



**RIPARIAN HABITAT INVENTORY
AND MAPPING OF THE
MAINSTEM TRINITY RIVER.**

**PREPARED FOR:
TRINITY RIVER RESTORATION PROGRAM**

**PREPARED BY:
MCBAIN AND TRUSH, INC.
P.O. BOX 663
ARCATA, CA 95518**

October 31, 2005

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1 BACKGROUND

The restoration strategy of the Trinity River Record of Decision (ROD) is to re-create a dynamic alluvial river that will provide the range of aquatic and terrestrial habitats necessary to support a healthy riverine ecosystem (US Department of the Interior 2000). Healthy rivers are characterized by 10 attributes that include a dynamic alternate bar morphology and periodic channel migration, frequent mobilization of the channelbed surface and periodic channelbed scour, a balance of fine and coarse sediment deposition and transportation, as well as a functional floodplain (McBain and Trush 2000). A critical factor presently limiting these processes from occurring is the existing riparian berm. Berms often form downstream of dams where low water flows allow the establishment of riparian vegetation. The lack of natural high flows prevents the scour of the vegetation which grows into a dense band along either side of the channel. The interwoven roots trap fine sediments that form a berm. The riparian berm acts as an armored wall that prevents natural migration of the channelbed and has virtually eliminated the ability of the river to create bars, move across the valley, create floodplains, and other natural fluvial processes. Removing riparian berms and restoring alluvial processes is fundamental to increase the quantity, quality, and diversity of Chinook salmon habitat (Hampton and Gilroy 1995, USFWS and Hoopa Valley Tribe 1999).

The Trinity River ROD encompasses two riparian goals that are detailed in the Environmental Impact Statement/Report (CH2M Hill 2000). The first goal is to diversify the species composition and age structure of riparian plant communities along the mainstem Trinity River. The second goal is to encourage recruitment of riparian hardwood species on floodplains rather than along the low water margin where riparian berms are formed. As specified in the Adaptive Environmental Assessment and Management Program, baseline information is necessary for comparison with the physical and biological results of implementation of the ROD. This report addresses the results of a baseline vegetation inventory and classification.

1.1 Project Description

McBain & Trush and the USDA Forest Service Redwood Sciences Laboratory (RSL) submitted a joint proposal in November 2002 to conduct an inventory of Trinity River riparian and adjacent upland vegetation. This technical memorandum summarizes the riparian habitat inventory field work and analysis performed by McBain and Trush during summer 2004 and 2005 (Tasks 5, 6, and 7 listed below). It is our understanding that Redwood Sciences Laboratory will submit a separate report of their activities during the FY2004 and FY2005 period (Tasks 3 and 8) and a final comprehensive report detailing this project (Task 9).

Specific tasks developed under the joint proposal and the fiscal years in which they were funded are as follows:

FY2003

- Task 1: Preparation and pre-field mapping (McBain and Trush, completed).
- Task 2: Field based vegetation and geomorphic response unit mapping (McBain and Trush, completed).
- Task 3: Associating stand mapping with wildlife attributes (RSL, in progress).

FY2004

- Task 4: Digitizing polygons and preparing maps (McBain and Trush, completed).
- Task 5: Selecting the Relevé sample plot locations in plant stand types (McBain and Trush, completed).
- Task 6: Field Based vegetation description sampling and monumenting (McBain and Trush, completed).

FY2005

- Task 7: Vegetation description analysis using TWINSPAN analysis (McBain and Trush, completed).
- Task 8: Assembly of source imagery and software for remote sensing model development for riparian habitat identification (RSL, in progress).
- Task 9: Riparian vegetation and habitat inventory final report will not be started until tasks 1-8 are completed (RSL).

The inventory and mapping project performed by McBain & Trush consisted of two components. The first component was completed during the summer of 2003. In that year, McBain & Trush created a high-resolution vegetation and geomorphic unit basemap for the Trinity River corridor from the Lewiston Dam to the confluence of the Trinity River North Fork with the mainstem Trinity River (Tasks 1, 2, and 4). The maps included riparian vegetation, adjacent upland vegetation, and geomorphic units (McBain and Trush 2004). These maps will be used as the basis for quantifying larger-scale changes in patch size, patch type, corridor diversity, ecotone complexity and geomorphic units as a result of TRRP management actions and natural high flow events.

The second component of the inventory and mapping project included describing the species composition and structure of mapped riparian and adjacent upland vegetation. The field data were also used to classifying sampled vegetation. Our analysis classified mapped patch types using standard vegetation classification methods (i.e., TWINSPAN, hierarchical cluster analysis, and indicator species analysis). The classification derived from our current analysis was compared to the initial patch type classification used when mapping. Some mapped patch types were combined, others were left alone. This report summarizes field work, subsequent analysis, and results of the field-based vegetation description.

2 METHODS

2.1 Field-Based Vegetation Description

During the summer of 2004, 87 relevé plots were sampled in the Trinity River riparian corridor. Prior to sampling, relevé plot locations were selected using vegetation maps developed in 2003. Each relevé was permanently monumented and carefully mapped to allow future sampling and monitoring. Sampling followed a modification of the California Native Plant Society's sampling protocols as described below. Access to private property where sample plots were located was obtained before field sampling.

2.1.1 CNPS Relevé Protocol Modification

The California Native Plant Society has a Field Sampling Protocol to quantitatively sample vegetation (CNPS 2000) called a relevé. The relevé method relies on estimating areas covered by individual plant species within different vegetation layers. We used relevés to quantify stand characteristics, such as plant species composition and structure within the most frequently occurring stand types on different geomorphic units within the Trinity River riparian corridor. The relevé method facilitates classifying large areas of vegetation in a limited amount of time.

The CNPS protocol provides methods for selecting plot locations, describing plot locations, and determining plot size. The protocol was more detailed than necessary for this project, especially in terms of plot shape and variable plot size. We worked with a CNPS Vegetation Ecologist to modify the protocol.

CNPS recommends variable plot sizes and shapes depending on the type of vegetation being sampled. For instance, forest and woodland habitats should be sampled using a 1000m² plot size. If the habitat is relatively homogeneous, a circular plot would be adequate. If the habitat is more variable, a long rectangle may better capture the stand's characteristics. For this project, single, rectangular, 400 m² plots were used to sample all selected patch types. The rectangular shape is suitable for vegetation patterns that tend to be long and narrow such as riparian stands growing along a river; the modified Relevé Sampling Protocol can be found in Appendix A.

2.1.2 Patch Type Selection

The patch types that covered the most area on commonly occurring geomorphic units were identified and relevés were installed within these stand types. Sampling all stands on all geomorphic units would be cumbersome and unnecessary. Patch types mapped in the summer 2003 were stratified using selected geomorphic units. Four patches from each patch type were randomly selected, which, by themselves or in combination with other patch types made up at least 80% of the vegetative cover on each selected geomorphic unit. The four randomly selected patches for each patch type were ordered from the largest to smallest, and the largest two were sampled. A selected patch was color-coded and a plot identification number assigned. Uncommon geomorphic units and patch types were excluded from sampling. A complete set of maps was developed for locating the sampled patches in the field.

2.1.3 Relevé Location

Randomly selected sample patches were often larger than the 400 m² relevé, and a representative portion of the patch had to be selected to sub-sample. Placing the relevé within the selected patch required finding a representative, homogenous area within the patch. The relevé was located in an area that captured the selected patch's common species composition and structural condition.

2.1.4 Relevé Monuments

Each plot was permanently monumented with a 3.3 foot-long piece of 5/8-inch diameter rebar (Figure 1). The monument was established at the upstream corner closest to the river and labeled with the plot identification number (i.e., unique plot name) stamped on a 1-inch aluminum tag. Six photographs were taken at each relevé, one at each corner of the plot facing plot center, and two of the plot monument including landmarks that were visible from the monument. The location of the installed rebar monument was carefully marked on aerial photographs and later digitized to create a GIS layer of relevé locations.

2.1.5 Relevé Data Collection

For each relevé, we followed the detailed vegetation sampling protocol described in Appendix A. Sampling included soil descriptions, Cowardian wetland classification, human impact classification, and adjacent patch type identification. Additionally, plant species within different layers of vegetation (i.e., herb layer = 0 to 1.5m, shrub layer= 1.5 to 5m, and tree layer = > 5m) were recorded, and the abundance of each species was estimated.



Figure 1. Permanent monument established at each relevé.

2.2 Vegetation Description Analysis

A vegetation description analysis was conducted to create a vegetation classification scheme that could be consistently applied throughout the mainstem Trinity River. The classical approach of using cluster analysis in conjunction with ordination techniques was used (Figure 2). Relevés were grouped together to form clusters of relevés with similar species compositions; the clusters were used to determine vegetation patch types. “Cluster” refers to a group of similar relevé plots and will be used in the context of discussing the results of cluster analysis. “Patch” refers to a particular type of vegetation and will be used to describe the vegetation cover type that is part of the resulting vegetation classification. The two terms are almost interchangeable since clusters are the basis for determining patch types.

Vegetation classification is sometimes considered more of an art than a science due to its heavy reliance on knowledge of the investigator. Many of the decisions made while developing a vegetation classification are subjective. To improve the objectivity of the vegetation classification, indicator species analysis was used in addition to more traditional methods for determining the final number of clusters (and therefore patch types). After vegetation patch types were determined, species that were characteristic of each patch type were sought. The resultant patch types were compared to the original mapped patches.

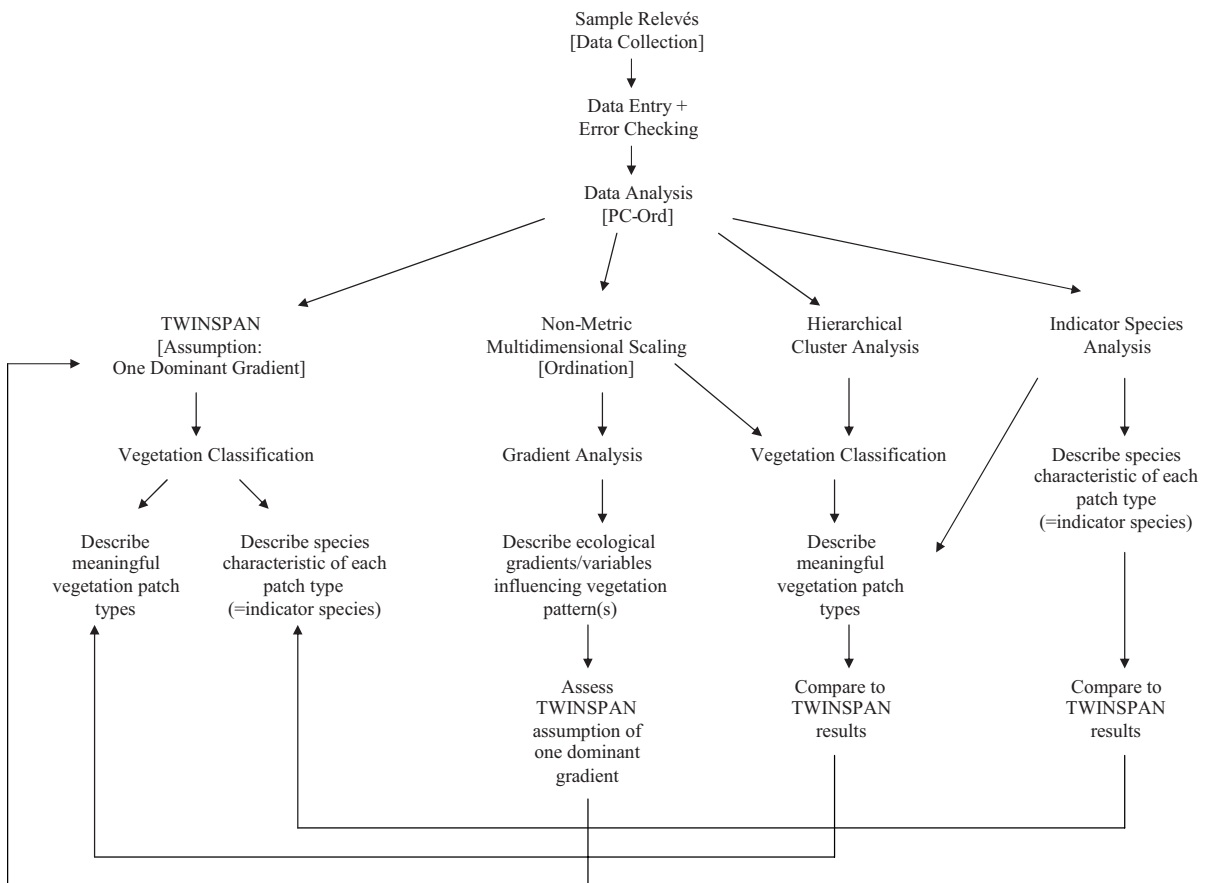


Figure 2. Flow chart showing general procedure for vegetation description analysis. Details for each analysis can be found in the methods section.

The final step in the vegetation classification involved a study of the environmental gradients that were potentially influencing the way relevés clustered. Indirect ordination techniques were used to find the variables that were then interpreted as environmental gradients. The presence of more than one gradient would violate the assumption of TWINSpan of a single dominant gradient. The ordination graph was used to independently assess the cluster analysis results.

Presence of infrequent or “rare” species is highly variable in any relevé, creating noise that can obscure patterns within the data and impede the interpretation of potential ecological relationships (McCune and Grace 2002). Species that occurred in fewer than 5% of all relevé plots were excluded from the cluster analyses and gradient analysis. Additionally, non-vascular plants (e.g., “moss,” and “lichen”) were not identified with enough consistency and detail to be associated consistently with patch types and were excluded after our preliminary analysis showed nonvascular plants strongly biasing the hierarchical cluster analysis. A total of 130 different plant species were included in each analysis.

Species presence and abundance were described in each layer of vegetation (herb, shrub, and tree) and a species’ presence in each layer was treated separately. For instance, white alder could occur in the herb layer, the shrub layer, and the tree layer. Its presence in each layer was treated as a separate species such that a relevé with white alder in the shrub and tree layers would have two white alder “species.” This preserved the vegetation structure sampled using the relevé and facilitated the examination of complex relationships among species.

2.2.1 TWINSpan and Hierarchical Cluster Analysis

Two cluster analyses were performed on the relevé plot data to assess the initial vegetation patch type classification used in mapping. Previously, patch types were field mapped and a patch type was assigned based on the dominant species in the canopy (Tasks 1 and 2 in Section 1.1). The patch type classification used in mapping was expected to be close to the patch type classification derived from the cluster analysis.

Relevés were grouped into clusters based on species composition and abundance using hierarchical cluster analysis and TWINSpan (PC-Ord version 4, McCune and Mefford 1999). Each method groups similar relevés into clusters which are then interpreted as patch types. The clusters defined by the hierarchical cluster analysis and TWINSpan were used to classify the samples into resultant patch types.

The TWINSpan method assesses how sample plots cluster based on similarities in species composition; plots with similar species compositions are placed in the same cluster. TWINSpan was historically the only widely used method of classifying sample plots into clusters and identifying indicator species for the clusters. Indicator species are defined as the most characteristic species of each cluster (Dufrêne and Legendre 1997). TWINSpan is now used less frequently to evaluate ecological data because it can only effectively cluster related samples if one singular “strong” environmental gradient (or variable) is influencing the data structure. Because the riparian environment is strongly influenced by proximity to a water source, it was presumed that TWINSpan analysis would adequately cluster samples in a meaningful way.

As an independent assessment of the TWINSpan results, a hierarchical cluster analysis was conducted on the relevé data (McCune and Grace 2002). Hierarchical cluster analysis is a method of aggregating samples based on dissimilarities in species composition and does not require a single causal variable. Furthermore, hierarchical cluster analysis is the best method to describe underlying ecological relationships where there may be two or more variables influencing patterns within the data set.

Hierarchical cluster analysis results are portrayed as a dendrogram with an individual relevé sample at the end of each “branch” (Figure 3). The method is agglomerative (i.e., individual branches come together to form small clusters, small clusters come together form larger clusters, etc.). The final number of clusters (and therefore patch types) varies depending how the degree of branching is interpreted and what defines a “meaningful” cluster. This is where subjectivity plays a role in determining the final vegetation classification. The significance of a branch cluster depends on how the dendrogram is “pruned.”

The dendrogram was pruned using a combination of objective and subjective criteria. Indicator species analysis (Dufrêne and Legendre 1997) was used as the primary method of objectively determining how to prune the dendrogram into consistent patch types (Figure 3). The methodology for using indicator species analysis is described in section 2.2.2. Once the “ideal” number of clusters from indicator species analysis was obtained, we examined the dendrogram to assess the resultant patch types. In addition to indicator species analysis, two additional subjective methods were employed (Kent and Coker 1992, McCune and Grace 2002). So-called “natural” groups are indicated by long “stems” in the dendrogram because long stems often indicate groups with very similar members (McCune and Grace 2002). The presence of natural groups was used to determine the final number of clusters. Additionally, the amount of information contained in the resulting clusters as indicated by the scale bar above the dendrogram was maximized to the extent possible (Figure 3).

2.2.2 Indicator Species Analysis

Indicator species analysis is used primarily to find species that are characteristic of particular patch types. Species with a strong and reliable affinity for a particular patch type offer predictive value for classifying vegetation and identifying patch types. This analysis calculates an Indicator Value (IV) for each species. The indicator value is a synthesis of relative abundance and frequency among different analyst-defined groups. Indicator Values range from 0 (species not present in a cluster) to 100 (species always present in that cluster), and are presented as the maximum IV for each species within each cluster. The species with the highest maximum IV within a particular cluster can be considered an “indicator” of that cluster. Indicator values over 30 are often used to signify a strong association with the indicated group; we designated all species with an IV higher than 30 as significant indicators of resultant patch types. The analysis additionally assesses whether a given species’ indicator value is higher than it would be if the species was randomly distributed between clusters. The value derived from this comparison is called the p value. The p value provides a statistical basis for determining the significance of an indicator species; the lower the p value the more likely that the species shows a true affinity or association with that patch type. Typically, p values lower than 0.05 are considered statistically significant. Higher p values suggest that the occurrence of plant species in a patch type is more likely to be random.

The first step in using indicator species analysis is to assign the number of groups into which the samples are clustered. Because the final number of groups was not known, an indicator species analysis for consecutively increasing numbers of groups was conducted beginning with two and ending with 20 groups. For example, we began with two groups, increased to three groups, then increased to four groups, etc., up to 20. The number of significant indicator species at each level of clustering was counted and then plotted against the level of clustering (Figure 3 graph A). The average p value of all plant species at each level of clustering was also calculated and plotted against the level of clustering (Figure 3 graph B). The number of clusters with the highest number of significant indicators and the lowest average p value is the best point at which to prune the dendrogram (Figure 3).

2.2.3 *Gradient Analysis*

A gradient analysis using indirect ordination was used to assess the applicability of TWINSpan and the underlying one gradient assumption (Figure 2). Ordination refers to the process of ordering units (e.g., relevés) along an axis based on similarities between the units. Each axis “explains” a certain proportion of the variation in the data as indicated by its r^2 value. The higher the r^2 value, the better the ordination describes the variation in the data. Often the ordination axes are interpreted as environmental gradients, and the number of axes in a given ordination depends on the intrinsic structure of the data. To satisfy our assumption of a single ecological gradient in applying the TWINSpan analysis, we would expect the sample relevés to be ordered along a single axis.

In addition, we wanted to describe the environmental gradient(s) that explain most of the variation in the data. The environmental variables with strong correlations to the axes were used to describe the gradient(s) that ultimately influences the pattern of vegetation. If the “important” environmental variables are chosen *a priori* (i.e., before sampling), the analysis is referred to as direct ordination. However, if the important variables are determined by the analysis itself, it is referred to as indirect ordination.

A form of indirect ordination analysis called nonmetric multidimensional scaling (NMS) was used to group the relevés based on similarities in their species composition. NMS is most appropriate for ecological data because it does not require normal distributions or linear relationships among the variables in question (McCune and Grace 2002). Along each of the resulting ordination axes, relevés with similar species composition are closer together (and may form clusters), and relevés with dissimilar species composition are further apart. Grouping the relevés by the clusters resulting from cluster analysis is another way to check the logic of the vegetation classification and to aid in interpreting the ordination axes. Before conducting NMS, the percent cover data were square-root transformed to reduce the importance of super-abundant species without losing relative abundance data.

3 RESULTS AND DISCUSSION

3.1 **Sampled Patches and Relevé Locations**

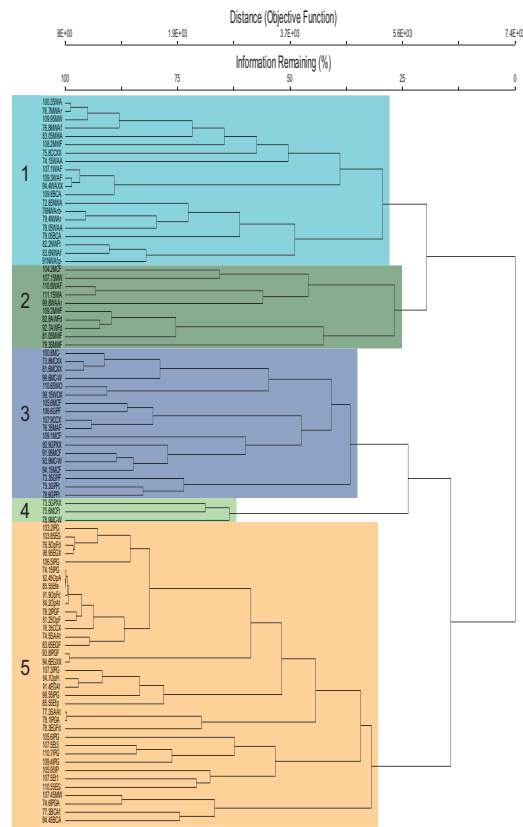
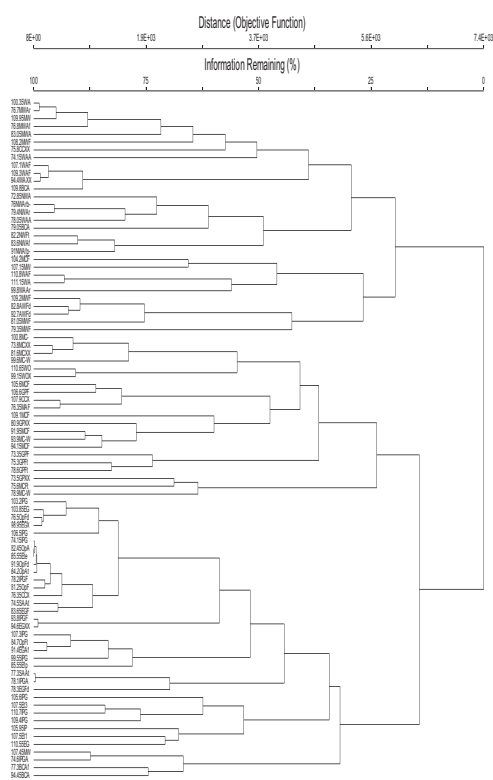
Table 1 shows the list of relevés and their locations in relation to patch type, geomorphic unit, and river mile. The photographs for each relevé are archived in the McBain and Trush photo library, and are included with this report on CD#1. GIS layers with geomorphic unit and patch type are also included on CD#2.

3.2 **Vegetation Description**

3.2.1 *Plant species sampled*

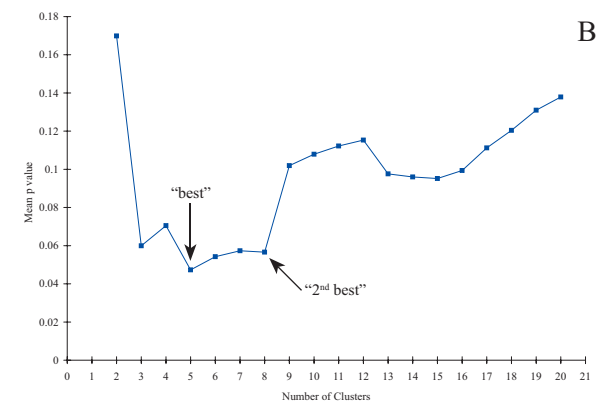
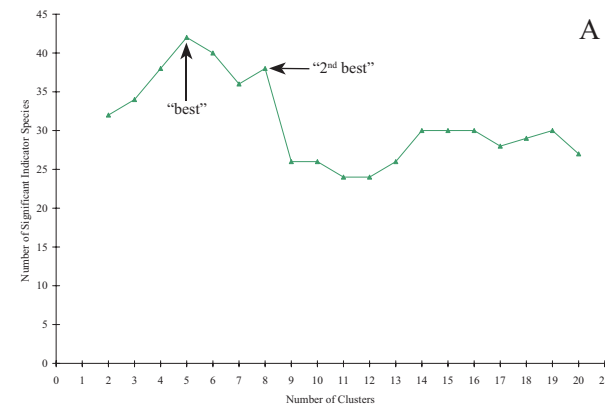
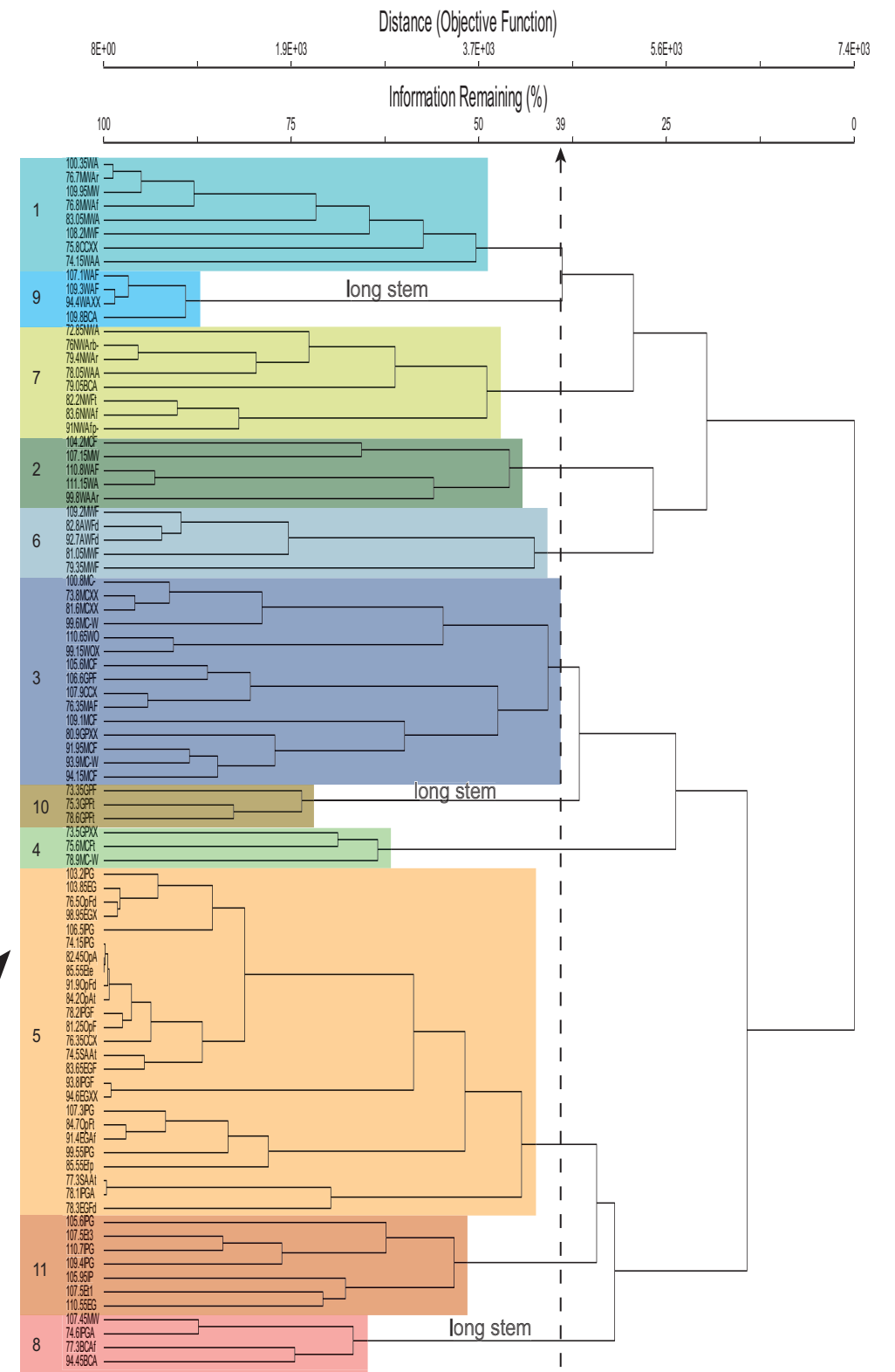
During relevé sampling, 325 plant species were catalogued. Plants were either identified in the field or assigned a code if unknown. Several factors influenced plant identification such as: 1) plant was not in flower, 2) variable plant morphology, and 3) lack of familiarity with a plant species. In some cases, not enough material was collected to identify the plant to the species level. Identification of unknown plants was prioritized using sampling frequency and the quality of the collected plant material. The original list of 325 cataloged plant species was pared down to 257 identified plant species and 36 genera (Table 2), which was further reduced to 133 after removing those species that occurred in 5% or less of the plots. Vascular plant taxonomy followed the Jepson Manual (Hickman 1993).

