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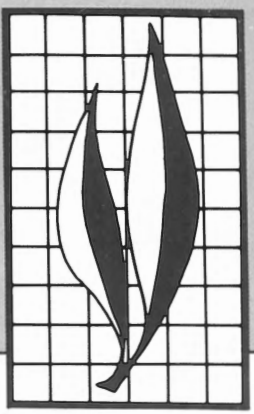

A Classification System for California's Hardwood Rangelands

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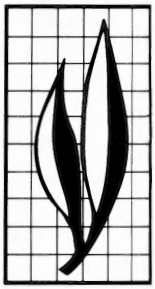

ABSTRACT

A hardwood rangeland classification system for California is described. The system provides private landowners, land managers, and researchers a unifying framework from which known ecological and management information can be retrieved. Standardization of type names facilitates the exchange of information on hardwood rangelands within and among agencies, landowners, and universities. The dichotomous keys to the type descriptions ensure that the system is field oriented and user-friendly.

The classification system consists of 57 subseries arranged hierarchically within 7 Series. The oak series are defined by the dominant oak species present on the site. A Mixed Oak Series is also defined from sites that contain three or more species of oak at constancies of greater than 30%. This system does not include subseries descriptions for Engelmann or garry oak types.

The classification system was developed from approximately 4,300 plots collected as part of the Vegetation Type Map (VTM) survey conducted during the 1920s-1940s by the USDA Forest Service, Pacific Southwest Forest and Range Experiment Station, and approximately 500 plots collected as part of the Forest Inventory conducted by

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Barbara H. Allen, Barbara A. Holzman, and Rand R. Evett

A Classification System for California's Hardwood Rangelands[1]

INTRODUCTION

HARDWOOD RANGELANDS occupy approximately 3 million hectares in California. They occur in 52 of the State's 58 counties, and span fully eight degrees of latitude west of the Sierra Nevada (Mayer et al. 1986). As might be expected in a state as ecologically diverse as California, hardwood rangelands support at least a dozen major tree species and many shrub and herbaceous species that occur in a myriad of combinations.

Since 1980, a number of trends have increasingly focused public attention on hardwood rangelands. These include:

- Continuing population growth that has resulted in conversion of wildlands to urban or semi-urban uses or agriculture.
- Increasing fuelwood use by households and industry.
- Loss of wildlife habitat in hardwood rangelands.
- Increasing oak cutting by ranchers to compensate for declining beef prices.
- Recognition of recruitment problems in riparian, valley oak, Engelmann oak, and blue oak ecosystems.
- Recognition of potential environmental impacts associated with the unregulated removal of hardwood trees.
- Increasing allocation of research effort to study the hardwood rangeland type.

Classification systems of vegetation, soils, habitats, and ecosystems are used by resource managers to group information by some unit. The units are labelled and described so that managers can use them to measure land area, plan treatments, conduct inventories, and aggregate information. Classification units can be broad or site specific, oriented to a single resource or to multiple resources, used locally or widely, or based on single or multiple factors (Allen 1987).

All classifications are artificial, but should describe or distinguish units that exist in nature. Units are typically identified and described to meet a specific need and are distinguished from each other by specific criteria. Natural classification units, such as habitat types or ecological types that are based on climax or potential vegetation, are generally based on relationships among plants, soils, and environment and thus serve a larger number of purposes (Pfister and Arno 1980).

Cover types are groupings of similar vegetation, soils, and environment based on existing vegetation. Some cover types may have occupied an area for long periods, whereas others are temporary occupants of disturbed sites, and through succession gradually give way to more stable cover and ultimately to a potential natural community. Cover type classifications may describe natural vegetation units or be based on single factors, such as a single tree species.

[1]Accepted for publication January 15, 1991

The hardwood rangeland cover types identified and described in this publication are natural units based on existing vegetation, soils, and environmental factors. They provide landowners and managers with a unifying framework from which known ecological and managerial information can be assessed. In addition, the cover type framework provides the logical units for aggregating information developed through ecological site description efforts, research, and landowner experience. Also, this classification standardizes names to facilitate the exchange of information among agencies, landowners, and universities. The classification system, with keys for field use, also provides landowners and agencies with a tool to improve predictions about site capabilities.

