The species directly benefits from mountain pine beetle eruptions.

2.2.2 Spruce budworm. The species directly benefits from spruce budworm irruptions.

2.2.3 Gypsy moth. The species directly benefits from gypsy moth irruptions.

2.3 Beaver/muskrat activity. The results of beaver activity including dams, lodges, and ponds, that are beneficial to other species.

2.4 Burrows. Aquatic or terrestrial cavities produced by burrowing animals that are beneficial to other species.

3. Non-Vegetative, Abiotic, Terrestrial Habitat Elements

Nonliving components found within any ecosystem. Primarily positive influences with a few exceptions as indicated.

3.1 Rocks. Solid mineral deposits.

3.1.1 Gravel. Particle size from 0.1-3.0 inches (0.2-7.6 cm) in diameter; gravel bars associated with streams and rivers are a separate category.

3.1.2 Talus. Accumulations of rocks at the base of cliffs or steep slopes; rock/boulder sizes varied and determine what species can inhabit the spaces between them.

3.1.3 Talus-like habitats. Refers to areas that contain many rocks and boulders but are not associated with cliffs or steep slopes.

3.2 Soils. Various soil characteristics.

3.2.1 Soil depth. The distance from the top layer of the soil to the bedrock or hardpan below.

3.2.2 Soil temperature. Any measure of soil temperature or range of temperatures that are key to the queried species.

3.2.3 Soil moisture. The amount of water contained within the soil.

3.2.4 Soil organic matter. The accumulation of decomposing plant and animal materials found within the soil.

3.2.5 Soil texture. Refers to size distribution and amount of mineral particles (sand, silt, and clay) in the soil; examples are sandy clay, sandy loam, silty clay, etc.

3.3 Rock substrates. Various rock formations.

3.3.1 Avalanche chute. An area where periodic snow or rock slides prevent the establishment of forest conditions; typically shrub and herb dominated (sitka alder [*Alnus sinuata*] and/or vine maple [*Acer circinatum*]).

3.3.2 Cliffs. A high, steep formation, usually of rock. Coastal cliffs are a separate category under Marine Habitat Elements.

3.3.3 Caves. An underground chamber open to the surface with varied opening diameters and depths; includes cliff-face caves, intact lava tubes, coastal caves, and mine shafts.

3.3.4 Rocky outcrops and ridges. Areas of exposed rock.

3.3.5 Rock crevices. Refers to the joint spaces in cliffs, and fissures and openings between slab rock; crevices among rocks and boulders in talus fields are a separate category (talus).

3.3.6 Barren ground. Bare exposed soil with >40% of area not vegetated; includes mineral licks and

bare agricultural fields; natural bare exposed rock is under the rocky outcrop category.

3.3.7 Playa (alkaline, saline). Shallow desert basins that are without natural drainage-ways where water accumulates and evaporates seasonally.

3.4 Snow. Selected features of snow.

3.4.1 Snow depth. Any measure of the distance between the top layer of snow and the ground below.

3.4.2 Glaciers, snow field. Areas of permanent snow and ice.

4. Freshwater Riparian and Aquatic Bodies Habitat Elements

Includes selected forms and characteristics of any body of freshwater.

4.1 Water characteristics. Includes various freshwater attributes. Ranges of continuous attributes that are key to the queried species, if known, will be in the comments.

4.1.1 Dissolved oxygen. Amount of oxygen passed into solution.

4.1.2 Water depth. Distance from the surface of the water to the bottom substrate.

4.1.3 Dissolved solids. A measure of dissolved minerals in water

4.1.4 Water pH. A measure of water acidity or alkalinity.

4.1.5 Water temperature. Water temperature range that is key to the queried species; if known, it is in the comments field.

4.1.6 Water velocity. Speed or momentum of water flow.

4.1.7 Water turbidity. Amount of roiled sediment within the water.

4.1.8 Free water. Water derived from any source.

4.1.9 Salinity and alkalinity. The presence of salts.

4.2 Rivers and streams. Various characteristics of streams and rivers.

4.2.1 Oxbows. A pond or wetland created when a river bend is cut off from the main channel of the river.

4.2.2 Order and class. Systems of stream classification.

4.2.2.1 Intermittent. Streams/rivers that contain nontidal flowing water for only part of the year; water may remain in isolated pools.

4.2.2.2 Upper perennial. Streams/rivers with a high gradient, fast water velocity, no tidal influence; some water flowing throughout the year, substrate consists of rock, cobbles, or gravel with occasional patches of sand; little floodplain development.