Unmodified dendrogram



Dendrogram 1
 "Best" number of clusters according to indicator species analysis. Five groups too broad and information remaining to be meaningful, therefore try next best.

Dendrogram 3 Final pruning of the dendrogram.



Dendrogram 2
 "2nd best" number of clusters. Better but some groups still too broad and information remaining still not great. Try to maximize information contained in groups and look for long stems.

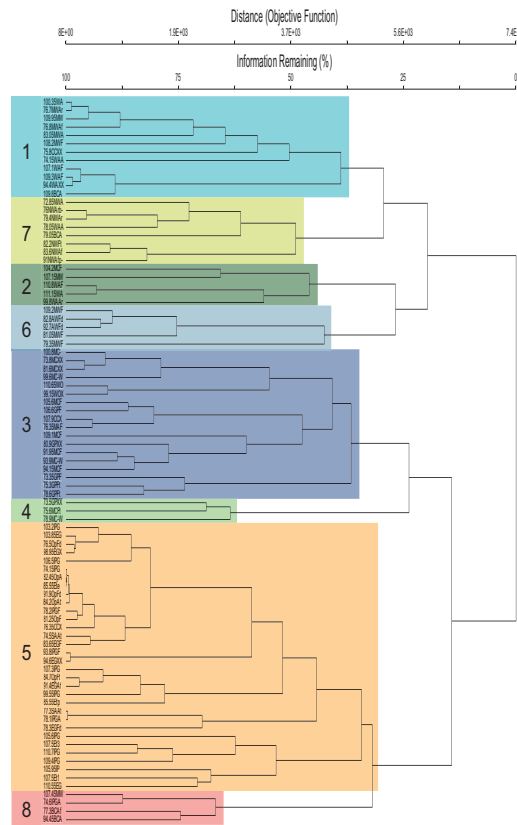


Figure 3. Process flow chart showing rationale for deciding where to prune the dendrogram. The objective results of indicator species analysis (graphs A and B) show the "best" and "2nd best" choices for determining meaningful patch types. The unmodified dendrogram is shown color-coded as Dendrograms 1, 2, and 3 based on the number of clusters dictated by indicator species analysis. Dendrogram 1 shows 5 clusters resulting in a vegetation classification that is not informative enough. Dendrogram 2 shows 8 groups and is more informative but still too broad. Dendrogram 3 shows 11 clusters and represents the final pruning of the dendrogram.

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Table 1. Relevé identification numbers, river mile, reach, 2003 mapped patch type, geomorphic unit, and dates sampled for 87 relevés sampled along the Upper Trinity River in summer 2004.

Releve ID	River Mile	2003 Mapped Patch Type	Geomorphic Unit	Date(s) Sampled
1	72.85	Narrowleaf willow	Alluvial Middle Terrace	6/24/04,
2	73.35	Grey Pine	Anthropomorphic High Terrace	6/23/2004
3	73.5	Grey Pine	Bedrock Hillslope	6/23/2004
4	73.8	Mixed Conifer	Bedrock Hillslope	8/18/2004
5	74.15	Introduced Perennial Grassland	Alluvial Low Terrace	8/4/2004
6	74.15	White Alder	Alluvial Low Terrace	6/24/2004
7	74.5	California Brickell Bush	Alluvial Low Terrace	7/29/2004
8	74.6	Introduced Perennial Grassland	Alluvial Floodplain	7/29/2004
9	75.3	Grey Pine	Anthropomorphic Middle Terrace	6/22/2004
10	75.6	Mixed Conifer	Anthropomorphic High Terrace	6/28/2004
11	75.8	Wedgleaf Ceanothus	Bedrock Hillslope	6/21/2004
12	76.3	Wedgleaf Ceanothus	Bedrock Hillslope	8/4/2004
13	76.35	Mixed Ash	Anthropogenic Dredge Tailings Stockpiles	6/22/2004
14	76.35	Open	Anthropogenic Dredge Tailings Stockpiles	6/15/2004
15	76.7	Mixed Willow	Alluvial Riparian Berm	6/16/2004
16	76.8	Mixed Willow	Alluvial Floodplain	6/16/2004
17	76	Narrowleaf willow	Alluvial Riparian Berm	6/17/2004
18	77.3	Black Cottonwood	Alluvial Floodplain	6/15/2004
19	77.3	California Brickell Bush	Alluvial Low Terrace	6/15/2004
20	78.05	White Alder	Alluvial Low Terrace	6/9/2004
21	78.1	Introduced Perennial Grassland	Alluvial Low Terrace	6/9/2004
22	78.2	Introduced Perennial Grassland	Anthropogenic Dredge Tailings Stockpiles	6/10/2004
23	78.3	Exotic Grassland	Anthropogenic Dredge Tailings Stockpiles	6/11/2004
24	78.6	Grey Pine	Anthropomorphic High Terrace	6/14/2004
25	78.9	Mixed Conifer-White Oak	Anthropomorphic Middle Terrace	6/8/2004
26	79.05	Black Cottonwood	Alluvial Low Terrace	6/11/2004
27	79.35	Mixed Willow	Anthropogenic Dredge Tailings Stockpiles	6/12/2004
28	79.4	Narrowleaf willow	Alluvial Riparian Berm	6/4/2004
29	80.9	Grey Pine	Bedrock Hillslope	8/16/2004

Table 1. Continued.

Releve ID	River Mile	2003 Mapped Patch Type	Geomorphic Unit	Date(s) Sampled
30	81.05	Mixed Willow	Anthropogenic Dredge Tailings Stockpiles	8/2/2004
31	81.25	Open	Anthropomorphic Middle Terrace	7/2/2004
32	81.6	Mixed Conifer	Bedrock Hillslope	8/4/2004
33	82.2	Narrowleaf willow	Anthropomorphic Middle Terrace	8/3/2004
34	82.45	Open	Alluvial Low Terrace	8/3/2004
35	82.8	Arroyo Willow	Anthropogenic Dredge Tailings Stockpiles	8/4/2004
36	83.05	Mixed Willow	Alluvial Riparian Berm	8/4/2004
37	83.65	Exotic Grassland	Anthropomorphic Middle Terrace	8/3/2004
38	83.6	Narrowleaf willow	Alluvial Floodplain	8/3/2004
39	84.2	Open	Alluvial Low Terrace	8/2/2004
40	84.7	Open	Anthropomorphic Middle Terrace	8/3/2004
41	85.55	Exotic Grassland	Alluvial Low Terrace	8/3/2004
42	85.55	Exotic Grassland	Alluvial Floodplain	8/3/2004
43	91.4	Exotic Grassland	Alluvial Floodplain	7/22/2004
44	91.95	Mixed Conifer	Anthropomorphic High Terrace	7/22/2004
45	91.9	Open	Anthropogenic Dredge Tailings Stockpiles	7/22/2004
46	91.9	Narrowleaf willow	Alluvial Floodplain	7/22/2004
47	92.7	Arroyo Willow	Anthropogenic Dredge Tailings Stockpiles	7/22/2004
48	93.8	Introduced Perennial Grassland	Anthropomorphic Middle Terrace	7/2/2004
49	93.9	Mixed Conifer-White Oak	Anthropogenic Dredge Tailings Stockpiles	7/29/2004
50	94.15	Mixed Conifer	Anthropomorphic Middle Terrace	7/28/2004
51	94.45	Black Cottonwood	Alluvial Floodplain	7/2/2004
52	94.4	White Alder	Bedrock Hillslope	7/29/2004
53	94.6	Exotic Grassland	Bedrock Hillslope	7/2/2004
54	98.95	Exotic Grassland	Bedrock Hillslope	8/16/2004
55	99.15	White Oak	Bedrock Hillslope	8/16/2004
56	99.55	Introduced Perennial Grassland	Anthropomorphic High Terrace	8/16/2004
57	99.6	Mixed Conifer-White Oak	Alluvial Low Terrace	8/17/2004
58	99.8	White Alder	Alluvial Riparian Berm	8/17/2004

Table 1. Continued.

Releve ID	River Mile	2003 Mapped Patch Type	Geomorphic Unit	Date(s) Sampled
59	100.35	White Alder	Alluvial Rinarian Berm	8/17/2004
60	100.8	Mixed Conifer	Anthropomorphic High Terrace	8/17/2004
61	130.2	Introduced Perennial Grassland	Anthropomorphic Middle Terrace	8/18/2004
62	103.85	Exotic Grassland	Anthropogenic Dredge Tailings Stockpiles	8/18/2004
63	104.2	Mixed Conifer	Anthropomorphic Middle Terrace	8/18/2004
64	105.6	Introduced Perennial Grassland	Bedrock Hillislope	7/28/2004
65	105.6	Mixed Conifer	Anthropomorphic Low Terrace	6/30/2004
66	105.95	Introduced Perennial Grassland	Anthropogenic Dredge Tailings Stockpiles	7/27/2004
67	106.5	Introduced Perennial Grassland	Bedrock Hillislope	7/13/2004
68	106.6	Grey Pine	Anthropomorphic Middle Terrace	7/27/2004
69	107.15	Mixed Willow	Anthropomorphic Middle Terrace	7/29/2004
70	107.1	White Alder	Anthropomorphic Middle Terrace	6/30/2004
71	107.3	Introduced Perennial Grassland	Alluvial Floodplain	7/14/2004
72	107.45	Mixed Willow	Alluvial Floodplain	7/14/2004
73	107.5	Exotic Grassland	Anthropomorphic Low Terrace	7/13/2004
74	107.5	Exotic Grassland	Anthropomorphic High Terrace	7/12/2004
75	107.9	Wedgleaf Ceanothus	Bedrock Hillislope	7/9/2004
76	108.2	Mixed Willow	Anthropomorphic Middle Terrace	7/28/2004
77	109.1	Mixed Conifer	Anthropomorphic Low Terrace	6/29/2004
78	109.2	Mixed Willow	Anthropomorphic Low Terrace	4/14/2004
79	109.3	White Alder	Anthropomorphic Low Terrace	6/29/2004
80	109.4	Introduced Perennial Grassland	Anthropomorphic High Terrace	7/27/2004
81	109.8	Black Cottonwood	Alluvial Low Terrace	7/1/2004
82	109.95	Mixed Willow	Anthropomorphic Low Terrace	7/1/2004
83	110.55	Exotic Grassland	Anthropomorphic Middle Terrace	7/13/2004
84	110.65	White Oak	Bedrock Hillislope	7/13/2004
85	110.7	Introduced Perennial Grassland	Anthropomorphic High Terrace	7/22/2004
86	110.8	White Alder	Anthropomorphic Middle Terrace	7/14/2004
87	111.15	White Alder	Anthropogenic Fill/Bank Stabilization	7/27/2004

Table 2. Plant species sampled and identified along the Upper Trinity River, California. This is a cumulative list of plants encountered during field sampling in 2003 and 2004. Taxonomy and common names follow the Jepson Manual (Hickman 1993). The listings written in red indicate exotic plant species.

CODE	Scientific Name	Common Name	Family	Habit	Exotic	USFWS wetland indicator code	Number of Plots	Layers
TREES								
ACMA	<i>Acer macrophyllum</i>	bigleaf maple	Aceraceae	Tree		FAC	2	T
AIAL	<i>Ailanthus altissima</i>	Tree of Heaven	Simaroubaceae	Tree	EX	FACU	5	L, M
ALRH	<i>Alnus rhombifolia</i>	white alder	Betulaceae	Tree		FACW	28	L, M, T
ARME	<i>Arbutus menziesii</i>	Pacific madrone	Ericaceae	Tree		FACU	20	L, M, T
CONU	<i>Cornus nuttallii</i>	mountain dogwood	Cornaceae	Tree		FACU	3	L, M
CRSU	<i>Crataegus suskdorffii</i>	hawthorn	Rosaceae	Tree		UPL	4	L, M, T
FRLA	<i>Fraxinus latifolia</i>	Oregon ash	Oleaceae	Tree		FACW	45	L, M, T
JURE	<i>Juglans regia</i>	English walnut	Juglandaceae	Tree	EX	FACW	3	M, T
PILA	<i>Pinus lambertiana</i>	sugar pine	Pinaceae	Tree		UPL	2	M, T
PIPO	<i>Pinus ponderosa</i>	ponderosa pine	Pinaceae	Tree		UPL	64	L, M, T
PISA	<i>Pinus sabiniana</i>	grey pine, foothill pine	Pinaceae	Tree		FACW	36	L, M, T
POBAT	<i>Populus balsamifera</i> ssp. <i>trichocarpa</i>	black cottonwood	Salicaceae	Tree		FACW	16	L, M, T
POFR	<i>Populus fremontii</i>	Fremont's cottonwood	Salicaceae	Tree		FAC+	2	T
PREM	<i>Prunus emarginata</i>	bitter cherry	Rosaceae	Tree			0	-
PRUN	<i>Prunus</i> sp.		Rosaceae	Tree			0	-
PSME	<i>Pseudotsuga menziesii</i>	Douglas-fir	Pinaceae	Tree			29	L, M, T
QUCH	<i>Quercus chrysolepis</i>	canyon live oak	Fagaceae	Tree			45	L, M, T
QUGA	<i>Quercus garryana</i>	Oregon white oak	Fagaceae	Tree		NI	31	L, M, T
QUKE	<i>Quercus kelloggii</i>	California black oak	Fagaceae	Tree			15	L, M, T
QUWI	<i>Quercus wislizenii</i>	interior live oak	Fagaceae	Tree			7	L, M
ROPS	<i>Robinia pseudoacacia</i>	black locust	Fabaceae	Tree	EX	FACU	4	M, T
SALAE	<i>Salix laevigata</i>	red willow	Salicaceae	Tree		FACW	15	L, M, T
SALUC	<i>Salix lucida</i> ssp. <i>lasianhra</i>	Pacific willow, shiny willow	Salicaceae	Tree		OBL	22	L, M, T
SHRUBS								
AGOC	<i>Ageratina occidentalis</i>	eupatorium	Asteraceae	Shrub			8	M
AMAL	<i>Amelanchier alnifolia</i>	service-berry	Rosaceae	Shrub		FACU	1	L
ARMA	<i>Arctostaphylos manzanita</i>	manzanita	Ericaceae	Shrub			10	L, M
ARVI	<i>Arctostaphylos viscida</i>	sticky manzanita	Ericaceae	Shrub			8	L, M, T
BRCA	<i>Brickellia californica</i>	California bricklebrush	Asteraceae	Shrub				
CECU	<i>Ceanothus cuneatus</i>	wedgeleaf ceanothus, buck brush	Rhamnaceae	Shrub			9	L, M
CEIN	<i>Ceanothus integrifolius</i>	deer brush	Rhamnaceae	Shrub			5	L, M
CELE	<i>Ceanothus lemmonii</i>	ceanothus	Rhamnaceae	Shrub			2	L, M
CEOC	<i>Cercis occidentalis</i>	western redbud	Fabaceae	Shrub			4	L, M
CEBE	<i>Cercocarpus betuloides</i>	mountain-mahogany	Rosaceae	Shrub			7	L, M
COSE	<i>Cornus sericea</i>	redtwig dogwood	Cornaceae	Shrub		FACW	3	M, T
COCOC	<i>Corylus cornuta</i> var. <i>californica</i>	hazelnut	Betulaceae	Shrub		FACU	1	M

Table 2. Continued.

CODE	Scientific Name	Common Name	Family	Habit	Exotic	USFWS wetland indicator code	Number of Plots	Layers
CYSC	<i>Cystisus scoparius</i>	Scotch broom	Fabaceae	Shrub	EX		1	M
DAGLO	<i>Datisca glomerata</i>	durango root	Datisacaceae	Shrub		FACW	1	L
ERCA	<i>Eriodictyon californicum</i>	yerba santa	Hydrophyllaceae	Shrub			1	?
GAFR	<i>Garrya fremontii</i>	silk-tassel	Garryaceae	Shrub			2	M
LUALAI	<i>Lupinus albifrons</i> var. <i>albifrons</i>	silvertleaf lupine	Fabaceae	Shrub		UPL	4	L, M
PHLE	<i>Philadelphus lewisii</i>	mock-orange	Philadelphaceae	Shrub		FAC-	2	M
PRVI	<i>Prunus virginiana</i> var. <i>demissa</i>	western choke-cherry	Rosaceae	Shrub			9	L, M, T
RHCA	<i>Rhamnus californica</i>	California coffeeberry	Rhamnaceae	Shrub			0	-
RHTR	<i>Rhus trilobata</i>	bucket bush, skunk brush	Anacardiaceae	Shrub		FACU	25	L, M
RIAU	<i>Ribes aureum</i>	golden currant	Scrophulariaceae	Shrub		FACW	2	M
RIDI	<i>Ribes divaricatum</i>	gooseberry	Grossulariaceae	Shrub		FACW	3	L, M
RIIN	<i>Ribes inerme</i>	white-stemmed gooseberry	Grossulariaceae	Shrub		FAC+	5	L, M
RILA	<i>Ribes lacustre</i>	swamp currant	Grossulariaceae	Shrub		FAC+	2	L, M
RIRO	<i>Ribes roeslii</i>	Sierra gooseberry	Grossulariaceae	Shrub			2	L, M
ROEG	<i>Rosa eglanteria</i>	sweet-briar	Rosaceae	Shrub	EX	FACU	32	L, M
ROGY	<i>Rosa gymnocarpa</i>	wood rose	Rosaceae	Shrub		FACU	3	M
ROPI	<i>Rosa pisocarpa</i>	cluster rose	Rosaceae	Shrub		FACU	3	M
ROSE	<i>Rosa</i> sp.	rose	Rosaceae	Shrub			5	L, M
RUDI	<i>Rubus discolor</i>	Himalaya blackberry	Rosaceae	Shrub	EX	FAC+	67	L, M
RULE	<i>Rubus leucodermis</i>	blackcap raspberry	Rosaceae	Shrub		FACU	21	L, M
RUUR	<i>Rubus ursinus</i>	California blackberry	Rosaceae	Shrub		FAC+	26	L, M
SAEX	<i>Salix exigua</i>	narrowleaf willow	Salicaceae	Shrub		FACW	57	L, M, T
SALAS	<i>Salix lasiolepis</i>	arroyo willow	Salicaceae	Shrub		FACW	34	L, M, T
SAME	<i>Salix melanopsis</i>	dusky willow	Salicaceae	Shrub		FACW	26	L, M, T
SASES	<i>Salix sessilifolia</i>	sandbar willow	Salicaceae	Shrub		FACW	2	M
SAMEX	<i>Sambucus mexicana</i>	blue elderberry	Caprifoliaceae	Shrub		FACU	5	L, M
SPDO	<i>Spiraea douglasii</i>	hardhack	Rosaceae	Shrub		OBL	1	M
SYAL	<i>Symphoricarpos albus</i> var. <i>laevigatus</i>	snowberry	Caprifoliaceae	Shrub		FACU	3	L, M, T
TODI	<i>Toxicodendron diversilobum</i>	poison-oak	Anacardiaceae	Shrub			34	L, M, T
CLLI	<i>Clematis ligusticifolia</i>	virgin's bower	Ranunculaceae	Vine		FAC	25	L, M, T
COAR	<i>Convolvulus arvensis</i>	orchard morning-glory	Convolvularaceae	Vine	EX		4	L
LOHI	<i>Lonicera hispidula</i> var. <i>vacillans</i>	hairy honeysuckle	Caprifoliaceae	Vine		FACU	14	L, M
SYMO	<i>Symphoricarpos mollis</i>	creeping snowberry	Caprifoliaceae	Vine			3	L, M
VICA	<i>Vitis californica</i>	California grape	Vitaceae	Vine		FACW	43	L, M, T
HERBS								
ACMI	<i>Achillea millefolium</i>	yarrow	Asteraceae	Herb		FACU	5	L, M
ANEM	<i>Anemone</i> sp.	windflower	Ranunculaceae	Herb			1	L

Table 2. Continued.

CODE	Scientific Name	Common Name	Family	Habit	Exotic	USFWS wetland indicator code	Number of Plots	Layers
ANCA	<i>Anthriscus caucalis</i>	bur-chervil	Apiaceae	Herb	EX	FAC+	4	L, M
ARDO	<i>Artemisia douglasiana</i>	mugwort	Asteraceae	Herb		FAC+	43	L, M
ASSP	<i>Asclepias speciosa</i>	showy milkweed	Asclepiadaceae	Herb		FAC	4	L, M
ASDE	<i>Aspidotis densa</i>	Indian's dream, snake fern	Pteridaceae	Herb			2	L
ASCH	<i>Aster chilensis</i>	aster	Asteraceae	Herb		FAC	1	M
BRNI	<i>Brassica nigra</i>	mustard	Brassicaceae	Herb	EX	FAC	34	L, M
BREL	<i>Brodiaea elegans</i>	harvest brodiaea	Liliaceae	Herb		FACU	2	L
CACA	<i>Cardamine californica</i>	toothwort	Brassicaceae	Herb		UPL	2	L
CAOL	<i>Cardamine oligosperma</i>	cardamine	Brassicaceae	Herb		FACW	2	L
CESO	<i>Centaurea solstitialis</i>	star thistle	Asteraceae	Herb	EX	FAC	36	L, M
CHAM	<i>Chenopodium ambrosioides</i>	Mexican tea	Chenopodiaceae	Herb	EX	FAC	9	L
CHBO	<i>Chenopodium botrys</i>	Jerusalem oak	Chenopodiaceae	Herb	EX	FACU	2	L
CIIN	<i>Cichorium intybus</i>	chicory	Asteraceae	Herb	EX	NI	14	L, M
CIAR	<i>Cirsium arvense</i>	Canada thistle	Asteraceae	Herb	EX	FAC-	0	
CIRE	<i>Cirsium remotifolium</i>		Asteraceae	Herb			2	L, M
CIRSI	<i>Cirsium</i> sp.	thistle	Asteraceae	Herb			3	L, M
CIVU	<i>Cirsium vulgare</i>	bull thistle	Asteraceae	Herb	EX	FAC	6	L, M
CLPAP	<i>Claytonia parviflora</i> ssp. <i>parviflora</i>	claytonia	Portulacaceae	Herb		UPL	1	L
CLPE	<i>Claytonia perfoliata</i>	miner's lettuce	Portulacaceae	Herb		FACU	0	
COPA	<i>Collinsia parviflora</i>	blue-eyed Mary	Scrophulariaceae	Herb			2	L
COGR	<i>Collomia grandiflora</i>	large-flowered collomia	Polemoniaceae	Herb			8	L
COHE	<i>Collomia heterophylla</i>	collomia	Polemoniaceae	Herb			16	L
COMA	<i>Conium maculatum</i>	poison hemlock	Apiaceae	Herb	EX	FAC	13	L, M
COCA	<i>Conyza canadensis</i>	horseweed	Asteraceae	Herb		FAC	1	H
COCAN	<i>Cornus canadensis</i>	bunchberry	Cornaceae	Herb		FAC	1	L
BORA	<i>Cryptantha/Plagiobothrys</i> sp.		Boraginaceae	Herb			1	L
DAPE	<i>Darmera peltata</i>	Indian rhubarb	Saxifragaceae	Herb		OBL	2	L, M
DACA	<i>Daucus carota</i>	Queen Anne's Lace	Apiaceae	Herb	EX		29	L, M
DICA	<i>Dichelostemma capitatum</i>	blue dicks	Liliaceae	Herb			0	
DUIN	<i>Duchesnea indica</i>	mock-strawberry	Rosaceae	Herb	EX	UPL	1	L
EPCI	<i>Epilobium ciliatum</i>	purple-leaved willowherb	Onagraceae	Herb		FACW	6	L, M
EPIL	<i>Epilobium</i> sp.		Onagraceae	Herb			10	L, M
ERSE	<i>Eremocarpus setigerus</i>	turkey mullein	Euphorbiaceae	Herb	EX		3	L
EROG	<i>Eriogonum</i> sp.	buckwheat	Polygonaceae	Herb			11	L, M
ERNU	<i>Eriogonum nudum</i>	naked buckwheat	Polygonaceae	Herb			15	L, M
ERLA	<i>Eriophyllum lanatum</i>	woolly sunflower	Asteraceae	Herb			6	L, M
ERBR	<i>Erodium brachycarpum</i>	storksbill	Geraniaceae	Herb	EX		1	L
ERCI	<i>Erodium cicutarium</i>	common storksbill	Geraniaceae	Herb	EX		4	L

Table 2. Continued.

CODE	Scientific Name	Common Name	Family	Habit	Exotic	USFWS wetland indicator code	Number of Plots	Layers
ESCA	<i>Eschscholzia californica</i>	California poppy	Papaveraceae	Herb			7	L
GAAP	<i>Galium aparine</i>	goose-grass	Rubiaceae	Herb		FACU	5	L, M
GAPA	<i>Galium parisiense</i>	wall bedstraw	Rubiaceae	Herb	EX	FACU	4	L, M
GAPO	<i>Galium porrigens</i>	climbing bedstraw	Rubiaceae	Herb			6	L, M
HYPE	<i>Hypericum perforatum</i>	St. John's wort	Hypericaceae	Herb	EX		37	L, M
HYGL	<i>Hypochaeris glabra</i>	smooth cat's-ear	Asteraceae	Herb	EX		4	L
HYRA	<i>Hypochaeris radicata</i>	rough cat's-ear	Asteraceae	Herb	EX	FACU	2	L
IRIS	<i>Iris</i> sp.	iris	Iridaceae	Herb			2	L
LASE	<i>Lactuca serriola</i>	prickly lettuce	Asteraceae	Herb	EX	FAC	5	L
LAJE	<i>Lathyrus jepsonii</i>		Fabaceae	Herb		OBL	0	-
LALA	<i>Lathyrus latifolius</i>	perennial sweet-pea	Fabaceae	Herb	EX		5	L, M
LEPID	<i>Lepidium</i> sp.	peppergrass	Brassicaceae	Herb			1	M
LENE	<i>Lessingia nemaclada</i>	lessingia	Asteraceae	Herb			13	L, M
LEVU	<i>Leucanthemum vulgare</i>	ox-eye daisy	Asteraceae	Herb	EX	NI	2	L
LIGE	<i>Linaria genistifolia</i>	dalmation toadflax	Fabaceae	Herb	EX		52	L, M
LIUS	<i>Linum usitatissimum</i>	common flax	Linaceae	Herb	EX		0	-
LONU	<i>Lomatium nudicaule</i>	lomatium	Apiaceae	Herb			1	M
LOCO	<i>Lotus corniculatus</i>	bird's-foot trefoil	Fabaceae	Herb	EX	FAC	7	L, M
LOMI	<i>Lotus micranthus</i>	small-flowered lotus	Fabaceae	Herb			12	L, M
LUBI	<i>Lupinus bicolor</i>	miniature lupine	Fabaceae	Herb			4	L
LUBR	<i>Lupinus breweri</i>	Brewer's lupine	Fabaceae	Herb			0	-
LUPIN	<i>Lupinus</i> sp.	lupine	Fabaceae	Herb			13	L, M
LYHY	<i>Lythrum hyssopifolium</i>		Lythraceae	Herb	EX	FACW	1	L
MAEL	<i>Madia elegans</i>	common madia	Asteraceae	Herb			13	L, M
MAEX	<i>Madia exigua</i>	threadstem madia	Asteraceae	Herb			5	L
MAGR	<i>Madia gracilis</i>	slender tarweed	Asteraceae	Herb			13	L, M
MADI	<i>Madia</i> sp.	tarweed	Asteraceae	Herb			14	L, M
MEMI	<i>Medicago minima</i>	burclover	Fabaceae	Herb			2	L
MEPO	<i>Medicago polymorpha</i>	California burclover	Fabaceae	Herb		FACU-	6	L
MESA	<i>Medicago sativa</i>	alfalfa	Fabaceae	Herb	EX	UPL	0	-
MEAL	<i>Melilotus alba</i>	white sweet clover	Fabaceae	Herb	EX		34	L, M
MEPU	<i>Mentha pulegium</i>	pennyroyal	Lamiaceae	Herb	EX	OBL	5	L
MIGU	<i>Mimulus guttatus</i>	yellow monkeyflower	Scrophulariaceae	Herb		FACW+	0-	
MOOD	<i>Monardella odoratissima</i>	monardella	Lamiaceae	Herb		FACU	4	L
NAININ	<i>Navarretia intertexta</i> ssp. <i>intertexta</i>	navarretia	Polemoniaceae	Herb		FACW	10	L
OSCH	<i>Osmorhiza chilensis</i>	mountain sweet-cicely	Apiaceae	Herb			5	L, M
PETR	<i>Pentagramma triangularis</i>	goldback fern	Pteridaceae	Herb			3	L

Table 2. Continued.