Previous classification efforts have developed descriptions of hardwood rangelands as part of efforts to classify California vegetation (Weislander 1935; Jensen 1947; Munz and Keck 1968; Cheatham and Haller 1975; Barbour and Major 1988; Eyre 1980; Paysen et al. 1980; Passof et al. 1985; and Holland 1986, to name a few). Such cover type descriptions have varying amounts of ecological information, and provide reasonable potential for establishing an hierarchical framework. For example, Eyre (1980) describes four hardwood cover types: California Black Oak (SAF 246), Canyon Live Oak (SAF 249), Blue Oak-Foothill Pine (SAF 250), and California Coast Live Oak (SAF 255). Griffin (1977) provides additional information on oak woodlands in his description of seven types: foothill woodland, valley oak, blue oak, north slope, interior live oak, Engelmann oak, and coast live oak.

However, none of the existing hardwood rangeland classification systems provides a statewide, ecologically based, unifying framework with keys to identify types. Our classification of California hardwood rangelands provides that framework.

The objectives in developing this classification system were to:

1. Develop rangeland cover type descriptions for California's hardwood rangelands, which would allow landowners, advisory agencies, and resource managers to classify and map hardwood rangelands.
2. Examine and incorporate current ecological and managerial information in rangeland cover type descriptions, as available.
3. Provide dichotomous keys for field identification of cover types by local landowners, researchers, and resource managers.
4. Develop hierarchical links, based on cover types, that will serve as a unifying framework and allow application, in general format, to hardwood rangelands throughout the state.
5. Provide a plan for a statewide hardwood rangeland data base, by providing methodology for further evaluation, testing, and refinement of the cover type classification.

METHODS

The development of the classification system was accomplished through a series of steps. Although three data bases were used (table 1), the classification structure relies most heavily on original field plots from the Vegetation Type Map (VTM) project taken during the 1920s and 1930s.

Initially, the USFS Pacific Northwest (PNW) Station's Forest Inventory (FI) plots were examined to identify major hardwood rangeland types throughout the state. The forest inventory plots were collected throughout California by Charles Bolsinger of

TABLE 1. NUMBER OF PLOTS BY DATA BASE WITHIN EACH COUNTY

County	Data base			County	Data base		
	Forest Inventory	Soil/ veg	VTM		Forest Inventory	Soil/ veg	VTM
Alameda	2	—	38	Orange	—	—	9
Alpine	—	—	—	Placer	15	—	69
Amador	10	—	83	Plumas	8	2	20
Butte	26	9	30	Riverside	1	—	7
Calaveras	22	10	314	Sacramento	—	—	7
Colusa	—	—	—	San Benito	4	—	155
Contra Costa	2	—	57	San Bernadino	1	—	69
Del Norte	15	3	—	San Diego	6	—	29
El Dorado	25	—	269	San Francisco	8	—	—
Fresno	10	11	56	San Joaquin	1	—	9
Glenn	—	3	—	San Luis Obispo	6	—	487
Humboldt	136	10	—	San Mateo	6	—	57
Imperial	—	—	—	Santa Barbara	—	—	143
Inyo	—	—	—	Santa Clara	6	—	343
Kern	14	—	68	Santa Cruz	11	—	109
Kings	—	—	6	Shasta	71	21	242
Lake	7	3	—	Sierra	3	—	21
Lassen	6	—	—	Siskiyou	28	—	2
Los Angeles	—	—	20	Solano	—	—	23
Madera	5	—	40	Sonoma	33	2	13
Marin	1	—	16	Stanislaus	1	—	42
Mariposa	9	—	297	Sutter	—	—	25
Mendocino	133	3	16	Tehama	18	21	3
Merced	—	—	19	Trinity	33	1	—
Modoc	1	—	—	Tulare	9	1	24
Mono	2	—	—	Tuolumne	13	1	468
Monterey	5	—	360	Ventura	—	—	34
Napa	9	—	50	Yolo	1	—	—
Nevada	11	—	89	Yuba	—	—	—

PNW, and his field crews. The plot records contain detailed information on species composition, as well as information on tree growth, and environmental conditions, such as elevation, slope, and aspect. The plot data for the state were received on floppy disks and subsequently reduced to approximately 725 plots containing *Quercus* species. Most of the oak plots were distributed in the northwest portion of the state, although a fair number were found in the northern Sierra Nevada (table 1).

