CURRENT STATUS OF THE VEGETATION IN HISTORIC KARUK CULTURAL USE SITES

by

Ellen Aegidia de Rijke

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Ellen de Rijke

We certify that we have read this study and that it conforms to acceptable standards of scholarly presentation and is fully acceptable, in scope and quality, as a thesis for degree of Master of Arts.

See original for signatures

Major Professor

John O. Sawyer, Major Professor

Kathy Hill

John Reiss

John B. Stuart

Approved by the Graduate Coordinator

Milton J. Boyd

Approved by the Graduate Dean

ABSTRACT

The Karuk Indians currently inhabit some half a million hectares of ancestral homeland in northern California and have done so for an unknown number of generations. Largely through the use of frequent, low intensity burns, the Karuk created, to some degree, the vegetation pattern encountered by Euro-Americans in the 1850's. Since this time, Forest Service land management has been based on the philosophy that the elimination of fire is fundamental to preserving natural environments. I selected five historic Karuk cultural use sites to investigate the nature of change in the forest and the associated meadow as a result of fire suppression.

I used digital orthoquadrangle maps to stratify the forest into tiers of plots with purposeful bias to capture potential change in stand structure and composition as distance from the meadow increased. I sampled these forests to determine structure (tree basal area and density) and composition (canopy, undestory, regeneration, shrub, and herbaceous species), Douglas-fir seedling density, and Douglas-fir age. In addition, I censused the associated meadow for composition and relative abundance.

Each use site is distinctive with general pattern found across them. Douglas-fir shared importance with madrone or tanoak. The Douglas-fir ages at Oak Bottom, Grasshopper Flat, Ishi Pishi, and Eyese Bar suggest that establishment has occurred after contact with Euro-Americans. The Douglas-fir ages and forest structure of the Persido Bar site are those of an old-growth stand. The pattern of Douglas-fir ages appears to show that Douglas-fir is moving towards the meadows where hardwoods are prominent and shade requirements are optimal.

The meadows support a large number of native non-use plant species though the abundance of these species is not as high as exotic weeds. The number of Karuk use plants is low. Several use plants with appropriate habitat requirements are not found.

These patterns support the hypothesis that Douglas-fir is invading forests and meadow habitats. The shade effects and cover changes of this invasion are negatively impacting the populations of plants used by the Karuk.

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INTRODUCTION

The Karuk Indians have lived along the lower region of the Klamath River in the Klamath Mountains of northwestern California for an unknown number of generations. Karuk villages once extended for a 150 km stretch just below Seiad Valley to fifteen kilometers below Bluff Creek (Bright 1978). The Karuk currently inhabit some half a million hectares of ancestral homeland in northern California (Hillman and Salter 1997). The Land and Resource Management Plan for the Klamath National Forest (Weigand et al. 1998) designates three Karuk Cultural Management Areas to be managed in consultation with Six Rivers and Klamath National Forest staffs. The Karuk will make decisions about adaptive management within management areas as provided by an agreed Memorandum of Understanding (Weigand et al. 1998). In this study, I characterize the current status of the vegetation in historic cultural sites of the Karuk and seek to provide a baseline of information that will help in making these management decisions.

The Karuk depended heavily upon salmon, however, the hunting of deer and elk and the gathering of plant material remained important for the Karuk. Everything the Karuk needed or used in their secular and religious lives existed in their territorial limits (Bell 1991). They made baskets, ropes, homes, and medicines with plants (Schenk and Gifford 1952, Davis and Hendryx 1991). Shamans and doctors used a variety of plants for curing purposes. Tobacco (*Nicotiana quadrivalvis*) was cultivated and used medicinally (Harrington 1932, Schenk and Gifford 1952, Baker 1981, Davis and Hendryx 1991). Acorns of tanoak (*Lithocarpus densiflorus*) were the major plant food,

along with the acorns of Oregon white oak (*Quercus garryana*), California black oak (*Quercus kelloggii*), and deer oak (*Quercus sadleriana*) (Schenck and Gifford 1952, Davis and Hendryx 1991). Some plants served multiple purposes. For instance, the nuts of California hazel (*Corylus cornuta*) were eaten while the young shoots were prepared for baskets. Also, madrone (*Arbutus menzeisii*) berries were eaten after steaming them and the wood was used as firewood in the ceremonial salmon cooking in the First Salmon ceremony (Schenck and Gifford 1952, Davis and Hendryx 1991). Homes were constructed of incense-cedar (*Calocedrus decurrens*) (Schenck and Gifford 1952, Baker 1981, Davis and Hendryx 1991). Table 1 summarizes Karuk plant use.

Photographs and descriptions suggest that forests encountered by Euro-Americans in the mid-nineteenth century consisted of open stands of Douglas-fir (*Pseudotsuga menziesii*), sugar pine (*Pinus lambertiana*), tanoak, madrone, canyon live oak (*Quercus chrysolepis*), and incense-cedar (Schenck and Gifford 1952, Baker 1981, Davis and Hendryx 1991). The Karuk, largely through the use of frequent, low intensity burns had created this vegetation pattern to some degree (Hillman and Salter 1997). Fire was used to preserve or increase the spatial and temporal extent of grasslands, woodlands, forests, and chaparral creating vegetation patterns that were rich with plant materials and game (Huntsinger and McCaffrey 1995).

In a recent fire history research on the Klamath National Forest, Wills and Stuart (1994) concluded that

"…the pre-settlement landscape was probably exceptionally patchy containing complex mosaics of different age and size Douglas-fir dominated stands"

Table 1. Cultural summary of Karuk plant utilization. Compiled by Beals and Hester (1974) from Schenk and Gifford (1952).

Plant use	#	Plant use	#
Abrasive	1	House furnishings	7
Adhesive	2	Implements	17
Bedding or Covering	15	House construction	5
Ceremonial uses	5	Medicines	37
Chewing gum	2	Musical instruments	1
Cordage or lashings	7	Mythological reference	6
Detergents	5	Perfume	4
Dyes and Stains	7	Personal ornaments	13
Food and beverages	63	Smoking and pipes	8
Fuel for smoking fish or meat	1	Snowshoes	1
Nectar	1	Sticks and poles	8
Seasoning for food	1	"Superstitions" (mostly charms)	25
Fumingants and repellants	4	Textiles	20
Games and play	10	Weapons	5
		Not used	65

Frequent fire was used to manipulate the characteristics of low elevation vegetation along the lower Klamath River. Burning opened the conifer tree canopy to favor oak reproduction and growth, to stimulate acorn production, and keep the understory open for ease of gathering, hunting, and travel (Huntsinger and McCaffrey 1995).

The Forest Service's land management has been based on the philosophy that the elimination of fire is fundamental to preserving natural environments (Lewis 1973). In 1911, the Weeks Act was passed to provide financial aid to protect timberlands from fire (Steen 1991). With fire suppression in effect in the early twentieth century, burned acreage dropped to 15% of presuppression levels in California (Martin and Sapsis 1992).

When frequent, low intensity fire was removed, the forests on the low elevation slopes of the lower Klamath River watershed would be expected to change. Douglas-fir is known to be a colonizer of open or moderately shady sites, through the dispersal and development of millions of seeds (Hermann and Lavender 1990). Douglas-fir seedlings tolerate some shade and may rapidly colonize stands.

It appears that Douglas-fir is invading forests and meadow habitats. This invasion through shade effects and cover change can negatively impact the populations of Karuk use plants. The historic Karuk cultural use sites in this study include a meadow with a surrounding forest.

Problem Statement

This study will describe the current status of Karuk cultural use sites in terms of:

- forest structure and species composition.
- the age pattern of Douglas-fir trees in the forest.
- the effect of fire suppression on forest structure and composition.
- meadow species composition.
- the status of the Karuk use plants in the meadows.

METHODS

Description of the Study Area

I chose five study sites located on the Ukonom Ranger District of the Klamath National Forest. State Route 96 is the major roadway through the region. Orleans and Happy Camp are the most densely populated towns of the area. Somes Bar is located nearest to the sites and has a population of about one hundred fifty people. The sites are located in the lower Klamath River watershed below 500 m in elevation along the Klamath and its tributaries including the Salmon River.

The Klamath and Salmon Rivers cut through 1,500-2,100 m high mountains with 1000 m high canyons (Harden 1998). At the base of these steep slopes are occasional landslide deposits and river terraces creating patches of flatter land composed of colluvial or alluvial deposits. The Salmon River watershed is composed of metavolcanic and metasedimentary rocks of the Western Paleozoic and Triassic Belt (Wagner and Saucedo 1987, Harden 1998). The lower part of this watershed is located on the Hayfork Terrane and is composed of meta-andesite, argillite, and chert-argillite breccia. The lower Klamath River watershed is included with the Western Jurassic Belt and is composed mainly of rocks from the Galice Formation which is a mixture of slate, metagraywacke, and some massive greenstone.

The climate of the study area is a cool Mediterranean one, with mild, wet winters and warm, dry summers. The annual rainfall of Somes Bar is 1525.7 mm. Most of the precipitation occurs November through March. The average temperature is

approximately 14° C, ranging from a mean December temperature of 6° C to a mean July temperature of 23°C. Average snowfall for the year is below 10 mm and rarely persists for a long period.

The Douglas-fir-tanoak forest type of Sawyer and Keeler-Wolf (1995) best describes the overall forest found on the more mesic upland slopes in these watersheds. In this type, Douglas-fir and tanoak are equally important and form a two-layered tree canopy in old-growth stands. Both trees are typically shorter than 75 m with an uneven canopy. Younger stands of this type can include Oregon white oak, black oak, California bay (*Umbellularia californica*), and madrone along with Douglas-fir. The most common shrubs are hazel, honeysuckle (*Lonicera ciliosa*), and poison-oak *(Toxicodendron diversilobum*). Plants in the grounds layer are generally sparse.

Stands of white alder (*Alnus rhombifolia*) border the streams. Willows, especially narrowleaf willow (*Salix exigua*), grow on the floodplains. On the upland woodlands, patches of chaparral and meadows are imbedded in the extensive stands of Douglas-fir and tanoak. The oak woodlands are typically comprised of canyon live oak when the slopes are steep and Oregon white oak on xeric sites. Two manzanita species, *Arctostaphylos visida* and/or *A. manzanita* var. *glabrescens*, dominate the patches of chaparral (Sawyer and Thornburgh 1988). The meadows are comprised mostly of annual and perennial grasses and annual herbaceous plants. Occasionally, patches of serpentine rock are found with buckbrush (*Ceanothus cuneatus*) and knobcone pine (*Pinus attenuata*).

Study Site Selection

The 5 sites I chose to study are either historic villages or ceremonial locations. Each site is centered on a meadow but the surrounding forest is included as well. Leaf Hillman, Director of Natural Resources for the Karuk Tribe of California, suggested the locations which I refer to as Eyese Bar, Grasshopper Flat, Ishi Pishi, Oak Bottom, and Persido Bar (Figure 1). Initial reconnaissance of the sites was done with Max Creasy, U.S. Forest Service ecologist in the winter of 1998.

Oak Bottom is located on the north side of the Salmon River, 6 km east of the confluence of the Salmon and Klamath Rivers (T11N R6E Section 2) at an elevation of 150 km. This site was a Karuk village that was occupied until the early 1900's by the Tripp family (Bill Tripp 1999, personal communication). Evidence of pit house and burial sites are still visible. The 0.03 ha meadow and surrounding forest are located on an alluvial terrace.

Grasshopper Flat is located 1.5 km northeast of the confluence of the Salmon and Klamath Rivers (T11N R6E Section 4) at an elevation of 330 m. This site was utilized by medicine men as a ceremonial ground and gathering site (Leaf Hillman 1999, personal communication). The 0.14 ha meadow occurs in the Western Jurrassic Belt and is composed of mainly of landslide deposits of Galice Formation. The meadow is flat ground and is surrounded by a south-easterly sloping forest of 10-15°.

