CLASSIFYING EARLY, POST-LOGGING VEGETATION IN THE LOWER REDWOOD CREEK BASIN OF REDWOOD NATIONAL PARK: A MANAGERS HANDBOOK

J.M. Lenihan, W.S. Lennox, E.H. Muldavin, and S.D. Veirs, Jr. 1983

ABSTRACT

This handbook has been prepared as a field tool for identifying 10 successional vegetation types established 1 to 10 yrs following clearcut logging of coastal redwood forests in northwestern California. A field data form has been included for use with either of two techniques developed for site classification: 1) a field key utilizing both floristic and environmental characters; and 2) a computer program, utilizing multiple discriminant functions that employ environmental characters when vegetation is absent or, if present, both environmental and floristic characters. The classification procedure can be applied systematically to generate a map of vegetation types which would stratify the cutover landscape into units of equivalent habitat. A species list has been annotated for use in selecting species which may be suitable for watershed rehabilitation tasks.

INTRODUCTION

A system for classifying vegetation found on recently harvested redwood forest lands in the lower Redwood Creek basin has been developed for Redwood National Park (Muldavin et al. 1981). The system was developed to describe natural plant succession patterns following logging. The 10 types that are described develop on sites 1 to 10 yrs after removal of the original forest overstory by clearcut logging. The relationship between the vegetation types and the extent of soil disturbance, slash burning, drainage alteration, and other environmental factors has been established. The intent of this work is to guide revegetation efforts on poorly revegetated sites and on sites disturbed during the rehabilitation process.

This is a handbook for the field application of a vegetation type classification system. The classification system may be applied in the lower Redwood Creek basin to map early successional vegetation, to predict appropriate species for revegetation of poorly revegetated sites or newly altered sites, and to identify areas representing special groundwater problems that might go unrecognized during dry season rehabilitation planning.

THE VEGETATION TYPE CLASSIFICATION SYSTEM

Vegetation Type Descriptions

Ten vegetation types are found on recently harvested forest lands in Redwood National Park. The classification system and its derivation is more fully described in Muldavin et al. (1981). The distribution of species throughout the vegetation types is presented in a summarized differential table (Table 1). It shows the percent constancy and modal cover values for species with greater than 5% constancy in at least one vegetation type. It also presents the mean values for the environmental variables.

An overall view of the relationships among vegetation types is presented in Fig. 1. The following type descriptions are grouped according to these relationships and are separated into two large groups:

1) Remnant Group: remnant vegetation which survived logging on the less disturbed sites.

Redwood National Park, P.O. Box SS, Arcata, CA 95521

Table 1

Summary Differential Table

Taxa listed with percent constancy and modal cover abundance values by vegetation type. Differential species blocks each vegetation type have been outlined. Only those species with greater than 5% overall constancy have been listed.

(T) = Tree Layer (S) = Shrub Layer Blank = Herb Layer

		Remnant Group				Invasion Group					
Species	Veg. Type / No. of Releves	L/W 12	R/V 25	R/G 29	P/O 34	J/E 27	A/A 34	H/A 14	B/W 80	P/W 9	
Sequoia sempervirens (T)		41-2	4-1	13-+	3-2		7-+	7-+			
Sequoia sempervirens (S)		25-+	72-+	55-+	35-+	7-+	18-+		35-+		
Sequoia sempervirens		8-+	12-+		9-+	3-+	21-+		13-+		
Pseudotsuga Menziesii (T)		16-2	8-+	10-1		3-+				22-+	
Pseudotsuga Menziesii (S)		58-1	16-+	20-+	6-+	19-+	12-+	29-+	11-+	100-4	
Pseudotsuga Menziesii		58-+	84-+	58-+	44-+	48+	85-+	85-+	83-+	89-2	6
Tsuga heterophylla (T)			16-+	17-2	3-1						
Tsuga heterophylla (S)		8-+	24-+	34-2	9-+	3-+	77-+		3-+	11-+	
Tsuga heterophylla		8-+	20-+	21-+	24-+	19-+	32-+	7-+	16-+	33-+	
Lithocarpus densiflora (T)		59-3	20-2	27-2	3-+						
Lithocarpus densiflora (S)		100-2	84-2	86-1	41-+	11-+	15-+	7-+	45-+	22-+	7
Lithocarpus densiflora		58-2	84-1	58-+	59-+	11-+	27-+	50-+	35-+	11-+	
Rhododendron macrophyllum (T)		8-1	4-+	17-1							
Rhododendron macrophyllum (S)		25-+	76-2	79-3	21-+		3-+	7-+	16-+		
Rhododendron macrophyllum		41-+	92-2	68-1	35-+	3-+	15-+	21-+	38-+	55-+	
Vaccinium ovatum (S)		25-+	64-1	72-+	9-+			6-+	22-+	11-+	
Vaccinium ovatum		16-+	76-1	62-1	41-+	15-+	47-+	42-+	36-+	33-+	
Vaccinium parvifolium (S)		25-+	8-+	20-+	21-+	6-+		1-+	11-+	3-+	
Vaccinium parvifolium		8-+	20-+	45-+	38-+	15-+		6-+		5-+	
Gaultheria shallon		66-1	88-+	100-3	79-1	44-+	35-+	14-+	62-+	44-+	
Polystichum munitum (S)			8-1	14-+	41-3		6-+	3-+			
Polystichum munitum		58-+	48-+	58-+	85-2	37-+	41-+	7-1	50-+	33-+	
Blechnum spicanth			4-+	34-+	76-+	41-+	47-+	7-+	13-+	11-+	
Athyrium filix-femina					12-+	33-+	12-+	7-+	1-+		
Galium triflorum		25-+	28-+	44-+	88-+	37-+	44-+	21-+	33-+		
Oxalis oregana		25-+	8-+	27-+	88-+	15-+	18-+	7-+	18-+	11-+	
Vancouveria hexandra		8-+	4-+	10-+	23-+			1-+			
Luzula parviflora		8-+		3-+	44-+	15-+	21-+	7-+	6-+	11-+	
Stachys rigida				3-+	29-+	15-+	6-+	7-+	5-+	11-+	
Rubus spectablis (S)				3-+	21-+	4-+	15-+		10-+		
Rubus spectablis					12-+		3-+				
Juncus effusus					6-+	52-5	15-+	4-+	11-+		
Juncus Bolanderi					3-+	33-2	6-+				
Juncus bufonius						19-2	9-+				
Typha latifolia (S)						26-+					
Typha latifolia			4-1			30-+	3-+				
Carex deweyana				3-+	9-+	26-2	15-+				
Petasites palmatus			4-+	3-+	15-+	48-+	26-+		4-+		
Salix spp. (S)						33-+	21-+	4-+	5-+		
Salix spp.				3-+		22-+	6-+		4-+	11-+	
Equisetum telmateia (S)		8-+				19-2	3-+				
Equisetum telmateia					6-+	63-4	26-+		1-+		
Equisetum arvense					3-+	19-2					
Alnus oregana (T)							53-3				
Alnus oregana (S)			4-+	3-+	9-1	19-1	77-3	4-+	5-+	22-+	
Alnus oregana			12-+	10-+	12-+	41-+	62-2	43-+	11-+	11-+	
Ceanothus thrysiflorus (T)											2
Ceanothus thrysiflorus (S)		8-+	4-+					14-+	6-+	33-+	7
Ceanothus thrysiflorus		8-+	20-+	10-+		4-+	6-+	43-+	15-+	22-+	5