The second data set was supplied by the Soil Vegetation Survey (SVS). This data set had approximately 127 records containing information on species composition and environmental variables. This set was recoded to standardize codes between the FI plots and the SVS plots. Then both data sets were combined for joint analyses. The distribution of SVS plots is noted in table 1.

Finally, field plot records from the VTM project were used as the basis for classification of hardwood rangeland cover types. The plots were collected as part of the statewide effort to map vegetation (Jensen 1947). The plot records contain information on understory plant species cover, tree stand structure (number per diameter class), elevation, slope, aspect, parent material, and other environmental variables. For trees greater than 10 cm at breast height (137 cm or 4.5 feet), information was collected on

TABLE 2. DATA ELEMENTS CONTAINED WITHIN A SPECIFIC DATA BASE*

Variable	Forest Inventory (PNW)	Soil/veg survey (SVS)	Vegetation type map (VTM)
Quad	X	X	X
Plot	X	X	X
County	X	X	X
Township	X	X	X
Range	X	X	X
Section	X	X	X
Plot date	—	—	X
Elevation	X	X	X
Aspect	X	X	X
Slope	X	X	X
Precipitation	—	X	X
Topography	X	X	—
Soil series	—	X	—
Parent material	—	X	X
Permeability	X	X	—
Penetrability	—	—	X
Drainage	—	X	—
Surface stoniness	—	X	—
Exposed bedrock	—	X	—
Plant species code	X	X	X
% species cover	X	X	X
Layer	—	X	X
DBH class	X	—	X
Year since burn	—	—	s
Site index	—	—	s
Species Ht	X	—	s
Number of plots	725	127	4,300+

*X = has information, — = no data, s = spotty

1/5-acre (0.08 ha) plots. Table 2 compares the variables contained in the three data sets.

All plant species were coded using national standard codes based on the first two letters of the genus and first two letters of the species (Powell 1987). A number is given after the four letters to distinguish between species having the same letter code. All plant species scientific and common names, and corresponding codes, are listed in appendix 1.

Approximately 4,300 plots from the VTM data set contained *Quercus* species. The plots were widely distributed in oak types throughout the state (table 1), although few plots were taken in Engelmann oak or garry oak types. Again, the first step standardized the coding of the VTM plots to match the FI and SVS plots, and converted the plots from paper records to a computerized data matrix. Plant species on VTM plots were originally recorded using an old and currently unused system, and thus had to be carefully recoded to current national standard plant species codes. This process took approximately 7 months to search the more than 8,000 paper VTM records, pull out plots with oaks, find the species name and convert old codes to new, and computerize

and clean the data base. The original VTM plots are on file at the Jepson Herbarium, University of California, Berkeley.

Once the data bases were established on RBASE (1985), analyses began. Later, the data base was converted to DBASE IV (1988) to facilitate manipulation of the large number of plot records. A computer programmer worked part-time on the project and wrote specific PASCAL programs to facilitate downloading of plot records to use in different analyses packages.

The FI/SVS and VTM data sets were analyzed separately and then compared visually. Initially, both data sets were treated the same as described below. In later analyses, only the VTM data set was used because it was the most geographically comprehensive.

The analysis strategy was to first look for patterns in plant species distribution to be able to identify plant communities. TWINSPAN, Two-Way Indicator Species Analysis (Hill 1979a), was the analytical tool used in the first step. TWINSPAN uses species percent cover to compare plots and species. Because the VTM data set contains percent cover values for shrub and herbaceous species, but not for trees, basal area was calculated from available stand structure information to serve as an index of cover for trees. Basal area is the cross-sectional area of a tree bole at 4.5 feet (137 cm), and thus is a reasonable index of the site occupancy of specific tree species. TWINSPAN cut levels were adjusted accordingly to incorporate "cover" values of greater than 100%. The six cut levels used in analysis were 2, 5, 15, 25, 75, and 95.

Because of the large number of plots in the VTM data set and the plot limits of the TWINSPAN program, the plots were initially divided into four large geographical regions: the central-south coast range, the lower elevation central and southern Sierra Nevada, the higher elevation central and northern Sierra Nevada, and the northern Sierra, Klamath Mountains, and north coast range. TWINSPAN was used to examine each of these geographic regions and the FI/SVS data sets independently.