4.2.2.3 Lower perennial. Streams/rivers with a low gradient, slow water velocity, no tidal influence; some water flowing throughout the year, substrate consists mainly of sand and mud; floodplain is well developed.

4.2.3 Zone. System of water body classification based on the horizontal strata of the water column.

4.2.3.1 Open water. Open water areas not closely associated with the shoreline or bottom.

4.2.3.2 Submerged/benthic. Relating to the bottom of a body of water, includes the substrate and the overlaying body of water within 3.2 feet (1 m) of the substrate.

4.2.3.3 Shoreline. Continually exposed substrate that is subject to splash, waves, and/or periodic flooding. Includes gravel bars, islands, and immediate nearshore areas.

4.2.4 In-stream substrate. The bottom materials in a body of water.

4.2.4.1 Rocks. Rocks >10 inches (256 mm) in diameter.

4.2.4.2 Cobble/gravel. Rocks or pebbles, .1-10 inches (2.5-256 mm) in diameter, substrata may consist of cobbles, gravel, shell, and sand with no substratum type >70% cover.

4.2.4.3 Sand/mud. Fine substrata <.01 inch (1mm) in diameter, little gravel present, may be mixed with organics.

4.2.5 Vegetation. Herbaceous plants.

4.2.5.1 Submergent vegetation. Rooted aquatic plants that do not emerge above the water surface.

4.2.5.2 Emergent vegetation. Rooted aquatic plants that emerge above the water surface.

4.2.5.3 Floating mats. Unrooted plants that form vegetative masses on the surface of the water.

4.2.6 Coarse woody debris in streams and rivers. Any piece of woody material (debris piles, stumps, root wads, fallen trees) that intrudes into or lies within a river or stream.

4.2.7 Pools. Portions of the stream with reduced current velocity, often with water deeper than surrounding areas.

4.2.8 Riffles. Shallow rapids where the water flows swiftly over completely or partially submerged obstructions to produce surface agitation, but where standing waves are absent.

4.2.9 Runs/glides. Areas of swiftly flowing water, without surface agitation or waves, which approximates uniform flow and in which the slope of the water surface is roughly parallel to the overall gradient of the stream reach.

4.2.10 Overhanging vegetation. Herbaceous plants that cascade over stream and river banks and are <3.2 feet (1m) above the water surface.

4.2.11 Waterfalls. Steep descent of water within a stream or river.

4.2.12 Banks. Rising ground that borders a body of water.

4.2.13 Seeps or springs. A concentrated flow of ground water issuing from openings in the ground.

4.3 Ephemeral pools. Pools that contain water for only brief periods of time usually associated with periods of high precipitation.

4.4 Sand bars. Exposed areas of sand or mud substrate.

4.5 Gravel bars. Exposed areas of gravel substrate.

4.6 Lakes/ponds/reservoirs. Various characteristics of lakes, ponds, and reservoirs.

4.6.1 Zone. System of water body classification based on the horizontal strata of the water column.

4.6.1.1 Open water. Open water areas not closely associated with the shoreline or bottom substrates.

4.6.1.2 Submerged/benthic. Relating to the bottom of a body of water, includes the substrate and the overlaying body of water within one meter of the substrate.

4.6.1.3 Shoreline. Continually exposed substrate that is subject to splash, waves, and/or periodic flooding. Includes gravel bars, islands, and immediate nearshore areas.

4.6.2 In-water substrate. The bottom materials in a body of water.

4.6.2.1 Rock. Rocks >10 inches (256 mm) in diameter.

4.6.2.2 Cobble/gravel. Rocks or pebbles, .1-10 inches (2.5-256 mm) in diameter, substrata may consist of cobbles, gravel, shell, and sand with no substratum type exceeding 70% cover.

4.6.2.3 Sand/mud. Fine substrata <.1 inch (2.5 mm) in diameter, little gravel present, may be mixed with organics.

4.6.3 Vegetation. Herbaceous plants.

4.6.3.1 Submergent vegetation. Rooted aquatic plants that do not emerge above the water surface.

4.6.3.2 Emergent vegetation. Rooted aquatic plants that emerge above the water surface.

4.6.3.3 Floating mats. Unrooted plants that form vegetative masses on the surface of the water.

4.6.4 Size. Refers to whether or not the species is differentially associated with water bodies based on their size.

4.6.4.1 Ponds. Bodies of water <5 acre (2 ha).

4.6.4.2 Lakes. Bodies of water ≥5 acre (2 ha).

4.7 Wetlands/marshes/wet meadows/bogs and swamps. Various components and characteristics related to any of these systems.