Figure 1. Map of historic Karuk cultural use sites used in my study (Bell 1991). Numbers indicate use site. 1= Oak Bottom, 2=Grasshopper Flat, 3=Ishi Pishi, 4= Eyese Bar, 5=Persido Bar.

Ishi Pishi is located 1.0 km northeast of the confluence of the Salmon and Klamath Rivers (T12N R6E Section 33) at an elevation of 200 m. This site was a village site for the Karuk (Kathy McCovey 2000, personal communication). Evidence of pit houses and burial sites are still visible. There are two meadows separated by a short band of tree less than 100 m wide and 200 m long. This site occurs in the Western Jurrassic Belt and is composed of landslide deposits of Galice Formation. The 0.79 ha meadows are flat ground and are surrounded by an easterly sloping forest of 5-40°.

Eyese Bar is located on the west side of the Klamath River 20 km north of the confluence of the Salmon and Klamath River (T13N R6E Section 19) at an elevation of 300 m. This site was a village occupied by Karuk until the early 1900's (Kathy McCovey 2000, personal communication). This 1.74 ha meadow is located on a easterly slope of 30° and occurs in the Western Jurrassic Belt and is composed of landslide deposits of Galice Formation. The surrounding forest also has an eastern aspect and slopes range from 1-45°.

Persido Bar is located 0.5 km inland on the west side of the Klamath River (T13N R6E Section 8) at an elevation of 300. The meadow is 25 km north of the confluence of the Salmon and Klamath Rivers. The historical use of this site is questionable (Julian Lang 2001, personal communication). A village site was located on the river bar nearby but the village was washed away in a flood. The 0.81 ha meadow was claimed by miners in the 1950's and was vigorously homesteaded. Evidence of a home

and garden plants are visible. The site occurs in the Western Jurrassic Belt and is composed of landslide deposits of Galice Formation. The meadow is flat ground and is surrounded by an easterly sloping forest of 5-40°.

Field Sampling

I collected field data from June through August 1999, and from March through July 2000. I used a DOQ (digital orthoquadrangle) map to define the meadow and forest components of each site. I drew a boundary on the map between the meadow and the forest creating a polygon that defined the meadow. I then placed numbered points roughly 15 m apart along the uphill side of the polygon to establish potential starting points for a line to sample the forest. I randomly chose four numbered points which were the locations of the first plot on each line.

On each line, I established four circular fixed area plots with a 12.6m radius (500 m^2). This systematic sampling scheme stratified the forest into 4 tiers along the established lines at 0, 50, 100 and 200 m up the slopes from the meadow. With this systematic sampling design, the plots occurred at the same relative position in each forest and were spread more evenly over the population (Cochran 1977). The tiers were purposely biased away from the meadow to capture potential variations in stand composition and structure up slope.

At each site, with the exception of Ishi Pishi, I established 4 lines and 16 plots. At Ishi Pishi I established eight lines, four for each meadow. Two of the lines on the lower meadow intersected the upper meadow and therefore contained only a plot at 0 m. For this site, I sampled 26 plots. Slope angle was corrected for when the slope degree was over 10%.

Within each plot, I measured the diameter at breast height (1.3m) of all trees 15 cm or greater in diameter. I picked from two to four different sized Douglas-fir trees depending on the tree density in the plot to determine tree age. I cored at breast height and counted the number of annual rings with a hand lens.

I determined the percent cover of trees in the canopy to be those that did not have other trees growing above them. I determined the percent cover for the understory trees that were overtopped by the canopy trees. I determined the percent cover for the regeneration layer trees and saplings whose diameter at breast height, dbh, were below 15 cm. I identified and ocularly estimated the percent cover for each tree species in three layers of the stand and for the shrub and herb layers. All cover values were made in 5% increments. I counted the number of Douglas-fir seedlings and made notes of any evidence of human activity or fire scars.

In the meadows, I censused the herbaceous plants during the two field seasons though a more intensive sampling effort was made from March through July 2000. I attempted to identify all the species in the meadow and collected specimens if the species was common in the meadow. I also made note of the relative abundance of each

species. The specimens collected were returned to the Humboldt State Herbarium (HSC) for identification and verification. Botanical names conform to the nomenclature of *The Jepson Manual* (Hickman 1993).

ANALYSIS

Site Descriptions

I described the forest at each site in terms of tree basal area, density and frequency. To determine basal area, I converted the dbh of each tree utlizing:

$$\text{basal area } (m^2/ha) = 0.00031416*((dbh/2)^2)*20$$

Tree density represents the average number of trees per plot of each species. Tree frequency represents the percentage of the total plots that contain at least one individual of a given species.

I calculated the importance value of tree species and expressed it as a percentage. This importance value represents an average of relative density, relative basal area, and relative frequency of each tree species (Barbour et al. 1998, Mueller-Dombois and Ellenberg 1974). The importance value refers to the relative contribution of a species to the stand.

For a consistent description of all layers of the forest, I calculated the cover for tree species in the canopy, understory and regeneration layers. I calculated a dominance value based on the relative percent cover and frequency of each species. This dominance value refers to the relative contribution of each tree species with respect to cover values.

I also calculated the cover of shrub species and described the meadow composition. The abundance of a species was considered infrequent if only one or a few

individuals were in a site, present if more than a few individuals were in a site, and abundant if most of the meadow was composed of that species.

I described the age of Douglas-fir based on a range of ages, mean age, median age, and a frequency distribution of age classes within each stand. I assigned trees to broad age classes to understand the general frequency pattern (Table 2).

Table 2. Douglas-fir age classes

age class	actual ages
1	16-30
2	31-45
3	46-60
4	61-75
5	76-90
6	91-105
7	106-120
8	121-135
9	136-200

10	200+

Patterns Across Sites

To determine patterns of forest composition across sites, I examined the species importance and dominance values for forests at each site. I used either a one-way analysis of variance (ANOVA) or the Kruskal-Wallis one-way ANOVA on ranks when normality and equal variance assumptions were not met to compare forests across sites. I also compared Douglas-fir ages by determining a pattern of age distribution within each stand utilizing a dotplot. I examined the presence of horticultural species at each site (Appendix A).

Patterns Within Sites

To describe internal forest patterns, I compared tiers in terms of tree basal area and density by species with importance values greater than 10%. A tier consisted of four plots equidistant but with a different azimuth from the meadow. Comparisons were made using either a one-way analysis of variance (ANOVA) or the Kruskal-Wallis one-way ANOVA on ranks when normality and equal variance assumptions were not met. When significant differences between tiers were found I used the one-way ANOVA test, the Fisher's LSD Multiple-Comparison Test to compare tiers. Data for the deciduous oak were combined on the basis of similar growth patterns.

I tested for significant differences in mean age of Douglas-fir between tiers using either a one-way analysis of variance (ANOVA) or the Kruskal-Wallis one-way ANOVA on ranks when normality and equal variance assumptions were not met. I tested for significance among the tiers and compared and contrasted age using graphical displays and descriptive statistics.

Seedling data among tiers were also tested for significant differences. Data were analyzed using either a one-way analysis of variance (ANOVA) or the Kruskal-Wallis one-way ANOVA on ranks when normality and equal variance assumptions were not met.

Meadow Composition

Descriptive statistics were used to describe the meadow component. I calculated the percentage of forbs (non-grass species), graminoids (grass species), and shrubs within sites. I reported the percentages of native and exotic Karuk use plants and the non-use plants.

Karuk Use Plants

I tallied the Karuk use plants in each meadow and determined the use thereof by referencing Davis and Hendryx (1991) and Schenk and Gifford (1952). I used simple statistics to determine the percentage of each type of use plant present. I noted the common name and Karuk name.

RESULTS

Site Descriptions

The forest composition is presented in terms of tree basal area and tree density. I report importance values for those tree species above 10%. I describe the forest composition and structure in terms of cover by layers: canopy, understory and regeneration, and shrub. I describe Douglas-fir age and seedling density per plot. I describe the meadow composition in terms of plant use: native use, native non-use, exotic use, and exotic non-use.

Oak Bottom

The tree basal area was 21 m^2/ha with a tree density of 353 stems/ha. Madrone (32%) and Douglas-fir (30%) were the important trees with madrone density similar to Douglas-fir density but madrone basal area surpassed that of Douglas-fir. Black oak (15%) and Oregon white oak (9%) were of secondary importance (Table 3).

Douglas-fir (36%) dominated the tree canopy while madrone (33%) ranked second. Madrone (20%) dominated over Douglas-fir (17%), California black oak (17%), and California bay (15%) in the understory. In the regeneration layer, California bay (29%) ranked over Douglas-fir (17%) and canyon live oak (12%, Table 4).

Table 3. Tree density (stems/ha), basal area (m^2/ha), frequency (%), and importance values ((relative density + relative basal area + relative frequency)/3) at Oak Bottom with the standard error in parenthesis.

Tree species	Density	Basal Area	Frequency	Importance
Big leaf maple	11.3 (11.25)	0.5 (0.47)	6.3	**2.1**
Black oak	57.5 (11.09)	2.0 (0.49)	87.5	**14.7**
California bay	22.5 (11.38)	1.0 (0.59)	31.3	**5.7**
Canyon live oak	2.5 (11.73)	0.1 (0.08)	12.5	**1.4**
Douglas-fir	103.8 (21.62)	11.7 (2.69)	91.8	**30.4**
Madrone	111.3 (21.91)	12.7 (2.35)	87.5	**31.7**
Oregon ash	15.0 (12.58)	0.7 (0.53)	12.5	**3.2**
Oregon white oak	26.30 (7.47)	1.2 (0.33)	66.8	**9.4**
Pacific dogwood	2.50 (1.71)	0.1 (0.05)	12.5	**1.3**
Total	352.5	20.5	412.5	**100**

Table 13. Forest composition in terms of tree dominance ((percent cover + relative frequency)/2) Ishi Pishi.

	Apple	Black oak	Bigleaf maple	California bay	Canyon live oak	Cherry	Douglas-fir
Canopy:							
Cover (%)	-	1.5	0.8	3.3	2.7	-	25.4
Frequency	-	7.7	3.8	7.7	25.4	-	80.8
Dominance (%)	**-**	**4.4**	**2.2**	**6.6**	**8.4**	**-**	**58.0**
Dominance Rank		5	8	4	3		1
Understory:							
Cover (%)	1.0	8.9	3.5	23.3	17.5	1.2	7.5
Frequency	7.7	69.2	26.9	65.4	61.5	7.7	57.7
Dominance (%)	**1.4**	**13.1**	**5.1**	**21.5**	**17.5**	**1.6**	**11.0**
Dominance Rank	11	3	7	1	2	10	5
Regeneration:							
Cover (%)	0.1	-	0.2	20.4	10.0	0.1	4.6
Frequency	3.8	-	3.8	92.3	96.2	3.8	57.7
Dominance (%)	**0.5**	**-**	**0.7**	**34.5**	**23.3**	**0.5**	**12.3**
Dominance Rank	11		10	1	2	11	4

Table 13 cont'd. Forest composition in terms of tree dominance ((percent cover + relative frequency)/2) at Ishi Pishi.

	Grand fir	Incense cedar	Madrone	Oregon white oak	Pacific dogwood	Sugar pine	Tanoak
Canopy:							
Cover (%)	-	-	0.6	1.4	-	2.9	1.5
Frequency	-	-	3.8	7.7	-	23.1	3.8
Dominance (%)	**-**	**-**	**1.9**	**4.2**	**-**	**11.1**	**3.2**
Dominance Rank	-		9	6		2	7
Understory:							

Cover (%)	0.2	-	9.8	3.7	1.2	0.8	3.5
Frequency	3.8	-	61.5	38.5	11.5	11.5	26.9
Dominance (%)	**0.5**	**-**	**12.8**	**6.5**	**1.9**	**1.8**	**5.1**
Dominance Rank	12	-	4	6	8	9	7
Regeneration:							
Cover (%)	-	0.5	0.2	0.1	0.4	1.0	6.7
Frequency (%)	-	11.5	7.7	1.9	7.7	42.3	69.2
Dominance (%)	**-**	**2.0**	**1.2**	**1.1**	**1.4**	**6.4**	**16.1**
Dominance Rank		6	8	9	7	5	3

Table 5. Douglas-fir ages in years at use sites. Standard error in parenthesis.