Initial analysis indicated that patterns in plant communities at the Series level, based on dominance of individual oak species, existed. The FI/SVS data set consisted of primarily tanoak, some garry oak, and conifer types and thus was not analyzed further, until the VTM set was analyzed in detail. The VTM data sets (four geographical regions) were then reanalyzed using TWINSPAN, combining plots that contained similar oak species dominance regardless of their original geographical region.

At this stage, DECORANA, Detrended Correspondence Analysis (Hill 1979b), was used to array plots from the vegetation types distinguished in TWINSPAN to examine relationships between types through environmental gradients. Simultaneously, regression and analysis of variance in SPSSPC+, Statistical Package for the Social Sciences (Norusis 1986, 1988), were used to evaluate the environmental characteristics of the types that could be used to explain the community distribution. Major oak series were distinguished, including coast live oak, interior live oak, blue oak, black oak, valley oak, scrub oak, and a mixed oak series that contained three or more oak species.

A period of continuous feedback analysis began as each oak series was reanalyzed independently using TWINSPAN, DECORANA, and regression analysis techniques, and plots were juggled between types making individual types more homogeneous. One-way ANOVA (Norusis 1986) was used to compare mean differences in species basal area or cover, and other environmental attributes between types. Differences were considered significant at $p<0.05$. Finally, several individual counties were analyzed separately to see if the same patterns in community types would hold true for localized areas.

Plant species coding problems became apparent throughout the analyses as unusual "types" appeared. Often, the species codes were traced back to the original VTM plot cards, and errors in identification were corrected. The unusual type plots were then correctly classified. However, other errors in the data set originated from original data collection and coding problems, our conversion of old codes to new plant species codes, and data entry errors. Any impact on the classification system from coding errors was minimized by field testing, reanalysis, the large number of plots, and common sense.

Plant community cover type keys were constructed for each oak series. The primary objective of key construction was to develop an accurate, easy-to-use key to aid field users in the correct identification of cover types. Thus, a few characteristic species and environmental attributes were used in the keys for each series. A key to the series was also constructed.

Descriptions were written for each rangeland cover type or subseries. Each description contains the type name, number of plots used to describe the type, location information, environmental setting, and plant species. Additionally, a stand table was given for the tree species. Because the descriptions were founded on old plot data, the original units were used, without conversion to metric units.

Keys and descriptions were field tested. Difficulties in use of the keys, format problems in the description, and errors in plant species coding were evaluated, discussed, and corrected as appropriate. This process often resulted in additional analyses of several subseries within an oak series. The analyses may have included TWINSPAN and DECORANA analyses, and combining or splitting of types.

The classification system was reviewed by a number of hardwood experts as well as individuals unfamiliar with hardwood rangeland ecosystems in several areas in the state. The review consisted of a discussion of the classification structure, instructions on how to use the system and keys, and field review and evaluation of the keys and type descriptions.

After field review, the classification was refined as appropriate by reworking the keys and carrying out additional analysis if necessary. The process of field review took place from January through May 1989.

RESULTS

The Cover Types

The hardwood rangelands of California are divided into 57 subseries within 7 Series. The oak series are defined by the dominant oak species present on the site. A Mixed Oak Series is also defined by sites containing three or more species of oak at constancies of 30% or more. To facilitate user-friendliness, a subseries may be listed in two Series and can be keyed from either Series' key.

The term subseries is used to describe the appropriate hierarchical level of the described hardwood types. Since site-specific response to management has not been used as a criterion in classification, nor was a complete species list (including all herbaceous species) available, the cover types described in this report cannot be called ecological types. However, the types or subseries described incorporate more ecological information than any other system to date, and are thus at a finer level of resolution than Series. Subseries, though unused before in the literature, is the appropriate classification level.

The rangeland cover type names are composed of the dominant species of the tree, shrub, or herbaceous layer. The species having the greatest constancy (presence) across all plots representing the type is used in the name. A slash (/) is used to separate species of different life forms, and a dash (-) is used to separate species of the same life form. Scientific species names, common names, and codes come from Munz and Keck (1968) and Powell (1987).

The seven Series and their associated subseries are listed in table 3.