4.7.1 Riverine wetlands. Wetlands found in association with rivers.

4.7.2 Context When checked, indicates that the setting of the wetland, marsh, wet meadow, bog, or swamp is key to the queried species.

4.7.2.1 Forest. Wetlands within a forest.

4.7.2.2 Nonforest. Wetlands that are not surrounded by forest.

4.7.3 Size. When checked, indicates that the queried species is differentially associated with a wetland, marsh, wet meadow, bog, or swamp based on the size of the water body.

4.7.4 Marshes. Frequently or continually inundated wetlands characterized by emergent herbaceous vegetation (grasses, sedges, reeds) adapted to saturated soil conditions.

4.7.5 Wet meadows. Grasslands with waterlogged soil near the surface but without standing water for most of the year.

4.8 Islands. A piece of land made up of either rock and/or unconsolidated material that projects above and is completely surrounded by water.

4.9 Seasonal flooding. Flooding that occurs periodically due to precipitation patterns.

5. Marine Habitat Elements

Selected biotic and abiotic components and characteristics of marine systems.

5.1 Zone. System of marine classification based on water depth, and relationship to substrate.

5.1.1 Supratidal. The zone that extends landward from the higher high water line up to either the top of a coastal cliff or the landward limit of marine process (i.e., storm surge limit).

5.1.2 Intertidal. The zone between the higher high water line and the lower low water line.

5.1.3 Nearshore subtidal. The zone that extends from the lower low water line seaward to the 65 foot (20 m) isobath, typically within .6 miles (1 km) of shore.

5.1.4 Shelf. The area between the 65-650 feet (20-200 m) isobath, typically within 36 miles (60 km) of shore.

5.1.5 Oceanic. The zone that extends seaward from the 650 feet (200 m) isobath.

5.2 Substrates. The bottom materials of a body of water.

5.2.1 Bedrock. The solid rock underlying surface materials.

5.2.2 Boulders. Large, worn, rocks >10 inches (256 mm) in diameter.

5.2.3 Hardpan. Consolidated clays forming a substratum firm enough to support an epibenthos and too firm to support a normal infauna (clams, worms, etc.), but with an unstable surface that sloughs frequently.

5.2.4 Cobble. Rocks or pebbles, 2.5-10 inches (64-256 mm) in diameter, may be a mix of cobbles, gravel, shells, and sand, with no type exceeding 70% cover.

5.2.5 Mixed-coarse. Substrata consisting of cobbles, gravel, shell, and sand with no substratum type exceeding 70% cover.

5.2.6 Gravel. Small rocks or pebbles, 0.2-2.5 inches (4-64 mm) in diameter.

5.2.7 Sand. Fine substrata <0.2 inch (4 mm) in diameter, little gravel present, may be mixed with organics.

5.2.8 Mixed-fine. Mixture of sand and mud particles <0.2 inch (4 mm) in diameter, little gravel present.

5.2.9 Mud. Fine substrata <.002 inch (0.06 mm) in diameter, little gravel present, usually mixed with organics.

5.2.10 Organic. Substrata composed primarily of organic matter such as wood chips, leaf litter, or other detritus.

5.3 Energy. Degree of exposure to oceanic swell, currents, and wind waves.

5.3.1 Protected. No sea swells, little or no current, and restricted wind fetch.

5.3.2 Semi-protected. Shorelines protected from sea swell, but may receive waves generated by moderate wind fetch, and/or moderate-to-weak tidal currents.

5.3.3 Partially exposed. Oceanic swell attenuated by offshore reefs, islands, or headlands, but shoreline substantially exposed to wind waves, and/or strong-to-moderate tidal currents.

5.3.4 Exposed. Highly exposed to oceanic swell, wind waves, and/or very strong currents.

5.4 Vegetation. Includes herbaceous plants and plants lacking vascular systems.

5.4.1 Mixed macro algae. Includes brown, green, and red algae.

5.4.2 Kelp. Subaquatic rooted vegetation found in the nearshore marine environment

5.4.3 Eelgrass. Subaquatic rooted vegetation found in an estuarine environment

5.5 Water depth. Refers to the vertical layering of the water column.

5.5.1 Surface layer. The uppermost part of the water column.

5.5.1.1 Tide rip. A current of water disturbed by an opposing current, especially in tidal water or by passage over an irregular bottom.

