

***Washington Wildlife Habitat Types:
Mapping and Classification
of Landscape-Level Habitats***

*Chris Kiilgaard
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LAND COVER CLASSIFICATION AND MAPPING

1.1 Introduction

Vegetation patterns are an integrated reflection of the physical and chemical factors that shape the environment of a given land area. They also are determinants for overall biological diversity patterns that can denote habitat types in conservation evaluations. A central concept in the wildlife habitat/vegetation relationship is that the physiognomic and floristic characteristics of vegetation (and, in the absence of vegetation, other landscape characteristics) across the land surface can be used to define biologically meaningful habitats. There may be considerable variation in floristic composition of sub canopy vegetation layers that are not resolved when mapping at the level of dominant canopy vegetation types, and there is a need to address this part of the diversity of nature. As information accumulates from field studies on patterns of variation in under story layers, it can be attributed to the mapped units of alliances.

2.1 Land Cover Classification

The major purpose of this mapping effort for the Species Habitat Project (SHP) was to portray wildlife habitats at a regional scale where remotely sensed data provide the fundamental data for the classification. Vegetation physiognomy was selected as the primary criteria for identifying wildlife habitats (detailed vegetation descriptions and wildlife habitat relationships are provided in Johnson and O'Neil (manuscript in preparation)). A second purpose for the classification was to establish relationships between major environmental controls and the identified habitat/vegetation units. For this reason, floristic composition was chosen as second criteria in combination with physiognomy

To classify barren, or non-vegetated lands we followed the classification approach described by the USGS (Anderson et al. 1976). The Anderson classification system is commonly used in remote sensing applications and uses a hierarchy that partitions regional landscapes into broad major land use/land cover categories such as agriculture, urban, forest, etc. Second level distinction separates the broad level I class into specific categories. For example, the Anderson level I class Barren Land is classified into dunes, exposed rock, salt flats in level II. We classified barren, or non-vegetated lands to Anderson level II in this mapping project. Agricultural lands were kept at Anderson level I in the interest of time, project finances and the general focus of SHP, which is to inventory natural ecosystems.

3.1 METHODS

3.1.1 Map Development:

Each of the 9 Landsat TM scenes that were used in the classification of eastern Washington's vegetation underwent a 2 phases, multi-step process. The major steps involved with the two phases are briefly described below.

Phase I—Image preparation, Radiometric Preview, and Image Analysis

- 1) *Partitioning imagery into ecoregional similarity.* Previous mapping efforts by the NHI staff have demonstrated that whenever classification takes place over a large land area, (such as a TM scene), the problem of signature extension severely compromises classification effort. Ecoregional partitioning reduces spectral complexity displayed in a full TM scene, and clusters vegetation types into more “probable” associations.
- 2) *Construct derivative bands.* A normalized difference vegetation index, (NDVI), and the first three principal component bands of a Tasseled Cap Transformation algorithm was incorporated with TM bands 1-5 and 7 to form a 10 band image. This image was the basis of all subsequent spectral analysis.
- 3) *Conversion of TM imagery to TIFF format files.* A three-band (bands 3, 4 and 5) image was subset from the 10-band image and converted to a TIFF (tagged image file format), which was downloaded to a lap top computer for field reconnaissance purposes.
- 4) *Conversion of vector format ancillary data.* Coverages which assist the analyst during field verification, especially the road and stream networks were converted to a DXF format and brought into the lap top computer to display over the TIFF images.