	Oak Bottom	Grasshopper Flat	Ishi Pishi	Eyese Bar	Persido Bar
Minimum	22	48	28	67	19
Mean	54.4 (4.19)	87.2 (5.0)	75.4 (2.99)	95.8 (3.55)	115.5 (103.05)
Median	53	85	74	94	68
Maximum	87	162	140	142	340

Table 6. Density of Douglas-fir seedlings per plot at use sites. Standard error in parenthesis.

	Oak Bottom	Grasshopper Flat	Ishi Pishi	Eyese Bar	Persido Bar
Minimum	0	5	0	0	0
Mean	9.4 (12.25)	58.8 (14.72)	9.7 (3.71)	4.0 (1.64)	8.1 (5.04)
Maximum	48	192	85	25	82

Table 7. Overall shrub cover values at use sites. Standard error in parenthesis.

	Oak Bottom	Grasshopper Flat	Ishi Pishi	Eyese Bar	Persido Bar
Minimum	15	0	0	0	0
Mean	37.0 (4.58)	10.9 (2.09)	8.6 (3.80)	1.8 (0.70)	8.1 (2.28)
Maximum	65	30	100	10	30

Table 8. Frequency table report of Douglas-fir age classes at Oak Bottom.

AGE_CLASS	Count	Percent	Graph of Percent
16-30	4	19.05	|||||||
31-40	1	4.76		
46-60	8	38.10	||||||||||||
61-75	4	19.05	|||||||
76-90	4	19.05	|||||||

The mean age of Douglas-fir approached 60 years (Table 5) while the median age was 53. The minimum age was 22 years while the maximum age was 87 years. Some 42% of the tree were found in age class three (46-60 years) and age class four (61-75 years) contained 21% of the trees. Almost two-thirds of the data is found in between the ages of 46-75 years suggesting two age cohorts (Table 8). The density of seedlings was 10 per plot (Table 6).

The cover of shrubs approached 40% (Table 7). Serviceberry (*Amelanchier alnifolia*), hazel, redbud (*Cercis occidentalis*), toyon (*Heteromeles arbutifolia*), honeysuckle (*Lonicera ciliosa*), oso berry (*Oemleria cerasiformis*),wood rose (*Rosa gymnocarpa*), cascara (*Rhamnus californica* ssp. *californica*), Himalayan blackberry (*Rubus discolor*), blackcap raspberry (*Rubus leucodermis*), snowberry (*Symphoricarpus albus* var. *laevigatus*), and poison-oak were the common species.

The meadow contained forty herbaceous species (Appendix A), sixteen of them were exotic. The Karuk did not use most of the native plants found in the meadow. The herbaceous use plants were: sword fern (*Polystichum munitum*), Klamath iris (*Iris tenax* ssp. *klamathensis*), bullrush (*Juncus ensifolius*), ripgut brome (*Bromus diandrus*), soft chess (*B. hordeaceus*), sweet cicely (*Osmorhiza chilensis*), plantain (*Plantago lanceolata*), and serviceberry. Eleven shrub species were identified of which poison-oak, hazel, blackcap raspberry, and serviceberry were the only Karuk use plants.

Grasshopper Flat

The tree basal area was 48 m^2/ha with a tree density of 365 stems/ha. Madrone (33%) and Douglas-fir (30%) were the important species. Madrone density surpassed Douglas-fir density while Douglas-fir basal area was greater than madrone. Canyon live oak (16%) and black oak (11%) were of secondary importance (Table 9).

Douglas-fir (48%) dominated the tree canopy while madrone (18%) and canyon live oak (18%) ranked second. In the understory, madrone (33%) dominated over Douglas-fir (20%) and canyon live oak (18%). In the regeneration layer, Douglas-fir (37%) ranked over canyon live oak (26%) and madrone (4%, Table 10).

The mean age of Douglas-fir approached 90 years (Table 5) while the median age was 85 years. The minimum age was 48 years while the maximum age was 162 years. Some 30% of the trees were in age class six (91-105 years). Almost two-thirds of the trees occurred between the ages of 61-105 years suggesting a single age cohort (Table 11). The density of seedlings was 60 per plot (Table 6).

The cover of shrubs approached 15% (Table 7). Service berry, deer brush (*Ceanothus integerrimus*), toyon, honeysuckle, oso berry, wood rose, Himalayan black berry, California wild grape and poison-oak were the common species.

The meadow contained fifty-four herbaceous species (Appendix A), eighteen of them were exotic. Half of the native species were native plants that were not used by the Karuk. The Karuk use plants were: plantain, wintergreen (*Pyrola picta*), prince's pine (*Chimophila umbellata*), yarrow (*Achillea millefolium*), sweet cicely, blue wild rye (*Elymus glaucus* ssp. *glaucus*), ripgut brome, soft chess, blue dicks (*Dichelostemma capitatum* ssp. *capitatum*), and sword fern. Seven shrub species were identified of which poison-oak, buck brush, toyon, hazel, and blackcap raspberry were the Karuk use plants.

Table 9. Tree density (stems/ha), basal area (m^2/ha), frequency (%), and importance values ((relative density + relative basal area + relative frequency)/3) at Grasshopper Flat with the standard error in parenthesis.

Tree species	Density	Basal Area	Frequency	Importance
Big-leaf maple	3.8 (2.72)	0.3 (0.24)	12.5	**1.7**
Black oak	37.5 (9.81)	2.9 (1.16)	62.5	**10.8**
California bay	2.5 (2.50)	0.1 (0.04)	6.3	**0.8**
Canyon live oak	78.8 (30.8)	7.9 (3.11)	43.8	**16.1**
Douglas-fir	96.3 (23.4)	19.9 (4.91)	93.8	**30.3**
Madrone	163.8 (36.3)	14.9 (2.89)	93.8	**32.5**
Oregon white oak	2.5 (2.50)	0.3 (0.25)	6.3	**1.0**
Ponderosa pine	1.3 (1.25)	0.4 (0.39)	6.3	**0.9**
Sugar pine	7.5 (4.03)	1.7 (1.14)	37.5	**5.2**
Tanoak	1.3 (1.25)	0.1 (0.01)	6.3	**0.7**

Total	365.0	48.3	368.8	**100**

Table 10. Forest composition in terms of tree dominance ((percent cover + relative frequency)/2) at Grasshopper Flat.

	Bigleaf maple	Black oak	California bay	Canyon live oak	Douglas-fir	Incense cedar
Canopy:						
Cover (%)	-	1.9	-	11.25	21.9	-
Frequency	-	18.8	-	18.8	81.3	-
Dominance (%)	**-**	**7.5**	**-**	**17.9**	**47.7**	**-**
Dominance Rank	-	4	-	3	1	-
Understory:						
Cover (%)	1.9	5.0	1.9	10.3	8.1	-
Frequency	12.5	50	50	50	75	-
Dominance (%)	**3.8**	**12.8**	**3.8**	**18.2**	**19.9**	**-**
Dominance Rank	5	4	5	3	2	-
Regeneration:						
Cover (%)	-	0.1	4.25	16.3	27.5	0.06
Frequency	-	0.1	68.8	93.8	100	6.3
Dominance (%)	**-**	**0.7**	**11.9**	**26.0**	**37.1**	**0.7**
Dominance Rank	-	7	3	2	1	8

Table 10 cont'd. Forest composition in terms of tree dominance ((percent cover + relative frequency)/2) at Grasshopper Flat.

	Madrone	Oregon white oak	Ponderosa pine	Sugar pine	Tanoak
Canopy:					
Cover (%)	6.9	-	0.9	1.9	-
Frequency	37.5	-	6.3	12.5	-
		-			
Dominance (%)	**18.4**	**-**	**2.8**	**5.7**	**-**
Dominance Rank	2	-	6	5	-
Understory:					
Cover (%)	20.0	1.3	-	0.9	0.6
Frequency	81.3	12.5	-	18.8	6.3
Dominance (%)	**32.7**	**3.2**	**-**	**3.8**	**1.6**
Dominance Rank	1	6	-	5	7
Regeneration:					

	Madrone	Oregon white oak	Ponderosa pine	Sugar pine	Tanoak
Cover (%)	3.8	0.3	-	0.2	1.4
Frequency	68.8	25	-	18.7	43.8
Dominance (%)	**11.5**	**3.1**	**-**	**2.3**	**6.4**
Dominance Rank	4	6	-	7	5

Table 11. Frequency table report of Douglas-fir age classes at Grasshopper Flat.

AGE_CLASS	Count	Percent	Graph of Percent
16-30	0	0	
31-45	0	0	
46-60	4	14.81	|||||
61-75	5	18.52	|||||||
76-90	8	29.63	||||||||||
91-105	5	18.52	|||||||
106-120	2	7.41	||
121-135	2	7.41	||
136-200	1	3.70		
200+	0	0	

Ishi Pishi

The tree basal area was 37 m^2/ha with a tree density of 429 stems/ha. Douglas-fir (30%) was the most important species. California bay tree density surpassed Douglas-fir, while Douglas-fir tree basal area surpassed the hardwood. California bay (17%), canyon live oak (13%), and black oak (13%) were of secondary importance (Table 12).

Douglas-fir (58%) dominated the tree canopy while sugar pine (11%) ranked second. In the understory, California bay (22%) dominated over canyon live oak (18%), black oak (13%), madrone (13%), and Douglas-fir (11%). In the regeneration layer, California bay (35%) ranked over canyon live oak (23%) and tan oak (16%, Table 13).

The mean age of Douglas-fir approached 80 years (Table 5) while the median age was 74 years. The minimum age of Douglas-fir was 28 years while the maximum age was 140 years. Some 36% of the trees were found in age class five and 86% of the trees were found in between the ages of 61-105 years (Table 14) suggesting a single age cohort. The density of seedlings was 10 per plot (Table 6).

The mean cover value of shrubs approached 10% (Table 7). Serviceberry, deer brush, hazel, toyon, honeysuckle, poison-oak, wood rose, Himalayan black berry, blackcap raspberry, and California wild grape (*Vitis californica*).

The meadow contained fifty herbaceous species (Appendix A), twenty-four of them were exotic. The Karuk did not use half of these native species. The herbaceous Karuk use plants found in the meadow were: sword fern, Klamath iris, wild oat (*Avena*

Table 12. Tree density (stems/ha), basal area (m^2/ha), frequency (%), and importance values ((relative density + relative basal area + relative frequency)/3) at Ishi Pishi with the standard error in parenthesis.

Tree species	Density	Basal Area	Frequency	Importance
Apple	0.8 (0.77)	0.1 (0.03)	3.9	**0.4**
Big-leaf maple	10.8 (5.89)	0.1 (0.22)	3.9	**1.5**
Black oak	68.5 (12.3)	2.5 (0.52)	69.2	**13.1**
California bay	113.9 (33.0)	3.3 (0.97)	65.4	**17.0**
Canyon live oak	50.8 (9.56)	5.3 (1.71)	59.2	**13.4**
Cherry	1.5 (1.07)	0.1 (0.03)	7.7	**0.8**
Douglas-fir	84.6 (12.4)	18.5 (3.01)	84.62	**29.9**
Madrone	46.9 (11.4)	2.9 (0.66)	19.2	**7.7**
Oregon white oak	27.7 (9.99)	1.1 (0.39)	34.6	**5.9**
Pacific dogwood	3.1 (2.40)	0.1 (0.01)	7.7	**0.9**
Sugar pine	10.0 (3.19)	2.3 (0.83)	30.8	**5.2**
Tanoak	9.2 (3.37)	1.0 (0.71)	26.9	**3.8**

White fir	0.8 (0.80)	0.1 (0.01)	3.9	**0.4**
Total	428.5	37.4	368.8	**100**

Table 13. Forest composition in terms of tree dominance ((percent cover + relative frequency)/2) Ishi Pishi.