Table 1 (Continued)

Species	Veg. Type / No. of Releves	Remnant Group				Invasion Group					
		L/W 12	R/V 25	R/G 29	P/O 34	J/E 27	A/A 34	H/A 14	B/W 80	P/W 9	C/A 36
Arbutus menziesii (T)		17-+	4-+	3-+	6-+						3-
Arbutus menziesii (S)		17-+	12-+	7-+		4-+		3-+	11-+	42-1	
Arbutus menziesii		8-1	32-+	17-+		4-+	6-+	4-+	20-+	22-+	39-
Arctostaphylos columbiana (S)								1-+	11-+	8-+	
Arctostaphylos columbiana		8-1	8-+	3-+				4-+	8-+		25-
Baccharis pilularis (S)		42-+	32-+	24-+	21-+	30-+	32-+	36-+	76-2	33-+	66-1
Baccharis pilularis		42-+	88-+	62-+	88-+	82-+	76-+	100-+	88-2	100-+	77-
Whipplea modesta		6|7-2	44-+	55-+	65-+	59-+	79-+	50-+	90-2	88-1	88-
Iris douglasii		58-+	16-+	38-+	59-+	40-+	65-+	57-+	85-+	88-+	28-
Hypochoeris radicata		33-+	36-+	24-+	21-+	44-+	59-+	100-3	63-+	77-+	44-
Deschampsia elongata				3-+	12-+	19-+	26-+	43-+	21-+		3-
Bromus vulgaris		16-+		3-+	3-3	3-+			10-+		6-
Danthonia californica			8-+					7-+	4-+	11-+	
Madia exiqua			4-+					7-1	5-+	11-+	
Madia gracilis								29-+	6-+	11-+	
Aira caryophyllea		8-+	4-+	2-+	6-+	7-+	12-+	43-+	11-+	11-+	16-
Gnaphalium purpureum		25-+	36-+	14-+	15-+	44-+	44-+	79-+	45-+	11-+	36-
Plantago lanceolata		8-+					3-+	21-1	13-+		3-1
Holcus lanatus		8-+		7-+	3-+	22-+	20-+	43-+	21-+	22-+	8-
Erechtities prenanthoides (S)		16-+	28-1	35-+	59-3	11-2	29-+	7-+	27-+		16-
Erechtities prenanthoides		66-+	96-+	97-+	88-+	89-+	82-+	50-+	79-+	33-+	72-
Epilobium paniculatum		17-+	40-+	20-+	24-+	11-+	26-+	43-+	46-+		36-
Epilobium adenocaulon		17-+	64-+	38-+	59-+	70-+	65-+	64-+	54-+	22-+	33-
Cirsium acanthodenton		17-+	16-+	21-+	15-+	33-+	12-+	14-+	41-+	11-+	19-
Cirsium vulgare (S)			12-+		15-+	4-+	12-+		6-+		5-1
Cirsium vulgare		8-+	40-+	28-+	35-+	26-+	41-+	43-+	50-+		33-
Gnaphalium californicum		17-+	12-+		6-+			7-+	15-+	11-+	3-
Gnaphalium chilense		25-+	20-+	17-+	12-+	33-+	21-+	14-+	38-+	22-+	44-
Gnaphalium collinum			20-+	7-+	3-+	19-+	12-+	7-+	15-+	11-+	16-
Hierochloe occidentalis		25-+	20-+	35-+	27-+	11-+	6-+	21-+	25-+	22-+	3-
Festuca occidentalis		17-+	16-+	21-+	15-+	11-+	9-+	21-+	23-+	22-+	3-
Sonchus asper		8-+	52-+	10-+	12-+	37-+	26-+	29-+	29-+		25-
Chamaecyparis lawsoniana (S)						4-+	9-+		9-+	44-+	14-
Chamaecyparis lawsoniana										22-+	8-
Anaphalis margaritacea		42-+	24-+	28-+	47-+	44-+	38-+	50-+	59-+	88-+	31-
Rubus leucodermis		33-+	24-+	24-+	50-+	22-+	44-+	29-+	51-+		22-
Rubus parviflorus			16-+	13-+	26-+	26-+	21-+	14-+	9-+		
Lolium multiflorum			4-+	4-+	8-+	30-+	41-+	71-+	15-+		14-