TABLE 3. HARDWOOD RANGELAND SUBSERIES ARRANGED BY SERIES, AND GEOGRAPHIC OR ENVIRONMENTAL LOCATION WITHIN SERIES*

QUAG SERIES

Lower Elevation, Mesic Subseries

1. Coast Live Oak/Blackberry/Bracken Fern (781 ft)
   QUAG/RUVI2/PTAQ
2. Coast Live Oak-Madrone/Hazelnut-Blackberry (870 ft)
   QUAG-ARME3/COCO5-RUVI2
3. Coast Live Oak/Poison Oak (910 ft)
   QUAG/RHDI

Upper Elevation, Mesic Subseries

4. Coast Live Oak/Ocean Spray-Snowberry (1300 ft)
   QUAG/HODI-SYRI
5. Coast Live Oak/Coffeeberry-Toyon (1250 ft)
   QUAG/RHCA2-HEAR2
6. Coast Live Oak-California Bay/Toyon-Scrub Oak (1318 ft)
   QUAG-UMCA1/HEAR2-QUDU2
7. Coast Live Oak-Maple/Coffeeberry-Ocean Spray (1695 ft)
   QUAG-ACMA/RHCA2-HODI

Middle Elevation, Xeric Subseries

8. Coast Live Oak/Poison Oak/Grass (1018 ft)
   QUAG/RHDI/GRASS
9. Coast Live Oak/Toyon-Poison Oak ((1205 ft)
   QUAG/HEAR2-RHDI
10. Coast Live Oak/Coast Sagebrush/Grass (1005 ft)
    QUAG/ARCA7/GRASS
11. Coast Live Oak/Chamise-Black Sage (1100 ft)
    QUAG/ADFA-SAME4
12. Coast Live Oak/Grass (1050 ft)
    QUAG/GRASS
13. Coast Live Oak (1178 ft)
    QUAG
14. Blue Oak-Coast Live Oak/Grass (1054 ft)
    QUDO-QUAG/GRASS
15. Coast Live Oak/Toyon/Grass (1312 ft)
    QUAG/HEAR2/GRASS

QUDO SERIES

Coast Range Subseries

1. Blue Oak-Valley Oak-Coast Live Oak/Grass (1567 ft)
   QUDO-QULO-QUAG/GRASS
2. Blue Oak-Valley Oak/Grass (1477 ft)
   QUDO-QULO/GRASS

(Continued on the next page.)

TABLE 3. *(Continued)*

QUDO SERIES *(Continued)*

Coast Range Subseries

3. Blue Oak–Coast Live Oak/Grass (1054 ft)
   QUDO–QUAG/GRASS

Sierra Nevada Subseries

4. Blue Oak–Foothill Pine/Whiteleaf Manzanita/Grass (1388 ft)
   QUDO–PISA2/ARVI3/GRASS

Coast Range and Sierra Nevada Subseries

5. Blue Oak/Grass (1296 ft)
   QUDO/GRASS
6. Blue Oak–Understory Blue Oak/Grass (1489 ft)
   QUDO–UQUDO/GRASS

Coast Range and Sierra Nevada Subseries

7. Blue Oak–Foothill Pine/Grass (1749 ft)
   QUDO–PISA2/GRASS
8. Blue Oak–Foothill Pine/Wedgeleaf Ceanothus–Mt. mahogany (2526 ft)
   QUDO–PISA2/CECU2–CEBE2
9. Blue Oak/Haplopappus (2288 ft)
   QUDO/HALI
10. Blue Oak–Interior Live Oak/Grass (1500 ft)
    QUDO–QUWI/GRASS
11. Blue Oak/Wedgeleaf Ceanothus/Grass (1752 ft)
    QUDO/CECU2/GRASS
12. Interior Live Oak–Blue Oak–Foothill Pine (1534 ft)
    QUWI–QUDO–PISA2

QULO SERIES

Upper Elevation Subseries

1. Valley Oak/Grass (2253 ft)
   QULO/GRASS
2. Black Oak–Valley Oak/Grass (2375 ft)
   QUKE–QULO/GRASS

Lower Elevation Subseries

3. Coast Live Oak–Valley Oak/Poison Oak (1101 ft)
   QUAG–QULO/RHDI
4. Mixed Oak–Valley Oak/Poison Oak–Coffeeberry (1443 ft)
   MO–QULO/RHDI–RHCA2
5. Valley Oak–Coast Live Oak/Grass (1318 ft)
   QULO–QUAG/GRASS
6. Blue Oak–Valley Oak/Grass (1477 ft)
   QUDO–QULO/GRASS

QUWI SERIES

Coast Range and Sierra Nevada Subseries

1. Interior Live Oak–Madrone/Poison Oak (1493 ft)
   QUWI–ARME3/RHDI
2. Interior Live Oak–Blue Oak–Foothill Pine (1533 ft)
   QUWI–QUDO–PISA2

Sierra Nevada Subseries

3. Interior Live Oak/Yerba Santa/Grass (2120 ft)
   QUWI/ERCA6/GRASS

(Continued on the next page.)