Phase II—Image Classification, Field Verification, and Accuracy Assessment

- 1) *Unsupervised classification of the scene ecoregion.* Initial classification procedure starts with a sufficiently large number of spectral clusters (generally between 100-150), to form mutually exclusive spectral signatures. These signatures are then run through a maximum likelihood classifier to produce the initial spectral cluster map.
- 2) *Preliminary assignment of spectral class to vegetation class.* Linking spectral clusters to vegetation information classes is first done through an on-screen examination of the clusters overlaid on the image. In many cases the information class is spectrally distinct enough that cluster labeling is very clear. However, there will always be a number of spectral clusters that are indeterminable at this stage, as well as, information classes that do not readily lend themselves to identification, (like palustrine forest). Spectral identity of these obscure clusters needs to pass through several iterative processes' to determine spectral/information class relationships.
- 3) *Field verification of spectral-vegetative condition.* This process involves recording vegetation identity at known points within the image. This entailed linking our global positioning satellite (GPS) unit to the TIFF version of the TM scene through Field Notes software and recording field-training sites. A database was developed for each ecoregion using the Field Notes software that includes XY coordinates, the vegetation/land cover class, and environmental variables that may be useful to the analyst in future processing iterations. The database was brought into ARC/INFO as a point location file and displayed over the various thematic classifications. Other ancillary data, (the National Wetland Inventory (NWI), stream and road network data) were utilized extensively with the TIFF data to assist in cover type identification.

- 4) Refinement-reclassification of spectral class to vegetative condition. This step begins the process of winnowing the scene into identifiable and unidentifiable, or “problem” spectral classes. Once the analyst was confident of the relationship between spectral cluster and land cover class that class is masked out of succeeding classification iterations. Once the problem spectral classes were identified, separate classifications were performed where each class partitioned into many spectral classes and, if possible, those classes are related to probable land cover types and masked out. Further refinement of spectral cluster/land cover type was accomplished through the use of ancillary data as “logical operators”. For example, deep shadows in mountainous terrain typically are confused with water signatures, by using a digital elevation model the analyst can overlay that spectral class on all slopes less than 1 % and quickly ascertain those areas which are to steep to pond water.
- 5) Field verification of “problem” spectral-vegetation classes. If the analyst cannot confidently relate spectral cluster to land cover class, another field visit was often necessary to uncover the spectral cluster identity.
- 6) Editing the refined coverage. As a last step in the classification phase the analyst uses on- screen editing of those areas, which are too obscure to classify by conventional image processing techniques. Typically, these were the cloud, cloud shadow, or smoke obscured areas. Aerial photo interpretation of recent aerial photography became the interpretation basis for the classification within these obscured regions.

3.2 Mapping Standards

3.2.1 Landsat TM Imagery.

Nine Landsat TM scenes formed the basis for interpretation of the SHP in eastern and central Washington. All imagery contained less than 10% cloud cover and was acquired from May to October 1996. Cloudy and smoke-obscured regions within the imagery were interpreted using adjacent imagery, where possible, or using aerial photography as the information sources. Imagery was registered to the Washington state plane coordinates: NAD 27.

Table 3.2.1 Landsat TM Imagery and dates used for mapping project

Path/Row	Month/year	Path/Row	Month/year	Path/Row	Month/year
P43/R26	June / 1996	P44/R26	May / 1996	P45/R26	Aug / 1996
P43/R27	July / 1996	P44/R27	June / 1996	P45/R27	June / 1996
P43/R28	July / 1996	P44/R28	Oct / 1996	P45/R38	July / 1996

3.2.3 Special Feature Mapping:

Several collateral databases were incorporated into this mapping project.

- 1) National Wetlands Inventory for westside, montane, and eastside riparian habitats
- 2) WDFW’s Blue Mountains habitat/vegetation mapping project directed by Brian Cosentino.
- 3) WDFW’s Shrub steppe vegetation mapping of eastern Washington, directed by John Jacobson.
- 4) WDNR-Heritage Program mapping project for west side grasslands and west side oak and dry Douglas fir forests for lands west of the Cascade crest.

- 5) US National Park Service for montane vegetation in Mount Ranier, North Cascades, and Olympic National Parks.
- 6) US Biological Service- Gap Analysis Program state of Washington vegetation map.

Wildlife Habitat Mapping.

Given that wildlife-habitat relationships are generally not available at the plant association or alliance levels, an additional lumping of alliances for the 286 NVCS alliances listed for Oregon and Washington was necessary. Species-habitat vegetation types were primarily identified based on vegetative characteristics. Criteria for the aggregation of alliances (Johnson and O'Neil 1997) was based on:

- ?? Floristic similarity of the vegetation between types.
- ?? Physiognomic and environmental similarity of alliances
- ?? Mosaic-like alliances in a similar environment were lumped together if they were not regional in extent and occurred in close proximity to each other.
- ?? Alliances that were largely the result of human modification were lumped based on physiognomy, and to a lesser degree, major environmental zones.