	Apple	Black oak	Bigleaf maple	California bay	Canyon live oak	**Cherry**	Douglas-fir
Canopy:							
Cover (%)	-	1.5	0.8	3.3	2.7	-	25.4
Frequency	-	7.7	3.8	7.7	25.4	-	80.8
Dominance (%)	**-**	**4.4**	**2.2**	**6.6**	**8.4**	**-**	**58.0**
Dominance Rank		5	8	4	3		1
Understory:							
Cover (%)	1.0	8.9	3.5	23.3	17.5	1.2	7.5
Frequency	7.7	69.2	26.9	65.4	61.5	7.7	57.7
Dominance (%)	**1.4**	**13.1**	**5.1**	**21.5**	**17.5**	**1.6**	**11.0**
Dominance Rank	11	3	7	1	2	10	5
Regeneration:							
Cover (%)	0.1	-	0.2	20.4	10.0	0.1	4.6
Frequency	3.8	-	3.8	92.3	96.2	3.8	57.7
Dominance (%)	**0.5**	**-**	**0.7**	**34.5**	**23.3**	**0.5**	**12.3**
Dominance Rank	11		10	1	2	11	4

Table 13 cont'd. Forest composition in terms of tree dominance ((percent cover + relative frequency)/2) at Ishi Pishi.

	Grand fir	Incense cedar	Madrone	Oregon white oak	Pacific dogwood	Sugar pine	Tanoak
Canopy:							
Cover (%)	-	-	0.6	1.4	-	2.9	1.5
Frequency	-	-	3.8	7.7	-	23.1	3.8
Dominance (%)	**-**	**-**	**1.9**	**4.2**	**-**	**11.1**	**3.2**
Dominance Rank	-		9	6		2	7

Understory:							
Cover (%)	0.2	-	9.8	3.7	1.2	0.8	3.5
Frequency	3.8	-	61.5	38.5	11.5	11.5	26.9
Dominance (%)	**0.5**	**-**	**12.8**	**6.5**	**1.9**	**1.8**	**5.1**
Dominance Rank	12	-	4	6	8	9	7
Regeneration:							
Cover (%)	-	0.5	0.2	0.1	0.4	1.0	6.7
Frequency (%)	-	11.5	7.7	1.9	7.7	42.3	69.2
Dominance (%)	**-**	**2.0**	**1.2**	**1.1**	**1.4**	**6.4**	**16.1**
Dominance Rank		6	8	9	7	5	3

Table 14. Frequency Table report of Douglas-fir age classes at Ishi Pishi.

AGE_CLASS	Count	Percent	Graph of Percent
16-30	1	2.38	|
31-45	0	0	
46-60	7	16.67	||||||
61-75	15	35.71	||||||||||||
76-90	14	33.33	|||||||||||
91-105	4	9.52	|||
106-120	0	0	
121-135	1	2.38	|
136-200	0	0	
200+	0	0	

fatua), ripgut brome, soft chess, yerba buena (*Satureja douglasii).* Eight shrub species were identified of which poison-oak, hazel, blackcap raspberry, deer brush, California wild grape, and serviceberry were the Karuk use plants.

Eyese Bar

The tree basal area was 478 m^2/ha with a tree density of 395 stems/ha. Douglas-fir (48%) was the most important species. Madrone (19%) was of secondary importance (Table 15).

Douglas-fir (63%) dominated over sugar pine (11%) in the tree canopy. In the understory, Douglas-fir (23%) dominated over madrone (22%), California bay (15%), and black oak (12%). The regeneration layer was dominated by tanoak (40%) while

California bay (16%) ranked second followed by canyon live oak (15%) and Douglas-fir (11%, Table 16).

The mean age of Douglas-fir approached 100 years (Table 5) while the median age was 94 years. The minimum age of Douglas-fir was 67 years while the maximum age was 142 years. Some 29% of the trees were found in age class five while 25% of the trees were distributed in age class six and seven (Table 17). Most of the trees range from 76 and 120 years suggesting a single age cohort. The density of seedlings was 4 per plot (Table 6).

The mean percent cover of shrubs approached 2% (Table 7). Serviceberry, hazel, honeysuckle, wood rose, and poison-oak were the common species.

The meadow contained sixty-one herbaceous species (Appendix A), five of them were exotic. The Karuk did not use forty-two of these native plants. The herbaceous Karuk use plants found in the meadow were: bracken fern (*Pteridium aquilinum* var.

Table 15. Tree density (stems/ha), basal area (m^2/ha), frequency (%), and importance values ((relative density + relative basal area + relative frequency)/3) at Eyese Bar with the standard error in parenthesis.

Tree species	Density	Basal area	Frequency	Importance
Big-leaf maple	2.5 (2.50)	0.2 (0.15)	6.3	**0.7**
Black oak	16.3 (3.75)	0.8 (0.21)	56.3	**6.0**
California bay	23.8 (7.58)	0.7 (0.24)	56.3	**6.6**
Canyon live oak	5.0 (2.89)	1.2 (1.02)	25.0	**3.1**
Douglas-fir	236.3 (27.9)	30.0 (2.68)	93.8	**47.7**
Incense-cedar	6.3 (3.01)	1.3 (0.84)	25.0	**3.2**

Jeffrey Pine	5.0 (2.89)	0.8 (0.50)	18.8	**2.4**
Madrone	75.0 (15.2)	8.6 (2.06)	87.5	**18.7**
Oregon white oak	12.5 (5.74)	0.6 (0.23)	37.5	**4.2**
Sugar Pine	8.8 (3.64)	3.3 (1.52)	31.3	**5.3**
Tanoak	3.8 (2.02)	0.6 (0.53)	18.8	**2.1**
Total	395.0	47.9	456.3	**100**

Table 16. Forest composition in terms of tree dominance ((percent cover + relative frequency)/2) at Eyese Bar.

	Bigleaf Maple	Black oak	California bay	Canyon live oak	Douglas-fir	Incense cedar
Canopy:						
Cover (%)	-	-	-	-	30.9	1.3
Frequency	-	-	-	-	100	12.5
Dominance (%)	**-**	**-**	**-**	**-**	**63.3**	**4.8**
Dominance Rank		-	-	-	1	5
Understory:						
Cover (%)	2.2	6.3	10.9	3.8	16.3	0.9
Frequency	6.3	68.8	56.3	25.0	93.8	12.5
Dominance (%)	**2.3**	**12.4**	**14.5**	**5.6**	**22.6**	**2.1**
Dominance Rank	8	4	3	7	1	9
Regeneration:						
Cover (%)	-	0.1	10.0	7.4	3.9	56.3
Frequency	-	12.5	68.8	100	75.0	31.3
Dominance (%)	**-**	**1.6**	**15.5**	**14.9**	**11.3**	**4.3**
Dominance Rank	-	7	2	3	5	6

Table 16 cont'd. Forest composition in terms of tree dominance ((percent cover + relative frequency)/2) at Eyese Bar.

	Jeffrey pine	Madrone	Oregon white oak	Sugar pine	Tanoak
Canopy:					
Cover	1.6	3.4	-	3.8	1.3
Frequency (%)	18.8	25.0	-	25.0	6.3
Dominance (%)	**6.8**	**10.7**	**-**	**11.1**	**3.1**
Dominance Rank	4	3	-	2	6
Understory:					
Cover (%)	-	17.8	4.1	0.9	5.0
Frequency	-	81.3	37.5	12.5	43.8
Dominance (%)	**-**	**22.4**	**7.3**	**2.1**	**8.7**
Dominance Rank	-	2	6	9	5
Regeneration:					
Cover (%)	0.1	-	0.1	1.9	41.6
Frequency	6.3	-	6.3	87.5	100
Dominance (%)	**0.8**	**-**	**0.9**	**10.7**	**39.9**
Dominance Rank	8	-	9	4	1

Table 17. Frequency table report of Douglas-fir age classes at Eyese Bar.

AGE_CLASS	Count	Percent	Graph of Percent
16-30	0	0	
31-45	0	0	
46-60	0	0	
61-75	4	14.29	|||||
76-90	8	28.57	||||||||||
91-105	7	25.00	|||||||||
106-120	7	25.00	|||||||||
121-135	0	0	
136-200	2	7.14	||
200+	0	0	

pubescens), sword fern, ground iris (*Iris macrosiphon*), blue dicks, deer potato (*Triteleia laxa*), ripgut brome, soft chess, blue wild rye, sweet cicely, yarrow, wintergreen, hill lotus (*Lotus humistratus*), vinegar weed (*Trichostema lanceolatum*), and naked buckwheat (*Eriogonum nudum* var. *oblongifolium*). Six shrub species were identified of which poison-oak, hazel, blackcap raspberry, and buck brush were the shrubs used by the Karuk.

Persido Bar

The tree basal area was 48 m^2/ha with a tree density of 450 stems/ha. Tanoak (42%) and Douglas-fir (36%) were equally important species. Madrone (13%) was of secondary importance (Table18).

Douglas-fir (53%) dominated the canopy while madrone (29%) was of secondary dominance. In the understory, tanoak (47%) dominated over Douglas-fir (18%) and madrone (15%). The regeneration layer was dominated by tanoak (56%) while Douglas-fir (19%) ranked second and California bay (13%) ranked third (Table 19).

The mean age of Douglas-fir approached 120 years (Table 5) while the median age was 68 years. The minimum age of Douglas-fir was 19 years while the maximum age was 340 years. Some 66% of the data was found in the first six age classes (15-105 years) suggesting two age cohorts (Table 20). The density of seedling was 8 per plot (Table 6).

The mean percent cover value for shrubs approached 10% (Table 7). Deer brush, honeysuckle, wood rose, Himalayan black berry, blackcap raspberry, snowberry, and poison-oak were the common species.

Table 18. Tree density (stems/ha), basal area (m^2/ha), frequency (%), and importance values ((relative density + relative basal area + relative frequency)/3) at Persido Bar with the standard error in parenthesis.

Tree species	Density	Basal Area	Frequency	Importance
Black oak	7.5 (7.50)	0.2 (0.23)	6.3	**1.4**
California bay	1.3 (1.25)	0.1 (0.09)	6.3	**0.8**
Canyon live oak	11.3 (7.74)	0.3 (0.25)	18.8	**3.0**
Douglas-fir	118.8 (45.7)	24.8 (4.07)	100	**36.4**
Madrone	50.0 (17.8)	4.6 (1.58)	56.3	**12.8**
Pacific dogwood	3.8 (2.02)	0.1 (0.04)	18.8	**2.3**
Tanoak	255.0 (34.3)	17.6 (2.70)	100	**41.5**
Sugar pine	1.3 (1.25)	0.2 (0.16)	6.3	**0.8**
White alder	1.3 (1.25)	0.3 (0.25)	6.3	**0.9**
Total	450.0	48.3	318.8	**100**

Table 16. Forest composition in terms of tree dominance ((percent cover + relative frequency)/2) at Eyese Bar.

	Bigleaf Maple	Black oak	California bay	Canyon live oak	Douglas-fir	Incense cedar
Canopy:						
Cover (%)	-	-	-	-	30.9	1.3
Frequency	-	-	-	-	100	12.5
Dominance (%)	**-**	**-**	**-**	**-**	**63.3**	**4.8**
Dominance Rank		-	-	-	1	5
Understory:						
Cover (%)	2.2	6.3	10.9	3.8	16.3	0.9
Frequency	6.3	68.8	56.3	25.0	93.8	12.5
Dominance (%)	**2.3**	**12.4**	**14.5**	**5.6**	**22.6**	**2.1**
Dominance Rank	8	4	3	7	1	9
Regeneration:						
Cover (%)	-	0.1	10.0	7.4	3.9	56.3
Frequency	-	12.5	68.8	100	75.0	31.3
Dominance (%)	**-**	**1.6**	**15.5**	**14.9**	**11.3**	**4.3**
Dominance Rank	-	7	2	3	5	6

Table 16 cont'd. Forest composition in terms of tree dominance ((percent cover + relative frequency)/2) at Eyese Bar.