CODE	Scientific Name	Common Name	Family	Habit	Exotic	USFWS wetland indicator code	Number of Plots	Layers
PEDU	<i>Petrorhagia dubia</i>	hairypink	Caryophyllaceae	Herb	EX	FAC	8	L
PHCO	<i>Phacelia corymbosa</i>	serpentine phacelia	Hydrophyllaceae	Herb			6	L, M
PHAC	<i>Phacelia</i> sp.	phacelia	Hydrophyllaceae	Herb			3	L, M
PLTE	<i>Plagiobothrys tenellus</i>	popcorn flower	Boraginaceae	Herb		FAC	1	L
PLLA	<i>Plantago lanceolata</i>	English plantain	Plantaginaceae	Herb	EX	FAC-	7	L
PLMA	<i>Plantago major</i>	common plantain	Plantaginaceae	Herb	EX	FAC	31	L, M
POCO	<i>Polygala cornuta</i>	milkwort	Polygalaceae	Herb		FACW	2	L
POLA	<i>Polygonum lapathifolium</i>	willow weed	Polygonaceae	Herb		OBL	1	M
POGL	<i>Polypodium glycyrrhiza</i>	licorice fern	Polypodiaceae	Herb			2	L
POIM	<i>Polystichum imbricans</i>		Dryopteridaceae	Herb			5	L
POMU	<i>Polystichum munium</i>	sword fern	Dryopteridaceae	Herb		FACU	1	L
PRVU	<i>Prunella vulgaris</i>	self heal	Lamiaceae	Herb	EX	FAC	2	L
RUAC	<i>Rumex acetosella</i>	sheep sorrel	Polygonaceae	Herb	EX	FAC-	7	L, M
RUCR	<i>Rumex crispus</i>	curly dock	Polygonaceae	Herb	EX	FACW-	13	L, M
RUHY	<i>Rumex hymenosepalus</i>	wild rhubarb	Polygonaceae	Herb			8	L, M
SAOC	<i>Sanguisorba occidentalis</i>	western burnett	Rosaceae	Herb			1	L
SAOF	<i>Saponaria officinalis</i>	soapwort	Caryophyllaceae	Herb	EX	FACU	16	L, M
SEVU	<i>Senecio vulgaris</i>	common groundsel	Asteraceae	Herb	EX	NI	30	L, M
SISY	<i>Sisyrinchium</i> sp.		Iridaceae	Herb			0	
SOMU	<i>Solidago multiradiata</i>	northern goldenrod	Asteraceae	Herb		FACU	2	L, M
SO	<i>Solidago</i> sp.	goldenrod	Asteraceae	Herb			2	L, M
STCR	<i>Stellaria crispa</i>		Caryophyllaceae	Herb		FACW	0	
STNI	<i>Stellaria nitens</i>	shining chickweed	Caryophyllaceae	Herb			0	
STTO	<i>Sireptanthus tortuosa</i>	mountain jewel/flower	Brassicaceae	Herb			3	L, M
TAOF	<i>Taraxacum officinale</i>	dandelion	Asteraceae	Herb	EX	FACU	8	L, M
THAR	<i>Thlaspi arvense</i>	fan-weed	Brassicaceae	Herb	EX	NI	1	L
THCU	<i>Thysanocarpus curvipes</i>	lacepod	Brassicaceae	Herb			1	L
TOAR	<i>Torilis arvense</i>	torilis	Apiaceae	Herb	EX		31	L, M
TRDUB	<i>Tragopogon dubius</i>	goat's beard	Asteraceae	Herb	EX		3	M
TRPO	<i>Tragopogon portifolius</i>	oyster plant	Asteraceae	Herb	EX		6	L, M
TRPR	<i>Tragopogon pratensis</i>	goatsbeard	Asteraceae	Herb	EX		1	M
TRLA	<i>Trichostemma lanceolatum</i>	vinegar weed	Labiatae	Herb			4	L
TRAR	<i>Trifolium arvense</i>	rabbitfoot clover	Fabaceae	Herb	EX		12	L
TRDU	<i>Trifolium dubium</i>	shamrock	Fabaceae	Herb	EX	FACU	0	
TRHI	<i>Trifolium hirtum</i>	rose clover	Fabaceae	Herb	EX		14	L
TRMI	<i>Trifolium microcephalum</i>	clover	Fabaceae	Herb		FACU	2	L
TRRE	<i>Trifolium repens</i>	white clover	Fabaceae	Herb	EX	FAC	4	L

Table 2. Continued.

CODE	Scientific Name	Common Name	Family	Habit	Exotic	USFWS wetland indicator code	Number of Plots	Layers
TRLAX	<i>Triteleia laxa</i>	Ithuriel's spear	Liliaceae	Herb			3	L
TREER	<i>Tryphosaria eriantha</i>	butter and eggs	Scrophulariaceae	Herb			0	-
TYLA	<i>Typha latifolius</i>	broad-leaved cattail	Typhaceae	Herb		OBL	3	M
URDI	<i>Urtica dioica</i>	stinging nettle	Urticaceae	Herb		FACW	2	M
VEFH	<i>Verbascum thapsus</i>	common mullein	Scrophulariaceae	Herb	EX	NI	14	L, M
VELAS	<i>Verbena lasiostachys</i>	verbena	Verbenaceae	Herb	EX	FAC-	3	M
VEAM	<i>Veronica americana</i>	American brooklime	Scrophulariaceae	Herb		OBL	1	L
VEAR	<i>Veronica arvensis</i>		Scrophulariaceae	Herb	EX	FACU	0	-
VIHI	<i>Vicia hirsuta</i>	vetch	Fabaceae	Herb	EX	FACU	3	L, M
WOFI	<i>Woodwardia fimbriata</i>	giant chain fern	Blechnaceae	Herb		FACW+	1	M
WYMO	<i>Wyethia mollis</i>	mules ears	Asteraceae	Herb			2	L, M
XAST	<i>Xanthium strumarium</i>	common cocklebur	Asteraceae	Herb		FAC+	3	M
LEMN	<i>Lemna</i> sp.	duckweed	Lemnaceae	Aq Herb		OBL	1	L
CAPR	<i>Carex praegracilis</i>		Cyperaceae	Em Herb		FACW-	0	-
CYER	<i>Cyperus eragrostis</i>	umbrella sedge	Cyperaceae	Em Herb		FACW	6	L, M
CYSQ	<i>Cyperus squarrosus</i>	bearded nutsedge	Cyperaceae	Em Herb		OBL	0	-
ELACA	<i>Eleocharis acicularis</i> var. <i>acicularis</i>		Cyperaceae	Em Herb		OBL	0	-
EQAR	<i>Equisetum arvense</i>	common horsetail	Equisetaceae	Em Herb		FAC	20	L, M
EQHY	<i>Equisetum hyemale</i>	common scouring rush	Equisetaceae	Em Herb		FACW	14	L, M
EQJIS	<i>Equisetum</i> sp.	horsetail, scouring rush	Equisetaceae	Em Herb			0	-
JUBA	<i>Juncus balticus</i>	baltic rush	Juncaceae	Em Herb		FACW+	0	-
JUBU	<i>Juncus bufonius</i>	toad rush	Juncaceae	Em Herb	EX	FACW+	2	L
JUEF	<i>Juncus effusus</i>		Juncaceae	Em Herb		FACW+	7	L, M
JUHO	<i>Juncus howellii</i>		Juncaceae	Em Herb			0	-
JUPA	<i>Juncus patens</i>		Juncaceae	Em Herb		FAC	2	M
JUSA	<i>Juncus saximontanus</i>		Juncaceae	Em Herb		OBL	0	-
JUNC	<i>Juncus</i> sp.	rush	Juncaceae	Em Herb			4	L, M
MENT	<i>Mentha</i> sp.		Labiatae	Em Herb			0	-
OESA	<i>Oenanthe sarmentosa</i>	Pacific water parsley	Apiaceae	Em Herb		OBL	0	-
SCAC	<i>Scirpus acutus</i> var. <i>occidentalis</i>	tule	Cyperaceae	Em Herb		OBL	1	M
GRASSES								
AGROS	<i>Agrostis</i> sp.	bent grass	Poaceae	Grass			6	L, M
AICA	<i>Aira carvophyllea</i>	European hairgrass	Poaceae	Grass	EX	NI	39	L
AVBA	<i>Avena barbata</i>	slender wild oat	Poaceae	Grass	EX		19	L, M
AVFA	<i>Avena fatua</i>	wild oat	Poaceae	Grass	EX		0	-
AVENA	<i>Avena</i> sp.	wild oat	Poaceae	Grass	EX		0	-
BRMI	<i>Briza minor</i>	small rattlesnake grass	Poaceae	Grass	EX	FACU	24	L

Table 2. Continued.

CODE	Scientific Name	Common Name	Family	Habit	Exotic	USFWS wetland indicator code	Number of Plots	Layers
BRAR	<i>Bromus arenarius</i>	brome	Poaceae	Grass	EX		5	L, M
BRDI	<i>Bromus diandrus</i>	ripout grass	Poaceae	Grass	EX		26	L, M
BRHO	<i>Bromus hordeaceus</i>	soft chess	Poaceae	Grass	EX	FACU-	18	L, M
BRJA	<i>Bromus japonicus</i>	brome	Poaceae	Grass	EX	FACU	5	L
BRMAR	<i>Bromus madritensis</i> ssp. <i>rubens</i>	foxtail chess	Poaceae	Grass	EX		2	L
BRMO	<i>Bromus mollis</i>		Poaceae	Grass	EX		1	L
BRTE	<i>Bromus tectorum</i>	cheat grass	Poaceae	Grass	EX		46	L, M
CYDA	<i>Cynodon dactylon</i>	Bermuda grass	Poaceae	Grass	EX	FACU	12	L
CYEC	<i>Cynosurus echinatus</i>	hedgehog dogtail	Poaceae	Grass	EX		32	L, M
DAGL	<i>Dactylis glomerata</i>	orchard grass	Poaceae	Grass	EX	FACU	9	L, M
DEDA	<i>Deschampsia danthoides</i>	annual hairgrass	Poaceae	Grass		FACW	0	-
DEEL	<i>Deschampsia elongata</i>	slender hairgrass	Poaceae	Grass		FACW	2	L
ECCR	<i>Echinochloa crus-galli</i>	barnyard grass	Poaceae	Grass	EX	FACW	0	-
ELEL	<i>Elymus elymoides</i>	squirreltail	Poaceae	Grass		FACU-	20	L, M
ELGL	<i>Elymus glaucus</i>	blue wildrye	Poaceae	Grass		FACU	14	L, M
ELYM	<i>Elymus</i> sp.	wildrye	Poaceae	Grass			3	L, M
FEAR	<i>Festuca arundinacea</i>	tall fescue	Poaceae	Grass	EX	FAC-	7	L, M
FECA	<i>Festuca californica</i>	California fescue	Poaceae	Grass		FACU	1	M
HOLA	<i>Holcus lanatus</i>	velvet grass	Poaceae	Grass	EX	FAC	3	L, M
LOMU	<i>Lolium multiflorum</i>	annual ryegrass	Poaceae	Grass	EX		0	-
LOPE	<i>Lolium perenne</i>	perennial ryegrass	Poaceae	Grass	EX	FAC	11	L, M
MECA	<i>Melica californica</i>	California melic	Poaceae	Grass			1	L
METO	<i>Melica torreyana</i>		Poaceae	Grass			0	-
PANI	<i>Panicum</i> sp.	panic grass	Poaceae	Grass			1	L
PHAR	<i>Phalaris arundinacea</i>	reed canary grass	Poaceae	Grass		OBL	6	L, M
PHCA	<i>Phalaris canariensis</i>	canary grass	Poaceae	Grass	EX	FACU	2	L, M
PHAL	<i>Phalaris</i> sp.	phalaris	Poaceae	Grass			4	M
PHPR	<i>Phleum pratense</i>	cultivated timothy	Poaceae	Grass	EX	FAC	1	M
POAN	<i>Poa annua</i>	annual bluegrass	Poaceae	Grass	EX	FAC	2	M
POBU	<i>Poa bulbosa</i>	bulbous bluegrass	Poaceae	Grass	EX		28	L, M
POPR	<i>Poa pratensis</i> ssp. <i>pratensis</i>	Kentucky bluegrass	Poaceae	Grass	EX	FAC	4	L, M
POSE	<i>Poa secunda</i>		Poaceae	Grass		FACU	0	-
POMA	<i>Polygona maritima</i>	Mediterranean beard grass	Poaceae	Grass	EX		1	L
POMO	<i>Polygona monspeliensis</i>	annual beard grass	Poaceae	Grass	EX	FACW+	0	-
PSSP	<i>Pseudoroegneria spicata</i> ssp. <i>spicata</i>	beardless wheat-grass	Poaceae	Grass		FACU	10	M
VUBR	<i>Vulpia bromoides</i>	annual fescue	Poaceae	Grass	EX	FACU	0	-
VUMI	<i>Vulpia microstachys</i>	annual fescue	Poaceae	Grass			0	-

Table 2. Continued.

CODE	Scientific Name	Common Name	Family	Habit	Exotic	USFWS wetland indicator code	Number of Plots	Layers
VUMY	<i>Vulpia myuros</i>	annual fescue	Poaceae	Grass	EX	FACU	24	L
Vulp	<i>Vulpia</i> sp.	annual fescue	Poaceae	Grass			16	L
LICHENS								
EVPR	<i>Evernia prunastri</i>	oak-moss	Parmeliaceae	:hlorolichen			17	L, M, T
LEVUL	<i>Letharia vulpina</i>	wolf lichen	Parmeliaceae	:hlorolichen			13	L, M, T
Usnea	<i>Usnea</i> sp.	usnea	Parmeliaceae	:hlorolichen			27	L, M, T

3.2.2 *TWINSpan and Hierarchical Cluster Analysis*

There are several things to consider when interpreting the results and selecting clusters to define patch types. The interpretation must have a sound statistical basis but must also make biological sense. We found that the results of the hierarchical cluster analysis were the most reliable because they do not necessarily rely on one single gradient controlling the sample organization.

The dendrogram branches were aggregated into 11 clusters (Figure 4). The indicator species analysis results suggest that 5 clusters were the best cut-off, followed by 8 clusters (Figure 3). The scale bar above the dendrogram showed that 25% of the information (i.e., uncertainty) in the data set remained unexplained at 5 clusters, or conversely that 75% of the information in the data set was contained in the 5 clusters. Approximately 30% remained at 8 clusters. More uncertainty is included in the groups when fewer groups are chosen; a single cluster would explain 100% of the uncertainty in the classification, and 0% would remain unexplained. However, a classification with a single patch type would not be a useful classification. In determining the number of clusters, it is important to maximize the amount of information contained in the resulting classification without sacrificing the meaning of each cluster. The 5 clusters were heterogeneous and quite broad. The clusters were more meaningful when 8 clusters were chosen. Looking at the dendrogram, we noticed three additional clusters with relatively long “stems.” Therefore, we decided to include the three long-stem clusters with the eight clusters for a total of 11 patch types (Table 3). The resulting 11 patch types contained approximately 61% of the information (i.e., 39% uncertainty remaining), and were used to develop vegetation descriptions and in the final indicator species analysis (Figures 5-15).

Many patch types defined using cluster analysis were similar to the initial patch type classification used in mapping. However, not every mapped patch type was sampled. In some cases, patch types were combined to create more ecologically relevant patch types (Table 3). As a result, this new classification represents a change in only a few original patch types.

Hierarchical cluster analysis results were complimentary to TWINSpan and combined results of these two analyses often corroborate each other. In comparing the classifications of both analyses, the TWINSpan was 76% similar to the hierarchical cluster analysis in terms of how the relevés were grouped. For instance, patches dominated by white alder were consistently classified in the same group regardless of the analysis used. Similarly, yellow star-thistle grassland relevés often were classified in the same group, as were non-native grassland relevés.

The two-way ordered table (Appendix B) resulting from TWINSpan provided clusters and the corresponding indicator species derived using this method. TWINSpan assigned the relevés to seven clusters. TWINSpan assumed that species and patch types were grouped using a primary controlling gradient. That gradient was interpreted as water availability. Four patches appeared to be “dry” patch types while three appeared to be “wet” patches. The results are reasonable but a little coarse; water has a strong influence in riparian systems and explains the separation of relevés with riparian species from those with upland species. However, the results are overly simplified due to the presence of other environmental gradients described below in the gradient analysis section.

The hierarchical cluster analysis defined a black cottonwood patch type and a grey pine patch type; TWINSpan did not. However, even to a novice, grey pine and black cottonwood patches are easily identified on the landscape and appear to be vegetatively unique. Black cottonwood patches and grey pine patches are obvious enough on the landscape that they often require almost no training to recognize. The TWINSpan analysis did not segregate samples in a way that defined these two patch types. The implication is that these two patch types are controlled by some other variable that the one used by TWINSpan (i.e., water availability). We used a combination of the results to define and describe vegetation patch types along the mainstem Trinity River.

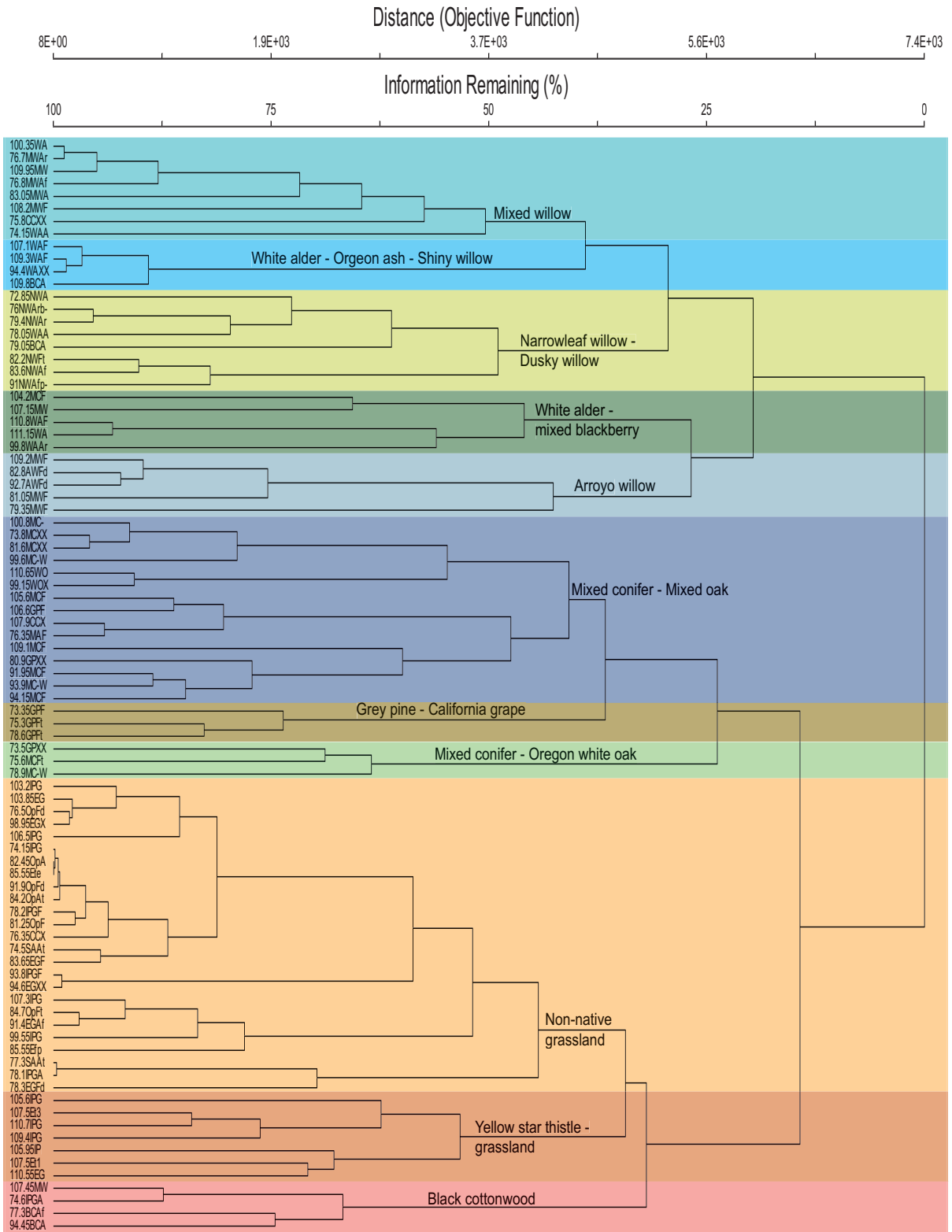


Figure 4. The Upper Trinity River dendrogram. Results of the hierarchical cluster analysis of frequently sampled plant species.

Table 3. Summary of the patch types classified in WY2004 and their relationship to other patch types classifications used in other studies conducted within the Trinity River Restoration Project Area. An asterisk (*) indicates a proposed plant series that was not included in the first edition of Sawyer and Keeler-Wolf (1995). A dagger (†) indicates a plant series that was not sampled during the 2004 field season but would likely be classified as the proposed 2004 patch type. No changes are proposed for 2003 patch types that were not sampled during the 2004 field season. Underlined patch types are dominated by exotic plant species. *Italicized patch types are not plant dominated.*

TRINITY RIVER MAINSTEM WY2004 VEGETATION CLASSIFICATION PATCH TYPES	TRINITY RIVER MAINSTEM WY2003 RIPARIAN INVENTORY PATCH TYPES (ADAPTED FROM SAWYER AND KEELER-WOLF 1995)	RIPARIAN VEGETATION TYPES (WILSON 1993)	CALIFORNIA WILDLIFE HABITAT RELATIONSHIP PATCH TYPE (MAYER AND LAUDENSLAYER 1988)	CNDDB/HOLLAND PATCH TYPE
[Not sampled]	Aquatic Emergent*	Aquatic	Freshwater Emergent Wetland	Coast and Valley freshwater marsh (52410) Montane freshwater marsh (52430 in part)
Arroyo Willow	Arroyo Willow	Willow dominant	Freshwater Emergent Wetland Valley Foothill Riparian	Southern cottonwood-willow riparian forest (61330 in part) Great Valley cottonwood riparian forest (61410 in part) Great Valley mixed riparian forest (61420 in part) Southern willow scrub (63320 in part)
	<u>Clematis**†</u>	Willow dominant Willow/alder mix	Valley Foothill Riparian Montane Riparian	Great Valley cottonwood riparian forest (61410 in part) Great Valley mixed riparian forest (61420 in part) Great Valley willow scrub (63410 in part) Southern willow scrub (63320 in part)
[Not sampled]	Basket Bush*	Willow/alder mix Alder dominant	Montane Riparian Montane Hardwood-Conifer	N/A N/A
[Not sampled]	Bigleaf Maple*	Willow/alder mix Alder dominant	Montane Riparian Montane Hardwood-Conifer	Montane black cottonwood riparian forest (61530)
Black Cottonwood	Black Cottonwood	Willow/alder mix Alder dominant	Montane Riparian Valley Foothill Riparian	Montane black cottonwood riparian forest (61530)
[Not sampled]	<u>Black Locust*</u>	Alder dominant	N/A	N/A
[Not sampled]	Black Walnut*	Willow/alder mix	Montane Riparian	Great Valley cottonwood riparian forest (61410 in part) Great Valley mixed riparian forest (61420 in part)
[Not sampled]	Blue Elderberry*	Willow dominant Willow/alder mix	Valley Foothill Riparian Montane Riparian	Great Valley cottonwood riparian forest (61410 in part) Great Valley mixed riparian forest (61420 in part) Great Valley willow scrub (63410 in part) Southern willow scrub (63320 in part)
[Not sampled]	Cattail	Aquatic	Freshwater Emergent Wetland	Coast and Valley freshwater marsh (52410 in part) Montane freshwater marsh (52430 in part)
[Not sampled]	Douglas Fir	Upland	Douglas Fir	Upland Douglas-fir forest (82420) Coast range mixed coniferous forest (84110 in part)
Grey Pine-California Grape	Grey Pine	Upland	Blue oak-Foothill Pine	Serpentine digger pine chaparral (71321) Non-serpentine digger pine chaparral (71322) Non-serpentine digger pine chaparral (71322)

Table 3. Continued.

TRINITY RIVER MAINSTEM WY2004 VEGETATION CLASSIFICATION PATCH TYPES	TRINITY RIVER MAINSTEM WY2003 RIPARIAN INVENTORY PATCH TYPES (ADAPTED FROM SAWYER AND KEELER-WOLF 1995)	RIPARIAN VEGETATION TYPES (WILSON 1993)	CALIFORNIA WILDLIFE HABITAT RELATIONSHIP PATCH TYPE (MAYER AND LAUDENSLAYER 1988)	CNDDDB/HOLLAND PATCH TYPE
Grey Pine-California Grape (cont.)	Grey Pine-White Oak*†	Upland	Blue oak-Foothill Pine	Serpentine digger pine chaparral (71321) Non-serpentine digger pine chaparral (71322)
[Not sampled]	California Grape*†	Upland	Montane Riparian Valley Foothill Riparian	Great Valley mixed riparian forest (61420 in part) Great Valley willow scrub (63410 in part)
[Not sampled]	Fremont Cottonwood	Upland	Valley Foothill Riparian	Great Valley cottonwood riparian forest (61410 in part) Great Valley mixed riparian forest (61420 in part)
[Not sampled]	<i>Human Disturbance</i>	N/A	Urban	N/A
[Not sampled]	Indian Rhubarb*	Aquatic	Valley Foothill Riparian	White alder riparian forest (61510)
[Not sampled]	Juncus	Open	Freshwater Emergent Wetland	Coast and Valley freshwater marsh (52410 in part) Montane freshwater marsh (52430 in part)
Mixed Conifer-Mixed Oak	Mixed Conifer	N/A	Klamath Mixed Conifer	North Range mixed coniferous forest (84110 in part)
	Canyon Live Oak†	Upland	Sierran Mixed Conifer	Coast range mixed coniferous forest (84110 in part)
			Mixed Chaparral	Canyon live oak ravine forest (61350)
			Montane Hardwood	Canyon live oak forest (61350)
			Montane Hardwood-Conifer	
	Mixed Conifer-Mountain Maple*†	N/A	Klamath Mixed Conifer	North Range mixed coniferous forest (84110 in part)
			Montane Hardwood-Conifer	Coast range mixed coniferous forest (84110 in part)
	Wedgeleaf Ceanothus (in part)	N/A	Mixed Chaparral	Mixed montane chaparral (37510 in part) Buck brush chaparral (37810) Poison oak chaparral (37F00 in part)
Mixed Conifer-Oregon White Oak	Mixed Conifer-White Oak*	N/A	Klamath Mixed Conifer	North Range mixed coniferous forest (84110 in part)
Mixed Willow	Mixed Willow	Willow dominant	Montane Hardwood-Conifer	Coast range mixed coniferous forest (84110 in part)
			Montane Riparian	Freshwater swamp (52600 in part)
			Valley Foothill Riparian	Great Valley cottonwood riparian forest (61410 in part) Great Valley mixed riparian forest (61420 in part) Great Valley willow scrub (63410 in part) Southern willow scrub (63320 in part)
	Mugwort	Open	Montane Riparian	North Coast riparian scrub (63100)
		Willow/alder mix	Valley Foothill Riparian	Montane riparian scrub (63500)
		Alder dominant		White alder riparian forest (61510)
	Shiny Willow (in part)	Willow/alder mix	Montane Riparian	Southern cottonwood-willow riparian forest (61330 in part)
		Alder dominant	Valley Foothill Riparian	Great Valley mixed riparian forest (61420 in part) Great Valley cottonwood riparian forest (61410 in part) Great Valley willow scrub (63410 in part) White alder riparian forest (61510)

Table 3. Continued.