5.5.1.2 Surface microlayer (neuston). The thin uppermost layer of the water's surface.

5.5.2 Euphotic. Upper layer of a water body that receives sufficient sunlight for the photosynthesis of plants.

5.5.3 Disphotic. Area below the euphotic zone where photosynthesis ceases.

5.5.4 Demersal/benthic. Submerged lands including vegetated and unvegetated areas.

5.6 Water temperature. Measure of ocean water temperature.

5.7 Salinity. The presence and concentration of salts; salinity range that is key to the species, if it is known, will be in the comments field.

5.8 Forms. Morphological elements within marine areas.

5.8.1 Beach. An accumulation of unconsolidated material (sand, gravel, angular fragments) formed by waves and wave-induced currents in the intertidal and subtidal zones.

5.8.2 Off-shore islands/rocks/sea stacks/off-shore cliffs. A piece of land made up of either rock and/or unconsolidated material that projects above and is completely surrounded by water at higher high water for large (spring) tide. Includes off-shore marine cliffs.

5.8.3 Marine cliffs (mainland). A sloping face steeper than 20½ usually formed by erosion and composed of either bedrock and/or unconsolidated materials.

5.8.4 Delta. An accumulation of sand, silt, and gravel deposited at the mouth of a stream where it discharges into the sea.

5.8.5 Dune. In a marine context; a mound or ridge formed by the transportation and deposition of wind-blown material (sand and occasionally silt).

5.8.6 Lagoon. Shallow depression within the shore zone continuously occupied by salt or brackish water lying roughly parallel to the shoreline and separated from the open sea by a barrier.

5.8.7 Salt marsh. A coastal wetland area that is periodically inundated by tidal brackish or salt water and that supports significant (15% cover) nonwoody vascular vegetation (e.g., grasses, rushes, sedges) for at least part of the year.

5.8.8 Reef. A rock outcrop, detached from the shore, with maximum elevations below the high-water line.

5.8.9 Tidal flat. A level or gently sloping (<5½) constructional surface exposed at low tide, usually consisting primarily of sand or mud with or without detritus, and resulting from tidal processes.

5.9 Water clarity. As influenced by sediment load.

6. (No Data)

Formerly contained topographic information, such as elevation, that has been moved to the life history matrix.

7. Fire as a Habitat Element

Refers to species that benefit from fire. The time frame after which the habitat is suitable for the species, if known, will be found in the comments field.

8. Anthropogenic Related Habitat Elements

This section contains selected examples of human-related Habitat Elements that may be a key part of the environment for many species. These Habitat Elements may have either a negative or positive influence on the queried species.

8.1 Campgrounds/picnic areas. Sites developed and maintained for camping and picnicking.

8.2 Roads. Either paved or unpaved.

8.3 Buildings. Permanent structures.

8.4 Bridges. Permanent structures typically over water or ravines.

8.5 Diseases transmitted by domestic animals. Some domestic animal diseases may be a source of mortality or reduced vigor for wild species.

8.6 Animal harvest or persecution. Includes illegal

harvest/poaching, incidental take (resulting from fishing net by-catch, or by hay mowing, for example), and targeted removal for pest control.

8.7 Fences/corrals. Wood, barbed wire, or electric fences.

8.8 Supplemental food. Food deliberately provided for wildlife (e.g., bird feeders, ungulate feeding programs, etc.) as well as spilled or waste grain along railroads and cattle feedlots.

8.9 Refuse. Any source of human-derived garbage (includes landfills).

8.10 Supplemental boxes, structures and platforms. Includes bird houses, bat boxes, raptor and waterfowl nesting platforms.

8.11 Guzzlers and waterholes. Water sources typically built for domestic animal use.

8.12 Toxic chemical use. Proper use of regulated chemicals; documented effects only.

8.12.1 Herbicides/fungicides. Chemicals used to kill vegetation and fungi.

8.12.2 Insecticides. Chemicals used to kill insects.

8.12.3 Pesticides. Chemicals used to kill vertebrate species.

8.12.4 Fertilizers. Chemicals used to enhance vegetative growth.

8.13 Hedgerows/windbreaks. Woody and/or shrubby vegetation either planted or that develops naturally along fencelines and field borders.

8.14 Sewage treatment ponds. Settling ponds associated with sewage treatment plants.

8.15 Repellents. Various methods used to repel or deter wildlife species that damage crops or property (excluding pesticides and insecticides).