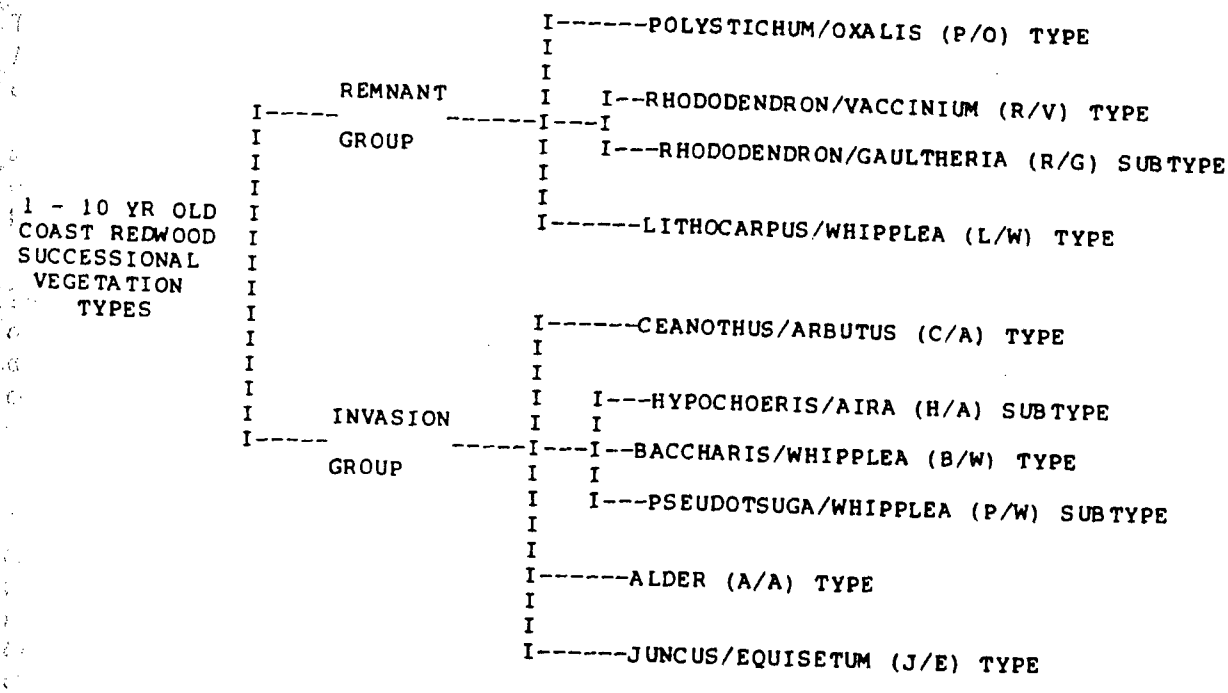

Figure 1

Hierarchial Classification Scheme for Successional Vegetation Types One to Ten Years Following the Logging of Coast Redwood in Redwood National Park

2) Invasion Group: vegetation which invaded sites more highly disturbed by logging.

Within the Remnant Group, the vegetation types are described as follows:

1) Polystichum munitum/Oxalis oregona Type (P/O)

This type is dominated by *Polystichum* in both the herb and shrub layers. *Oxalis, Blechnum spicanth* and *Galium triflorum* are characteristic species of the herb layer. Generally, all remnant species begin with some cover which gradually increases with time. *Gaultheria shallon,* though it does not reach its optimum in this type, can be important in later years, co-dominating with *Polystichum.* Invading species such as *Erechtites prenanthoides* can be strong early, but fade after the third or fourth year.

2(a) Rhododendron macrophyllum/Vaccinium ovatum Type (R/V)

This type is characterized by the dominance of *Rhododendron, Vaccinium ovatum* and *Lithocarpus densiflora* in both the herb and shrub layers. In this type, total *Rhododendron* cover stabilizes by yr 3. *Gaultheria,* though present, develops little cover until yr 5, after *Rhododendron* develops from a multi-branched sprouting form to a taller giant shrub. Loss of lower *Rhododendron* leaves effectively increases habitat available at ground level for the low growing *Gaultheria.*

2(b). Rhododendron macrophyllum/Gaultheria shallon Subtype (R/G)

This subtype, like the R/V type above, is dominated by *Rhododendron, Vaccinium ovatum* and *Lithocarpus* in the shrub layer, but by *Gaultheria* in the herb layer. *Rhododendron* fails to develop extensive cover as a multi-branched form allowing *Gaultheria* to dominate the herb layer. *Gaultheria* occurs initially on the sites with fairly high cover and increases until yr 4 with *Rhododendron* following a similar pattern in the shrub layer as a few-branched giant shrub. The many-branched form is a result of extensive basal sprouting where logging activity damaged or removed the stem(s). Stems of the few-branched forms persisted through logging and little sprouting occurred.

3) Lithocarpus densiflora/Whipplea modesta Type (L/W)

This type is dominated by *Lithocarpus* in the tree and shrub layers, with *Pseudotsuga menziesii* occasionally co-dominating. *Whipplea* forms a low-lying mat under sprouting *Lithocarpus. Lithocarpus* definitely reaches its optimum in this type, but this vegetation type was found only in the older age classes (yrs 5 through 9), and the early phase remains undefined.

The Invasion Group vegetation types are as follows:

1) Ceanothus thrysiflorus/Arbutus menziesii Type (C/A)

This type is almost exclusively dominated by *Ceanothus* and *Arbutus. Ceanothus* attains an average cover of 70% in the tree layer by yr 8 and still has not peaked. At yr 3, when *Ceanothus* shrub cover peaks and enters the tree layer, most other species are on the decline except for *Arbutus* which steadily increases in cover. *Baccharis* initially has a strong growth rate in competition with *Ceanothus,* but *Ceanothus* soon prevails. *Whipplea* has a moderate cover in the early years but also declines as the *Ceanothus* canopy increases. Smaller *Ceanothus* individuals decline in number as the dominant canopy closes. *Ceanothus* occurs primarily as a single age class.