TRINITY RIVER MAINSTEM WY2004 VEGETATION CLASSIFICATION PATCH TYPES	TRINITY RIVER MAINSTEM WY2003 RIPARIAN INVENTORY PATCH TYPES (ADAPTED FROM SAWYER AND KEELER-WOLFF1995)	RIPARIAN VEGETATION TYPES (WILSON 1993)	CALIFORNIA WILDLIFE HABITAT RELATIONSHIP PATCH TYPE (MAYER AND LAUDENSLAYER 1988)	CNDDDB/HOLLAND PATCH TYPE
[Not sampled]	<i>Open Water</i>	Water	Lacustrine	N/A
[Not sampled]	Oregon White Oak	N/A	Montane Hardwood	Oregon oak woodland (71110) Mixed north cismontane woodland (71420 in part)
[Not sampled]	Ponderosa Pine	N/A	Ponderosa Pine	Upland Coast Range ponderosa pine forest (84131) Westside ponderosa pine forest (84210) Sierran mixed coniferous forest (84230 in part)
[Not sampled]	River	Water	Riverine	N/A
[Not sampled]	Road	N/A	Urban	N/A
Non-Native Grassland	California Annual Grassland	Open	Annual grassland	Non-native grassland (4220)
	California Brickellbush*	Open	Barren	N/A
	Introduced Perennial Grassland	Open	Annual grassland	Non-native grassland (4220)
	Open	Gravel Bar	Perennial Grassland	Non-native grassland (42200)
	Dusky Willow	Willow dominant	Barren	N/A
Narrowleaf Willow-Dusky Willow			Montane Riparian	Great Valley cottonwood riparian forest (61410 in part)
			Valley Foothill Riparian	Great Valley mixed riparian forest (61420 in part) Great Valley willow scrub (63410 in part) Southern willow scrub (63320 in part)
	Narrowleaf Willow	Willow dominant	Montane Riparian	Southern cottonwood-willow riparian forest (61330 in part)
			Valley Foothill Riparian	Great Valley cottonwood riparian forest (61410 in part) Great Valley willow scrub (63410 in part)
[Not sampled]	Rose*	Willow/alder mix	Montane Riparian	North Coast riparian scrub (63100)
			Valley Foothill Riparian	Montane riparian scrub (63500) White alder riparian forest (61510)
[Not sampled]	Rose-California Grape*	Willow/alder mix	Montane Riparian	North Coast riparian scrub (63100)
			Valley Foothill Riparian	Montane riparian scrub (63500) White alder riparian forest (61510)
[Not sampled]	Sedge	Gravel Bar	Freshwater Emergent Wetland	Wet montane meadow (45110 in part) Freshwater seep (45400 in part)
[Not sampled]	Straggly Gooseberry*	N/A	Montane Riparian	North Coast riparian scrub (63100) Montane riparian scrub (63500)

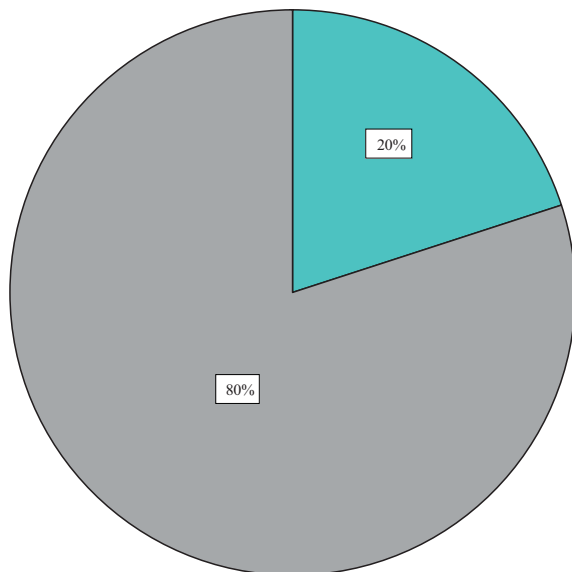
Table 3. Continued.

TRINITY RIVER MAINSTEM WY2004 VEGETATION CLASSIFICATION PATCH TYPES	TRINITY RIVER MAINSTEM WY2003 RIPARIAN INVENTORY PATCH TYPES (ADAPTED FROM SAWYER AND KEELER-WOLFF1995)	RIPARIAN VEGETATION TYPES (WILSON 1993)	CALIFORNIA WILDLIFE HABITAT RELATIONSHIP PATCH TYPE (MAYER AND LAUDENSLAYER 1988)	CNDDB/HOLLAND PATCH TYPE
[Not sampled]	Tree of Heaven*	N/A	N/A	N/A
[Not sampled]	Wedgeleaf Ceanothus (in part)	N/A	Mixed Chaparral	Mixed montane chaparral (37510 in part) Buck brush chaparral (37810) Poison oak chaparral (37F00 in part)
[Not sampled]	Western Chokecherry*	N/A	Montane Riparian	N/A N/A
White Alder-Mixed Blackberry	White Alder	Willow/alder mix Alder dominant	Montane Riparian Valley Foothill Riparian	White alder riparian forest (61510)
	<u>Himalaya Berry**†</u>	Willow/alder mix Alder dominant	Montane Riparian Valley Foothill Riparian	Great Valley cottonwood riparian forest (61410 in part) Great Valley mixed riparian forest (61420 in part) Great Valley willow scrub (63410 in part)
White Alder-Oregon Ash-Shiny Willow	White Alder-Shiny Willow*	Willow/alder mix Alder dominant	Montane Riparian Valley Foothill Riparian	White alder riparian forest (61510)
	Oregon Ash*†	Willow/alder mix Alder dominant	Montane Riparian Valley Foothill Riparian	Southern cottonwood-willow riparian forest (61330 in part) Great Valley mixed riparian forest (61420 in part) Great Valley cottonwood riparian forest (61410 in part) Great Valley willow scrub (63410 in part)
	Shiny Willow (in part)	Willow/alder mix Alder dominant	Montane Riparian Valley Foothill Riparian	Southern cottonwood-willow riparian forest (61330 in part) Great Valley mixed riparian forest (61420 in part) Great Valley cottonwood riparian forest (61410 in part) Great Valley willow scrub (63410 in part)
[Not sampled]	Whiteleaf Manzanita	N/A	Mixed Chaparral	White alder riparian forest (61510) Mixed montane chaparral (37510 in part) Montane manzanita chaparral (37520 in part)

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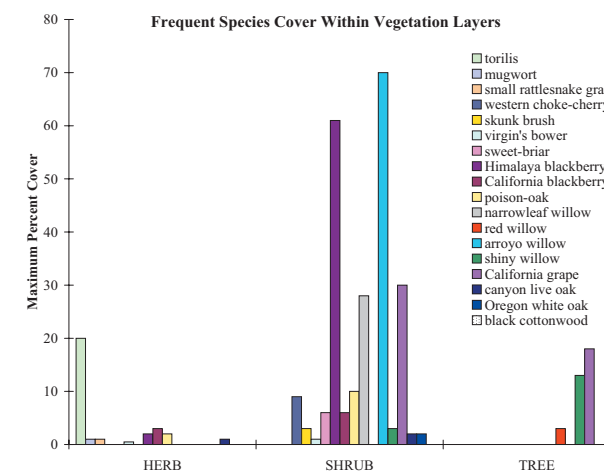
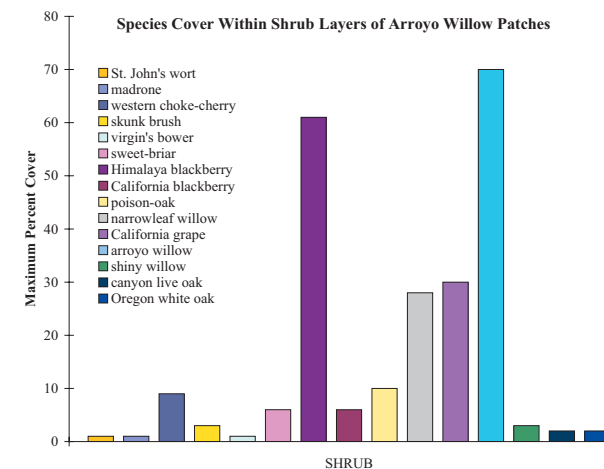
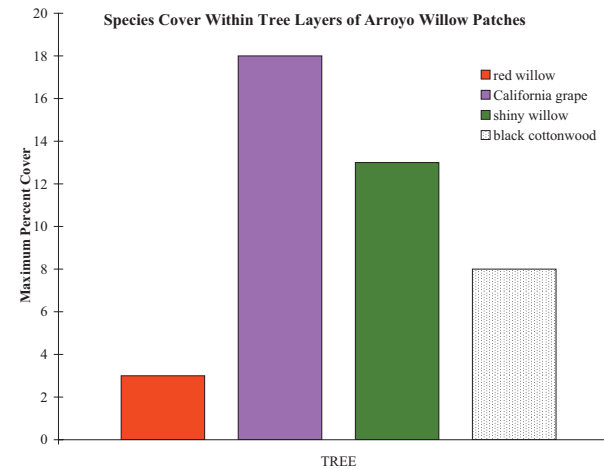
Geomorphic Units Supporting Arroyo Willow-Virgin's Bower Patches



Percentage of Arroyo Willow Patches Originally Mapped in 2003 As:

Patch Type	Percentage
arroyo willow	40
mixed willow	60

■ Alluvial Low Terrace
■ Anthropogenic Dredge Tailing Stockpiles



ARROYO WILLOW PATCH TYPE

Common constituents in alphabetical order of botanical name.

Listings written in **bold** signify an indicator plant species.

Listings written in **red** signify an exotic plant species.

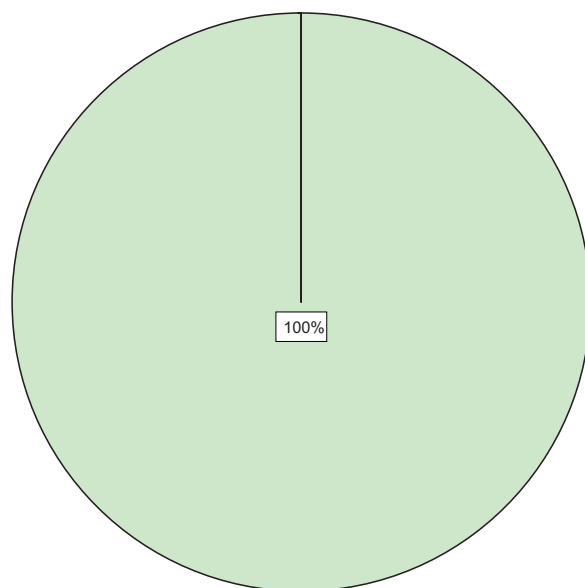
Common Name	Botanical Name	Growth Habit	USFWS Hydric Code
European hairgrass	<i>Aira caryophyllea</i>	Grass	-
White alder	<i>Alnus rhombifolia</i>	Tree	FACW
Mugwort	<i>Artemesia douglasiana</i>	Herb	FAC+
Small rattlesnake grass	<i>Briza minor</i>	Grass	-
Virgin's bower	<i>Clematis ligusticifolia</i>	Vine	FAC
St. John's wort	<i>Hypericum perforatum</i>	Herb	-
Dalmation toadflax	<i>Linaria genistifolia</i>	Herb	-
Ponderosa pine	<i>Pinus ponderosa</i>	Tree	UPL
Canyon live oak	<i>Quercus chrysolepis</i>	Tree	-
Oregon white oak	<i>Quercus garryana</i>	Tree	-
Black cottonwood	<i>Populus balsamifera</i> ssp. <i>trichocarpa</i>	Tree	FACW
Western choke-cherry	<i>Prunus virginiana</i> var. <i>demissa</i>	Shrub	FAC_
Skunk brush	<i>Rhus trilobata</i>	Shrub	FACU
Sweet-briar	<i>Rosa eglanteria</i>	Shrub	FACU
Himalaya blackberry	<i>Rubus discolor</i>	Shrub	FAC+
California blackberry	<i>Rubus ursinus</i>	Shrub	FAC+
Narrowleaf willow	<i>Salix exigua</i>	Shrub	FACW
Red willow	<i>Salix laevigata</i>	Tree	FACW
Arroyo willow	<i>Salix lasiolepis</i>	Shrub	FACW
Shiny willow	<i>Salix lucida</i> ssp. <i>lasiandra</i>	Tree	OBL
torilis	<i>Torilis arvensis</i>	Herb	-
Poison-oak	<i>Toxicodendron diversilobum</i>	Shrub	-
California grape	<i>Vitis californica</i>	Vine	FACW

ARROYO WILLOW PATCH DESCRIPTION: Five relevé plots were classified as this arroyo willow by cluster analysis. Arroyo willow (*Salix lasiolepis*) dominates the shrub layer of this patch type. Other frequent species that occurred in the shrub layer of two or more of the relevés included Himalaya blackberry (*Rubus discolor*), western choke-cherry (*Prunus virginiana*), sweet-briar (*Rosa eglanteria*), narrowleaf willow (*Salix exigua*), and California grape (*Vitis californica*). The combination of virgin's bower (*Clematis ligusticifolia*) in both the shrub and herb layers with an arroyo willow-dominated shrub layer is indicative of this patch type. 80% of the arroyo willow patches sampled occurred on anthropomorphic dredge tailing stockpiles.

Figure 5. Arroyo willow patch type description.



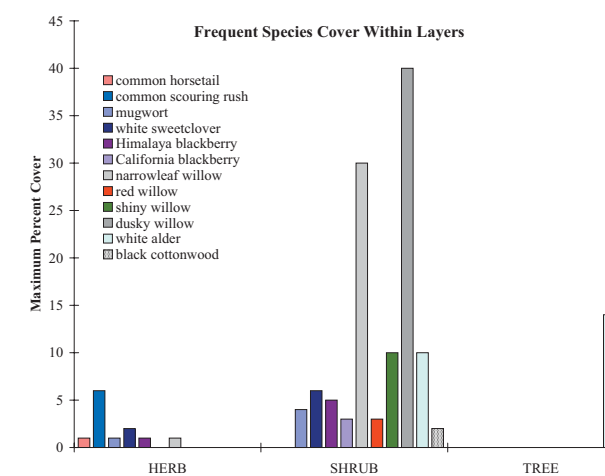
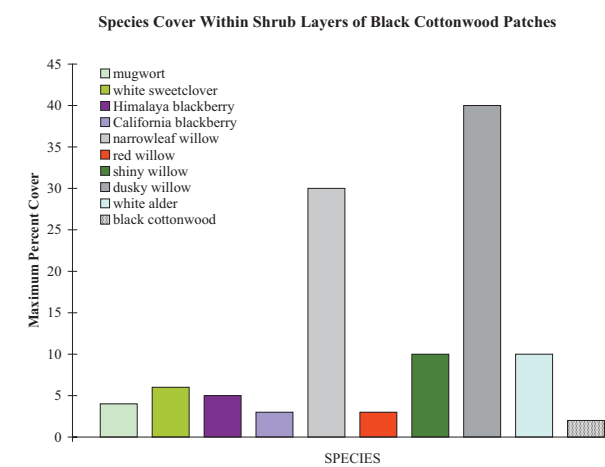
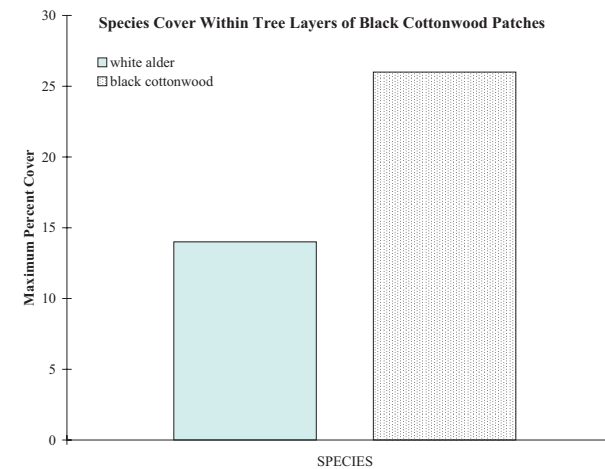
Geomorphic Units Supporting Black Cottonwood Patches



Percentage of Black Cottonwood Patches Originally Mapped in 2003 As:

Patch Type	Percentage
black cottonwood	50
mixed willow	25
introduced perennial grassland	25

□ Alluvial Floodplain



BLACK COTTONWOOD PATCH TYPE

Common constituents in alphabetical order of botanical name.
Listings written in **bold** signify an indicator plant species.
Listings written in *red* signify an exotic plant species.

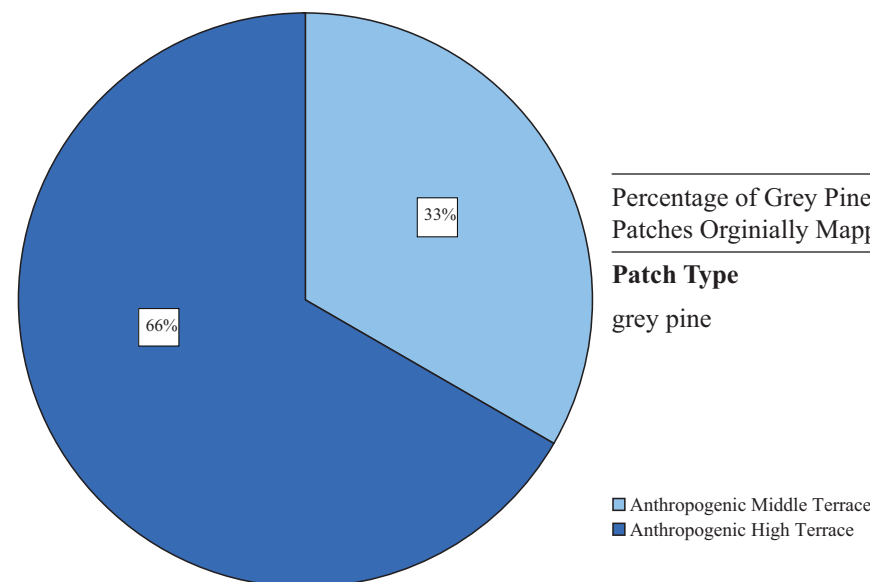
Common Name	Botanical Name	Growth Habit	USFWS Hydric Code
White alder	<i>Alnus rhombifolia</i>	Tree	FACW
Mugwort	<i>Artemisia douglasiana</i>	Herb	FAC+
<i>Mustard</i>	<i>Brassica nigra</i>	Herb	-
<i>Mexican tea</i>	<i>Chenopodium ambrosioides</i>	Herb	FAC
<i>Queen Anne's lace</i>	<i>Daucus carota</i>	Herb	-
Purple-leaved willow-herb	<i>Epilobium ciliatum</i>	Herb	FACW
Common scouring rush	<i>Equisetum hyemale</i>	Em Herb	FACW
<i>Tall fescue</i>	<i>Festuca arundinacea</i>	Grass	FAC-
Oregon ash	<i>Fraxinus latifolia</i>	Tree	FACW
<i>St. John's wort</i>	<i>Hypericum perforatum</i>	Herb	-
<i>Dalmatian toadflax</i>	<i>Linaria genistifolia</i>	Herb	-
White sweetclover	<i>Melilotus alba</i>	Herb	-
Pennyroyal	<i>Mentha pulegium</i>	Herb	OBL
<i>Common plantain</i>	<i>Plantago major</i>	Herb	FAC
Black cottonwood	<i>Populus balsamifera</i> ssp. <i>trichocarpa</i>	Tree	FACW
<i>Himalaya blackberry</i>	<i>Rubus discolor</i>	Shrub	FAC+
<i>California blackberry</i>	<i>Rubus ursinus</i>	Shrub	FAC+
<i>Wild rhubarb</i>	<i>Rumex hymenosepalus</i>	Herb	-
Narrowleaf willow	<i>Salix exigua</i>	Shrub	FACW
<i>Red willow</i>	<i>Salix laevigata</i>	Tree	FACW
<i>Shiny willow</i>	<i>Salix lucida</i> ssp. <i>lasiandra</i>	Tree	OBL
Dusky willow	<i>Salix melanopsis</i>	Shrub	FACW
<i>Common groundsel</i>	<i>Senecio vulgaris</i>	Herb	-
Common cocklebur	<i>Xanthium strumarium</i>	Herb	FAC+

BLACK COTTONWOOD PATCH DESCRIPTION: Four relevé plots were classified as black cottonwood by cluster analysis. Black cottonwood (*Populus balsamifera* ssp. *trichocarpa*) dominates the tree layer of this patch type. White alder (*Alnus rhombifolia*) is frequent in both the tree and shrub layers. Other frequent species occurring in two or more relevés included narrowleaf willow (*Salix exigua*), shiny willow (*Salix lucida* ssp. *lasiandra*), and dusky willow (*Salix melanopsis*). The herb layer is diverse. Many herbs in this patch type are tall and grow into the shrub layer. 100% of the black cottonwood patches sampled occurred on alluvial floodplains.

Figure 6. Black cottonwood patch type description.

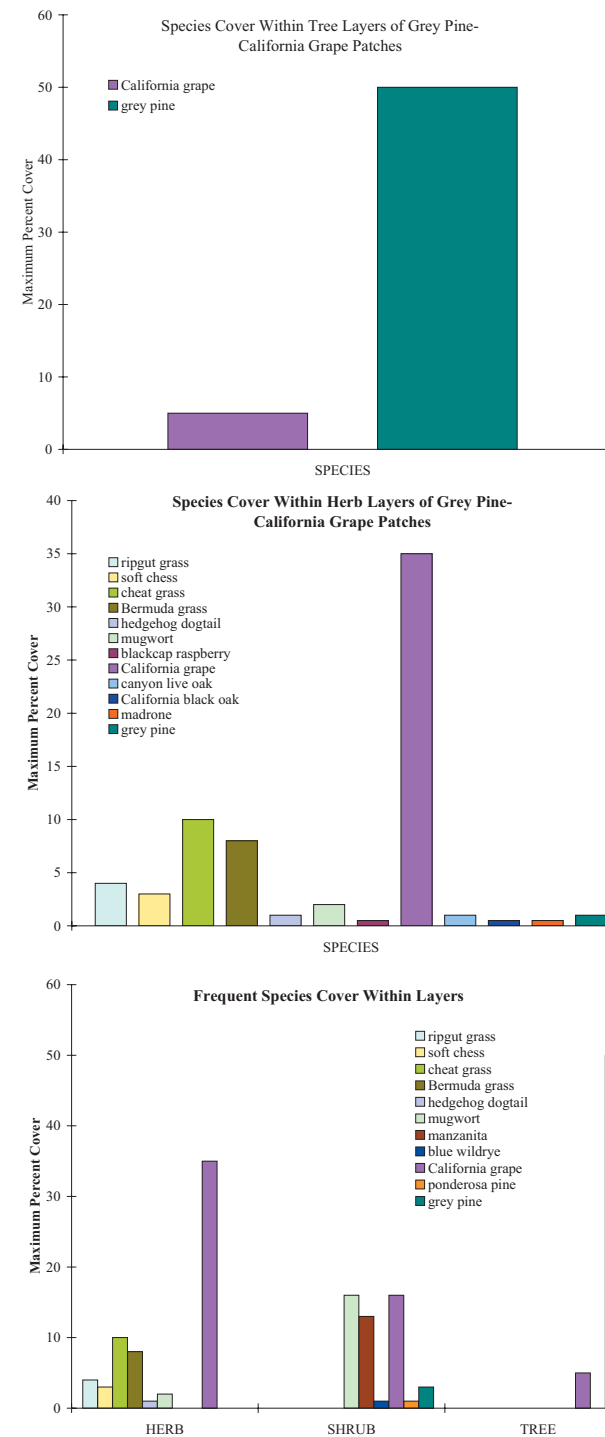


Geomorphic Units Supporting Grey Pine-California Grape Patches



Percentage of Grey Pine-California Grape Patches Originally Mapped in 2003 As:

Patch Type	Percentage
grey pine	100



GREY PINE-CALIFORNIA GRAPE PATCH TYPE:

Common constituents in alphabetical order of botanical name.

Listings written in **bold** signify an indicator plant species.

Listings written in *red* signify an exotic plant species.

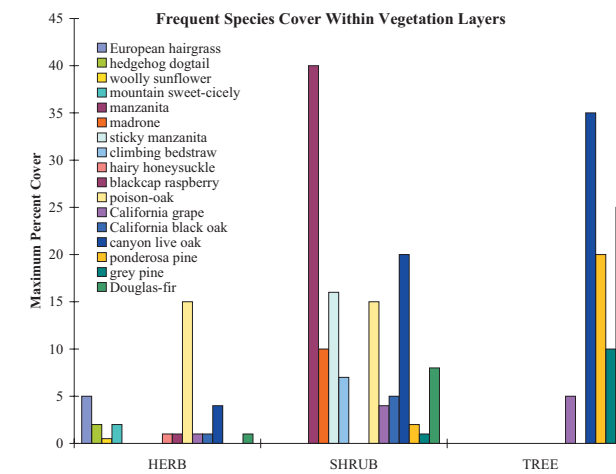
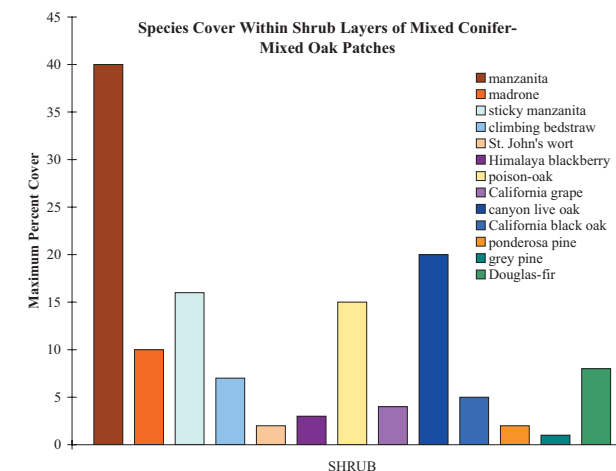
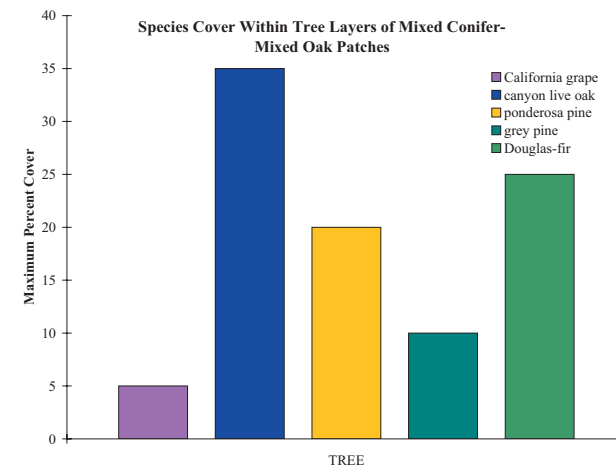
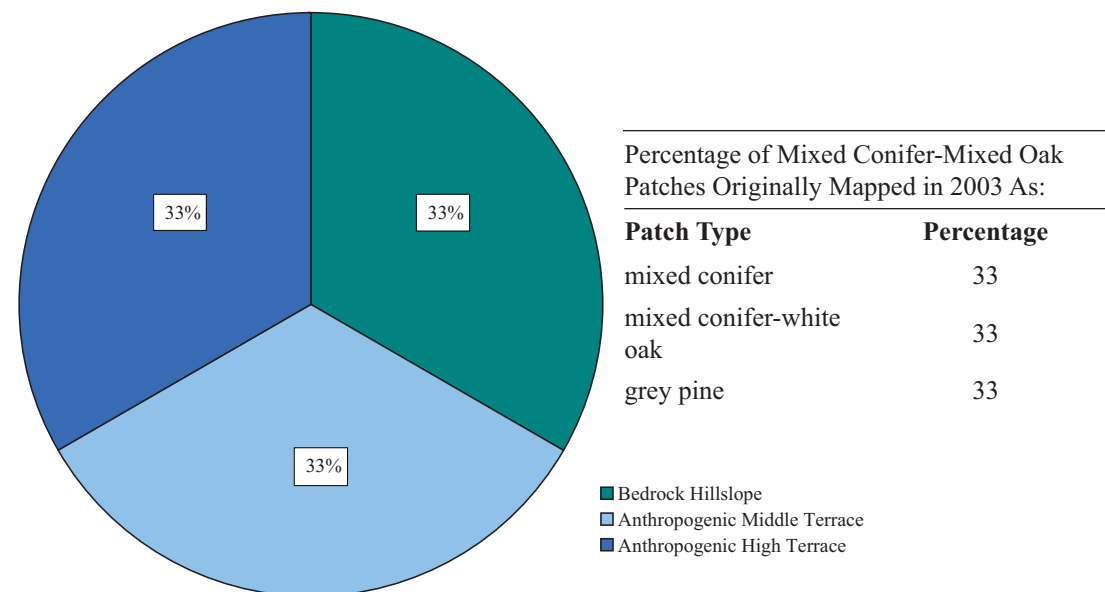
Common Name	Botanical Name	Growth Habit	USFWS Hydric Code
<i>European hairgrass</i>	<i>Aira caryophyllea</i>	Grass	-
Madrone	<i>Arbutus menziesii</i>	Tree	-
Manzanita	<i>Arctostaphylos manzanita</i>	Shrub	-
Mugwort	<i>Artemisia douglasiana</i>	Herb	FAC+
<i>Ripgut grass</i>	<i>Bromus diandrus</i>	Grass	-
<i>Soft chess</i>	<i>Bromus hordeaceus</i>	Grass	FACU-
<i>Cheat grass</i>	<i>Bromus tectorum</i>	Grass	-
<i>Yellow star-thistle</i>	<i>Centaurea solstitialis</i>	Herb	-
<i>Hedgehog dogtail</i>	<i>Cynosurus echinatus</i>	Grass	-
Large-flowered collomia	<i>Collomia grandiflora</i>	Herb	-
<i>Bermuda grass</i>	<i>Cynodon dactylon</i>	Grass	FACU
Squirreltail	<i>Elymus elymoides</i>	Grass	FACU-
Blue wildrye	<i>Elymus glaucus</i>	Grass	FACU
<i>St. John's wort</i>	<i>Hypericum perforatum</i>	Herb	-
<i>Smooth cat's-ears</i>	<i>Hypochaeris glabra</i>	Herb	-
Ponderosa pine	<i>Pinus ponderosa</i>	Tree	UPL
Grey pine	<i>Pinus sabiniana</i>	Tree	-
Canyon live oak	<i>Quercus chrysolepis</i>	Tree	-
California black oak	<i>Quercus kelloggii</i>	Tree	-
Skunk brush	<i>Rhus trilobata</i>	Shrub	FACU
Blackcap raspberry	<i>Rubus leucodermis</i>	Shrub	FACU
California grape	<i>Vitis californica</i>	Vine	FACW

GREY PINE-CALIFORNIA GRAPE PATCH DESCRIPTION: Three relevé plots were classified as grey pine-California grape by cluster analysis. Grey pine (*Pinus sabiniana*) dominates the tree layer of this patch type. California grape (*Vitis californica*) is frequent in herb, shrub, and tree layers. The herb layer is dominated by a variety of annual bromes (e.g., ripgut grass, soft chess, cheat grass) and Bermuda grass (*Cynodon dactylon*). The grassy understory, adjacency to non-native grassland patches, and similarity in species composition indicate that grey pine-California grape patches often replace non-native grasslands. 66% of the grey pine-California grape patches sampled occurred on anthropomorphic high terraces.