	Jeffrey pine	Madrone	Oregon white oak	Sugar pine	Tanoak
Canopy:					
Cover	1.6	3.4	-	3.8	1.3
Frequency (%)	18.8	25.0	-	25.0	6.3
Dominance (%)	**6.8**	**10.7**	**-**	**11.1**	**3.1**
Dominance Rank	4	3	-	2	6
Understory:					
Cover (%)	-	17.8	4.1	0.9	5.0
Frequency	-	81.3	37.5	12.5	43.8
Dominance (%)	**-**	**22.4**	**7.3**	**2.1**	**8.7**
Dominance Rank	-	2	6	9	5
Regeneration:					
Cover (%)	0.1	-	0.1	1.9	41.6
Frequency	6.3	-	6.3	87.5	100
Dominance (%)	**0.8**	**-**	**0.9**	**10.7**	**39.9**

Dominance Rank	8	-	9	4	1

Table 20. Frequency table report of Douglas-fir age classes at Persido Bar.

AGE_CLASS	Count	Percent	Graph of Percent
16-30	9	33.33	|||||||||||
31-45	2	7.41	||
46-60	1	3.70		
61-75	3	11.11	||||
76-90	2	7.41	||
91-105	1	3.70		
106-120	0	0	
121-135	0	0	
136-200	3	11.11	||||
200+	6	22.22	||||||

The meadow contained thirty-eight herbaceous species (Appendix A), twenty-two of them were exotic. The Karuk did not use twelve of the native plants. The herbaceous Karuk use plants in the meadow were: bracken fern, sword fern, ripgut brome, soft chess, and wintergreen. Fourteen shrub species identified of which poison-oak, hazel, blackcap raspberry, Oregon grape (*Berberis aquilinum* var. *aquilinum*), and California wild grape were Karuk use plants.

Patterns Across Sites

Many characteristics of Persido Bar differed from the other sites. The tree basal area and tree density of tanoak at Persido Bar varied significantly from the other sites ($p<0.0000$). Persido Bar differed from the other sites in the high importance of tanoak (40%, Figure 2). At the other sites, tanoak importance never exceeded more than 4%.

Based on Douglas-fir age distribution, Persido Bar was also very different from the other sites (Figure 2). The age distribution at Persido Bar included ages from 19 years to 340 years. The oldest trees at the other sites never surpassed 162 years.

The meadow at Persido Bar contained several European horticultural species. The species that stand out among the sites making Persido Bar very different included: St. John's wort (*Hypericum patulum*), California privet (*Ligustrum ovalifolium*), Japanese honeysuckle (*Lonicera japonica*), apple, cherry, common lilac (*Syringa vulgaris*), and Japanese wisteria (*Wisteria floribunda*). Of these, only apple and cherry were located in other meadow sites (Appendix A).

Patterns Within Sites

Tree Basal Area and Density

Based on the across sites comparisons, I combined the data from four sites (Oak Bottom, Grasshopper, Ishi Pishi, and Eyese Bar) to make comparisons between tiers. I then compared results between tier for these four sites to the four tiers at Persido Bar.

As a result of the tier comparison, I found that California bay was a meadow edge species, as basal area varied significantly across tiers (Kruskal-Wallis one-way ANOVA on ranks, p=0.0030, Table 21), being highest near the meadow edge (tier 1) and generally lower with distance from the meadow margin. California bay density also varied significantly across tiers (Kruskal-Wallis one-way ANOVA on ranks p=0.0035). The pattern was one of increasing tree density with distance towards the meadow.

Figure 2. Tanoak importance ((relative density + relative basal area + relative frequency)/3) across sites.

Figure 3. Age distribution of Douglas-fir across sites.

The deciduous oaks were also considered to be a meadow edge species. Tree basal area varied significantly across tiers (Kruskal-Wallis one-way ANOVA on ranks, p=0.0004, Table 21). Tree basal area was highest near the meadow margin (tier 1) and generally lower with distance from the meadow margin. Tree density varied significantly across tiers (Kruskal-Wallis one-way ANOVA on ranks, p=0.0008). The pattern was one of increasing tree density with distance toward the meadow.

Canyon live oak tree basal area and tree density did not vary significantly across tiers and was indifferent to the meadow (Table 21). Tree basal area and density increased with distance from the meadow edge, but the general pattern displayed was one of similar low basal area and density across tiers.

Table 21. Tree basal area (m^2/ha) and tree density (stems/ha) by species within sites, with the standard error in parenthesis. Means with the same letter are not significantly different (one-way ANOVA, p=0.05).

Tree species	Tier one	Tier two	Tier three	Tier four	p value
California bay					
Basal area	3.9 (1.22) [a]	0.4 (0.19) [b]	1.1 (0.52) [b]	0.4 (0.23) [b]	0.0030
Density	129 (41.51) [a]	14.4 (6.43) [b]	32.2 (12.22) [b]	17.8 (10.71) [b]	0.0035
Canyon live oak					
Basal area	1.0 (0.55)	1.1 (0.48)	3.1 (1.67)	10.4 (3.14)	0.1480
Density	12 (3.95)	23.3 (9.60)	43.3 (24.00)	70 (19.08)	0.1821
Deciduous oaks					
Basal area	3.0 (0.59) [a]	1.2 (0.23) [b]	0.9 (0.24) [b]	0.68 (0.23) [b]	0.0004
Density	52.5 (8.46) [a]	36.7 (7.45) [ab]	24.4 (6.53) [a]	17.8 (6.26) [b]	0.0009
Douglas-fir					
Basal area	12.3 (2.54) [a]	29.5 (3.38) [b]	24.1 (4.44) [b]	14.2 (2.69) [a]	0.0010
Density	81.0 (17.07) [a]	171.1 (27.31) [b]	135.6 (23.68) [ab]	114.4 (25.45) [ab]	0.0346
Madrone					
Basal area	11.6 (2.26)	9.5 (2.27)	5.8 (1.59)	8.2 (1.61)	0.5958
Density	115 (32.92)	82.2 (17.48)	67.8 (15.60)	101.1 (19.23)	0.5827
Tanoak					
Basal area	1.4 (1.16)	0.7 (0.60)	0.1 (0.05)	0.2 (0.15)	0.7672

Density	7.5 (4.03)	5.7 (3.27)	4.3 (3.09)	4.3 (3.09)	0.8650

Figure 4. General pattern of Douglas-fir ages across tiers of plots with standard error represented by bars.

Figure 5. General pattern of Douglas-fir seedling density across tiers of plots with standard error represented by bars.

Douglas-fir pattern was complicated. Tree basal area varied significantly across tiers (one way ANOVA, p=0.0009, Table 21). Mid-distances (tier 2 and 3) contained the higher tree basal area values with equally low values near the meadow margin and far from the meadow margin (tier 4). Tree density varied significantly across tiers (Kruskal-Wallis one-way ANOVA on ranks, p=0.034). Mid-distances (tier 2) had the highest tree density and it varied significantly from the meadow margin (tier 1). Low tree densities occurred far from the meadow margin (tier 3 and 4).

Madrone tree basal area and density did not vary significantly across tiers and was indifferent to the meadow (Table 21). Tree basal area and density of madrone did decrease slightly at the mid-distances from the meadow margin.

Tanoak tree basal area and density was low throughout the stands and did not vary across tiers (Table 21). The importance value of tanoak was minimal.

Age Pattern

The age of Douglas-fir trees varied significantly (one-way ANOVA, p=0.046) across tiers. The youngest trees were near the meadow margin (tier 1) and averaged 68 years and oldest trees were farthest from the meadow margin at an average of 87 years (Figure 3).

Douglas-fir Seedlings

Seedling density of Douglas-fir varied significantly (Kruskal-Wallis one-way ANOVA on ranks, p=0.0324) across tiers. Mid-distance (tier 2) had the highest seedling density, seven times that of plots far from the meadow margin (tier 4, Figure 4).

Persido Bar

Tree Basal Area and Density

California bay tree basal area and density was extremely low. California bay only occurred in the mid-distance (tier two) from the meadow margin. Canyon live oak tree basal area and density was extremely low. Canyon live oak only occurred at distances far from the meadow margin. Deciduous oak tree basal area and density was extremely low. Oaks only occurred far from the meadow margin (tier 4, Table 22).

Douglas-fir tree basal area varied insignificantly across tiers. Mid-distances (tier 2,3) contained the higher basal area values with equally low values near the meadow margin (tier 1) and far from the meadow margin (tier 4). Tree density of Douglas-fir varied insignificantly across tiers. However, the Douglas-fir density was three times higher near the meadow margin (tier 1) than at other distances (Table 22).

Madrone tree basal area and density did not vary significantly across tiers. The tree basal area and density did increase with distances from the meadow margin. The highest tree basal area and density occurred far from the meadow margin (tier 4). Tanoak tree basal area and density did not vary significantly across tiers. The tree basal area and density was slightly higher in the mid-distances (tier 2 and 3, Table 22).

Age Distribution

Douglas-fir age varied significantly (one-way ANOVA, p=0.0001) across tiers. The youngest conifers were near the meadow margin (tier 1) at 32 years of age. At mid-distance, ages were about 200 years and 97 years of age far from the meadow margin (tier 4, Figure 6).

Douglas-fir Seedlings.

Seedling density of Douglas-fir varied significantly across tiers. The highest density was at the meadow margin (tier 1), and density there was five times that at other distances from the meadow margin (Figure 7).

Table 22. Basal area (m^2/ha) and density (stems/ha) by species at Persido Bar, with the standard error in parenthesis. Means with the same letter are not significantly different (one-way ANOVA, p=0.05).

Tree Species	Tier one	Tier two	Tier three	Tier four	p value
California bay					
Basal area	0	0.4 (0.37)	0	0	0.3916
Density	0	5.0 (0.50)	0	0	0.3916
Canyon live oak					
Basal area	0 [a]	0 [a]	0 [a]	1.3 (0.90) [b]	0.0165
Density	0 [a]	0 [a]	0 [a]	45.0 (26.30) [b]	0.0165
Deciduous oaks					
Basal area	0	0	0	0.9 (0.46)	0.3916
Density	0	0	0	30 (30.00)	0.3916
Douglas-fir					
Basal area	17.8 (6.35)	26.8 (3.89)	39.5 (11.86)	15.3 (3.82)	0.1317
Density	305.0 (157.56)	35.0 (9.57)	40.0 (8.16)	90.0 (26.30)	0.1688
Madrone					
Basal area	2.2 (1.68)	0.4 (0.37)	5.9 (3.43)	10.2 (4.00)	0.1208
Density	20.0 (11.55)	5.0 (5.00)	40.0 (24.49)	135.0 (46.46)	0.0763
Tanoak					
Basal area	16.0	23.8	20.7	10.1	0.3211

	(14.69)	(10.06)	(6.89)	(8.68)	
Density	185.0	325.0	330.0	180.0	0.2193
	(61.84)	(61.84)	(55.08)	(76.16)	

Figure 6. Persido Bar Douglas-fir ages across tiers of plots with standard error represented by bars.

Figure 7. Persido Bar Douglas-fir seedling density across tiers of plots with standard error represented by bars.

Meadow Composition

Based on the results of the patterns across sites section, I combined the data within four sites (Oak Bottom, Grasshopper, Ishi Pishi, and Eyese Bar) to examine the general pattern of meadow composition. I then compared results within sites to the pattern at Persido Bar.