2(a) Baccharis pilularis/Whipplea modesta Type (B/W)

This is the most widespread type within the study area. Both *Baccharis* and *Whipplea* attain their greatest cover in this type, dominating in the shrub and herb layers respectively. Both species increase in cover rapidly in the first 3 to 4 yrs and peak at 5 to 6 yrs. Unlike *Ceanothus* in the C/A type, *Baccharis* maintains some reproduction after shrub layer establishment. Remnant type species can be present but generally do not flourish except for *Iris Douglasiana* and *Whipplea.*

2(b) Pseudotsuga menziesii/Whipplea modesta Subtype (P/W)

This subtype is very similar to the B/W type above except that *Pseudotsuga* replaces *Baccharis* as the dominant in the shrub layer. This type is found only in older sites and may reflect the silvicultural treatment (aerial seeding) during that period.

2(c) Hypochoeris radicata/Aira caryophyllea Subtype (H/A)

This subtype is also similar to the B/W type except that *Baccharis,* though present, is not robust and fails to reach shrub height (1 m), even after 9 yrs. Overall vegetative cover is lower than the cover for other types. *Hypochoeris, Aira* and two *Lolium* species replace *Whipplea* as the dominant ground cover.

3) Alnus oregona Type (A/A)

This type is dominated in all layers by *Alnus. Whipplea* can be an important component in the herb layer in early years; but after crown closure of *Alnus,* it declines. *Baccharis* shows a similar trend, increasing early and then declining when outpaced by *Alnus.* Several remnant species can be present during the first 10 yrs. These may become common as understory species in later years. Several species which find their optimum in the *Juncus effusus/Equisetum telmateia* type described below may also occur.

4) Juncus effusus/Equisetum telmateia Type (J/E)

This is a broadly defined type which is characterized by dominance or co-dominance of several wet-site species including *Juncus effusus, J. Bolanderi, J. bufonius, Carex deweyana, Petasites palmatus, Typha latifolia, Equisetum telmateia* or *E. arvense.* Cover for any combination of these species appears to reach a peak at yr 3 and is maintained at a more or less constant level for the remaining 6 yrs with little evidence of successional progression. The presence of this type strongly indicates that the soils of the site are groundwater saturated for substantial periods during the year and are of special concern to rehabilitation workers.

The Vegetation Types in Relation to Two Major Environmental Gradients.

Based on the distribution of the vegetation types, it is evident that the vegetation on recently logged redwood forest lands in Redwood National Park develops along two major environmental gradients. The relative position of the 10 vegetation types along these two environmental gradients is shown in Fig. 2. The first and most important gradient is relative soil disturbance. Soil disturbance ranges from soils with intact topsoil (i.e. litter layer and A horizon) to those with exposed subsoil (i.e., B and C horizons) at the surface. The second important environmental gradient is moisture. The moisture gradient varies from xeric to hydric conditions as a result of the combined influence of groundwater levels, topography, slope position, aspect and other environmental conditions. Fig. 2 also shows the compounding influence of slash burning which is essential for the establishment of the *Ceanothus/Arbutus* type.

Guidelines to the Field Application of the Vegetation-Type Classification System

This section is a guide to the field application of the classification system described above. A data collection procedure and field key for classifying vegetation on recently harvested redwood forest land in Redwood National Park are presented below.

The Data Collection Procedure

The first step in the data collection procedure is to establish one or more sample plots within the vegetation to be classified. The number of plots necessary to characterize the vegetation, the location of these plots, and the plot size and shape are on-site decisions affecting the accuracy of classification. A guide to making these decisions makes up the first part of this section. A plot data form and instructions for its completion are presented in the second part of this section.

Plot Establishment

The number of vegetation plots necessary to accurately classify a rehabilitation site is a function of the site's floristic and environmental variability. Look for major changes in the environment of the site, especially changes in slope, aspect, soil moisture, and soil disturbance. Changes in the environment are often accompanied by changes in the structure and species dominance of the vegetation. Where such changes occur, each homogeneous (i.e., uniform) section of the vegetation should be sampled separately.