Using the aggregation criteria the 286 NVCS alliances were aggregated to 87 landscape level alliances. These 87 types were condensed into 27 upland terrestrial wildlife habitat types following the cluster analysis procedure (O'Neil et al. 1995) first produced for Oregon wildlife habitat types.

4.1 RESULTS

4.1.1 Habitat Mapping.

The statewide wildlife habitat map displays distributional information for the 32 terrestrial and marine habitats designated in Washington.

Wildlife habitat proportions follow closely the landscape level vegetation results. Not surprisingly, the single largest habitat type is the shrub steppe (which is the accumulation of big sage and sagebrush steppe). Excepting Oceanic (2nd largest), and agriculture (5th largest), the Westside Lowlands Conifer and Hardwood Forest (douglas fir/w. hemlock/w. red cedar) and Ponderosa Pine Forest and Woodland, Eastside Mixed Conifer, and Western Juniper Woodlands occupied the greatest land area. The rarest type, Westside Grasslands, exists in small, scattered patches within the agricultural mosaic of western Washington that are not large enough to meet minimum mapping resolution. It is questionable as to why this type is included as a wildlife habitat type.

Table 4.1.1. Rank of habitat type by proportional land area.

Class	Habitat Type	Rank	Acres
1	Westside Lowlands Conifer-Hardwood Forest	3	8826049
2	Westside Oak & Dry Douglas Fir Forest & Woodlands	18	333633
3	Southwest Oregon Mixed Conifer-Hardwood Forest	N/A	N/A
4	Montane Mixed Conifer Forest	10	2739511
5	Eastside Mixed Conifer Forest	7	3990049
6	Lodgepole Pine Forest and Woodlands	20	312551
7	Ponderosa Pine Forest and Woodlands	4	6367172
8	Upland Aspen Forest	29	20019
9	Subalpine Parkland	25	71180
10	Alpine Grasslands and Shrublands	21	271395
11	Westside Grasslands		
12	Ceanothus-Manzanita Shrublands	N/A	N/A
13	Western Juniper and Mountain Mahogany Woodlands	N/A	N/A
14	Eastside Canyon Shrublands	19	327879
15	Eastside Grasslands	11	1787524
16	Shrub-Steppe	1	17645256
17	Dwarf Shrub Steppe	17	403075
18	Desert Playa and Salt Scrub Shrublands	15	693489
19	Agriculture	5	6269685
20	Urban	16	582653
21	Open Water	14	717566
22	Herbaceous Wetlands	13	977741
23	Westside Riparian-Wetlands	24	75464
24	Montane Coniferous Wetlands	28	35749
25	Eastside Riparian-Wetlands	30	19815
26	Coastal Dunes	26	53351
27	Coastal Headlands and Islets	32	3174
28	Bays and Estuaries	23	170676
30	Inland Marine Deeper Waters	22	217959
31	Marine Shelf	8	3908523
32	Oceanic	2	14017991

When you aggregate the cover types by vegetative form (i.e. forest, shrub, etc.), forest and woodland occupy 48% of total land area (Figure 4.1.2). Of the entire state 85.4% is classified as having predominantly natural vegetation. Agriculture non-vegetated, water, and urban comprise the remainder. The proportion of vegetated to non-vegetated surface (85.4) is very similar to California's (79.8%), (Stoms et al. 1998), Kiilsgaard 1999).

6.1 Limitations and Discussion

There are no constraints to the use of this data. However, this data was produced with intended application at the state, or ecoregional level, with an accuracy in detail and precision based on USGS 1:100,000 maps. The data was created to provide a coarse filter approach to vegetation/wildlife habitat relationships where not every occurrence of animal habitat is mapped, only large, generalized distributions. Therefore, this dataset is most valid when used in analysis of 1:100,000 applications or greater.

Area calculations of the various cover types need to be interpreted with some caveats. The coarse scale (1:100,000) of vegetation and habitat maps provide reasonable representations of the actual acreage, but not as accurate as fine-scale maps because fine-scale maps depict boundaries with greater precision, which in turn affects area calculations.

7.1 REFERENCES

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