Figure 7. Grey pine-California grape patch type description.



Geomorphic Units Supporting Mixed Conifer-Mixed Oak Patches



MIXED CONIFER-MIXED OAK PATCH TYPE

Common constituents in alphabetical order of botanical name.
Listings written in bold signify an indicator plant species.
Listings written in red signify an exotic plant species.

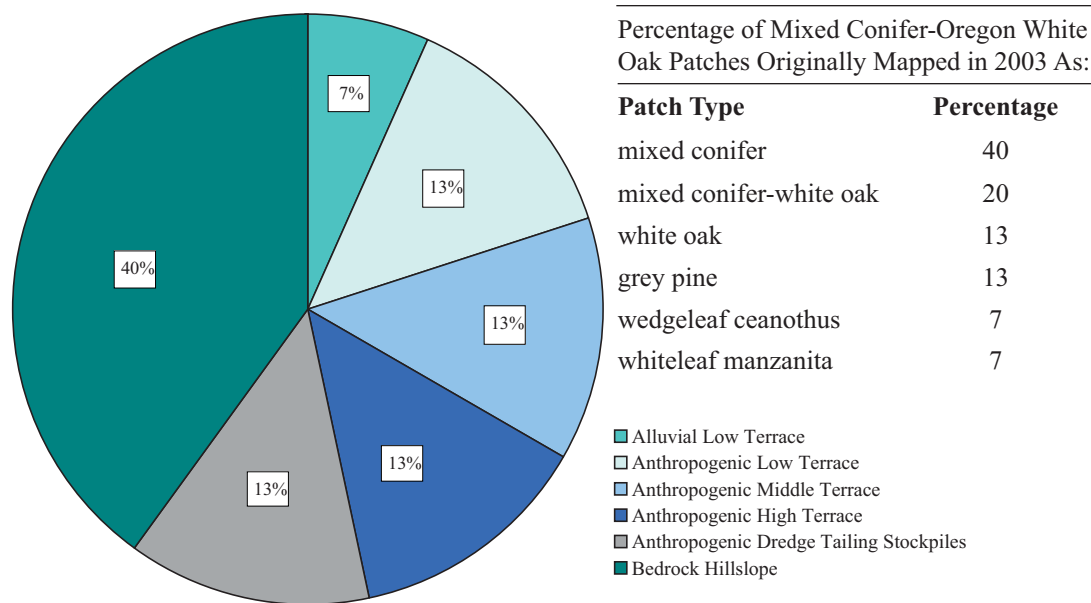
Common Name	Botanical Name	Growth Habit	USFWS Hydric Code
Madrone	<i>Arbutus menziesii</i>	Tree	-
Manzanita	<i>Arctostaphylos manzanita</i>	Shrub	-
Sticky manzanita	<i>Arctostaphylos viscida</i>	Shrub	-
Hedgehog dogtail	<i>Cynosurus echinatus</i>	Grass	-
Woolly sunflower	<i>Eriophyllum lanatum</i>	Herb	-
Climbing bedstraw	<i>Galium porrigens</i>	Herb	-
St. John's wort	<i>Hypericum perforatum</i>	Herb	-
Hairy honeysuckle	<i>Lonicera hispidula</i> var. <i>vacillans</i>	Vine	FACU
Mountain sweet-cicely	<i>Osmorhiza chilensis</i>	Herb	-
Ponderosa pine	<i>Pinus ponderosa</i>	Tree	UPL
Grey pine	<i>Pinus sabiniana</i>	Tree	-
Douglas-fir	<i>Pseudotsuga menziesii</i>	Tree	-
Canyon live oak	<i>Quercus chrysolepis</i>	Tree	-
California black oak	<i>Quercus kelloggii</i>	Tree	-
Himalaya blackberry	<i>Rubus discolor</i>	Shrub	FAC+
Blackcap raspberry	<i>Rubus leucodermis</i>	Shrub	FACU
Poison-oak	<i>Toxicodendron diversilobum</i>	Shrub	-
California grape	<i>Vitis californica</i>	Vine	FACW

MIXED CONIFER-MIXED OAK PATCH DESCRIPTION: Three relevé plots were classified as this patch type by cluster analysis. Ponderosa pine (*Pinus ponderosa*), grey pine (*Pinus sabiniana*), Douglas-fir (*Pseudotsuga menziesii*), and canyon live oak (*Quercus chrysolepis*) co-dominate the tree layer of this patch type. The general absence of Oregon white oak (*Quercus garryana*) and interior live oak (*Q. wizlisenii*) distinguish this patch type from mixed conifer-Oregon white oak patches. Madrone (*Arbutus menziesii*), manzanita (*Arctostaphylos manzanita*, *A. viscida*), and poison-oak (*Toxicodendron diversilobum*) are frequent in the shrub layer. The 16 indicator species revealed by indicator species analysis show that this patch type has a consistent species composition. Mixed conifer-mixed oak patches occurred with equal frequency on bedrock hillslopes, anthropomorphic high terraces, and anthropomorphic middle terraces. Of all the patch types sampled, the mixed conifer patches occurred on the most upland sites furthest from a water source.

Figure 8. Mixed conifer-mixed oak patch type description.



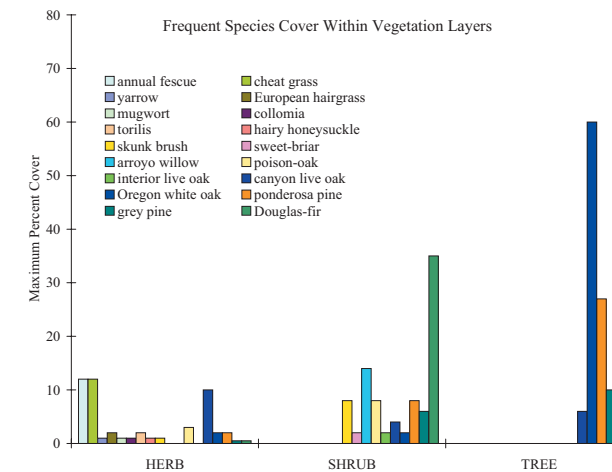
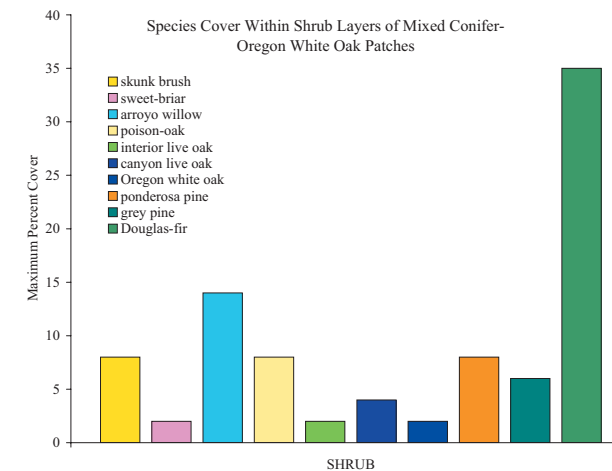
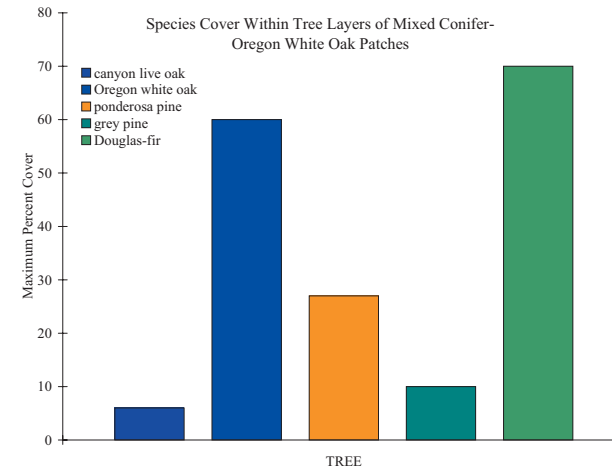
Geomorphic Units Supporting Mixed Conifer-Oregon White Oak Patches



Percentage of Mixed Conifer-Oregon White Oak Patches Originally Mapped in 2003 As:

Patch Type	Percentage
mixed conifer	40
mixed conifer-white oak	20
white oak	13
grey pine	13
wedgeleaf ceanothus	7
whiteleaf manzanita	7

- Alluvial Low Terrace
- Anthropogenic Low Terrace
- Anthropogenic Middle Terrace
- Anthropogenic High Terrace
- Anthropogenic Dredge Tailing Stockpiles
- Bedrock Hillslope



MIXED CONIFER-OREGON WHITE OAK PATCH TYPE:

Common constituents in alphabetical order of botanical name.

Listings written in **bold** signify an indicator plant species.

Listings written in **red** signify an exotic plant species.

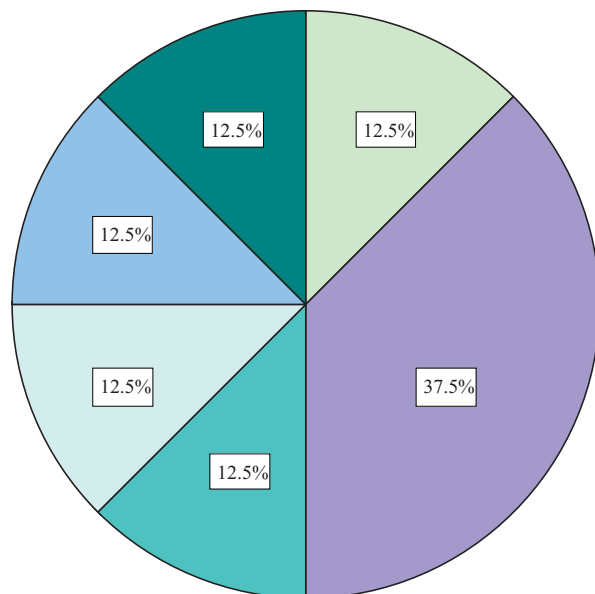
	Botanical Name	Growth Habit	USFWS Hydric Code
Yarrow	<i>Achillea millefolium</i>	Herb	FACU
European hairgrass	<i>Aira caryophylla</i>	Grass	-
Madrone	<i>Arbutus menziesii</i>	Tree	-
Mugwort	<i>Artemisia douglasiana</i>	Herb	FAC+
Cheat grass	<i>Bromus tectorum</i>	Grass	-
Wedgeleaf ceanothus	<i>Ceanothus cuneatus</i>	Shrub	-
Large-flowered collomia	<i>Collomia grandiflora</i>	Herb	-
Squirreltail	<i>Elymus elymoides</i>	Grass	FACU-
Common horsetail	<i>Equisetum arvense</i>	Em Herb	FAC
St. John's wort	<i>Hypericum perforatum</i>	Herb	-
Hairy honeysuckle	<i>Lonicera hispidula</i> var. <i>vacillans</i>	Vine	FACU
Ponderosa pine	<i>Pinus ponderosa</i>	Tree	UPL
Grey pine	<i>Pinus sabiniana</i>	Tree	-
Bulbous bluegrass	<i>Poa bulbosa</i>	Grass	-
Douglas-fir	<i>Pseudotsuga menziesii</i>	Tree	-
Canyon live oak	<i>Quercus chrysolepis</i>	Tree	-
Oregon white oak	<i>Quercus garryana</i>	Tree	-
Interior live oak	<i>Quercus wislizenii</i>	Tree	-
Skunk brush	<i>Rhus trilobata</i>	Shrub	FACU
Sweet-briar	<i>Rosa eglantheria</i>	Shrub	FACU
Himalaya blackberry	<i>Rubus discolor</i>	Shrub	FAC+
Arroyo willow	<i>Salix lasiolepis</i>	Shrub	FACW
Torilis	<i>Torilis arvensis</i>	Herb	-
Rose clover	<i>Trifolium hirtum</i>	Herb	-
Poison-oak	<i>Toxicodendron diversilobum</i>	Shrub	-

MIXED CONIFER-OREGON WHITE OAK PATCH DESCRIPTION: Fifteen relevé plots were classified as mixed conifer-Oregon white oak by cluster analysis. Douglas-fir (*Pseudotsuga menziesii*), ponderosa pine (*Pinus ponderosa*), grey-pine, and Oregon white oak (*Quercus garryana*) co-dominate the tree layer of this patch type. The shrub layer is composed of these species, as well as of canyon live oak (*Q. chrysolepis*), skunk brush (*Rhus trilobata*), poison-oak (*Toxicodendron diversilobum*), and sweet-briar (*Rosa eglantheria*). Interior live oak (*Quercus wislizenii*) occurred exclusively in this patch type, and its presence is an indicator of mixed conifer-Oregon white oak patches. 40% of the mixed conifer-Oregon white oak patches sampled occurred on anthropomorphic high terraces. Of all the patch types sampled, the mixed conifer patches occurred on the most upland sites furthest from a water source.

Figure 9. Mixed conifer-Oregon white oak patch type description.



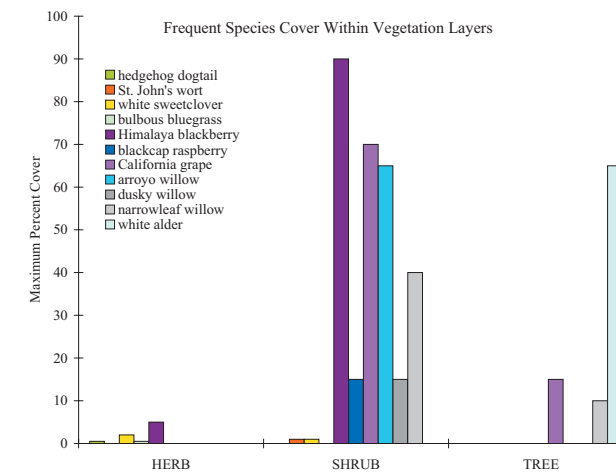
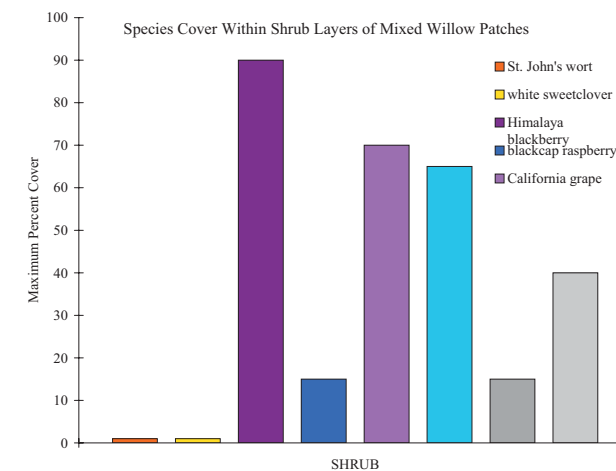
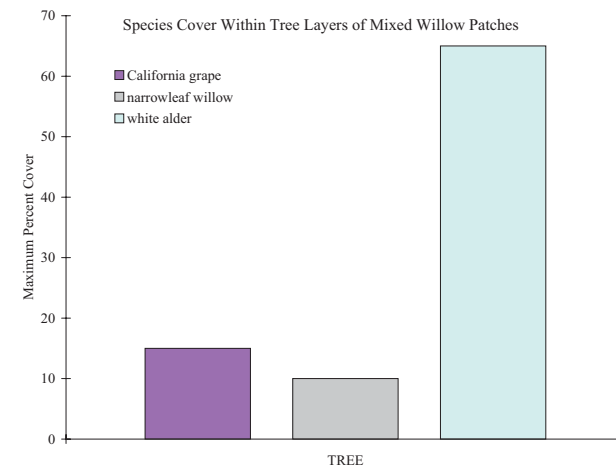
Geomorphic Units Supporting Mixed Willow Patches



Percentage of Mixed Willow Patches Originally Mapped in 2003 As:

Patch Type	Percentage
mixed willow	63
white alder	25
wedgeleaf ceanothus	13

- Alluvial Floodplain
- Alluvial Riparian Berm
- Alluvial Low Terrace
- Anthropogenic Low Terrace
- Anthropogenic Middle Terrace
- Bedrock Hillslope



MIXED WILLOW PATCH TYPE:

Common constituents in alphabetical order of botanical name.
Listings written in bold signify an indicator plant species.
Listings written in red signify an exotic plant species.

Common Name	Botanical Name	Growth Habit	USFWS Hydric Code
White alder	<i>Alnus rhombifolia</i>	Tree	FACW
Mugwort	<i>Artemisia douglasiana</i>	Herb	FAC+
St. John's wort	<i>Hypericum perforatum</i>	Herb	-
Himalaya blackberry	<i>Rubus discolor</i>	Shrub	FAC+
Blackcap raspberry	<i>Rubus leucodermis</i>	Shrub	FACU
California blackberry	<i>Rubus ursinus</i>	Shrub	FAC+
Narrowleaf willow	<i>Salix exigua</i>	Shrub	FACW
Red willow	<i>Salix laevigata</i>	Tree	FACW
Arroyo willow	<i>Salix lasiolepis</i>	Shrub	FACW
Shiny willow	<i>Salix lucida ssp. lasiandra</i>	Tree	OBL
Dusky willow	<i>Salix melanopsis</i>	Shrub	FACW
California grape	<i>Vitis californica</i>	Vine	FACW

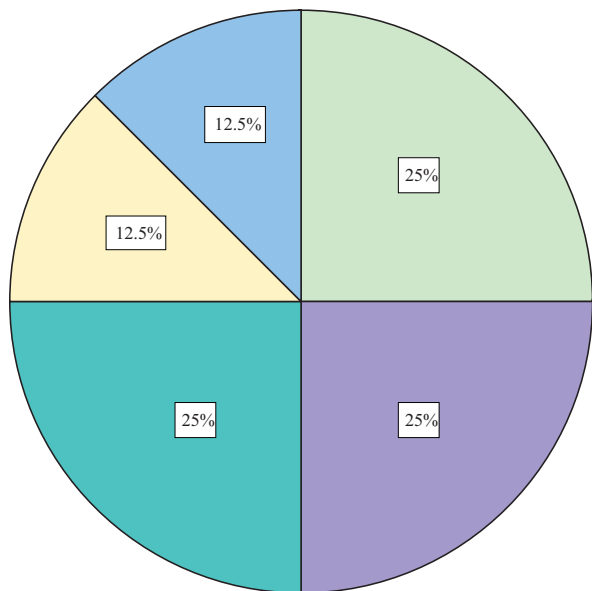


MIXED WILLOW PATCH DESCRIPTION: Eight relevé plots were classified as mixed willow by cluster analysis. Narrowleaf willow (*Salix exigua*), white alder (*Alnus rhombifolia*), and California grape (*Vitis californica*) are frequent in the tree and shrub layers. Arroyo willow (*S. lasiolepis*), dusky willow (*S. melanopsis*), Himalaya blackberry (*Rubus discolor*), and blackcap raspberry (*Rubus leucodermis*) are also frequent in the shrub layer. No single willow species dominates this patch type, and no indicator species were revealed by indicator species analysis. Mixed willow patches occurred on a variety of geomorphic units, but approximately 38% of the mixed willow patches sampled occurred on riparian berms.

Figure 10. Mixed willow patch type description.



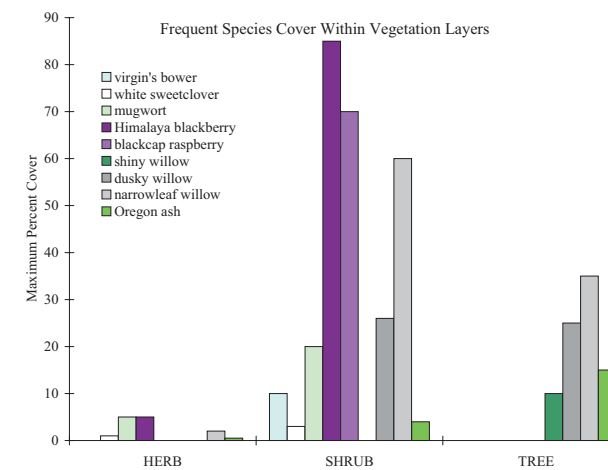
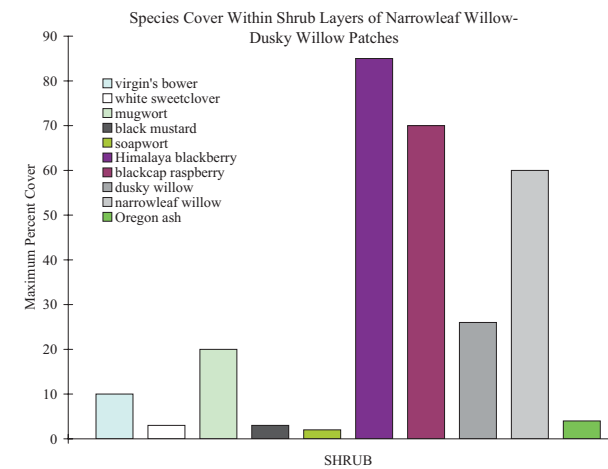
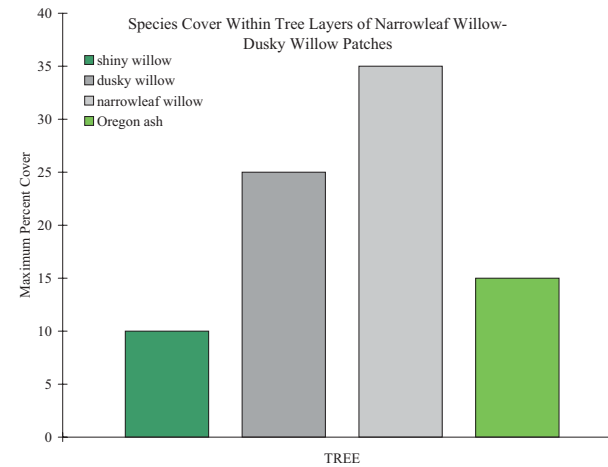
Geomorphic Units Supporting Narrowleaf Willow-Dusky Willow Patches



Percentage of Narrowleaf Willow-Dusky Willow Patches Originally Mapped in 2003 As:

Patch Type	Percentage
narrowleaf willow	75
black cottonwood	12.5
white alder	12.5

- Alluvial Floodplain
- Alluvial Riparian Berm
- Alluvial Low Terrace
- Alluvial Middle Terrace
- Anthropogenic Middle Terrace



NARROWLEAF WILLOW-DUSKY WILLOW PATCH TYPE

Common constituents in alphabetical order of botanical name.

Listings written in **bold** signify an indicator plant species.

Listings written in *red* signify an exotic plant species.

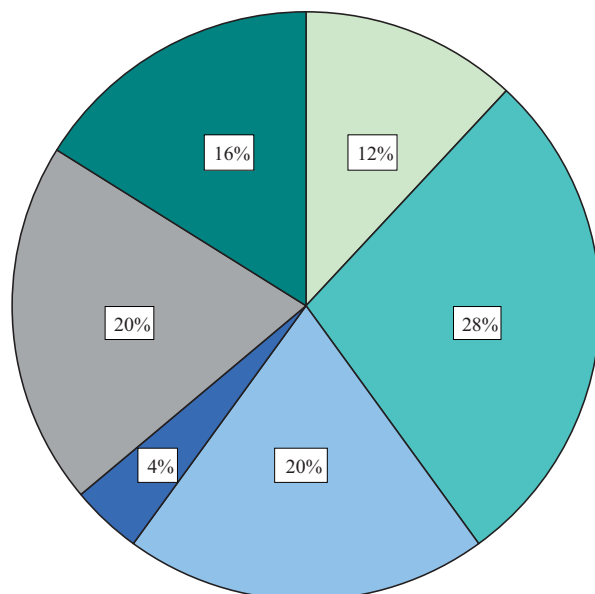
Common Name	Botanical Name	Growth Habit	USFWS Hydric Code
White alder	<i>Alnus rhombifolia</i>	Tree	FACW
Mugwort	<i>Artemesia douglasiana</i>	Herb	FAC+
<i>Slender wild oat</i>	<i>Avena barbata</i>	Grass	-
<i>Mustard</i>	<i>Brassica nigra</i>	Herb	-
<i>Ripgut grass</i>	<i>Bromus diandrus</i>	Grass	-
<i>Soft chess</i>	<i>Bromus hordeaceus</i>	Grass	FACU-
<i>Cheat grass</i>	<i>Bromus tectorum</i>	Grass	-
<i>Mexican tea</i>	<i>Chenopodium ambrosioides</i>	Herb	FAC
<i>Bermuda grass</i>	<i>Cynodon dactylon</i>	Grass	FACU
<i>Hedgehog dogtail</i>	<i>Cynosurus echinatus</i>	Grass	-
Virgin's bower	<i>Clematis ligusticifolia</i>	Vine	FAC
<i>Poison hemlock</i>	<i>Conium maculatum</i>	Herb	FAC
<i>Queen Anne's lace</i>	<i>Daucus carota</i>	Herb	-
Oregon ash	<i>Fraxinus latifolia</i>	Tree	FACW
<i>White sweetclover</i>	<i>Melilotus alba</i>	Herb	-
<i>Himalaya blackberry</i>	<i>Rubus discolor</i>	Shrub	FAC+
Canyon live oak	<i>Quercus chrysolepis</i>	Tree	-
Narrowleaf willow	<i>Salix exigua</i>	Shrub	FACW
Arroyo willow	<i>Salix lasiolepis</i>	Shrub	FACW
Shiny willow	<i>Salix lucida ssp. lasiandra</i>	Tree	OBL
Dusky willow	<i>Salix melanopsis</i>	Shrub	FACW
<i>Soapwort</i>	<i>Saponaria officinalis</i>	Herb	FACU

NARROWLEAF WILLOW-DUSKY WILLOW PATCH DESCRIPTION: Eight relevé plots were classified as narrowleaf willow-dusky willow by cluster analysis. These patches are shrub-dominated with occasional riparian trees and very tall narrowleaf (*Salix exigua*) and dusky willows (*Salix melanopsis*) in the overstory. Oregon ash (*Fraxinus latifolia*) and shiny willow (*Salix lucida ssp. lasiandra*) are also frequent in the tree layer. In addition to narrowleaf and dusky willows, Himalaya blackberry (*Rubus discolor*) and blackcap raspberry (*Rubus leucodermis*) dominate the shrub layer. Mugwort (*Artemesia douglasiana*) is frequent in the shrub and herb layers. Approximately 82% of the narrowleaf willow-dusky willow patches sampled occurred on geomorphic units of alluvial origin.

Figure 11. Narrowleaf willow-dusky willow patch type description.