General Pattern

Most of the forb species are native non-use plants. Exotic non-use plants represent a large part of the meadow composition while native and exotic use plants are low (Table 23).

Native non-use graminoid species represent the largest portion of the meadow species while exotic non-use plants are substantially represented as well. Native and exotic use graminoid species are low in number (Table 23).

Most of the shrub species are native-use shrubs while native non-use shrubs are also relatively well represented. Exotic shrubs species are uncommon (Table 23).

Persido Bar

Exotic non-use forb species represent a large part of the meadow composition while no exotic use forb species are present. Native non-use forb species represent a smaller portion of the meadow composition while native use forbs are low in number (Table 24).

Table 23. General pattern of meadow composition by class (%).

	Forbs (n=77)	Graminoids (n=27)	Shrubs (n=17)
Native use	19	7	47
Native non-use	47	52	29
Exotic use	1	11	12
Exotic non-use	33	30	12

Table 24. Persido Bar meadow composition by class (%).

	Forbs (n=32)	Graminoids (n=8)	Shrubs (n=16)
Native use	13	0	30
Native non-use	28	25	19
Exotic use	0	25	13
Exotic non-use	59	50	38

The meadow was limited with only 8 graminoid species found. Exotic non-use graminoid species represent the largest portion of the meadow grasses while native non-use grasses and exotic use grasses represent the other half of the graminoid composition in the meadow. There are no native use grasses in the meadow (Table 24).

Most of the shrubs species are exotic non-use shrubs while native-use shrubs relatively well represented. Native non-use shrubs and exotic use shrubs are uncommon (Table 24).

Karuk Use Plants

Plants of many uses were found at all sites. The majority of the use plants found in the sites (46 species) were food plants (Table 25). Medicine plants were also common. Plants used for cords, ceremonial uses, and charms were represented by six or fewer species. The other uses of plants were represented by one species. Appendix B lists the Karuk use plants found along with their common name, Karuk name and use.

Table 25. Number of plant species used by Karuk at use sites.

Plant use	#
Ceremonial use	2
Charm	3
Cord	6
Dye	1
Food	17
Food covering	1
Fumigant	1
Game	1
House construction	1
Implement	1
Medicine	11
Perfume	1

DISCUSSION

Site Descriptions

The Karuk had a distinctive influence on the landscape of the lower Klamath River drainage. To understand this influence, I will describe the current status of the vegetation in each historic Karuk cultural use site in terms of tree composition and structure, age distribution of Douglas-fir, seedling density, and meadow composition before comparing general patterns.

Oak Bottom

The forest has the lowest tree basal area and tree density of the sites. There are relatively fewer, smaller trees in this forest than at the other sites. Forests with this structure characterizes this stand to be in the young stages of forest development (Oliver and Larson 1990). The high tree basal area and density of madrone is explained by the dry, south facing slopes that is favored by madrone and its ability to sprout from a burl (McDonald and Tappeiner 1990). I noticed when sampling that madrone stems were not evenly dispersed throughout the stand, but appeared in patches. Forest structural and compositional characteristics suggest that this forest was more open in the past.

Finding Oregon ash and the high tree density of Oregon white oak is expected for a terrace location (Stein 1990). Apple trees are a sign of Euro-American influence. It appears that the Karuk brought in the trees after contact because this site was never occupied by Euro-Americans.

The average age of Douglas-fir trees are the youngest found in the study with the oldest tree at 87 years and most about 60 years old (Table 5). Two age cohorts are seen (Table 8); one for 30 year-aged trees and another at 80 years. This pattern suggests an initial establishment of Douglas-fir seedlings soon into the fire suppression period and a second later as the forest canopy opens with understory reinitiation (Oliver and Larson 1990).

The meadow contained many exotic grass species (Appendix A) and few Karuk use plants. Orleans iris (*Iris tenax* ssp. *klamathensis*), a plant used in basketry, occurred in the meadow in low numbers. This rare plant (Skinner et al. 1994) is threatened by periwinkle, a sprawling yard ornamental that reproduces vegetatively (Hickman 1993).

Its river terrace and south facing slopes account for some of the site characteristics. The Karuk occupied this location until the early 1900's. I found substantial evidence of pit houses and graves so this site was utilized heavily at one time. This dry location or late abandonment may account for the lower level of forest development as well.

Grasshopper Flat

Douglas-fir and madrone share importance in the forest with similar tree basal area and density. Canyon live oak importance may be explained by the dry, south facing slopes that is favored by canyon live oak (Thornburgh 1990). The canopy is dominated by Douglas-fir (Table 9). The highest density of Douglas-fir seedlings is found at this site (Table 6). One plot has almost 200 seedlings while other plots have as few as five.

The average age of Douglas-fir trees is 87 years and most of the trees established less than 100 years ago (Table 5). These trees represent the initial cohort following fire suppression (Table 11). The forest structure is further along in development (Oliver and Larson 1990) with older trees than Oak Bottom. This previously open stand follows a forest pattern of development seen at all sites but Persido Bar.

The meadow has a larger number of native species mixed with exotic ones (Appendix A) including yellow tritelia (*Triteleia crocea* var. *crocea*). The Karuk did not use this rare lily (Skinner et al. 1994) but the potential loss of this lily is high at this site as many abundant species of exotic grass are present. This meadow is distinctive with nineteen other herbaceous species not found in the other meadows. This meadow borders a serpentine slope, which may account for distinctiveness.

Its south facing slopes may account for some of the site characteristics. This was the only site in my study that the Karuk used for ceremonial purposes. This dry location or different utilization may account for the younger stage of forest development.

Ishi Pishi

Douglas-fir is the most important species in terms of tree basal area and density (Table 12). California bay has a larger compositional role than other sites with a high density. The California bay tree basal area is low indicating many stems are very small. This was the only stand where white fir appears. This is unusual because typically white fir is found at elevations above 900m (Hickman 1993). The presence of apple and cherry indicate planting by Euro-American settlers. Sugar pine (*Pinus lambertiana)* plays a minor role in this stand as well. This species was of particular use to the Karuk, as the

seeds were a primary source of food (Schenck and Gifford 1952, Davis and Hendryx 1991).

Douglas-fir occurs often in the canopy with a higher percent cover than the other species combined (Table 13). At this time Douglas-fir are overtopping California bay, canyon live oak, black oak, and madrone trees of lower stature. Douglas-fir seedling density in the forest is low and patchy (Table 6).

The average age of Douglas-fir trees is 75 years (Table 5) with the oldest cored tree at 140 years and most of the cored trees less than 100 years old. This pattern suggests that the initial establishment of Douglas-fir occurs with early attempts to suppress fire (Table 14). The forest structure is further along in development (Oliver and Larson 1990) with older trees. This previously open stand follows a forest pattern of development seen at all sites but Persido Bar.

The meadow has contains many exotic grass species and forb species such as *Erodium cicutarium, Geranium molle, Silene gallica,* and *Stellaria media,* which are pernicous urban weeds (Hickman 1990) that are often found in disturbed areas (Appendix A). The number of Karuk use plants is very low. The Orleans Iris occurs in low numbers here and as seen at Oak Bottom, this rare plant (Skinner et al. 1994) is threatened by periwinkle (Hickman 1993). Yerba buena, a plant used for making tea, was found only at this site.

The Karuk occupied this site until Euro-Americans moved on to the land in the 1850's. I found substantial evidence of both Karuk settlement, in the form of pit houses

and artifacts, and Euro-American settlement, in the form of decayed housing structures and scrap metal. The earlier change in settlement may account for some of the more advanced stage of forest development found here.

Eyese Bar

Douglas-fir is the most important species at Eyese Bar (Table 15) with more than twice as many Douglas-fir trees than any other species. Madrone has a secondary role, but the basal area and density are low. Douglas-fir dominates the canopy as well (Table 16) and overtops the understory species, which include the deciduous oaks, canyon live oak, California bay, and madrone. A very high amount of tanoak regeneration is seen at this site. Sawyer et al. (1977) suggest that tanoak regeneration is common under Douglas-fir dominated stands and may lead to the initiation of a tanoak understory as Douglas-fir trees mature. Similar to other sites, Douglas-fir seedling density in the forest is low and patchy (Table 5).

The age distribution of Douglas-fir shows that most trees are less than 120 years (Table 17) and that the trees established over a long period. This pattern suggests that there was an initial establishment of Douglas-fir with the suppression of fire. The forest structure is further along in development (Oliver and Larson 1990) with older trees than other use sites. This previously open stand follows the forest pattern of development seen at all sites but Persido Bar.

The meadow at Eyese Bar has the highest number of many native species (Appendix A) of the sites. Though the same exotic grasses are present here, a few interesting native perennial bunch grasses appear here. Its location on the west side of

the river has made access to the site difficult as major roads are on the east side. In addition, there has not been evidence of Euro-American homesteading. This is the only site where deer potato appears. This was an important food plant for the Karuk (Schenck and Gifford 1952, Davis and Hendryx 1991).

The village associated with this site was most likely on the river bar. The meadow is located about 300m above the river bars. Though evidence of grave sites are apparent in the forest above the meadow, most of the Karuk lived on the river bar. This site was abandoned earlier than other sites, which may account for the later stage of forest development.

Persido Bar

Persido Bar is different than the other sites in many ways. Tanoak density is twice as great as Douglas-fir. However, Douglas-fir basal area is larger than tanoak basal area. There are few, large Douglas-fir trees mixed with smaller tanoak trees. Madrone is present in less numbers than tanoak, and deciduous oaks are a very small portion of the stand (Table 18).

The canopy is dominated by Douglas-fir (Table 19). Tanoak trees have high cover forming a layer below the Douglas-fir trees. Tanoak dominates the understory and regeneration layers. The forest meets old-growth definitions for being an old-growth

stand (Marcot et al. 1991). It has mature and overmature trees in the overstory with stand diameters above 81cm, and has a multi-layered canopy and trees of several age classes (Table 20).

The age of Douglas-fir trees are the oldest of the sites (Table 5). The oldest tree 340 years old though most are less than 100 years old. Two cohorts are seen: one for trees that are 160 years or older and one for trees aged 100 or younger (Table 20). This pattern suggests that there was an initial establishment of Douglas-fir hundreds of years ago and a second cohort with the suppression of fire.

The Persido Bar meadow is composed mostly of exotic species (Appendix A). Yellow star-thistle (*Centaurea solstitialis*) and Scotch broom (*Cytisus scoparius*) are indicators of a highly disturbed site as they are commonly found in pastures and roadsides and are categorized as invasive species (Hickman 1993). The numerous horticultural species are an artifact of Euro-American homesteading. Interestingly, mock orange (*Philadelphus lewisii*), a plant the Karuk used for making arrow shafts, was found only at Persido Bar.

Patterns Across Sites

The general pattern seen at Oak Bottom, Grasshopper Flat, Ishi Pishi, and Eyese Bar suggests younger forests than the one at Persido Bar. Even though the forests differed to some degree in composition, they have Douglas-fir or Douglas-fir / madrone canopies. The age distributions were similar in that no sampled tree exceeded 162 years in age. Most of the cored trees were 100 years old or younger.

The four sites were traditionally used by the Karuk as either a village or a ceremonial ground. LaLande and Pullen (1999) believe that Indian fires were limited to resource and settlement grounds. They consider fire to be the major force in establishing and maintaining forests immediately around settlements and in areas used to obtain resources.

Persido Bar appeared similar to the other sites in that it was an open meadow surrounded by a forest, but at this site Douglas-fir and tanoak form two layers. Bingham and Sawyer (1991) point out that forest canopies with two levels are characteristic of old-growth Douglas-fir-tanoak forests and that forests under 100 years of the same type have one level.

I initially believed Persido Bar to be a historic Karuk cultural use site, but it did not appear on W.L. Bright's map of Karuk villages (Bright 1978). Kathy McCovey, USFS Cultural Resource specialist, surveyed the area with me and did not find any "normal" characteristics of a village site or ceremonial ground. No artifacts were uncovered or pit houses located. We found no evidence to suggest that this area was a gathering ground though the presence of a large stand of tanoak suggests that the Karuk may have gathered acorns at this site.