8.15.1 Chemical (taste, smell, or tactile). Chemical substances that repel wildlife.

8.15.2 Noise or visual disturbance. Nonchemical methods to deter wildlife.

8.16 Culverts. Drain crossings under roads or railroads.

8.17 Irrigation ditches/canals. Ditches built to transport water to agricultural crops or to handle runoff.

8.18 Powerlines/corridors. Utility lines, poles, and rights-of-way associated with transmission, telephone, and gas lines.

8.19 Pollution. Human-caused environmental contamination.

8.19.1 Chemical. Contamination caused by chemicals.

8.19.2 Sewage. Contamination caused by human waste.

8.19.3 Water. Aquatic contamination from any source.

8.20 Piers. Structures built out over water.

8.21 Mooring piles, dolphins, buoys. Floating objects anchored out in the water for nautical purposes.

8.22 Bulkheads, seawalls, revetment. Retaining structures built to protect the shoreline from wave action.

8.23 Jetties, groins, breakwaters. Structures built to influence the current or protect harbors.

- 8.24 Water diversion structures. Structures built to funnel or direct water, including dams, dikes and levies.
- 8.25 Log boom. A raft of logs lashed together either to transport the logs or as barriers to boat traffic near marinas or dams.
- 8.26 Boats/ships. Watercraft, either motorized or nonmotorized.
- 8.27 Dredge spoil islands. Sediment deposited from dredging operations.
- 8.28 Hatchery facilities and fish. Fish that are hatched in captivity and later released into the wild. For simplicity this refers to freshwater areas, though marine birds and mammals likely feed on hatchery-released fish too. This also includes the facilities and their operation.

Habitat Elements Data Matrix

Based on Marcot's work, the Habitat Elements or HEs Digital Matrix (found on the CD-ROM) focuses on those correlates that consist of fine-scale or within-stand features. In keeping with the initial intent, HEs do not include those elements that may be used, but are nonessential to the success or viability of a population, thus they may also be thought of as the drivers of habitat selection. The HEs matrix depicts associations with all common species, including both residents and migrants, in Oregon and Washington.

The list of HEs and their definitions was derived from Marcot et al.¹⁴ and was refined and edited based on the published literature (in Literature Cited, these are identified with an asterisk) and expert review. The final list comprises 287 HEs, including naturally occurring biological and physical elements as well as elements created or caused by human actions. Definitions are provided to characterize each element, and clarify the nature of its influence on wildlife species. The HEs are grouped into seven major categories, six of which have related subclasses (Table 2).

Category 1, entitled Habitat Elements, contains two broad subclasses: Forest/Woodland Vegetative Elements or Substrates and Shrubland/grassland Vegetative Elements or Substrates. These subclasses denote the floristic components and attributes that are found within forested and nonforested (shrubland/grassland) communities. Floristic components include plants (lichens, fungi, and ferns), and plant parts (roots, flowers, and bark); attributes include the herbaceous and shrub layers. The subclasses are nested within the broad wildlife habitats (see Chapter 1). That is, only species that occur within Forested Wildlife-habitats may be associated with Forest/Woodland Vegetative Elements or Substrates, and only species that occur within Shrubland/Grassland Wildlife-habitats may be associated with Shrubland/Grassland Vegetative Elements or Substrates. Some species that occur within both forested and nonforested habitats may be associated with HEs in both of the subclasses. Conversely, some forest or shrubland/grassland species may not be associated with any of the floristic components and

attributes found in the category HEs; other HEs may play a larger role in driving the species' occurrence. Salamanders and other amphibians, for example, may occur in forested habitats but are most influenced by water characteristics, found in the category Freshwater Riparian and Aquatic Bodies discussed below. Thus, while the broader Wildlife-habitat determines which HEs (either forested or nonforested) a species may be associated with, however, it does not mandate an association. That is, when a HE from either or both of the two subclasses Forest/Woodland Vegetative Elements or Shrubland/Grassland Vegetative Elements is associated with a species, the association(s) imply that the HE is key to the species well being because it promotes the species' distribution, abundance, fitness, and viability

Category 2, Ecological Habitat Elements, contains HEs that describe interspecific relationships. Namely, these elements depict the influence of exotic species, insect population irruptions, beaver/muskrat activities, and burrows on a given species. The first two, Exotic Species and Insect Population Control may exert either positive or negative influences on a given species, whereas the latter two depict positive relationships only. For example, only species that are positively influenced by another species' burrow (e.g., secondary burrow users) will be associated with burrows. Species that are negatively influenced, such as animals that may break their legs stepping into badger burrows, are not.