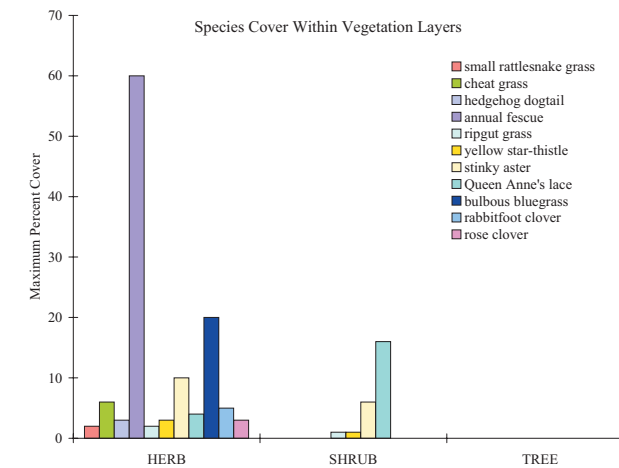
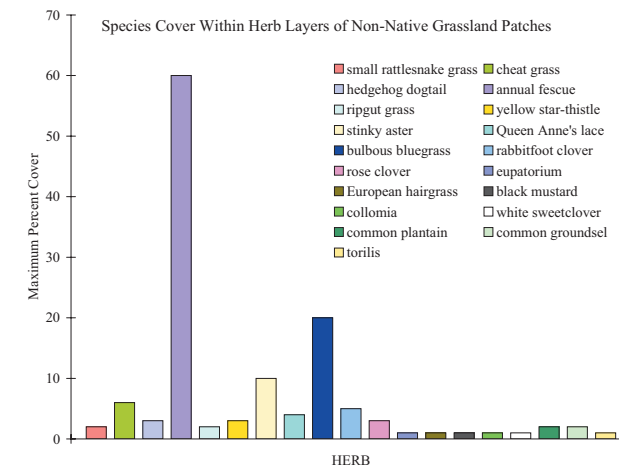
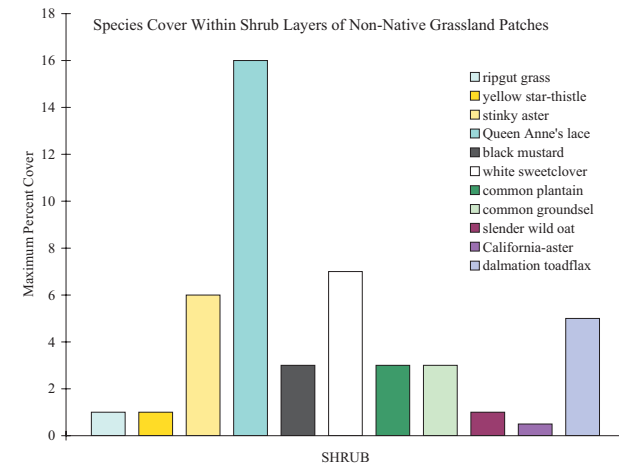
Geomorphic Units Supporting Non-Native Grassland Patches



Percentage of Non-Native Grassland Patches Originally Mapped in 2003 As:

Patch Type	Percentage
exotic grassland	32
introduced perennial grassland	32
California bricklebrush	8
wedgeleaf ceanothus	4
open	24

- Alluvial Floodplain
- Alluvial Low Terrace
- Anthropogenic Middle Terrace
- Anthropogenic High Terrace
- Anthropogenic Dredge Tailing Stockpiles
- Bedrock Hillslope



NON-NATIVE GRASSLAND PATCH TYPE

Common constituents in alphabetical order of botanical name.

Listings written in **bold** signify an indicator plant species.

Listings written in **red** indicate an exotic plant species.

Common Name	Botanical Name	Growth Habit	USFWS Hydric Code
Slender wild oat	<i>Avena barbata</i>	Grass	-
Mustard	<i>Brassica nigra</i>	Herb	-
Small rattlesnake grass	<i>Briza minor</i>	Grass	FACU
Cheat grass	<i>Bromus tectorum</i>	Grass	-
Yellow star-thistle	<i>Centaurea solstitialis</i>	Herb	-
Hedgehog dogtail	<i>Cynosurus echinatus</i>	Grass	-
Queen Anne's lace	<i>Daucus carota</i>	Herb	-
California poppy	<i>Eschscholzia californica</i>	Herb	-
Dalmation toadflax	<i>Linaria genistifolia</i>	Herb	-
Bird's-foot trefoil	<i>Lotus corniculatus</i>	Herb	FAC
Common plantain	<i>Plantago major</i>	Herb	FAC
Bulbous bluegrass	<i>Poa bulbosa</i>	Grass	-
Rabbitfoot clover	<i>Trifolium arvense</i>	Herb	-
Annual fescue	<i>Vulpia myuros</i>	Grass	FACU
Common cocklebur	<i>Xanthium strumarium</i>	Herb	-

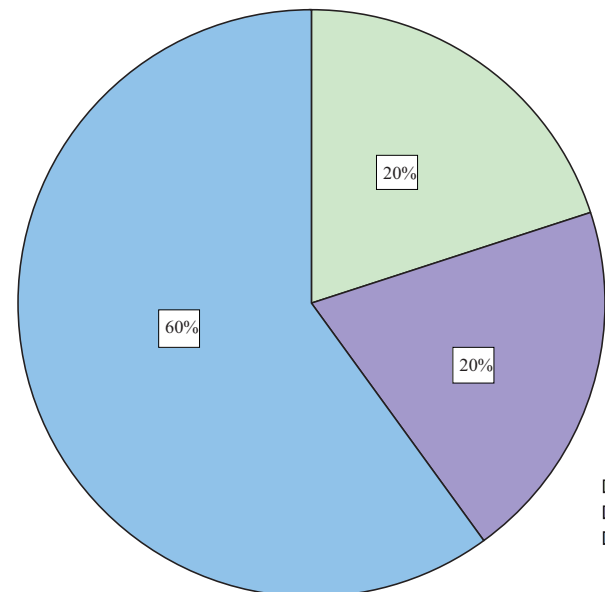


NON-NATIVE GRASSLAND PATCH DESCRIPTION: Twenty-five relevé plots were classified as non-native grassland by cluster analysis. Non-native grasslands are herb-dominated cover types that generally lack shrubs and trees. Many non-native grasses dominate the herb layer of this patch type, including oats (*Avena barbata*), small rattlesnake grass (*Briza minor*), cheat grass (*Bromus tectorum*), hedgehog dogtail (*Cynosurus echinatus*), bulbous bluegrass (*Poa bulbosa*) and one-sided annual fescue (*Vulpia myuros*). Some species such as Queen Anne's lace (*Daucus carota*), bastard toadflax (*Linaria genistifolia*), and white sweetclover (*Melilotus alba*) are tall and grow into the shrub layer. No indicator species were revealed by indicator species analysis. Non-native grassland patches sampled occurred on a variety of geomorphic units.

Figure 12. Non-native grassland patch type description.



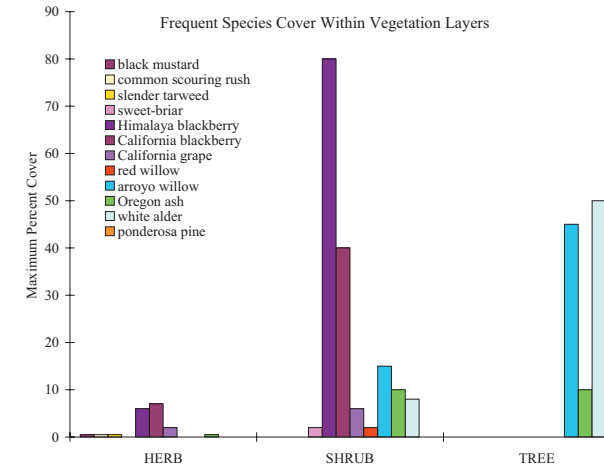
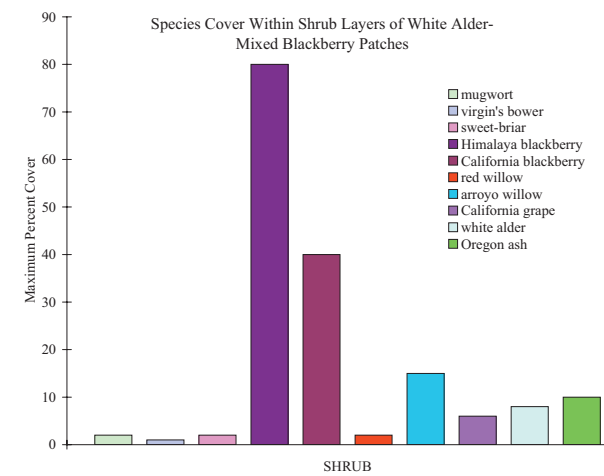
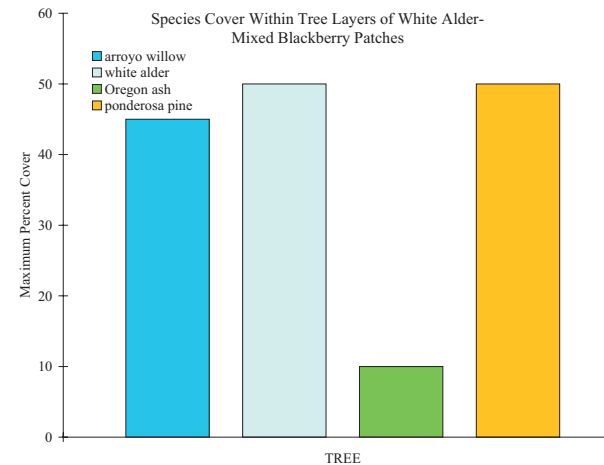
Geomorphic Units Supporting White Alder-Mixed Blackberry Patches



Percentage of White Alder-Mixed Blackberry Patches Originally Mapped in 2003 As:

Patch Type	Percentage
white alder	60
mixed willow	20
mixed conifer	20

- Alluvial Floodplain
- Alluvial Riparian Berm
- Anthropogenic Middle Terrace



WHITE ALDER-MIXED BLACKBERRY PATCH TYPE

Common constituents in alphabetical order of botanical name. Listings written in **bold** signify an indicator plant species. Listings written in *red* signify an exotic plant species.

Common Name	Botanical Name	Growth Habit	USFWS Hydric Code
White alder	<i>Alnus rhombifolia</i>	Tree	FACW
Mugwort	<i>Artemisia douglasiana</i>	Herb	FAC+
<i>Small rattlesnake grass</i>	<i>Briza minor</i>	Grass	FACU
Virgin's bower	<i>Clematis ligustifolia</i>	Vine	FAC
<i>Poison hemlock</i>	<i>Conium maculatum</i>	Herb	FAC
Common horsetail	<i>Equisetum arvense</i>	Em Herb	FAC
Common scouring rush	<i>Equisetum hyemale</i>	Em Herb	FACW
Oregon ash	<i>Fraxinus latifolia</i>	Tree	FACW
Slender tarweed	<i>Madia gracilis</i>	Herb	-
Ponderosa pine	<i>Pinus ponderosa</i>	Tree	UPL
Skunk brush	<i>Rhus trilobata</i>	Shrub	FACU
<i>Sweet-briar</i>	<i>Rosa eglantheria</i>	Shrub	FACU
Himalaya blackberry	<i>Rubus discolor</i>	Shrub	FAC+
California blackberry	<i>Rubus ursinus</i>	Shrub	FAC+
<i>Curly dock</i>	<i>Rumex crispus</i>	Herb	FACW-
Arroyo willow	<i>Salix lasiolepis</i>	Shrub	FACW
California grape	<i>Vitis californica</i>	Vine	FACW

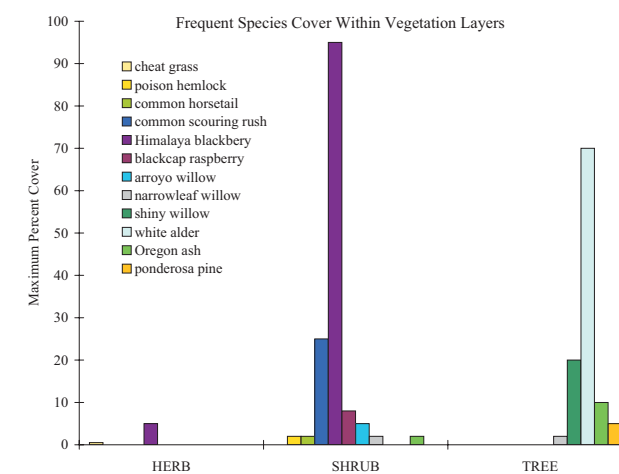
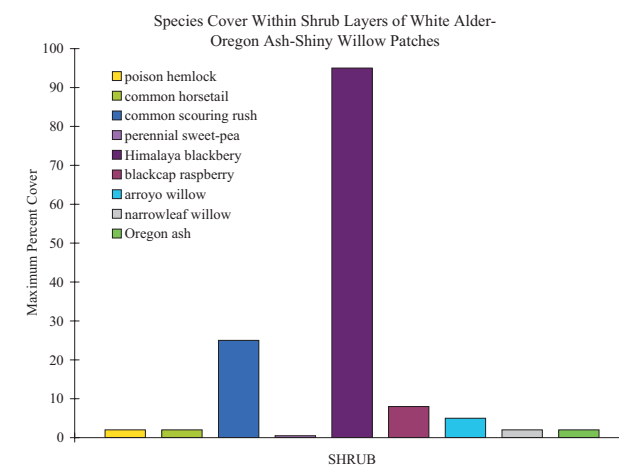
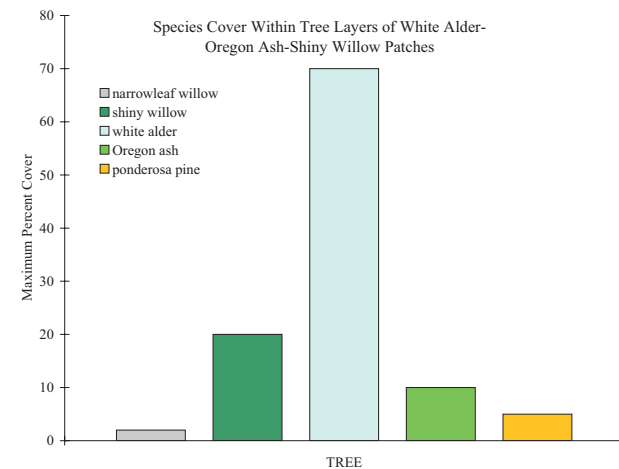
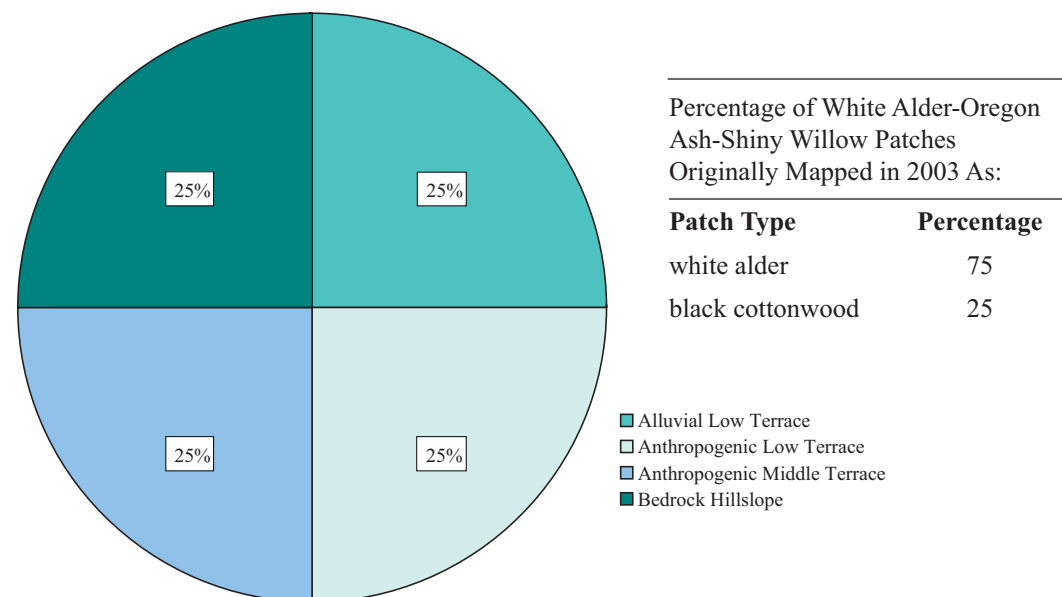


WHITE ALDER-MIXED BLACKBERRY PATCH DESCRIPTION: Four relevé plots were classified as white alder-mixed blackberry by cluster analysis. White alder (*Alnus rhombifolia*) dominates the tree layer and Oregon ash (*Fraxinus latifolia*), Ponderosa pine (*Pinus ponderosa*), and arroyo willow (*Salix lasiolepis*) are often present in the tree layer as well. The shrub layer is well-developed and is dominated by Himalaya blackberry (*Rubus discolor*), California blackberry (*Rubus ursinus*), and arroyo willow (*Salix lasiolepis*). Species richness in the herb layer is relatively depauperate due to the dominance of blackberries in the shrub layer. 60% of the white alder-Himalaya blackberry patches sampled occurred on anthropomorphic middle terraces.

Figure 13. White alder-mixed blackberry patch type description.



Geomorphic Units Supporting White Alder-Oregon Ash-Shiny Willow Patches



WHITE ALDER-OREGON ASH-SHINY WILLOW PATCH TYPE

Common constituents in alphabetical order of botanical name.

Listings written in **bold** signify an indicator plant species.

Listings written in **red** signify an exotic plant species.

Common Name	Botanical Name	Growth Habit	USFWS Hydric Code
White alder	<i>Alnus rhombifolia</i>	Tree	FACW
Common horsetail	<i>Equisetum arvense</i>	Em Herb	FAC
Common scouring rush	<i>Equisetum hyemale</i>	Em Herb	FACW
Oregon ash	<i>Fraxinus latifolia</i>	Tree	FACW
Perennial sweet-pea	<i>Lathyrus latifolius</i>	Herb	-
Ponderosa pine	<i>Pinus ponderosa</i>	Tree	UPL
Himalaya blackberry	<i>Rubus discolor</i>	Shrub	FAC+
Blackcap raspberry	<i>Rubus leucodermis</i>	Shrub	FACU
Narrowleaf willow	<i>Salix exigua</i>	Shrub	FACW
Shiny willow	<i>Salix lucida ssp. lasiandra</i>	Tree	OBL

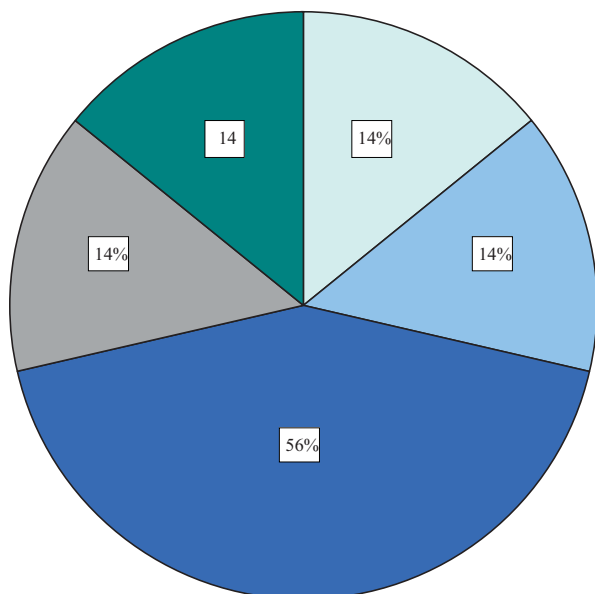


WHITE ALDER-OREGON ASH-SHINY WILLOW PATCH DESCRIPTION: Four relevé plots were classified as white alder-Oregon ash-shiny willow by cluster analysis. White alder (*Alnus rhombifolia*) dominates the tree layer while Oregon ash (*Fraxinus latifolia*) and shiny willow (*Salix lucida ssp. lasiandra*) comprise a smaller portion of the tree layer. Himalaya blackberry (*Rubus discolor*) common scouring rush (*Equisetum hyemale*) dominate the shrub layer. The herb layer is composed of young and/or small shrub species. White alder-Oregon ash-shiny willow patches can be distinguished from white alder-mixed blackberry patches by the presence of shiny willow in the tree layer, the absence of arroyo willow in the tree layer, and the absence of California blackberry in the shrub layer. White alder-Oregon ash-shiny willow patches occurred with equal frequency on bedrock hillslopes, alluvial low terraces, and anthropomorphic low and middle terraces.

Figure 14. White alder-Oregon ash-shiny willow patch type description.



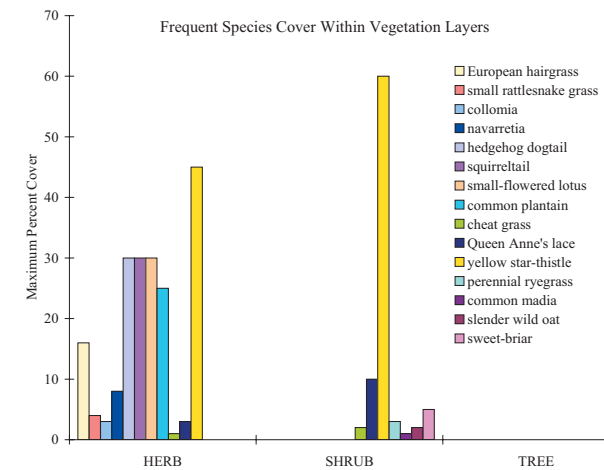
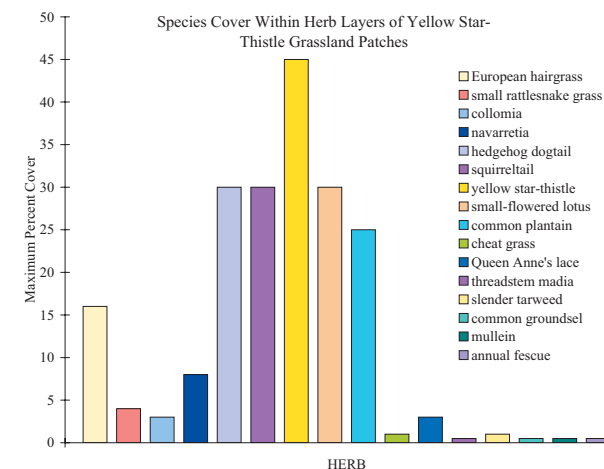
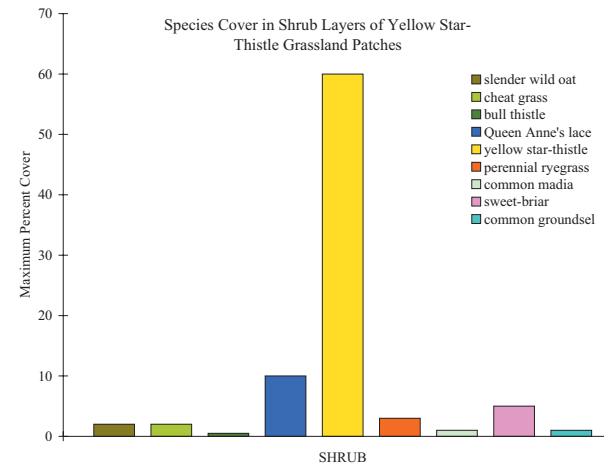
Geomorphic Units Supporting Yellow Star-Thistle Grassland Patches



Percentage of Yellow Star-Thistle Grassland Patches Originally Mapped in 2003 As:

Patch Type	Percentage
exotic grassland	43
introduced perennial grassland	57

- Anthropogenic Low Terrace
- Anthropogenic Middle Terrace
- Anthropogenic High Terrace
- Anthropogenic Dredge Tailing Stockpiles
- Bedrock Hillslope



YELLOW STAR-THISTLE GRASSLAND PATCH TYPE:

Common constituents in alphabetical order of botanical name.

Listings written in **bold** signify an indicator plant species.

Listings written in **red** indicate an exotic plant species.

Common Name	Botanical Name	Growth Habit	USFWS Hydric Code
European hairgrass	<i>Aira caryophyllea</i>	Grass	-
Slender wild oat	<i>Avena barbata</i>	Grass	-
Mustard	<i>Brassica nigra</i>	Herb	-
Small rattlesnake grass	<i>Briza minor</i>	Grass	FACU
Cheat grass	<i>Bromus tectorum</i>	Grass	-
Yellow star-thistle	<i>Centaurea solstitialis</i>	Herb	-
Bull thistle	<i>Cirsium vulgare</i>	Herb	FAC
Hedgehog dogtail	<i>Cynosurus echinatus</i>	Grass	-
Queen Anne's lace	<i>Daucus carota</i>	Herb	-
Squirreltail	<i>Elymus elymoides</i>	Grass	FACU-
California poppy	<i>Eschscholzia californica</i>	Herb	-
Dalmation toadflax	<i>Linaria genistifolia</i>	Herb	-
Perennial rye-grass	<i>Lolium perenne</i>	Grass	FAC
Bird's-foot trefoil	<i>Lotus corniculatus</i>	Herb	FAC
Small-flowered lotus	<i>Lotus micranthus</i>	Herb	-
Thread-stem tarweed	<i>Madia exigua</i>	Herb	-
Slender tarweed	<i>Madia gracilis</i>	Herb	-
Common plantain	<i>Plantago major</i>	Herb	FAC
Bulbous bluegrass	<i>Poa bulbosa</i>	Grass	-
Rabbitfoot clover	<i>Trifolium arvense</i>	Herb	-
One-sided annual fescue	<i>Vulpia myuros</i>	Grass	FACU
Common cocklebur	<i>Xanthium strumarium</i>	Herb	-

YELLOW STAR-THISTLE GRASSLAND PATCH DESCRIPTION: Fifteen relevé plots were classified as yellow star-thistle grassland by cluster analysis. A variety of non-native grasses and herbs dominate this patch type, especially yellow star-thistle (*Centaurea solstitialis*). Frequent grasses include European hairgrass (*Aira caryophyllea*), wild oats (*Avena barbata*), small rattlesnake grass (*Briza minor*), cheat grass (*Bromus tectorum*), hedgehog dogtail (*Cynosurus echinatus*), squirreltail (*Elymus elymoides*), perennial rye-grass (*Lolium perenne*), and bulbous bluegrass (*Poa bulbosa*). Small-flowered lotus (*Lotus micranthus*) and common plantain (*Plantago major*) are also frequent in the herb layer. 86% of the yellow star-thistle grassland patches sampled occurred on geomorphic units of anthropomorphic origin. 56% occurred on anthropomorphic high terraces.

Figure 15. Yellow star-thistle grassland patch type description.

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The final vegetation classification misclassified some relevés. For instance, “open” was an original patch type included in the 2003 vegetation maps. Open patches were characterized by very low plant cover and generally included gravel bars and floodplains. Open patches are also easily identified on the landscape. However, cluster analysis placed all open patches within non-native grassland patches. This inability to discriminate between open patches and true grassland patches indicates that the classification needs refinement.

3.2.3 Gradient Analysis

Three axes, or environmental gradients, collectively explained 66% of the variation in how the relevés were ordered (Table 4). The three axes can be interpreted as those environmental gradients that most strongly influence the clustering of samples. Although the axes are numbered from one to three, the numbering itself is arbitrary and does not indicate importance or priority of any axis. The first two axes are shown in Figure 16 and were relatively easy to interpret. The third axis was difficult to interpret and therefore is not shown in these results.

Correlations between environmental variables and the final ordination enabled us to better interpret the gradients. Only the variables that were correlated with the ordination are shown in the resulting graph (Figure 16). The variables are represented as vectors or lines. The length of each line indicates the strength of the correlation; the direction of the line corresponds to the axis with which it is most strongly correlated.

Please refer to Figure 16 during the following discussion. The vertical axis was interpreted as increasing water availability. Patch types dominated by riparian tree and shrub species (as indicated

Table 4. Hypothesized gradients represented by three ordination axes revealed by non-metric multidimensional scaling. The amount of variation in the data “explained” by each axis (incremental r^2) and the cumulative amount of variation (cumulative r^2) are shown.

Axis	Gradient	r^2 Increment	r^2 Cumulative
1	disturbance	0.182	0.182
2	light?	0.2	0.382
3	water availability	0.282	0.664

by solid symbols) grouped near the positive end of the vertical axis while patches dominated by upland and drier-site species grouped near the negative end. The vertical axis explained more of the variation than the other two axes and confirmed that water availability was a primary explanatory factor in the Trinity River corridor’s vegetation pattern (Table 4). Water was expected to play an important role in determining how plant species interact to form recognizable and repeatable vegetation patch types. However, the presence of two other axes indicated that water availability was not the only important gradient.