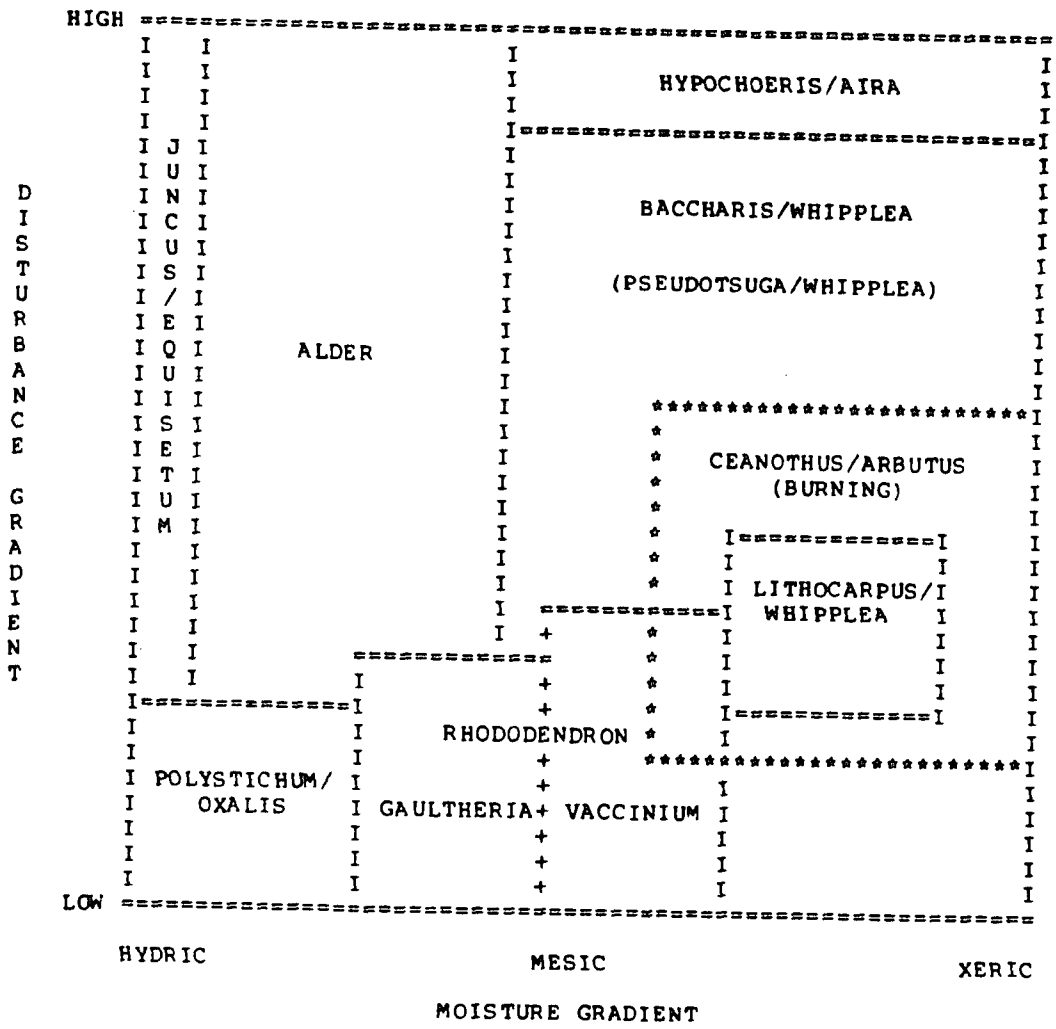

Figure 2

Schematic Representation of the Successional Vegetation Types Along the Gradients of Moisture and Disturbance

Locate the sample plot in a typical spot, one that best represents a homogeneous section of the vegetation. Strive for as much environmental uniformity as possible. Levels of burning, disturbance, and slash cover should not vary appreciably within plot boundaries.

Plot size and shape can be variable. Sample an area which includes all species occurring within the homogeneous section of vegetation. Minimum area curves developed after Mueller-Dombois and Ellenberg (1974) indicate that 400 sq ft is generally the minimum plot area required for sampling cutover land in the Redwood Creek Basin (800 sq ft was the average size of the plots used to develop this classification).

Square or rectangular plots are most efficient for sampling, but occasionally an irregularly-shaped plot is useful for sampling irregularly-shaped sections of homogeneous vegetation (e.g., vegetation associated with meandering seeps, winding skid trails, or tractor islands).

Plot boundaries may be flagged with plastic tape or more permanently marked with numbered metal tags at the perimeter of the plots if additional work on the plot is anticipated.

Completing the Data Form

Once a sample plot has been selected and plot boundaries are established, a data form is completed for the plot. Fig. 3 is an example of a completed data form. The user is urged to be as accurate as possible while completing the data form. The data form serves several functions. Most importantly, it is a permanent record of the location, vegetation and environmental setting of the plot. Each completed form will also serve to expand the data base on the vegetation of cutover lands within the park. This expanded data base may aid in future refinement of the classification system. It may also serve as a basis for vegetation mapping and other successional studies.

The following instructions are for completing the four major sections of the data form. Note the numbers alongside the boxes on the form. These numbers are an aid to keypunching for the computer classification program described later.

The General Information Section

The first section of the data form is a record of who sampled what plot, when and where. The plot number and location are particularly important. The plot is assigned a number which identifies it in the field, on maps and aerial photos, and throughout the course of computer analysis. Any suitable six-digit plot numbering system may be used. The precise legal description is the best record of a plot location. Mark the plot on a map or aerial photo, and include the map name or photo number in this section of the data form.

The Vegetation Section

The 25 species listed alphabetically in the vegetation section of the data form are the only species which need to be identified during the site classification process. Those not familiar with one or more of these species should refer to Munz and Keck (1973) for additional descriptive information.

Note that the boxes following the species names may occur in three different columns (Fig. 3). These columns represent the three different vegetation layers (tree [>15 ft] shrub [3-15 ft] and herb [<3 ft]). Each species will receive a separate estimate of cover (the area of the foliage projected on the ground in the plot) in each layer for which it is listed.

To complete the vegetation section, work down the species list searching the plot for one species at a time. If a species is not found within the plot boundaries, indicate its absence with a zero in every box following the species name. If the species is present in one or more vegetation layers, estimate its cover in each layer as a percentage of the total surface area of the plot. Then refer to the cover scale below the species list on the data form and find the cover code corresponding to your percentage estimate. Enter the cover code in the appropriate box following the species name.

The Environment Section

This section of the data form is for recording the few measures of the environment necessary for site classification. The slope, aspect, and elevation are best measured from the center of the plot, although these and any other measures of the environment should be nearly uniform from any point within the plot boundaries. The slope is measured in percent with a clinometer. The aspect of the plot

Figure 3

Example of a Completed Data Form to be Used with the Field Key or Computer Program to Classify Sites into One of the Ten Vegetation (Sub) Types

GENERAL

NAME: Rosa Lee Ontodor PLOT NUMBERS: 8 1 0 7 2

DATE: July 21, 1981

LOCATION: Miller Creek, above the rehabilitation s
SW ¼ of Sec 22, T10N, R1E, HBM Photo 10

VEGETATION

	TREE (>15')	SHRUB (3-15')	HERB (<3')	
Alnus oregona (red alder)	0	0	0	10
Arbutus menziesii (madrone)	1	2	0	13
Baccharis pilularis (coyote brush)		1	0	15
Blechnum spicant (deer fern)			0	16
Carep sps. (sedge)		0	0	18
Ceanothus thrysiflorus (blueblossom)	5	2	1	21
Equisetum telmatia (horsetail)			0	22
Erechtites prenanthoides (Australian fireweed)		0	1	24
Galium sps. (bedstraw)			0	25
Gaultheria shallon (salal)		0	0	27
Hierochloe occidentalis (vanilla grass)			0	28
Hypochoeris radicata (cat's ear)			1	29