Forest Pattern Within Sites

General Pattern

Historic Karuk cultural use sites are being invaded by Douglas-fir. This invasion is a result of the change in management from traditional Karuk to Euro-American management. Fire suppression has allowed Douglas-fir to increase in numbers and expand into meadows.

Tree basal area and density, and Douglas-fir age are consistent with the position that fire would maintain rather open forests at use sites. Hillman and Salter (1997) argue that the Karuk set fires at the top of the ridges and that they burned downhill at low intensities. The effects of fire on Douglas-fir is well studied (Agee 1991, 1993, Isaac 1943, Stuart et al. 1993, Wills and Stuart 1994). Temperatures above 60° C are lethal to Douglas-fir seeds and will destroy most seeds on the forest floor (Isaac 1943). Agee (1993) maintains that if young stands of Douglas-fir/hardwoods are repeatedly burned, the small Douglas-fir tree will be killed. This fire pattern leaves the sprouting hardwoods, such as madrone and the deciduous oaks, to continue on as a part of the stand.

Tree age varies within the forests. Douglas-fir trees are youngest near the meadow margin (Figure 4) and oldest farther from the meadow margin, but Douglas-fir tree age in general is similar throughout the forests. This pattern suggests that seeds did not come from a far distance, but instead Douglas-fir has been a component of these

stands for centuries. However, the higher density of Douglas-fir with fire suppression has lead to the decline of shade intolerant species such as black oak and Oregon white oak (Barnhardt et al. 1987, Sugihara and Reed 1987).

Leiberg (1900) observed that most Indian-set fires occurred in the fall and were "small and circumscribed" but of frequent occurrence. Wills and Stuart (1994) report that the pre-suppression mean fire interval for their study sites within the Klamath National Forest was 10-17 years.

The condition of the hardwoods is consistent with the position that fire maintained rather open forests at the use sites. Hardwoods could grow to large trees with stronger shade during a long period lacking fire. Tappeiner et al. (1992) and Stuart et al. (1993) point out a dense hardwood, shrub, or grass cover inhibits Douglas-fir seedling establishment, but as a stand of hardwood tree ages the canopy will open up creating less shady conditions suitable for Douglas-fir establishment. This pattern is seen near the meadow margin (Figure 4).

Frequent fire would maintain rather open patches of hardwoods with meadow-like conditions between the patches. Full light and grass cover would inhibit Douglas-fir establishment. Once the hardwoods grew, the meadow-like areas would be closed and areas of moderately shady conditions necessary for Douglas-fir establishment would exist. These conditions should not be found at the meadow margin or distances remote from the meadow. Plots in the second tier have highest Douglas-fir seedling densities (Figure 5).

Persido Bar

If a village site existed in the past, it was apparently some distance from my study site. Less frequent and or intense fire would allow the forest to develop old-growth characteristics and allow trees to reach older ages (Agee 1993) and for Douglas-fir and tanoak to have similar basal area near the meadow margin (Table 22). However,

Douglas-fir density is almost twice as large as tanoak density suggesting that there are many small Douglas-fir trees at the meadow margin. Fewer, larger trees are established further from the meadow edge. The forest lacks many deciduous oak trees and those present occur far from the meadow edge unlike the general pattern seen at the other four sites.

The age distribution of Douglas-fir is concurrent with old-growth characteristics (Bingham and Sawyer 1991). The forest is two-layered with old Douglas-fir trees farther away from the meadow margin (Figure 6). The oldest tree cored at Persido Bar was 350 years, almost 200 years older than trees in other sites.

The distribution of Douglas-fir seedlings is unlike the general pattern in that Douglas-fir seedlings appear to be invading the meadow (Figure 7). Such a pattern is consistent with the idea that Persido Bar was homesteaded. Euro-Americans would clear and expand open lands forming an abrupt boundary with the adjacent forest. Once gone, these boundaries could be invaded by Douglas-fir.

Why is the pattern of Douglas-fir establishment so different? The Karuk used infrequent, low severity fires regime, but at Persido Bar fires were less frequent. Agee (1993) points out that when fire is not part of the system for long periods of time, forests with Douglas-fir develops a "multi-layered architecture". Douglas-fir can survive moderately intense fires once a thick, corky bark on the lower bole and roots develop to protect the cambium from heat damage (Hermann and Lavender 1990).

Meadow Composition

General Pattern

The number and abundance of use plants found in the meadows was low (Table 23). Herbaceous and graminoid use-species comprised less than a quarter of the species found in the meadow. Abundant species in the meadow are exotic, annual grasses such as dogtail (*Cynosurus echinatus*), Kentucky bluegrass (*Poa pratensis*), rattlesnake grass (*Briza minor*) and European hairgrass (*Aira caryophllea*). Two other exotic grasses, ripgut brome (*Bromus diandrus*) and soft chess (*B. hordeaceus*), were used by the Karuk. A large percent of the abundant herbaceous species are also exotic.

These species were most likely brought into the area with homesteaders in the 1850's and later. Some of the meadows, such as Ishi Pishi and Oak Bottom, are currently accessible

and are used by the Karuk for fishing grounds and ceremonies, respectively. Current activities may also account for the high frequency of exotic species in these meadows.

Persido Bar

Homesteading has produced a very different effect on the species composition than did Karuk practices. Exotic weeds, such as Scotch broom and star thistle, and horticultural species result in a very different species composition today from the general meadow pattern (Table 24).

Karuk Use Plants

Karuk ethnobotany has been well studied (Baker 1981, Davis and Hendryx 1991, and Schenck and Gifford 1952). Other investigators have commented on Karuk ethnobotany (Harrington 1932, Kroeber 1953, and Beals and Hester 1974). Beals and Hester (1974) have compiled a list of 239 identifiable use plant species, subspecies or varieties using Schenck and Gifford (1952; Table 1). The Karuk did not use sixty-five of these identified taxa. My list presents the current status of the Karuk use plants in the studied meadows (Appendix B).

Four of the use plants recognized by Schenck and Gifford (1952) are lichen and fungi. Six tree species common to the region but not found in my sites were: ghost pine (*Pinus sabiniana*), knobcone pine (*Pinus attenuata*), western juniper (*Juniperus occidentalis* var. *occidentalis*), coastal redwood (*Sequoia sempervirens*), Port-Orford cedar (*Cupressus lawsoniana*), Pacific yew (*Taxus brevifolia*), and black cottonwood (*Populus trichocarpa*).

Of the eleven grass species recognized by the Karuk, five species were used. The four species found in my sites were wild oat, ripgut brome, soft chess, and blue wildrye. The two species not found in my census are California vanilla grass (*Heirchloe macrophllya*) and slender hairgrass (*Deschampsia elongata*). Both species occur below 750 meters in either meadows or dry conifer forests (Hickman 1993). These plants were ground into flour and used as food (Schenck and Gifford 1952).

The Karuk utilized eight lily species as food. The bulbs were harvested with a stick and baked in an earth oven and eaten (Schenck and Gifford 1952). I found deer potato and blue dicks (*Dichelostemma capitatum* ssp. *capitatum*). I did not find two species of soap plant (*Chlorogalum pomeridianum* and *C. angustifolium*), two species of wild onion (*Alium bolanderi* and *A. acuminatum*), yellow globe lily (*Calochortus amabilis*), and tiger lily (*Lilium pardalinum*). These plants are typically found below 500m in forest edges, woodlands, gaps in conifer forests, and moist wooded slopes (Hickman 1993). The other lily species listed in similar habitats and elevations but not in my study sites included: firecracker plant (*Dichelostemma ida-maia*) and coast trillium (*Trillium ovatum* ssp. *ovatum*). These species were used as ornaments and medicine.

Unfound taxa that I expected to find in the meadows based on habitat and elevational requirements include: candy flower (*Claytonia sibirica*), four o'clock (*Mirabilis greenei*), bell catchfly (*Silene campanulata* ssp. *glandulosa*), red colombine (*Aquilegia formosa*), California fuschia (*Epilobium canum* ssp. *canum*), poison sanicle (*Sanicula bipinnata*), wild celery (*Lomatium californicum*), Indian tobacco (*Nicotiana quadrivalvis*) and sweet bedstraw (*Galium triflorum*).

Four use plants (plantain, wild oat, ripgut brome, and soft chess) are exotic plants introduced from Europe and common throughout most of California. The gold miners and settlers contacted the Karuk in the 1850's. It is reasonable to assume that these plants began to play a role in Karuk diets at that time although it is not known when these plants were introduced to Karuk lands.

CONCLUSIONS

The major findings regarding the current status of the vegetation in historic Karuk cultural use sites are:

1) Each site has a unique stand composition and structure though general patterns can be found across them.

2) The Karuk influenced stand composition and structure on the lands around areas of use.

3) After fire suppression, Douglas-fir trees increased in forests and expanded into meadows.

4) The average age of Douglas-fir suggests establishment of these trees after Euro-American contact and subsequent change in management.

5) Douglas-fir age and forest structure at Persido Bar are those of a old-growth stand.

6) Current meadow composition contains few Karuk use plants.

7) Numerous Karuk use plants were not found in the use sites.

It would be interesting to locate other open meadows to see if similar patterns of stand composition are found elsewhere. The Karuk territory extended sixty kilometers beyond the northernmost site. Open meadow sites may be located along this stretch of the river which were or were not Karuk use sites.

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APPENDIX A

Plants identified in meadows at use sites. N/E indicates whether taxon is native (N) or exotic (E). Use is indicated by *. OB= Oak Bottom, GH= Grasshopper Flat, IP= Ishi Pishi, EB= Eyese Bar, PB= Persido Bar. I= infrequent, P= present, A= abundant.

Appendix A. cont'd.

	N/E	Use	OB	GH	IP	EB	PB
Cyperaceae							
Carex fracta	N			I			
Carex subfusca	N						I
Dennstaedtiaceae							
Pteridium aquilinum var. *pubescens*	N					P	A
Dryopteridaceae							
Athyrium filix-femina var. *cyclosorum*	N				P	P	
Polystichum munitum	N	*	P	P	P	P	P
Cupressaceae							
Calocedrus decurrens	N	*			P	P	
Pinaceae							
Pinus jeffryi	N	*				P	
Pinus lambertiana	N	*		P		P	P
Pinus ponderosa	N	*		I			
Pseudotsuga menziesii	N	*	P	P	P	P	P
Iridaceae							
Iris tenax ssp. *klamathensis*	N	*	I		I		
Iris macrosiphon	N	*		I		P	
Juncaceae							
Juncus ensifolius	N	*	P	P			
Luzula comosa	N		P	P	P	P	
Liliaceae							
Brodiaea elegans	N			P		P	
Calochortus tolmiei	N				P	P	
Dichelostemma capitatum ssp. *capitatum*	N	*		P		P	
Dichelostemma multiflorum	N					P	
Disporum hookeri	N		P				
Fritillaria recuva	N				I		
Triteleia bridgesii	N				P		
Triteleia crocea var. *crocea*	N			P			
Triteleia laxa	N	*				P	
Zigadenus venenosus var. *venenosus*	N		P	P			

Appendix A. cont'd.