The horizontal axis was interpreted as disturbance (Figure 16). Conifer-dominated patches clustered near the negative end of the axis while grassland patches and black cottonwood patches clustered near the positive end. Willow and white alder dominated patches clustered near the middle of this axis. In addition, non-native species richness (i.e., non-nat_rich) increased along this axis. Non-native species tend to colonize and sometimes dominate high-disturbance sites. The arrangement of patch types coupled with increasing non-native species richness suggests that this axis represents a disturbance gradient. Conifer-dominated patches occur where disturbance is minimal and have a low diversity of non-native plants. In contrast, non-native grasslands and yellow star-thistle grasslands occur where

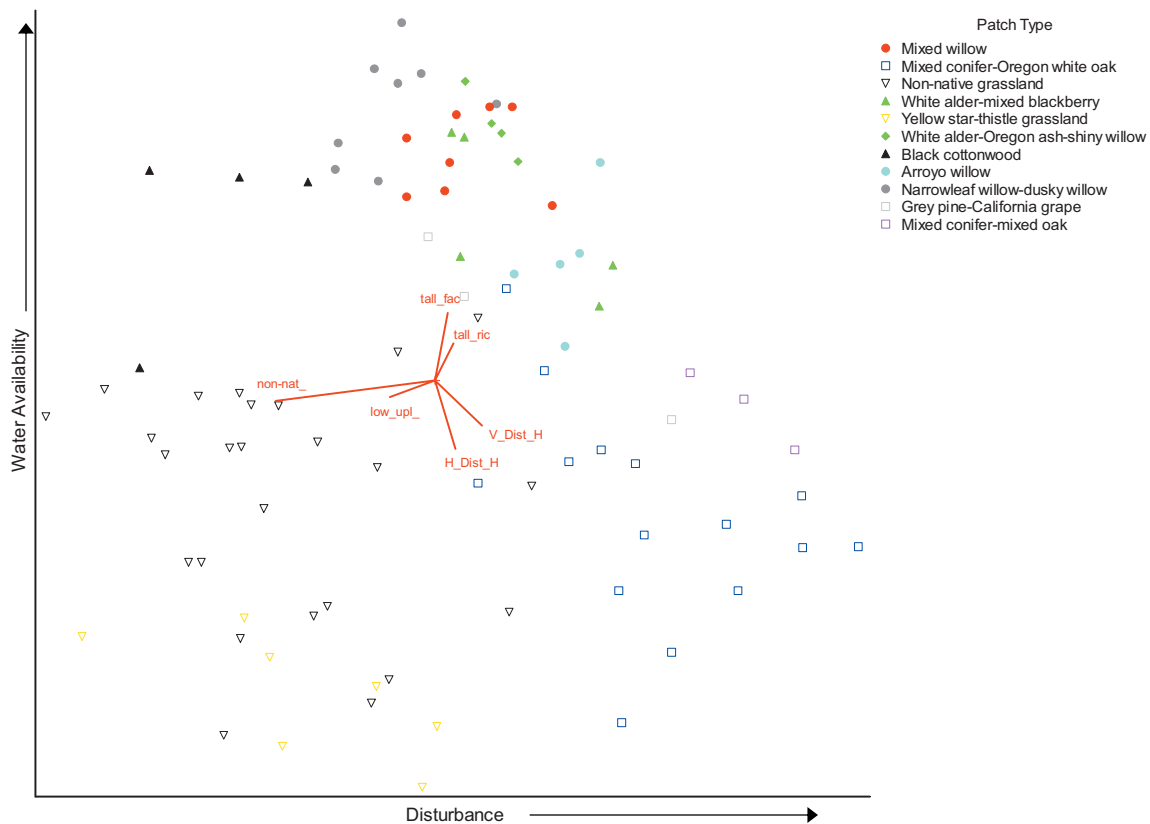


Figure 16. Two of the three axes resulting from indirect ordination of 87 relevés along the upper Trinity River. Relevés with similar species composition occur closer together; relevés with dissimilar species composition occur farther apart. Riparian relevés are coded by solid symbols; upland relevés are coded by open symbols. The direction and length of the vectors (lines) originating from the center of the graph indicate the direction and strength of the correlations between the axes and measured environmental variables. The variables were used to interpret the ecological meaning of the axes. The horizontal axis was interpreted as increasing disturbance. The vertical axis was interpreted as increasing water availability. V_dist_H2O = vertical distance to water; H_dist_H2O = horizontal distance to water; $tall_fac_rich$ = species richness of facultative species in the tree layer; $tall_rich$ = species richness of species in the tree layer; non_nat_rich = species richness of non-native species; low_upl_rich = species richness of upland species in the herb layer.

disturbance is high and non-native species richness is also high. Similarly, black cottonwood patches occur in high disturbance areas. The nature of the disturbance, however, is probably different for grasslands than black cottonwood patches, and could not be discerned with our results.

The third axis proved quite difficult to interpret. None of the measured environmental variables or the species richness summary variables was correlated with this axis. Himalaya blackberry was aligned at the extreme positive end and cheat grass was aligned at the extreme negative end. Himalaya blackberry dominated the understory of various riparian patch types. Cheat grass, on the other hand, dominated non-native grasslands, yellow star-thistle grasslands, and the conifer dominated patches. While it may seem that water is again the gradient responsible for this pattern, we would suggest instead that it relates more to the species composition of the understory. Himalaya blackberry generally occurs to the exclusion of most other understory species. Cheat grass often co-occurs with

many species and is widespread in the understory of both grassland and conifer dominated plots. This difference in understory species composition is likely related to species composition in the canopy. Conifer dominated patches and the grassland patches tend to be open and bright whereas riparian shrub and tree dominated patches tend to be densely vegetated and somewhat dark in the understory. It is possible that this third axis represents a light gradient. However, our ability to clearly interpret this gradient is limited.

It is interesting to note that of the many environmental variables that were measured, only horizontal distance to water and vertical distance to water were correlated with any of the ordination axes. These two variables were strongly related to each other and could in some ways be considered different aspects of the same environmental gradient, namely proximity to water. It is puzzling that geomorphic unit did not appear to influence the data set. The geomorphic unit itself is a synthesis of a few variables. It encompasses substrate characteristics (fine, coarse), the origin (alluvial, anthropogenic, etc.) of the substrate, and the relative height of the surface in relation to low water (McBain and Trush 2004.). It seems reasonable that an alluvial floodplain would host different types of vegetation as compared to anthropomorphic dredger tailings; however, geomorphic unit was not a valuable variable when interpreting the ordination's ecological implications.

3.2.4 Indicator Species Analysis

Indicator species analysis added a further level of detail to patch type descriptions resulting from hierarchical cluster analysis. The results identified species that would offer predictive value in classifying a patch type in the field, and included indicator species associated with each patch type whose indicator value (IV) was greater than 30 (Table 5). A higher IV indicates a stronger affinity for a patch and therefore a higher predictive value of that indicator species.

Mixed willow patches and non-native grassland patches did not have any indicator species, presumably because the dominant species that comprise these patch types varies. Mixed willow patches are by definition mixed. For example, one mixed willow patch may be co-dominated by shiny willow and arroyo willow, yet another mixed willow patch may be co-dominated by arroyo willow, and narrowleaf willow with a few shiny willows. The main criterion for mixed willow patches is that no particular willow species dominates the patch. Non-native grasslands are similar in their differences in dominant species between patches.

Several species were indicators for more than one group. For instance, narrowleaf willow and dusky willow were both indicators for black cottonwood patches and for narrowleaf willow-dusky willow patches. The vegetation layer where each species was found can account for this apparent discrepancy (Table 5). Narrowleaf and dusky willows in the tree layer were characteristic of narrowleaf willow-dusky willow patches. In contrast, narrowleaf willow in the herb layer and dusky willow in the shrub layer were characteristic of black cottonwood patches. In addition, we should consider the suite of indicator species for each patch type together instead of viewing each individual species as characteristic of the patch.

Table 5. Summary of the indicator species for each patch type classified in WY2004 and the vegetation layer for which the species is significant. Some species are characteristic of more than one patch type; the vegetation layer in which the species is significant is unique. The listings written in red indicate exotic plant species.

TRINITY RIVER MAINSTEM WY2004 VEGETATION CLASSIFICATION PATCH TYPES	INDICATOR SPECIES		Vegetation		Indicator Value	p value
	Botanical Name	Common Name	Layer Where Significant	(IV)		
Arroyo Willow	<i>Clematis ligusticifolia</i>	virgin's bower	Herb	36.1	0.014	
	<i>Salix lasiolepis</i>	arroyo willow	Shrub	49.2	0.002	
Black Cottonwood	<i>Alnus rhombifolia</i>	white alder	Shrub	37.8	0.003	
	<i>Equisetum hyemale</i>	common scouring rush	Herb	29.9	0.044	
	<i>Melilotus alba</i>	white sweetclover	Herb	31.6	0.046	
	<i>Mentha pulegium</i>	pennyroyal	Herb	33.4	0.018	
	<i>Populus balsamifera ssp. trichocarpa</i>	black cottonwood	Tree	47.1	0.004	
	<i>Rumex hymenosepalus</i>	wild rhubarb	Shrub	58.9	0.001	
	<i>Salix exigua</i>	narrowleaf willow	Herb	38.7	0.018	
	<i>Salix melanopsis</i>	dusky willow	Shrub	31.6	0.031	
	<i>Xanthium strumarium</i>	common cocklebur	Herb	34.9	0.017	
	<i>Artemisia douglasiana</i>	mugwort	Herb	30.2	0.028	
Foothill Pine-California Grape	<i>Arbutus menziesii</i>	Pacific madrone	Herb	42.6	0.008	
	<i>Bromus diandrus</i>	ripgut grass	Herb	33.9	0.019	
	<i>Bromus hordeaceus</i>	soft chess	Herb	37.0	0.011	
	<i>Bromus tectorum</i>	cheat grass	Herb	50.4	0.005	
	<i>Cynodon dactylon</i>	Bermuda grass	Herb	54.4	0.002	
	<i>Pinus sabiniana</i>	foothill pine	Tree	33.1	0.001	
	<i>Vitis californica</i>	California grape	Herb	67.2	0.001	
	<i>Arctostaphylos manzanita</i>	manzanita	Shrub	30.4	0.044	
	<i>Arbutus menziesii</i>	Pacific madrone	Shrub	55.8	0.005	
	<i>Arctostaphylos viscida</i>	sticky manzanita	Shrub	62.0	0.003	
Mixed Conifer-Mixed Oak	<i>Eriophyllum lanatum</i>	woolly sunflower	Herb	57.0	0.002	
				85.6	0.001	
				49.5	0.008	

Table 5. Continued.

TRINITY RIVER MAINSTEM WY2004 VEGETATION CLASSIFICATION PATCH TYPES		INDICATOR SPECIES		Vegetation	Indicator	
	Botanical Name	Common Name	Layer Where Significant	Value (IV)	p value	
Mixed Conifer-Mixed Oak (cont.)	<i>Galium porrigens</i>	climbing bedstraw	Shrub	58.3	0.002	
	<i>Hypericum perforatum</i>	St. John's wort	Shrub	31.5	0.022	
	<i>Lonicera hispidula</i> var. <i>vacillans</i>	hairy honeysuckle	Herb	35.9	0.018	
	<i>Osmorhiza chilensis</i>	mountain sweet-cicely	Herb	50.3	0.002	
	<i>Pinus ponderosa</i>	ponderosa pine	Tree	30.3	0.02	
	<i>Pseudotsuga menziesii</i>	Douglas-fir	Herb	37.2	0.027	
			Shrub	64.5	0.001	
			Tree	31.3	0.023	
		<i>Quercus kelloggii</i>	California black oak	Herb	54.6	0.002
			Shrub	49.0	0.007	
	<i>Toxicodendron diversilobum</i>	poison-oak	Herb	48.9	0.004	
		Shrub	44.8	0.007		
Mixed Conifer-Oregon White Oak	<i>Achillea millefolium</i>	yarrow	Herb	33.3	0.026	
	<i>Quercus wislizenii</i>	interior live oak	Shrub	33.3	0.03	
Mixed Willow	no indicator species					
Narrowleaf Willow-Dusky Willow	<i>Salix exigua</i>	narrowleaf willow	Tree	50.5	0.001	
	<i>Salix melanopsis</i>	dusky willow	Tree	32.4	0.036	
Non-Native Grassland	no indicator species					
White Alder-Mixed Blackberry	<i>Fraxinus latifolia</i>	Oregon ash	Herb	43.5	0.004	
	<i>Rubus discolor</i>	Himalaya blackberry	Herb	32.7	0.012	
	<i>Rubus ursinus</i>	California blackberry	Herb	69.3	0.001	
		Shrub	41.8	0.006		
White Alder-Oregon Ash-Shiny Willow	<i>Alnus rhombifolia</i>	white alder	Tree	39.9	0.011	
	<i>Equisetum hyemale</i>	common scouring rush	Shrub	44.1	0.009	
	<i>Fraxinus latifolia</i>	Oregon ash	Tree	39.2	0.007	
	<i>Salix lucida</i> ssp. <i>lasiandra</i>	shiny willow	Tree	48.0	0.002	

Table 5. Continued.

TRINITY RIVER MAINSTEM WY2004 VEGETATION CLASSIFICATION PATCH TYPES	INDICATOR SPECIES		Vegetation Layer Where Significant	Indicator Value (IV)	p value
	Botanical Name	Common Name			
Yellow Star-Thistle Grassland	<i>Bromus tectorum</i>	soft chess	Shrub	37.4	0.013
	<i>Centaurea solstitialis</i>	yellow star-thistle	Herb	29.6	0.028
	<i>Cirsium vulgare</i>	bull thistle	Shrub	52.5	0.005
	<i>Elymus elymoides</i>	squirreltail	Shrub	39.2	0.021
	<i>Lotus micranthus</i>	small-flowered lotus	Herb	38.6	0.011
	<i>Lolium perenne</i>	perennial ryegrass	Herb	30.3	0.05
	<i>Madia exigua</i>	threadstem madia	Shrub	39.4	0.01
	<i>Madia gracilis</i>	slender tarweed	Herb	32.9	0.039
	<i>Plantago major</i>	common plantain	Herb	32.1	0.016
			Herb	44.0	0.004

4 CONCLUSIONS

The purpose of this project was to gather baseline data on the riparian vegetation of the Trinity River from the Lewiston Dam to the North Fork of the Trinity River. Specifically, a riparian inventory and classification was conducted to describe the vegetation patterns currently within the river corridor. The classification identified 11 patch types or plant communities that occur within or adjacent to the riparian corridor. The patch types included riparian communities such as white alder-mixed blackberry, white alder-Oregon ash-shiny willow, black cottonwood, arroyo willow, mixed willow, and narrowleaf willow-dusky willow. Upland communities included mixed conifer-Oregon white oak, mixed conifer-mixed oak, grey pine-California grape, non-native grassland, and yellow star-thistle grassland.

The vegetation classification provides a description and classification scheme that can be used to interpret and define vegetation patterns along the mainstem Trinity River and quantitatively measure changes resulting from management actions. This work was intended to standardize methods and classifications for future comparisons, thereby reducing several sources of user and classification variability. The use of a common “language” to describe vegetation would allow researchers from different backgrounds to share data and compare results across several studies. The management value of the classification and vegetation description was to create a quantitative benchmark from which changes in vegetation patterns and geomorphology resulting from physical and streamflow restoration could be gauged.

The inventory and classification can be used to track changes in the vegetation in response to TRRP management actions. The removal of the riparian berm and the willow thickets associated with it is one of the goals of restoration. Therefore if the program is successful, changes in bank and channel morphology combined with targeted flows will alter the vegetation along the Trinity River. Following the trajectory of riparian vegetation response will enable evaluation of the success or failure of specific restoration activities.

Some patch types may convert to different patch types more quickly than others. For example, open floodplains may be colonized by willows and become narrowleaf willow-dusky willow patches within only a few years. Non-native grasslands that are being encroached by grey pines may not actually become grey pine stands for 20 years or more. Therefore, the riparian areas should be re-mapped and relevés re-sampled every five years; upland vegetation types should be visited during re-mapping and evaluated for major vegetation change. Major vegetation change involves those changes that would alter the classification of the patch type. Coniferous forest patches probably will not undergo large changes and therefore will not need to be re-sampled. Non-native grasslands and yellow star-thistle grasslands, on the other hand, may change considerably and should be re-sampled if major changes are observed.

The vegetation description and classification could be improved. For each patch type, only two relevés were selected for sampling. Because riparian patch types are highly variable in species composition compared to upland patch types, more relevé samples of each riparian patch type would increase the power of the classification. Upland patch types will not need to be re-sampled with relevés unless field based reconnaissance indicates major shifts in species composition and structure. When re-sampling relevés, the percent cover of open ground in each relevé should be recorded along with species cover. Percent open ground was not recorded for this classification, which is the reason why an open patch type was not identified. When riparian relevés are re-sampled, the number of relevés sampled within each patch type should be increased from two to four.

The hierarchical cluster analysis and indicator species analysis allowed us to describe in great detail the vegetation patch types found in and adjacent to the riparian corridor of the mainstem Trinity River. However, the ordination analysis revealed that we do not understand all of the environmental variables controlling vegetation patterns within the Trinity River corridor. If the riparian habitat inventory and description is repeated, a new list of potentially meaningful environmental variables should be developed from these results and measured during field sampling. Some potential environmental variables include: river channel morphology, bank morphology, restoration treatment (if any), seed dispersal period for important riparian woody species (e.g., black cottonwood, narrowleaf willow, dusky willow, and white alder), and magnitude, timing, frequency, duration, and rate of change in streamflows.

The geomorphic unit as it is currently defined did not influence how vegetation is arranged on the landscape. However, substrate is extremely important in determining plant communities. Perhaps the current definitions of geomorphic units were too broad to be meaningful. A finer level of detail in geomorphic unit mapping may be necessary to determine the real effects of this environmental variable on the vegetation. Conversely, it is possible the variety of variables represented in each geomorphic unit should be treated separately, such as origin of substrate (alluvial vs. anthropogenic).

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APPENDIX A

CALIFORNIA NATIVE PLANT SOCIETY RELEVÉ
PROTOCOL CNPS VEGETATION COMMITTEE
October 20, 2000 (Revised 2/5/03)

CALIFORNIA NATIVE PLANT SOCIETY RELEVÉ
FIELD FORM CODE LIST (revised 7/8/02)

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CALIFORNIA NATIVE PLANT SOCIETY RELEVÉ PROTOCOL CNPS VEGETATION
COMMITTEE October 20, 2000 (Revised 2/5/03)

Introduction

In *A Manual of California Vegetation* (Sawyer and Keeler-Wolf 1995), CNPS published a Vegetation Sampling Protocol that was developed as a simple quantitative sampling technique applicable to many vegetation types in California. Investigators use an ocular estimation technique called a relevé to classify and map large areas in a limited amount of time.

The relevé method of sampling vegetation was developed in Europe and was largely standardized by the Swiss ecologist Josias Braun-Blanquet. He helped classify much of Europe's vegetation, founded and directed a synecology center in France, and was editor of *Vegetatio* for many years. The relevé was, and is, a method used by many European ecologists, and others around the world. These ecologists refer to themselves as phytosociologists. The use of relevé in the United States has not been extensive with the exception of the US Forest Service.

The relevé is particularly useful when observers are trying to quickly classify the range of diversity of plant cover over large units of land. In general, it is faster than the point intercept technique. One would use this method when developing a classification that could be used to map of a large area of vegetation, for example. This method may also be more useful than the line intercept method when one is trying to validate the accuracy of mapping efforts.

The relevé is generally considered a "semiquantitative" method. It relies on ocular estimates of plant cover rather than on counts of the "hits" of a particular species along a transect line or on precise measurements of cover/biomass by planimetric or weighing techniques .

Selecting a stand to sample:

A stand is the basic physical unit of vegetation in a landscape. It has no set size. Some vegetation stands are very small, such as alpine meadow or tundra types, and some may be several square kilometers in size, such as desert or forest types. A stand is defined by two main unifying characteristics:

- 1) It has compositional integrity. Throughout the site the combination of species is similar. The stand is differentiated from adjacent stands by a discernable boundary that may be abrupt or indistinct, and

- 2) It has structural integrity. It has a similar history or environmental setting that affords relatively similar horizontal and vertical spacing of plant species throughout. For example, a hillside forest originally dominated by the same species that burned on the upper part of the slopes, but not the lower, would be divided into two stands. Likewise, a sparse woodland occupying a slope with very shallow rocky soils would be considered a different stand from an adjacent slope with deeper, moister soil and a denser woodland or forest of the same species.

The structural and compositional features of a stand are often combined into a term called homogeneity. For an area of vegetated ground to meet the requirements of a stand it must be homogeneous.

Stands to be sampled may be selected by assessment prior to a site visit (delineated from aerial photos or satellite images for example), or may be selected on site (during reconnaissance to determine extent and boundaries, location of other similar stands, etc.). Depending on the project goals, you may want to select just one or a few representative stands for sampling (e.g., for developing a classification for a vegetation mapping project), or you may want to sample all of them (e.g., to define a rare vegetation type and/or compare site quality between the few remaining stands).

Selecting a plot to sample within in a stand:

Because most stands are large, it is difficult to summarize the species composition, cover, and structure of an entire stand. We are also usually trying to capture the most information with the least amount of effort. Thus, we are typically forced to select a representative portion to sample.

When sampling a vegetation stand, the main point to remember is to select a sample that, in as many ways possible, is representative of that stand. This means that you are not randomly selecting a plot; on the contrary, you are actively using your own best judgement to find a representative example of the stand.

Selecting a plot requires that you see enough of the stand you are sampling to feel comfortable in choosing a representative plot location. Take a brief walk through the stand and look for variations in species composition and in stand structure. In many cases in hilly or mountainous terrain look for a vantage point from which you can get a representative view of the whole stand. Variations in vegetation that are repeated throughout the stand should be included in your plot. Once you assess the variation within the stand, attempt to find an area that captures the stand's common species composition and structural condition to sample.

Plot Size

All relevés of the same type of vegetation to be analyzed in a study need to be the same size. It wouldn't be fair, for example, to compare a 100 m² plot with a 1000 m² plot as the difference in number of species may be due to the size of the plot, not a difference in the stands.

A minimal area to sample is defined by species/area relationships; as the sampler identifies species present in an area of homogeneous vegetation, the number will increase quickly as more area is surveyed. Plot shape and size are somewhat dependent on the type of vegetation under study. Therefore general guidelines for plot sizes of tree-, shrub-, and herb-dominated upland, and fine-scale herbaceous communities have been established. Sufficient work has been done in temperate vegetation to be confident the following conventions will capture species richness:

Alpine meadow and montane wet meadow: 100 sq. m
Herbaceous communities: 100 sq. m plot or 400 sq. m plot
(Consult with CNPS, and use one consistent size)
Grasslands and Shrublands: 400 sq. m plot
Forest and woodland communities: 1000 sq. m plot
Open desert vegetation: 1000 sq. m plot

Plot Shape

A relevé has no fixed shape, plot shape should reflect the character of the stand. If the stand is about the same size as a relevé, you need to sample the entire stand. If we are sampling a desert

wash, streamside riparian, or other linear community our plot dimensions should not go beyond the community's natural ecological boundaries. Thus, a relatively long, narrow plot capturing the vegetation within the stand, but not outside it, would be appropriate. Species present along the edges of the plot that are clearly part of the adjacent stand should be excluded.

If we are sampling broad homogeneous stands, we would most likely choose a shape such as a circle (which has the advantage of the edges being equidistant to the center point) or a square (which can be quickly laid out using perpendicular tapes). If we are trying to capture a minor bit of variety in the understory of a forest, for example a bracken fern patch within a ponderosa pine stand, we would want both bracken and non-bracken understory. Thus, a rectangular shape would be appropriate.

GENERAL PLOT INFORMATION

The following items appear on each data sheet and are to be collected for all plots. Where indicated, refer to attached code sheet.

Polygon or Relevé ID: Assigned either in the field or in the office prior to sampling.

Date: Date of sampling.

County: County in which located.

USGS Quad: The name of the USGS map the relevé is located on; note series (15' or 7.5').

CNPS Chapter: CNPS chapter, or other organization or agency if source is other than CNPS chapter.

Landowner: Name of landowner or agency acronym if known. Otherwise, list as private.

Contact Person: Name, address, and phone number of individual responsible for data collection.

Observers: Names of individuals assisting. Circle name of recorder.

Plot shape: indicate the sample shape as: square, rectangle, circle, or the entire stand.

Plot size: length of rectangle edges, circle radius, or size of entire stand.

NOTE: See page 3.

Alpine meadow, montane wet meadow, and small herbaceous communities: 100 sq. m

All intermittent to dense shrub and extensive herbaceous communities: 400 sq. m

All forest and woodland plots: 1000 sq. m.

All open desert plots: 1000 sq. m

Photo interpreter community code: If the sample is in area for which delineation and photo interpretation has already been done, the code which the photointerpreters applied to the polygon. If the sample site has not been photointerpreted, leave blank.

Other polygons of same type (yes or no, if applicable), if yes, mark on map: Other areas within view that appear to have similar vegetation composition. Again, this is most relevant to areas that have been delineated as polygons on aerial photographs as part of a vegetation-mapping project. If one is not working from aerial photographs, draw the areas as on a topographic map.

Is plot representative of whole polygon? (yes or no, if applicable), if no explain: Detail what other vegetation types occur in the polygon, and what the dominant vegetation type is if there is more than one type.

Global Positioning System Readings: Due to the recent availability of very accurate and relatively low cost GPS units, we highly recommend obtaining and using these as a standard piece of sampling equipment. Now that the military intentional imprecision (known as “selective availability”) has been “turned off” (as of July 2000), it is typical for all commercial GPS units these units to be accurate to within 5 m of the actual location. Also note that the GPS units can be set to read in UTM or Latitude and Longitude coordinates and can be easily translated. Thus, the following fields for Latitude, Longitude, and legal description are now optional. In order for all positional data to be comparable within the CNPS vegetation dataset We request using UTM coordinates set for the NAD 83 projection (see your GPS user’s manual for instructions for setting coordinates and projections).

Caveat: Although GPS units are valuable tools, they may not function properly due to the occasionally poor alignment of satellites or due to the complexity of certain types of terrain, or vegetation. We thus also recommend that you carry topographic maps and are aware of how to note your position on them in the event of a non-responsive or inaccurate GPS.

UTMN and UTME: Northing and easting coordinates using the Universal Transverse Mercator (UTM) grid as delineated on the USGS topographic map, or using a Global Positioning System.

UTM zone: Universal Transverse Mercator zone. Zone 10S for California west of the 120th longitude; zone 11S for California east of 120th longitude.

Legal Description: Township/Range/Section/Quarter Section/Quarter-Quarter section/Meridian: Legal map location of the site; this is useful for determining ownership of the property. California Meridians are Humboldt, Mt. Diablo, or San Bernardino. (this is optional, see above discussion of GPS units)

Latitude and Longitude: Degrees north latitude and east longitude. This is optional (see above)

Elevation: Recorded in feet or meters. Please indicate units.

Slope: Degrees, read from clinometer or compass, or estimated; averaged over relevé

Aspect: Degrees from true north (adjust declination), read from a compass or estimated; averaged over relevé.

Macrotopography: Characterize the large-scale topographic position of the relevé. This is the general position of the sample along major topographic features of the area. *See attached code list.*

Microtopography: Characterize the local relief of the relevé. Choose the shape that mimics the lay of the ground along minor topographic features of the area actually within the sample. *See attached code list.*

VEGETATION DESCRIPTION

Dominant layer: Indicate whether the community is dominated by the Low layer (L), Mid-layer (M), or Tall (T) layer.

Preliminary Alliance name: Name of series, stand, or habitat according to CNPS classification (Sawyer and Keeler-Wolf 1995); if the type is not defined by the CNPS classification, note this in the space.

Adjacent alliance: Adjacent vegetation series, stands or habitats according to CNPS classification; list in order of most extensive to least extensive.

Structure: Characterize the structure of each layer.

Continuous = greater than 2/3 (67%) cover; crowns touching

Intermittent = between 1/3 and 2/3 cover (33% to 66 %); interlocking or touching crowns interrupted by openings.

Open = less than 1/3 (33%) cover; crowns not touching or infrequently touching.

Phenology: Based on the vegetative condition of the principal species, characterize the phenology of each layer as early (E), peak (P), or late (L).

WETLAND COMMUNITY TYPES

Community type: Indicate if the sample is in a wetland or an upland; note that a site need not be officially delineated as a wetland to qualify as such in this context.

Dominant vegetation form: This is a four letter code which relates the vegetation of the plot to the higher levels of the NBS/NPS National Vegetation Classification System hierarchy. *See attached code list.*

Cowardin class: See “Artificial Keys to Cowardin Systems and Names” (attached). If the plot is located in a wetland, record the proper Cowardin system name. Systems are described in detail in Cowardin et al. 1979. Classification of wetlands and deepwater habitats of the United States. US Dept. of the Interior, Fish and Wildlife Service, Office of Biological Services, Washington, D.C.

Marine: habitats exposed to the waves and currents of the open ocean (subtidal and intertidal habitats).

Estuarine: includes deepwater tidal habitats and adjacent tidal wetlands that are usually semi-enclosed by land but have open, partly obstructed, or sporadic access to the open ocean, and in which ocean water is at least occasionally diluted by freshwater runoff from the land (i.e. estuaries and lagoons).

Riverine: includes all wetlands and deepwater habitats contained within a channel, excluding any wetland dominated by trees, shrubs, persistent emergent plants, emergent mosses, or lichens. Channels that contain oceanic-derived salts greater than 0.5% are also excluded.

Lacustrine: Includes wetlands and deepwater habitats with all of the following characteristics: 1) situated in a topographic depression or a dammed river channel; 2) lacking trees or shrubs, persistent emergents, emergent mosses or lichens with greater than 30% aerial coverage; and total area exceeds 8 ha (20 acres). Similar areas less than 8 ha are included in the lacustrine system if an active wave-formed or bedrock shoreline feature makes up all or part of the low tide boundary, or if the water in the deepest part of the basin exceeds 2 m (6.6 feet) at low tide. Oceanic derived salinity is always less than 0.5%.

Palustrine: Includes all nontidal wetlands dominated by trees, shrubs, persistent emergents, emergent mosses or lichens, and all such wetlands that occur in tidal areas where salinity derived from oceanic salts is less than 0.5%. Also included are areas lacking vegetation, but with all of the following four characteristics: 1) areas less than 8 ha (20 acres); active waveformed or bedrock shoreline features lacking; 3) water depth in the deepest part of the basin less than 2 m (6.6 feet) at low water; and 4) salinity due to ocean-derived salts less than 0.5%.

Vertical distance from high water mark of active stream channel: If the plot is in or near a wetland community, record to the nearest meter or foot the estimated vertical distance from the middle of the plot to the average water line of the channel, basin, or other body of water.

Horizontal distance from high water mark of active stream channel: If the plot is in or near a wetland community, record to the nearest meter or foot the estimated horizontal distance from the middle of the plot to the average water line of the channel, basin, or other body of water.