	TREE (>15')	SHRUB (3-15')	HERE (<3')
Iris douglasiana (iris)			1
Juncus bolanderi (Bolanders rush)			0
Juncus effusus (common rush)			0
Lithocarpus densiflorus (tanoak)	1	2	0
Mahonia nervosa (Oregon-grape)			0
Oxalis oregana (redwood sorrel)			0
Petasites palmatus (western coltsfoot)			0
Polystichum munitum (swordfern)		0	0
Pseudotsuga menziesii (Douglas-fir)	0	0	2
Rhododendron macrophyllum (pacific rhododendron)	0	1	0
Vaccinium ovatum (evergreen huckleberry)		0	1
Vaccinium parvifolium (red huckleberry)		0	0
Whipplea modesta (Yerba de Selva)			2

COVER SCALE

PERCENT COVER	COVER CODE
absent	0
1-10%	1
10-25%	2
25-50%	3
50-70%	5
70-90%	7
90-99%	9

Figure 3-A (Continued)

ENVIRONMENT

SLOPE (percent) 40 54

DISTURBANCE (percent) 40 63

ASPECT (degrees azimuth) 195 57

SLASH COVER (percent) 10 65

ELEVATION (feet) 1810 61

TERRAIN TYPE (enter a "1" in the appropriate box)

Skid Trail		66	Landing		70
Tractor Island		67	Sidecast		71
Cable Yarded	1	68	Seep		72
Cutbank		69			

BURNED (1=yes, 0=no) 1 73

SANDSTONE (1=yes, 0=no) 1 74

NOTES

Ceanothus heavily browsed
Soil profile taken (#721)
Age of Ceanothus = ~ 7 yrs
Reproduction of Pseudotsuga in openings

is measured in degrees azimuth with a hand compass. Azimuth is the bearing in the horizontal plane measured clockwise from true north, from 0 to 360 degrees. (Do not confuse the azimuth with the true or magnetic bearing which can never exceed 90 degrees and remember to consider the 18-degree difference between the magnetic North and true North in this locale.) The elevation of the plot in feet can be estimated from a topographic map or measured with an altimeter.

The disturbance entry requires an estimate of the missing topsoil (i.e., the litter and A horizon) expressed as a percentage of the total surface area of the plot. The slash cover item requires an estimate of the area of the plot covered with logs, branches and other woody debris. The value range permitted for these two variables is 0 to 99%.

The next item is a list of seven types of terrain created by different methods of logging or by activities associated with logging. The boundaries of the plot should encompass only one of these terrain types. Indicate the type with a "1" in the box alongside the appropriate item.

The next two items in the environment section require a yes or no answer. If the area within the plot was burned, place a "1" for yes in the box next to this item. If the plot was not burned, place a zero in the box. Search the plot for evidence of the soil's parent material. If it is sandstone, record a "1" in the box alongside this item. If the parent material is some rock other than sandstone, place a zero in the box.

The Notes Section

This section of the data form is for recording any additional information which the observer feels may aid in understanding or interpreting any special characteristics of the plot.

The Vegetation Type Key

After completing the data form, the vegetation of the sample plot may be classified into one of the 10 vegetation types using the following key. Each key step is based on information found on the completed data form. Note that the key requires the use of both vegetative and environmental characteristics. An alternative method of classification, based on the environmental variables only, is available for sites where vegetation is absent. This alternative technique requires that the data be transferred for computer processing. The computer program can also be used when vegetation is present. Program documentation is available (Lennox 1981) if this alternative is chosen.

A FIELD KEY FOR THE IDENTIFICATION OF VEGETATION TYPES ON RECENTLY HARVESTED LAND IN THE LOWER REDWOOD CREEK BASIN

1 Exposed subsoil (B and C horizons) covers more than 70% of the plot surface area or the vegetation is dominated by one or more of the following species:

Alnus oregona	*Hypochoeris radicata*
Baccharis pilularis	*Juncus spp.*
Carex spp.	*Petatsites palmatus*
Ceanothus thrysiflorus	*Pseudotsuga Menziesii*
Equisetum telmateia	*Typha latifolia*

Invasion Group, see ---------- 2

1 Intact topsoil (litter layer and A horizon) covers more than 30% of the plot surface area or the vegetation is dominated by one or more of the following species:

Gaultheria shallon *Polystichum munitum*
Lithocarpus densiflora *Rhododendron macrophyllum*
Oxalis oregana *Vaccinium ovatum*

Remnant Group, see
---------- 7

2 Vegetation dominated by *Baccharis, Ceanothus,* or *Hypochoeris*
---------- 3

2 Vegetation not dominated by *Baccharis, Ceanothus,* or *Hypochoeris*
---------- 5

3 *Ceanothus* dominates in the tree, shrub or herb layer; or *Ceanothus* co-dominates with *Baccharis* in the shrub or herb layer.
(The aspect of the plot is usually 90-180 degrees azimuth or there is evidence of burning.)

Ceanothus/Arbutus type

3 When present, the shrub layer is dominated by *Baccharis. Hypochoeris, Whipplea, Iris,* or *Baccharis* dominate or co-dominate the herb layer.
---------- 4

4 Herb layer dominated or co-dominated by *Whipplea, Iris,* or *Baccharis. Hypochoeris* is absent or with low cover.

Baccharis/Whipplea type

4 Herb layer dominated by *Hypochoeris. Whipplea* and *Iris* absent or with low cover.

Hypochoeris/Aira subtype

5 Shrub layer dominated by *Pseudotsuga.* Herb layer dominated by *Whipplea* and *Pseudotsuga.*

Pseudotsuga/Whipplea subtype

5 Shrub layer not dominated by *Pseudotsuga*
---------- 6

6 *Alnus* dominates in the tree, shrub, or herb layer; or *Alnus* co-dominates with *Baccharis* in the shrub or herb layer. (The soil parent material is usually schist.)

Alnus type

6 Vegetation dominated by wet-site species of the genera *Carex, Juncus, Equisetum, Petasites,* or *Typha.* (Soil moisture is seasonally high.)