Nonvegetative, Abiotic Terrestrial Habitat Elements, Category 3, contains a variety of abiotic HEs such as Rocks, Soils, Rock Substrates, and Snow; each has >2 subclasses. Habitat Elements under the classes Soils and Snow may depict either negative or positive influences. Freshwater Riparian and Aquatic Bodies Habitat Elements, Category 4 characterizes many aquatic attributes, including those associated with rivers and streams, lakes, ponds and reservoirs, and wetlands/marshes/wet meadows/bogs/swamps. These HEs depict primarily positive influences, with the exception of the class Water Characteristics, which includes Habitat Elements such as Water Temperature, Water Velocity and Water Depth, all of which could either promote or inhibit species' viability.

Marine Habitat Elements are found in Category 5. Only species that occur in the Marine Wildlife-habitats are associated with Marine Habitat Elements. Examples include the classes Zone, Substrates, Energy Vegetation, Water Depth, Water Temperature Salinity, Forms, and Water Clarity. The only HEs that may exhibit either positive or negative influences are Water Temperature and Salinity.

Category 7 consists of only one Habitat Element, Fire. This element, when associated with a given species, indicates that fire has a positive effect on the species distribution, occurrence, and viability. Some species that benefit from fire include grazers, which feed on the lush new growth initiated after burns, cavity and snag users, and species that use down wood. Panelists indicated in the comments the period of time after which the burned stand becomes beneficial to the species.

Lastly, Category 8, Anthropogenic-related Habitat Elements, contains human-made features, such as roads, buildings, and fences; activities such as toxic chemical use, animal harvest and hatchery fish releases; and outcomes, such as pollution and refuse. We included these HEs to acknowledge that most animals encounter the effects of humans in their environment, some of which may benefit certain species, many of which do not. Because of the dual nature of these anthropogenic elements, all of them may exert positive or negative influences depending on a variety of factors, including the species involved, the intensity and scale of the activity or effect, and the duration of the activity.

On completion of the HEs list, we used expert panels to indicate which HEs are associated with each species. Specifically, we posed the question, Which HEs, based on our list, most strongly influence this species' distribution, abundance, fitness, and viability? As a group, the panelists reviewed the HEs list, and indicated those elements they believed to be most relevant. When necessary, the panelists formulated comments to elucidate the relationship between the Habitat Element and the species. Clarification was particularly important for Habitat Elements that may exert both positive and negative influences. Other types of information that may be found in the comments include the following: (1) the range of values necessary for use of the HE. For example, if the element Water Depth is listed as being important to the animal, the specific water depth(s) may be described; (2) the spatial, temporal, or geographical/topographical contexts necessary for use of the HE. That is, whether the HE is used only in certain parts of the animal's range, or in specific seasons of the year, or on particular slopes, etc.; (3) whether the importance of the HE is dependent on relationships with other HEs, Structural Conditions, and/or Wildlife Habitats. If so, the relevant habitat components are listed; and (4) the activity (e.g., reproduction, foraging, etc.) associated with the HE. Some HEs may only be used for specific purposes, for example, snags during the nesting season.

Conclusion

The final Structural Conditions and Habitat Elements Matrices are the most complete characterization of intermediate and fine-scale features to date; however, because of the sheer magnitude of the exercise, some species associations may have been mistakenly omitted. We expect that as our collective knowledge about wildlife-habitat relationships evolves, additions and corrections to all three habitat matrices (Wildlife-Habitat Types, Structural Conditions, and Habitat Elements) may be identified. The matrices associated with this book are relationally tied to illustrate the fact that wildlife exist in a multi-dimensional environment. For this reason, we stress the importance of getting the big picture and using the matrices to their best advantage, that is, as inter-related databases, each providing a part of the equation that depicts in its entirety the wildlife environment. For

example, there are 130 species closely associated with the forest structural conditions, but 40 (38%) of these species require a specific Habitat Element to reproduce in the forest environment. Thus, when classifying what is or is not habitat for a particular species it is imperative to look across scales and ask, What is important at the landscape or regional scale? This information is provided in the broad Wildlife-habitat Types Matrix that depicts habitat relationships based on floristic communities (see Chapter 1). Next, one must assess the particular structures and/or seral stages within those communities to derive information on how species occurrence is influenced by vegetation of varying age, size class, and density. The Structural Conditions Matrix, defined in this chapter, elucidates wildlife-habitat relationships at what can be thought of as the "stand-level." Lastly, the fine-scale features, both physical and biological, that are essential for a species occurrence or precludes it, must be identified. The Habitat Elements Matrix, described in this chapter, delineates the within-stand attributes that most influence each species.

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