Stream channel form: If the plot is located in or near a community along a stream, river, or dry wash, record the channel form of the waterway. The channel form is considered S (single channeled) if it consists of predominately a single primary channel, M (meandering) if it is a meandering channel, and B (braided) if it consists of multiple channels interwoven or braided.

Photographs: Describe the number of color photographs taken at the relevé, and the camera's view direction from compass bearings. It is helpful to take a photograph of the relevé from the intersection of the tapes (if tapes were used to define the plot), and another from inside the relevé. Additional photos of the stand may also be helpful. If using a digital camera or scanning in the image into a computer, relevé numbers and compass directions can be recorded digitally. If using a 35mm camera, please note the roll number, frame number, compass direction, and the initials of the person whose camera is being used. (e.g. Roll 5, #1, to the NW, SS)

STAND AND ENVIRONMENTAL INFORMATION

Vegetation trend: Based on the regenerating species and relationship to surrounding vegetation, characterize the stand as either increasing (expanding), stable, decreasing, fluctuating, or unknown.

Impacts: Enter codes for potential or existing impacts on the stability of the plant community. Characterize each as either 1. Light, 2. Moderate, or 3. Heavy. *See attached code list.*

Site location and plot description: A concise, but careful description that makes locating and/or revisiting the vegetation stand and plots possible; give landmarks and directions. Used in conjunction with the GPS position recorded earlier, this should enable precise re-location of the plot. Indicate where the GPS reading was taken within the plot. In general, the location of the GPS reading should be on the Southeastern corner of the plot, if the plot is square or rectangular, or in the center if the

plot is circular. It is also helpful to briefly describe the topography, aspect, and vegetation structure of the site. If you can't take the GPS reading at the Southeast corner (an obstacle in the way) then note where the GPS point was taken. If you can't get a GPS reading, then spend extra time marking the plot location as precise as possible on a topo map.

Site history: Briefly describe the history of the stand, including type and year of disturbance (e.g. fire, landslides or avalanching, drought, flood, or pest outbreak). Also note the nature and extent of land use such as grazing, timber harvest, or mining.

Unknown plant specimens: List the numbers of any unknown plant specimens, noting any information such as family or genus (if known), important characters, and whether or not there is adequate material for identification. Do not take samples of plants of which there are only a few individuals or which you think may be rare. Document these plants with photographs.

Additional comments: Feel free to note any additional observations of the site, or deviations from the standard sampling protocol. If additional data were recorded, e.g. if tree diameters were measured, please indicate so here.

COARSE FRAGMENTS AND SOIL INFORMATION

Coarse fragments, litter: Estimate the cover class of each size at or near the ground surface averaged over the plot. Always remember to estimate what you actually see on the surface as opposed to what you think is hiding under, organic litter, big rocks, etc. However, rocks, organic litter, or fine material visible under the canopy of shrubs or trees should be included in the cover estimate.

One way to consider this is to assume that all of the components of coarse fragments plus the basal cross-section of living plant stems and trunks (at ground level) will add up to 100%. Thus, estimate the cover value of each of the items in the box on the form for coarse fragments (including the basal area of plant stems) so that they will add up to 100%. Remember that the basal area of plant stems is usually minimal (e.g., if there were 10 trees, each 1 m in diameter at ground level on a 1000 square meter plot, they would cover less than 1% {0.79%} of the plot).

These data are asked for because certain categories of coarse fragments of rock and other materials have been shown to correlate with certain vegetation types and are thus likely influencing the type of vegetation that is growing in a given area. These estimates should be made quickly with the main point to keep in mind being a rough estimate of the relative proportions of different coarse fragments on the plot.

Fines: Fine mineral fragments including sand, silt, soil, "dirt" < 3 mm in diameter

Gravel: rounded and angular fragments >0.3, <10 cm (>0.125, < 3 in.) diameter

Cobble: rounded and angular fragments 10-25 cm (3 -10 in.) in diameter

Stone: rounded and angular coarse fragments >25 cm (> 10 in.) in diameter

Bedrock: continuous, exposed, non-transported rock

Litter: extent of undecomposed litter on surface of plot (this includes all organic matter, e.g. fallen logs, branches, and twigs down to needles and leaves).

Soil texture: Record the texture of the upper soil horizon, below the organic layer if one is present. *See attached key and code list.*

Parent Material: Geological parent material of site. *See attached code list.*

VEGETATION DATA

Assessment of Layers

This first step is described in the CNPS point-intercept transect protocol. Estimates the maximum height for the low and mid layers and the minimum height for the tall layer are recorded. These estimates are made after a quick assessment of the vegetation and its structure. The estimates need not be overly precise and will vary among vegetation types. A caveat: if several relevés are being sampled within the same vegetation type, it is important to be consistent when assigning layers. Some types will have more than three layers (e.g. two tree layers of different maximum height); this should be indicated in the relevé description. However, data are recorded for only three layers (low, mid, and tall). The layer a species occupies will often be determined by growth form, but exceptions do occur. For example, with trees young seedlings may occupy the low layer, saplings the mid layer, and mature individuals the tall layer for some taxa, for example.

Species List

The collection of vegetation data continues with making a comprehensive species list of all vascular plants within the relevé. This list is achieved by meandering through the plot to see all microhabitats. During list development, observers document each taxon present in each layer in which it occurs separately, recording it on a different line of the data form and noting which layer is represented. This is important for data entry because each layer of each represented taxon will be entered separately. Each individual plant is recorded in only one layer, the layer in which the tallest portion of the individual is found. One should reach a point at which new taxa are added to the list only very slowly, or sporadically. When one has reached that point, the list is probably done.

The following sections explain how to perform the actual relevé, the Estimation of Cover Values. The sections prefaced by bold-faced titles explain the technique, the sections with regular font titles refer to the steps needed to complete the accompanying Field Form.

Tree dbh (optional)

The CNPS protocol does not require observers to record the diameter at breast height (dbh) of each tree species in the plot. However, the dbh is important in certain studies and may be recorded next to the each tree species name, in the column labeled "Final species determination or Tree dbh". You should measure the tree dbh of every tree trunk that has diameter $>$ or $=$ 10 cm at breast height in the plot, and each measurement should be in centimeters (cm) using a dbh tape measure. For trunks that may be fused below breast height and branched at breast height, each trunk at breast height gets a separate measurement.

Depending on the density of trees in each plot, you can record dbh of trees for every tree trunk in the plot, or you can sub-sample the trunks to estimate dbh for every tree species in relatively dense

plots. If you opt to sub-sample, you should do it for each tree species in a representative “quarter” or quadrant of the plot, and then you will come up with an estimated dbh for the entire plot (once data is processed).

When sub-sampling, make sure to denote this as a sub-sample (can note in the Additional comments field) and record the sub-sample of dbh’s for each tree species in the appropriate row on the Field Form. Once the data are post-processed and entered into a database, then you will need to record each sub-sampled dbh reading three additional times to come up with a full sample of dbh readings. For example, with a sub-sampled tree dbh of 15 cm, this value of 15 should be entered four times (not just once) when it is entered in the database.

Estimating Cover:

There are many ways to estimate cover. Many people who have been in the cover estimation “business” for a long time can do so quickly and confidently without any props and devices. However, to a novice, it may seem incomprehensible and foolhardy to stand in a meadow of 50 different species of plants and systematically be able to list by cover value each one without actually “measuring” them in some way.

Of course, our minds make thousands of estimates of various types every week. We trust that estimating plant cover can be done by anyone with an open mind and an “eye for nature.” It’s just another technique to learn. ¹⁰ It is very helpful to work initially with other people who know and are learning the technique. In such a group setting, typically a set of justifications for each person’s estimate is made and a “meeting of the minds” is reached. This consensus approach and the concomitant calibration of each person’s internal scales is a very important part of the training for any cover estimate project.

An underlying point to remember is that estimates must provide some level of reliable values that are within acceptable bounds of accuracy. If we require an accuracy level that is beyond the realm of possibility, we will soon reject the method for one more quantitative and repeatable. As with any scientific measurement, the requirement for accuracy in the vegetation data is closely related to the accuracy of the information needed to provide a useful summary of it. Put into more immediate perspective - **to allow useful and repeatable analysis of vegetation data, one does not need to estimate down to the exact percent value the cover of a given plant species in a given stand.**

This point relates to two facts: there is inherent variability of species cover in any environment. For example, you would not expect to always have 23% *Pinus ponderosa*, 14% *Calocedrus decurrens*, and 11% *Pinus lambertiana* over an understory of 40% *Chamaebatia foliosa*, 3% *Clarkia unguiculata*, and 5% *Galium bolanderi* to define the Ponderosa pine-Incense cedar/mountain misery/bolander bedstraw plant community. Anyone who has looked at plant composition with a discerning eye can see that plants don’t space themselves in an environment by such precise rules. Thus, we can safely estimate the representation of species in a stand by relatively broad cover classes (such as <1%, 1-5 %, 5-25%, etc.) rather than precise percentages.

The data analysis we commonly use to classify vegetation into different associations and series (TWINSPAN and various cluster analysis programs, for example) is likewise forgiving. When analyzed by quantitative multivariate statistics information on species cover responds to coarse differences in cover and presence and absence of species, but not to subtle percentage point differences. This has been proven time and again through quantitative analysis of vegetation

classification. Many of the world's plant ecologists estimate cover rather than measure it precisely. Some of the seminal works in vegetation ecology have been based on cover estimates taken by discerning eyes.

With this as a preamble, below we offer some suggestions on estimating cover that have proven helpful. These are simply "tricks" to facilitate estimation, some work better for different situations. You may come up with other methods of estimation that may seem more intuitive, and are equally reliable in certain settings. All values on the relevé protocol that require a cover class estimate, including coarse fragment and vegetation layer information, may rely on these techniques. Just make the appropriate substitutions (using the coarse fragment example substitute, bedrock, stone, cobbles, gravel, and litter for vegetation).

Method 1: The invisible point-intercept transect:

This method works well in relatively low, open vegetation types such as grasslands and scrubs where you can see over the major stand components. For those who have worked with the original CNPS line intercept methodology it's like counting hits along an imaginary line at regular intervals of the 50 m tape. Here's how it goes:

Envision an imaginary transect line starting from your vantage point and running for 50 m (or however many meters you wish, as long as you are still ending up within the same stand of vegetation you're sampling - never keep counting outside of your homogeneous stand). Now "walk" your eye along this tape for 50 m and visually "take a point" every 0.5 m. Don't worry about precision, just try to "walk" your eye along the line and stop every 0.5 m or at any other regular interval until you reach its end and mentally tally what species you hit. Once you come up with a number of hits for each major species in one imaginary transect, take another transect in another direction and estimate the number of hits on that one. Do this several times (usually 3-4 is enough if you are in a homogeneous stand), then average your results. This can go quickly in simple environments and in environments where the major species are easily discernable (chaparral, bunch-grassland, coastal scrub, desert scrub). Your average number of hits need not be a total of 100 as in the original transect method, but could be 50 along a 25 m imaginary line (in which case you would multiply by two to get your estimated cover), or 25 along a 12.5 m line (multiply average by 4), etc.

Method 2: Subdivision of sample plot into quadrants:

Many plots, whether they are square, circular, or rectangular, may be "quartered" and have each quadrant's plant cover estimated separately. If the plot is a given even number of square meters (such as 100, 400, or 1000 m²) then you know that a quarter of that amount is also an easily measurable number. If you can estimate the average size of the plants in each of the quarters (e.g, small pinyon pines may be 5 m² (2.2m x 2.2m), creosote bush may be 2m² (or 1.41 m x 1.41 m), burrobush may be 0.5m²) then you simply count the number of plants in each size class and multiply by their estimated size for the cover in a given quadrant. Then you average the 4 quadrants together for your average cover value.

This method works well in vegetation with open-to-dense cover of low species such as grasses or low shrubs, in open woodlands, and desert scrubs.

Method 3; “Squash” all plants into a continuous cover in one corner of the plot :

Another way to estimate how much of the plot is covered by a particular species is to mentally group (or “march”, or “squash”) all members of that species into a corner of the plot and estimate the area they cover. Then calculate that area as a percentage of the total plot area. This technique works well in herb and shrub dominated plots but is not very useful in areas with trees.

Method 4: How to estimate tree cover:

Cover estimates of tall trees is one of the most difficult tasks for a beginning relevé sampler. However it is possible to do this with consistency and reliability using the following guidelines.

1. Have regular sized and shaped plots that you can easily subdivide.
2. Estimate average crown spread of each tree species separately by pacing the crown diameter of representative examples of trees of each species and then roughly calculating the crown area of each representative species.
3. Add together the estimated crown area of each individual of each species of tree on the plot for your total cover.

Method 5: The process of elimination technique:

This method is generally good for estimating cover on sparsely vegetated areas where bare ground, rocks, or cobbles cover more area than vegetation. In such a situation it would be advisable to first estimate how much of the ground is not covered by plants and then subdivide the portion that is covered by plants into rough percentages proportional to the different plant species present. For example, in a desert scrub the total plot not covered by plants may be estimated at 80%. Of the 20% covered by plants, half is desert sunflower (10% cover), a quarter is California buckwheat (5% cover), an eighth brittlebush (2.5% cover), and the rest divided up between 10 species of herbs and small shrubs (all less than 1% cover).

Any of these techniques may be used in combination with one another for a system of checks and balances, or in stands that have characteristics lending themselves for a different technique for each layer of vegetation.

In a relevé, cover estimates, using the techniques described above, are made for each taxon as it is recorded on the species list. Estimates are made for each layer in which the taxon was recorded. For example, if individuals of coast live oak occur in the tall, the mid, and the low layer, an estimate is made for Tall CLO, for mid CLO, and for low CLO.

In a traditional relevé, cover is estimated in “cover classes,” not percentages, because of the variability of plant populations over time and from one point to another, even within a small stand. This protocol uses the following 6 cover classes:

- Cover Class 1: the taxon in that layer covers < 1 % of the plot area
- Cover Class 2: the taxon in that layer covers >1% - 5% of the plot area
- Cover Class 3: the taxon in that layer covers >5 - 25 % of the plot area
- Cover Class 4: the taxon in that layer covers >25 - 50 % of the plot area
- Cover Class 5: the taxon in that layer covers >50 - 75 % of the plot area
- Cover Class 6: the taxon in that layer covers > 75% of the plot area

Percentages (optional)

This CNPS protocol also encourages observers to estimate percentages if they feel confident in their estimation abilities. This optional step allows the data to be compared more easily to data collected using different methods, such as a line or point intercept. It also instills confidence in the cover estimate of borderline species that are close calls between two cover classes (e.g., a cover class 2 at 5% as opposed to a cover class 3 at 6%). It is particularly useful for calculating cover by the process of elimination techniques and for estimating total vegetation cover (see below) and coarse fragment cover. 13

Total Vegetation Cover

In addition to cover of individual taxa described above, total cover is also estimated by vegetation layer. This is done using the same cover classes as described above but combines all taxa of a given layer. This can be calculated from the species percent cover estimates but if one does it independently, and comes up with the same cover class estimate, it is very satisfying.

National Vegetation Classification height Classes for Vegetation Strata

The relevé method just described calls for estimates of plant cover for each taxon. It is strongly floristically oriented. Another way of considering the relationships between plants in vegetation is by evaluating structure, or physiognomy. The underlying thinking is that life forms within a stand of vegetation occur in response to similar ecological pressures (TNC 1998). Estimation of cover within predetermined height classes is one way to describe the structure of vegetation. Structure of a stand of vegetation also is used in modeling wildlife use of the vegetation (WHR).

For information gathered using this CNPS protocol to be comparable with the wealth of information being gathered by the National Park Service and the Biological Resources Division (BRD) of the USGS it is also necessary for CNPS to estimate vegetation cover according to predefined vegetation strata. The following height classes are defined by the USGS/NPS:

High Tree	>30 m.
Medium High Tree	20-30 m.
Medium Low Tree	10-20 m.
Low Tree	5-10 m.
High Shrub	2-5 m.

High Herb/ Medium Shrub	1-2 m.
Low Shrub	0.5-1 m
Medium Herb	25-50 cm.
Low Herb	0-25 cm.
Moss/Lichen	

Cover in these vegetation strata is estimated using the same cover classes as were used for cover of individual taxa. Again, estimation of percentages is optional. Please note that although these strata have names in the national classification, they don't necessarily have to be populated by the type of species that are their namesake (e.g., tall herbaceous species may be diagnostic of the tall shrub category in the case of a giant reed stand). For this reason we have simply listed the strata by their height classes and have opted not to name them.

We have also requested that you list the diagnostic species for each layer. In this case the diagnostic species is the single species that seems to best characterize that layer it may be the only species found in a given layer, it may be as common as other species in that layer but is more restricted to that single layer, or it may be less common than other species in that layer, but so representative of that layer that it can't be ignored. The cover of the diagnostic species in that layer does not have to be re-estimated as it is estimated in the individual species tally already.

Caveats: Please consult with the members of the vegetation committee for advice and feedback on proposed vegetation surveys prior on initiating projects.

Notes on the Order and Division of Labor for Data Collection: As with every procedure there are always more and less efficient ways to collect the information requested. Although we respect each field crews' option to choose in what order they collect the data, we suggest the following general rules:

- * Work with teams of two for each plot collected.
- * Both team members can determine the plot shape and size and lay out the tapes and mark the edges for the plot boundary (see below).
- * The two person teams can also divide up tasks of data collection with one member collecting location, environmental (slope, aspect, geology, soil texture, etc.) and plot description information while the other begins the species list. Thus, two clipboards are useful and data sheets that are at first separated (not stapled).
- * Following the making of the initial species list and collection of location and environmental data both team members convene to do the estimation of plant cover by species followed by the estimation of total vegetation cover and cover by layer.
- * Following that process, the estimation of cover by the up to 10 height strata classes and the listing of the diagnostic species for each is done collaboratively.
- * This is followed by the estimation of the coarse fragment information, again done collaboratively.

For egalitarian and familiarization purposes we suggest that the roles be switched regularly between the team members and that if multiple teams are being used in a larger project, that each team member switches frequently between teams, building all-important calibration, and camaraderie among the whole group.

Suggestions for Laying out Plots:

If you are laying out a circular plot, work with two or more people. One person stands at the center of the plot and holds the tape case while the other walks the end of the tape out to the appointed distance (radius 5.6 for 100 m² circle, radius 11.3 m for a 400 m² circle, and radius 17.6 m for a 1000m² circle). The walker then fixes the tape end with a pin flag and walks back to the center where he/she instructs the center person to walk in the opposite direction of the already laid out tape radius, stretching the rest of the tape to an equal length (another 11.3 or 17.6 m) to the opposite edge of the plot, where he/she affixes it with another pin flag. This process is again repeated with another tape

laid out perpendicular to the first so that an “+” shape is created. The margins of the circle can be further delineated by measuring to the center of the circle with an optical tape measure (rangefinder) and marking mid points between the four ends of the crossed tapes.

When laying out square or rectangular plots work with two or more people per team. If doing a rectangle, determine the long axis of the plot first and have one person be stationed at the zero m end of the tape while the other person walks the unrolling tape case out to the appropriate length. The stationary end person can guide the walker, keeping them moving in a straight line. Once that tape is laid out and the far end staked, the team lays out another tape perpendicular to the first, either at one end, using the same type of process. This establishes the width of the rectangle (or square). Using an optical rangefinder and pin-flags, or colored flagging the team can further mark additional points along the other parallel long axis and short axis of the plot (every 5 m for shorter plots or every 10 m for longer plots is suggested) so that the entire plot boundary can be easily visualized.

References:

Barbour M.G., J.H. Burk, and W.D. Pitts 1987. *Terrestrial Plant Ecology*, Second Edition. Benjamin/Cummings Publishing Co. Menlo Park, CA. 634 pages.

Sawyer and Keeler-Wolf. 1995. *Manual of California Vegetation*. California Native Plant Society, Sacramento, CA. 471 pages

The Nature Conservancy and Environmental Systems Research Institute. 1994. Final Draft, Standardized National Vegetation Classification System. Prepared for United States Department of the Interior, National Biological Survey, and National Park Service. Arlington, VA. Complete document available at the following website: <http://biology.usgs.gov/npsveg/fieldmethods.html>

Suggested Equipment: Equipment List: Prices as of May 2000, toll free orders from Forestry Suppliers (1-800-647- 5368) (item numbers in parentheses)

Chaining pins, surveyor steel (#39167) \$21.50
Fiberglass tapes 2 - 165’/50 m (#39972) \$42.90
Logbook cover 8 ½ “ x 12” (#53200) \$23.95
Perforated flagging (#57960) \$1.95
UTM Coordinate Grid (#45019) \$16.95
Rangefinder, 10-75m (#38973) \$51.60
Silva Compass w/ clinometer (#37036) \$43.90
Garmin GPS 12XL (#39095, #39111) \$244.90 17

Simplified Key to Soil Texture (Brewer and McCann, 1982)

Place about three teaspoons of soil in the palm of your hand. Take out any particles >2mm in size, and use the following key to figure out the soil texture (e.g. loamy sand). Then figure out the texture subclass by using the Code List attached (e.g. coarse loamy sand).

- A1 Soil does not remain in a ball when squeezed.....sand
- A2 Soil remains in a ball when squeezed.....B
- B1 Add a small amount of water. Squeeze the ball between your thumb and forefinger, attempting to make a ribbon that you push up over your finger. Soil makes no ribbon.....loamy sand
- B2 Soil makes a ribbon; may be very short.....C
- C1 Ribbon extends less than 1 inch before breaking.....D
- C2 Ribbon extends 1 inch or more before breaking.....E
- D1 Add excess water to small amount of soil; soil feels very gritty or at least slightly grittyloam or sandy loam
- D2 Soil feels smooth.....silt loam
- E1 Soil makes a ribbon that breaks when 1–2 inches long; cracks if bent into a ring.....F
- E2 Soil makes a ribbon 2+ inches long; does not crack when bent into a ring.....G
- F1 Add excess water to small amount of soil; soil feels very gritty or at least slightly gritty.....sandy clay loam or clay loam
- F2 Soil feels smooth.....silty clay loam or silt
- G1 Add excess water to a small amount of soil; soil feels gritty or at least slightly gritty.....sandy clay or clay
- G2 Soil feels smooth.....silty clay

CALIFORNIA NATIVE PLANT SOCIETY RELEVÉ FIELD FORM CODE LIST (revised 7/8/02)

MACRO TOPOGRAPHY

- 00 Bench
- 01 Ridge top (interfluve)
- 02 Upper 1/3 of slope
- 03 Middle 1/3 of slope
- 04 Lower 1/3 of slope (lowslope)
- 05 Toeslope (alluvial fan/bajada)
- 06 Bottom/plain
- 07 Basin/wetland
- 08 Draw
- 09 Other
- 10 Terrace (former shoreline or floodplain)
- 11 Entire slope
- 12 Wash (channel bed)
- 13 Badland (complex of draws & interfluves)
- 14 Mesa/plateau
- 15 Dune/sandfield
- 16 Pediment
- 17 Backslope (cliff)

MICRO TOPOGRAPHY

- 01 Convex or rounded
- 02 Linear or even
- 03 Concave or depression
- 04 Undulating pattern
- 05 Hummock or Swale pattern
- 06 Mounded
- 07 Other

SITE IMPACTS

- 01 Development
- 02 ORV activity
- 03 Agriculture
- 04 Grazing
- 05 Competition from exotics
- 06 Logging

- 07 Insufficient population/stand size
- 08 Altered flood/tidal regime
- 09 Mining
- 10 Hybridization
- 11 Groundwater pumping
- 12 Dam/inundation
- 13 Other
- 14 Surface water diversion
- 15 Road/trail construction/maint.
- 16 Biocides
- 17 Pollution
- 18 Unknown
- 19 Vandalism/dumping/litter
- 20 Foot traffic/trampling
- 21 Improper burning regime
- 22 Over collecting/poaching
- 23 Erosion/runoff
- 24 Altered thermal regime
- 25 Landfill
- 26 Degrading water quality
- 27 Wood cutting
- 28 Military operations
- 29 Recreational use (non ORV)
- 30 Nest parasitism
- 31 Non-native predators
- 32 Rip-rap, bank protection
- 33 Channelization (human caused)
- 34 Feral pigs
- 35 Burros
- 36 Rills
- 37 Phytogenic mounding

PARENT MATERIAL

- ANDE Andesite
- ASHT Ash (of any origin)
- GRAN Granitic (generic)
- GREE Greenstone
- DIOR Diorite

Riparian Habitat Inventory and Mapping of the Mainstem Trinity River

BASA Basalt
OBSI Obsidian
PUMI Pumice
IGTU Igneous (type unknown)
MONZ Monzonite
PYFL Pyroclastic flow
QUDI Quartz diorite
RHYO Rhyolite
VOLC General volcanic extrusives
VOFL Volcanic flow
VOMU Volcanic mud
BLUE Blue schist
CHER Chert
DOLO Dolomite
FRME Franciscan melange
INTR General igneous intrusives
GNBG Gneiss/biotite gneiss
HORN Hornfels
MARB Marble
METU Metamorphic (type unknown)
PHYL Phyllite
SCHI Schist
SESC Semi-schist
SLAT Slate
BREC Breccia (non-volcanic)
CACO Calcareous conglomerate
CASA Calcareous sandstone
CASH Calcareous shale
CASI Calcareous siltstone
CONG Conglomerate
FANG Fanglomerate
GLTI Glacial till, mixed origin, moraine
LALA Large landslide (unconsolidated)
LIME Limestone
SAND Sandstone
SETU Sedimentary (type unknown)
SHAL Shale
SILT Siltstone
DIAB Diabase
GABB Gabbro
PERI Peridotite
SERP Serpentine
ULTU Ultramafic (type unknown)
CALU Calcareous (origin unknown)
DUNE Sand dunes
LOSS Loess
MIIG Mixed igneous
MIME Mixed metamorphic
MIRT Mix of two or more rock types
MISE Mixed sedimentary
CLAL Clayey alluvium
GRAL Gravelly alluvium
MIAL Mixed alluvium
SAAL Sandy alluvium (most alluvial fans
and washes)
SIAL Silty alluvium
OTHE Other than on list

SOIL TEXTURE

COSA Coarse sand
MESN Medium sand
FISN Fine sand
COLS Coarse, loamy sand
MELS Medium to very fine, loamy sand
MCSL Moderately coarse, sandy loam
MESAL Medium to very fine, sandy loam
MELO Medium loam
MESIL Medium silt loam
MESI Medium silt
MFCL Moderately fine clay loam
MFSA Moderately fine sandy clay loam
MFSL Moderately fine silty clay loam
FISA Fine sandy clay
FISC Fine silty clay
FICL Fine clay
SAND Sand (class unknown)
LOAM Loam (class unknown)

CLAY Clay (class unknown)
UNKN Unknown
PEAT Peat
MUCK Muck

DOMINANT VEGETATION GROUP

Trees:

TBSE Temperate broad-leaved seasonal
evergreen forest
TNLE Temperate or subpolar needle-leaved
evergreen forest
CDF Cold-deciduous forest
MNDF Mixed needle-leaved evergreen-cold
deciduous. forest
TBEW Temperate broad-leaved evergreen
woodland
TNEW Temperate or subpolar needle-leaved
evergreen woodland
EXEW Extremely xeromorphic evergreen
woodland
CDW Cold-deciduous woodland
EXDW Extremely xeromorphic deciduous
woodland
MBED Mixed broad-leaved evergreen-cold
deciduous woodland
MNDW Mixed needle-leaved evergreen-cold
deciduous woodland

Shrubs:

TBES Temperate broad-leaved evergreen
shrubland
NLES Needle-leaved evergreen shrubland
MIES Microphyllous evergreen shrubland
EXDS Extremely xeromorphic deciduous
shrubland
CDS Cold-deciduous shrubland
MEDS Mixed evergreen-deciduous shrubland
XMED Extremely xeromorphic mixed evergreen
deciduous shrubland

Dwarf Shrubland:

NMED Needle-leaved or microphyllous evergreen
dwarf shrubland
XEDS Extremely xeromorphic evergreen dwarf
shrubland
DDDS Drought-deciduous dwarf shrubland
MEDD Mixed evergreen cold-deciduous dwarf
shrubland

Herbaceous:

TSPG Temperate or subpolar grassland
TGST Temperate or subpolar grassland with
sparse tree
TGSS Temperate or subpolar grassland with
sparse shrublayer
TGSD Temperate or subpolar grassland with
sparse dwarf shrub layer
TFV Temperate or subpolar forb vegetation
THRV Temperate or subpolar hydromorphic
rooted vegetation
TAGF Temperate or subpolar annual grassland or
forb vegetation

Sparse Vegetation:

SVSD Sparsely vegetated sand dunes
SVCS Sparsely vegetated consolidated substrates

APPENDIX B

TWO-WAY ORDERED TABLE FROM TWINSPAN ANALYSIS
OF FREQUENTLY SAMPLED PLANT SPECIES ALONG
THE UPPER TRINITY RIVER.

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