Juncus/Equisetum type

7 *Rhododendron* or *Vaccinium* dominate or co-dominate with *Lithocarpus* in the shrub layer. The herb layer is dominated by *Vaccinium, Rhododendron, Lithocarpus,* or *Gaultheria.*

---------- 8

7 *Rhododendron* or *Vaccinium* do not dominate or co-dominate in the shrub layer.

---------- 9

8 Herb layer dominated by *Vaccinium, Rhododendron,* or *Lithocarpus*

Rhododendron/Vaccinium type

8 Herb layer dominated by *Gaultheria*

Rhododendron/Gaultheria subtype

9 Shrub layer dominated by *Polystichum* or *Erechtites. Polystichum, Gaultheria, Oxalix, Blechnum,* or *Galium* dominate or co-dominate in the herb layer.

Polystichum/Oxalis type

9 *Lithocarpus* dominates or co-dominates with *Pseudotsuga* in the tree or shrub layer. *Whipplea* dominates or co-dominates with *Lithocarpus* and *Pseudotsuga* in the herb layer.

Lithocarpus/Whipplea type

Vegetation-Type Mapping and the Application to the Watershed Rehabilitation Program

The vegetation classification procedure described here may be used as a planning tool in the Redwood National Park revegetation program. The classification procedure can be applied systematically to generate a map of vegetation types which would stratify the cutover landscape into units of equivalent habitat. Each mapping unit would be defined by a distinct combination of vegetation and environmental characteristics. The relative success of a given method of revegetation within a mapping unit will, to a large extent, be closely tied to the effect of the ecological complex defining that unit (assuming other factors such as quality of stock and planting method remain constant). If the results of various methods of revegetation were reported by mapping unit (i.e. vegetation type), then the relative success of each method within each unit could be established. The type map would then become a tool for determining which methods of revegetation should be employed in the mapped rehabilitation unit.

Interpretation of the Annotated Species List

The annotated species list is a guide to species which may be suitable for rehabilitation work (Table 2). Each species is rated in three different categories. The first category distinguishes between native and non-native species. Native species are indicated by an asterisk. Species with an asterisk in the second category are aggressive colonizers of open, disturbed lands within the study area. Species commonly found on harsh sites are indicated by an asterisk in the third category. Harsh sites are defined here as highly-disturbed tractor skid trails and cutbanks of roads (e.g., typical *Hypochoeris/Aira* habitat). Other species have little expectation of survival or growth on these sites without additional site rehabilitation work.

Table 2

Annotated Species List

Plant species occurring on clear-cut coast redwood forest sites 1 to 10 yrs after logging, Redwood Creek basin, Redwood National Park. Nomenclature from Munz (1974) except for # Abrams (1940) and ## Hitchcock and Cronquist (1976).

Harsh Site Occupants	Aggressive Colonizers	Natives	Species
*			*Abies grandis Lindl.*
*			*Acer macrophyllum Pursh.*
*			*Achlys triphyllea (Smith) DC.*
*			*Adenocaulon bicolor Hook.*
*			*Adiantum pedatum L. var. aleuticum Rupr.*
*			*Agrostis longiligula Hitchc.*
			Agrostis tenuis Sibth.
		*	*Aira caryophyllea L.*
			Aira praecox L.
*	*	*	*Alnus oregana Nutt.*
*	*	*	*Anaphalis margaritacea (L.) A. Gray*
*			*Aralia californica S. Wats.*
*	*	*	*Arbutus Menziesii Pursh.*
*		*	*Arctostaphylos columbiana Piper*
			Arrhenatherum elatius (L.) Presl.
*			*Asarum caudatum Lindl.*
*			*Athyrium filix-femina (L.) Roth. var. Sitchense Rupr.*
			Avena sativa L.
*	*	*	*Baccharis pilularis v. D.C. ssp. consanguinea C.B. Wolf.*
*			*Berberis nervosa Pursh.*
*			*Blechnum spicant J.E. Smith*
			Boykinia elata (Nutt.) Greene.
			Briza minor L.
*			*Bromus marginatus Nees.*
			Bromus mollis L.
*			*Bromus vulgaris (Hook.) Shear.*
*			*Campanula prenanthoides Durand.*
*	*		*Carex deweyana W. Boott. ##*
*			*Carex simulata Mackenzie*
			Carex spp.
*			*Castanopsis chrysophylla (Dougl.) A. DC.*
*	*	*	*Ceanothus thrysiflorus Esch.*
*			*Ceanothus velutinus Dougl.*
*			*Centaurium floribundum (Benth.) Robinson*
*		*	*Centaurium Muhlenbergii (Griseb.) W. F. Wright*
*			*Chamaecyparis Lawsoniana (Murr.) Parl.*
			Cirsium acanthodontum Blake #
	*		*Cirsium arvense (L.) Scop.*
	*	*	*Cirsium vulgare (Savi) Tenore.*
*			*Clintonia Andrewsiana Torr.*
*			*Collomia heterophylla Hook.*
*			*Conyza canadensis (L.) Cronquist.*
	*	*	*Cortaderia Sellonana Schult.*
*			*Cornus sessilis Torr.*
*			*Corylus cornuta v. Marsh. var. californica (A. DC.) Sharp.*
			Crepis capillaris (L.) Wallr.
	*		*Cynosurus echinatus L.*
*			*Cyperus melanostachys H. B. K.*
*			*Cyperus rivularis Kunth.*
	*		*Dactylis glomerata L.*
*			*Danthonia californica Boland.*
*	*		*Deschampsia elongata (Hook.) Munro ex Benth.*
			Digitalis purpurea L.
*			*Disporum Hookeri (Torr.) Britt.*
*			*Disporum Smithii (Hook.) Piper*

Table 2 (Continued)