	N/E	Use	OB	GH	IP	EB	PB
Poaceae							
Achnatherum occidentalis ssp. *pubescens*	N				I		
Agrostis micropylla	N			I			
Aira caryophyllea	E		A	A	A	A	A
Avena fatua	E	*			P		
Briza minor	E		A	A	A	A	A
Bromus carinatus var. *maritimus*	N			P	P	P	
Bromus diandrus	E	*	A	A	A	A	A
Bromus hordeaceus	E	*	A	A	A	A	A
Bromus laevipes	N					P	
Bromus tectorum	E				A		
Cynosurus echinatus	E		A	A	A	A	A
Dactylis glomerata	E						
Danthonia californica ssp. *californica*	N			P	P	P	
Elymus elymoides ssp. *californicus*	N			P		P	P
Elymus glaucus ssp. *glaucus*	N	*		P		P	
Festuca californica	N					P	
Holcus lanatus	E				P		
Hordeum jubatum	N			P			
Koleria macrantha	N					P	
Panicum oligosanthes var. *scribnerianum*	N				A		
Poa bulbosa	E		P				
Poa pratensis ssp. *pratensis*	E			A	A		A
Poa secunda ssp. *secunda*	N			P			
Trisetum canescens	N					P	
Vulpia myuros var. *hirsuta*	E				P		
Aceraceae							
Acer macrophyllum	N	*			P		
Anacardiaceae							
Toxicodendron diversilobum	N	*	P	P	P	P	P
Apiaceae							
Daucus pusillus	E			P			P
Lomatium triternatus var. *macrocarpum*	N					P	
Osmorhiza chilensis	N	*	P	P	P	P	
Sanicula bipinnafida	N			P		P	
Sanicula tuberosa	N			P			

Torilis arvensis	N		P				P

Appendix A. cont'd

	N/E	Use	OB	GH	IP	EB	PB
Apocynaceae							
Vinca major	E		P		P		
Asteraceae							
Achillea millefolium	N	*		P		P	
Agoseris heterophylla	N					A	
Calycadenia fremonti	N			P			
Calycadenia truncata	N					P	
Centaurea solstitialis	E						A
Erigeron foliosus var. *confinus*	N			P		P	
Eriophyllum lanatum	N					P	
Gnapthalium purpureum	N						P
Hypochaeris glabra	E				A		A
Madia exigua	N			A		A	A
Madia gracilis	N						P
Madia madiodes	N			P			P
Micropus californicus var. *californicus*	N					A	
Nothocalais troximoides	N					P	
Soliva sessilis	E						A
Taraxacum officinale	E		P				
Tragopogon pratensis	E						P
Wyethia angustifolia	N		P				
Berberidaceae							
Berberis aquilifolium var. *aquifolium*	N	*					I
Betulaceae							
Alnus rhombifolia	N	*			P		P
Corylus cornuta var. *californica*	N	*	P	P	P	P	P
Boraginaceae							
Cynoglossum grande	N				P	P	P
Plagiobothrys nothofulvus	N		A		A	A	
Brassicaceae							
Cardamine hirsuta	E		P				P
Erysimum capitatum ssp. *capitatum*	N						I
Buddlejaceae							
Buddleja davidii	E						I

Campanulaceae							
Githopsis specularioides	N		P	P	P	P	

Appendix A cont'd

	N/E	Use	OB	GH	IP	EB	PB
Caprifoliaceae							
Ligustrum ovalifolium	E						P
Lonicera ciliosa	N		P	P	P	P	P
Lonicera japonica	E						P
Symphoricarpos albus var. *laevigatus*	N		P				
Cornaceae							
Cornus nuttallii	N	*	P	P			P
Caryophyllaceae							
Arenaria serpyllifolia ssp. *serpyllifolia*	E				P		
Cerastium glomeratum	E				P		
Minuatia douglasii	N			P		P	
Petrohagia nanteuilii	E		A				
Silene gallica	E		P		P		
Stellaria media	E		P		P		
Ericaceae							
Arbutus menziesii	N	*	P	P	P	P	P
Chimophila umbellata	N	*		P			
Chimophila menziesii	N					P	
Pyrola picta	N	*		P		P	P
Fabaceae							
Cercis occidentalis	N		P				
Cytisus scoparius	E						A
Lotus humistratus	N	*				P	
Lotus micranthus	N					P	
Lotus wranglianus	N		P		P		P
Lupinus bicolor	N		P		P	P	
Medicago minima	E			P			
Medicago polymorpha	E			A			
Trifolium albopurpureum	N		A	A	A	A	A
Trifolium dubium	E			A			A
Trifolium ciliolatum	N				P		
Trifolium wildenovii	N		A				

Vicia sativa ssp. *nigra*	E			P			
Wisteria floribunda	E						P
Fagaceae							
Chrysolepis chrysophylla var. *chrysophylla*	N				I		
Lithocarpus densiflorus var. *densiflorus*	N	*	P	P	P	P	P

Appendix A. cont'd.

	N/E	Use	OB	GH	IP	EB	PB
Quercus chrysolepis	N	*	P	P	P	P	P
Quercus garryana	N	*	P	P	P	P	
Quercus kelloggii	N	*	P	P	P	P	
Garryaceae							
Garrya fremontii	N						I
Geraniaceae							
Erodium cicutarium	E				A		A
Geranium dissectum	E			A			
Geranium molle	E				A		A
Hypericaceae							
Hypericum patulum	E			P			
Hypericum perforatum	E		P		P		P
Hydrophyllaceae							
Nemophila heterophylla	N		P		P		
Nemophila menzeisii	N		P		P		
Lamiaceae							
Monardella sheltonii	N					P	
Satureja douglasii	N	*			P		
Trichostema lanceolatum	N	*				P	
Lauraceae							
Umbellularia californica	N	*	P	P	P	P	P
Linanceae							
Linum bienne	E				P		
Malvaceae							
Sidalcea malvaeflora ssp. *malvaeflora*	N				P	P	
Oleaceae							
Fraxinus latifolia	N	*	P				
Syringa vulgaris	E						P
Onagraceae							
Clarkia purpurea ssp. *quadrivulnera*	N				P	P	

Gayophytum diffusum ssp. *parviflorum*	N			P		P	
Papaveraceae							
Eschscholtzia californica	N					P	
Philadelphaceae							
Philadelphus lewisii	N	*					I
Whipplea modesta	N						P

Appendix A. cont'd

	N/E	Use	OB	GH	IP	EB	PB
Plantaginaceae							
Plantago lanceolata	E	*	P	P			
Polemoniaceae							
Collomia heterophylla	N		P			P	
Gilia capitata ssp. *capitata*	N					P	
Linanthus androsaceus	N			A			
Linanthus harknessii	N			P		P	
Polygalaceae							
Polygala californica	N		P	P	P	P	
Polygonaceae							
Eriogonum nudum var. *oblongifolium*	N	*				P	
Rumex acetolla	E		P		P		A
Portulaceae							
Claytonia perfoliata ssp. *perfoliata*	N		P		P		
Primulaceae							
Anagallis arvensis	E		A	A	A		A
Dodecatheon hendersonii	N					I	
Trientalis latifolia	N		P				
Ranunculaceae							
Ranunculus californicus	N				P	P	
Ranunculus muicatus	E			P			
Rhamnaceae							
Ceanothus cuneatus	N	*		P		P	
Ceanothus integerrimus	N	*			P		
Rhamnus californica ssp. c*alifornica*	N		P				
Rhamnus purshiana	N	*	P				
Rosaceae							
Amelanchier alnifolia	N	*	P		P		
Heteromeles arbutifolia	N	*		P			
Malus sylvestris	E	*	P		P		
Oemleria cerasiformis	N		P	P			
Prunus avium	E	*			P		P
Rosa eglanteris	E						P
Rosa gymnocarpa	N					P	P
Rubus discolor	E		P				P
Rubus leucodermis	N	*	P	P	P	P	P

Appendix A. cont'd

	N/E	Use	OB	GH	IP	EB	PB
Rubiaceae							
Galium aparine	N		P	P	P	P	P
Galium parisiense	E						P
Sherardia arvensis	E			P			
Scrophulariaceae							
Castilleja attenuata	N				P		
Mimulus douglasii	N					P	
Mimulus guttatus	N			P		P	
Tonella tenella	N		P				
Triphysaria pusilla	N			P			
Verbascum blattaria	E				I		
Veronica arvensis	E				P		A
Valerianaceae							
Plectritis brachystemon	N		A	A		A	
Violaceae							
Viola ocellata	N				P		
Vitaceae							
Vitis californica	N	*			P		P

APPENDIX B

Karuk use plants listed by habit, scientific name with common name, Karuk name and use. Common name and Karuk names as listed in Schenck and Gifford (1992) or Davis and Hendryx (1991). N= native, E=exotic, Hab=habit. f=forb, g=graminoid,

s=shrub, t=tree.

Appendix B. cont'd.

Plant name	N/E	hab	common name	Karuk name	use
Achillea millefolium	N	f	yarrow	achnatapvuyhich	medicine
Chimophila umbellata	N	f	prince's pine	hunyeip rukwtixa	medicine
Dichelostemma capitatum ssp. *capitatum*	N	f	blue dick	tayiee	food
Eriogonum nudum var. *oblongifolium*	N	f	naked buckwheat	tuhukannaich	food
Iris macrosiphon	N	f	ground iris	s'appakash	cordage
Iris tenax ssp. *klamathensis*	N	f	Klamath iris	s'appakash	cordage
Lotus humistratus	N	f	hill lotus	imtanasuhanpinishik	medicine
Osmorhiza chilensis	N	f	sweet cicely	kishwuf	medicine
Plantago lanceolata	E	f	plantain	none	medicine
Polystichum munitum	N	f	sword fern	tip tip hich	game
Pteridium aquilinum var. *pubescens*	N	f	bracken fern	kataship	food covering
Pyrola picta	N	f	wintergreen	yumarepeisera	medicine
Satureja douglasii	N	f	yerba buena	champinnishich	perfume
Trichostema lanceolatum	N	f	vinegar weed	yufivmatnakvanna	fumigant
Triteleia laxa	N	f	deer potato	pufish tayish	food
Avena fatua	E	g	wild oat	ikravapu	food
Bromus diandrus	E	g	ripgut brome	aktipanara	food
Bromus hordeaceus	E	g	soft chess	ikravapu	food

Appendix B. cont'd.

Plant name	N/E	hab	common name	Karuk name	use
Juncus ensifolius	N	g	bullrush	tapraratumnijuaich	cordage
Amelanchier alnifolia	N	s	serviceberry	afishiip	food
Berberis aquilifolium var. *aquifolium*	N	s	Oregon-grape	eieunan'aay	medicine
Ceanothus cuneatus	N	s	buck brush	poh'rip	ceremonial use
Ceanothus integerrimus	N	s	deer brush	kisiriip	medicine
Corylus cornuta var. *californica*	N	s	California hazel	assis	cordage
Heteromeles arbutifolia	N	s	toyon	pushiip	food
Philadelphus lewisii	N	s	mock orange	xawish	implement
Rubus leucodermis	N	s	blackcap raspberry	paturupven	food
Toxicodendron diversilobum	N	s	poison-oak	kusveip	medicine
Vitis californica	N	s	wild grape	aiyi'pa	food
Acer macrophyllum	N	t	bigleaf maple	mahsaan	charm
Alnus rhombifolia	N	t	white alder	kitwitip	dye
Arbutus menziesii	N	t	madrone	koshri'pan	food
Calocedrus decurrens	N	t	incense-cedar	ichiwaneiich	house construct-ion
Cornus nuttallii	N	t	Pacific dogwood	aya'amma	charm
Fraxinus latifolia	N	t	Oregon ash	akravshiip	charm
Lithocarpus densiflorus	N	t	tanoak	xunyeip	food
Pinus jeffryi	N	t	Jeffrey pine	isvirip	cordage

Appendix B. cont'd.

Plant name	N/E	hab	common name	Karuk name	use
Pinus ponderosa	N	t	ponderosa pine	sarum	cordage
Pseudotsuga menziesii	N	t	Douglas-fir	tapush	ceremonial use
Quercus chrysolepis	N	t	canyon live oak	xanputip	food
Quercus garryana	N	t	Oregon white oak	axaweiip	food
Quercus kelloggii	N	t	black oak	xansipi	food
Rhamnus purshiana	N	t	cascara sagrada	xoutyeupin	medicine
Umbellularia californica	N	t	California laurel	pahip	medicine