Harsh Site Occupants	Aggressive Colonizers	Natives	Species
*			*Elymus glacus Buckl.*
*	*	*	*Epilobium adenocaulon Hausskan.*
*	*	*	*Epilobium paniculatum Nutt.*
*	*		*Equisetum arvense L.*
*	*		*Equisetum telmateia Ehrh.*
	*		*Erechtites arguta DC.*
	*	*	*Erechtites prenanthoides (A. Rich.) DC.*
*			*Eschscholzia californica Cham.*
			Festuca bromoides L.
			Festuca dertonenis (All.) Asch. and Graebn.
*			*Festuca elatior L.*
*			*Festuca idahoensis Elmer.*
			Festuca megalura Nutt.
*			*Festuca Myuros L.*
*		*	*Festuca occidentalis Hook.*
*			*Festuca subuliflora Scribn.*
			Fragaria californica Cham. & Sch.
*			*Galium aparine L.*
			Galium triflorum Michx.
*			*Gastridium ventricosum (Goan) Schinz & Thell*
*			*Galtheria Shallon Pursh.*
*	*		*Glyceria elata (Nash) Hitchc.*
	*		*Gnaphalium californicum DC.*
	*		*Gnaphalium collinum Labill.*
*	*		*Gnaphalium chilense Spreng.*
*	*	*	*Gnaphalium purpureum L.*
*			*Goodyera oblongiflora Raf.*
*			*Hieracium albiflorum Hook.*
	*		*Hierchloe occidentalis Buckl.*
*		*	*Holcus lanatus L.*
			Holodiscus discolor (Pursh) Maxim
	*		*Hordeum vulgare L.*
*	*	*	*Hypochoeris radicata L.*
*	*		*Iris Douglasiana Herbert.*
*			*Juncus Bolanderi Engelm.*
*	*		*Juncus bufonius L.*
*			*Juncus effusus L.*
*			*Juncus ensifolius Wiks.*
*			*Juncus patens Meyer.*
*			*Lathyrus polyphyllus Nutt.*
			Lathyrus Torreyi A. Gray.
*			*Lathyrus species*
			Lilium columbianum Hanson
*		*	*Linum angustifolium Huds.*
		*	*Lithocarpus densiflora (Hook. & Arn.) Rehd.*
		*	*Lolium multiflorum Lam.*
		*	*Lolium perenne L.*
*			*Lonicera hispidula Dougl.*
*	*	*	*Lotus aboriginum Jepson.*
*			*Lotus crassifolius Greene.*
*			*Lotus oblongifolius Greene.*
*			*Lotus pinnatus Hook. Abrams.*
*			*Lotus Purshianus Benth.*
*			*Lotus stipularis Greene.*
*			*Lupinus bicolor Lindl.*
*	*	*	*Lupinus rivularis Dougl.*
*			*Luzula comosa Meyer.*
*			*Luzula parviflora (Ehrh.) Desv.*
*		*	*Madia exigua (Smith.) A. Gray.*
*		*	*Madia gracilis (Sm.) Keck.*
*		*	*Madia madioides (Nutt.) Greene.*
*			*Menziesia ferruginea Smith.*
*			*Mimulus dentatus Nutt.*

Table 2 (Continued)

Harsh Site Occupants	Aggressive Colonizers	Natives	Species
*			*Mimulus naustus Greene.*
*		*	*Montia diffusa (Nutt.) Greene.*
*			*Montia sibirica (L.) Howell.*
*			*Myrica californica Cham. & Sch.*
*			*Navarretia mellita Greene.*
*			*Navarretia squarrosa (Eschsch.) Hook. & Arn.*
*			*Osmaronia cerasiformis (Torr. & Gray.) Greene.*
			Oxalis oregana Nutt.
			Parentucellia viscosa (L.) Caruel.
*			*Penstemon Rattanii A. Gray.*
			Petasites palmata (Ait.) Gray.
*			*Phalaris arundinacea L.*
*			*Picea sitchensis (Bong.) Carr.*
			Plantago lanceolata L.
			Poa annua L.
*			*Poa Howellii Vasey and Scribn.*
*			*Polygala californica Nutt.*
*			*Polygala cornuta Kell.*
			Polypogon monspeliensis (L.) Desf.
*			*Polystichum munitum (Kaulf.) Presl.*
*		*	*Pseudotsuga Menziesii (Mirb.) Franco.*
*			*Pteridium aquilinium L. var. pubescens Underw.*
*			*Quercus Kelloggii Newb.*
*			*Ranunculus occidentalis Nutt.*
*			*Rhamnus purshiana DC.*
*			*Rhododendron macrophyllum D. Don*
*			*Ribes bracteosum Dougl.*
*			*Ribes Menziesii Pursh.*
*			*Ribes sanguineum Pursh.*
*			*Rhus diversiloba Torr. and Gray.*
*			*Rosa gymnocarpa Nutt.*
*			*Rubus leucodermis Dougl.*
*			*Rubus parviflorus Nutt.*
			Rubus procerus P. J. Muell.
*			*Rubsu spectabilis Pursh.*
*	*		*Rubus vitifolius Cham. and Sch.*
			Rumex acetosella L.
*			*Salix lasiolepis Benth.*
*			*Salix sitchensis Sanson.*
			Satureja Douglasii (Benth.) Brig.
*			*Sequoia sempervirens D. Don. Endl.*
			Sonchus arvensis L.
			Sonchus asper (L.) Hill.
			Spergularia rubra (L.) Presl.
*			*Spiranthes Romanzoffiana Cham. Schl.*
*			*Stachys Emersonii Piper.*
*			*Stachys rigida Nutt.*
*			*Taxus brevifolia Nutt.*
*			*Trientalis latifolia Hook.*
			Trifolium dubium Sibth.
*			*Trillium ovatum Pursh.*
*			*Trisetum cernuum Trin.*
*			*Tsuga heterophylla (Raf.) Sarg.*
*			*Typha latifolia L.*
*			*Vaccinium ovatum Pursh.*
*			*Vaccinium parvifolium Smith.*
*			*Vancouveria hexandra (Hook.) Moor. & Dec.*
*			*Veronica americana (Raf.) Schwein.*
			Vicia disperma DC.
*		*	*Viola sempervirens Greene.*
*	*	*	*Whipplea modesta Torr.*
*			*Woodwardia fimbriata Sm. in Rees.*