TABLE 3. *(Continued)*

QUWI SERIES *(Continued)*

Coast Range Subseries

4. Interior Live Oak–Foothill Pine/Manzanita (1144 ft)
   QUWI–PISA2/ARMA3
5. Interior Live Oak/Toyon (1855 ft)
   QUWI/HEAR2
6. Interior Live Oak/Whiteleaf Manzanita (1780 ft)
   QUWI/ARVI3

QUKE SERIES

Coast Range Subseries

1. Black Oak–Madrone–Coast Live Oak (1293 ft)
   QUKE–ARME3–QUAG
2. Mixed Oak–Coast Live Oak/Poison Oak (1465 ft)
   MO–QUAG/RHDI
3. Black Oak–Coast Live Oak–Beach Pine/Ocean Spray (1691 ft)
   QUKE–QUAG–PICO1/HODI
4. Black Oak–Valley Oak/Grass (2375 ft)
   QUKE–QULO/GRASS

Sierra Nevada Subseries

5. Black Oak/Poison Oak–Calif. Storax/Grass-nut (1484 ft)
   QUKE/RHDI–STOFC/BRLA2
6. Black Oak/Deerbrush–Poison Oak/Bracken Fern (2527 ft)
   QUKE/CEIN3–RHDI/PTAQ
7. Black Oak/Deerbrush (3435 ft)
   QUKE/CEIN3
8. Black Oak/Greenleaf Manzanita (5647 ft)
   QUKE/ARPA9

Coast Range and Sierra Nevada Subseries

9. Black Oak/Poison Oak (2486 ft)
   QUKE/RHDI
10. Black Oak/Poison Oak/Grass (2746 ft)
    QUKE/RHDI/GRASS
11. Black Oak–Canyon Live Oak/Poison Oak (2963 ft)
    QUKE–QUCH2/RHDI
12. Canyon Live Oak–Black Oak (3231 ft)
    QUCH2–QUKE
13. Black Oak/Grass (4193 ft)
    QUKE/GRASS

QUDU2 SERIES

1. Scrub Oak–Blue Oak/Grass (1400 ft)
   QUDU2–QUDO/GRASS
2. Scrub Oak/Grass (1369 ft)
   QUDU2/GRASS
3. Scrub Oak (1427 ft)
   QUDU2

MIXED OAK SERIES

Sierra Nevada Subseries

1. Interior Live Oak/Toyon (1854 ft)
   QUWI/HEAR2

(Continued on the next page.)

TABLE 3. *(Continued)*

MIXED OAK SERIES *(Continued)*

Sierra Nevada Subseries

2. Mixed Oak-Interior Live Oak-Foothill Pine (1900 ft)
   MO-QUWI-PISA2

Coast Range, Lower Elevation Subseries

3. Mixed Oak-California Buckeye/Grass (872 ft)
   MO-AECA2/GRASS
4. Mixed Oak/Grass (1019 ft)
   MO/GRASS
5. Mixed Oak/Poison Oak-Baccharis (950 ft)
   MO/RHDI-BAPI

Coast Range, Middle Elevation Subseries

6. Mixed Oak-Foothill Pine/Grass (1526 ft)
   MO-PISA2/GRASS
7. Mixed Oak-Valley Oak/Poison Oak-Coffeeberry (1443 ft)
   MO-QULO/RHDI-RHCA2
8. Mixed Oak-Coast Live Oak/Poison Oak (1465 ft)
   MO-QUAG/RHDI
9. Mixed Oak-Black Oak/Grass (1351 ft)
   MO-QUKE/GRASS

Coast Range, Upper Elevation Subseries

10. Blue Oak-Valley Oak-Coast Live Oak/Grass (1567 ft)
    QUDO-QULO-QUAG/GRASS
11. Black Oak-Valley Oak/Grass (2375 ft)
    QUKE-QULO/GRASS

*Hardwood rangeland subseries arranged by Series, and geographic or environmental location within Series. The common name for the subseries is listed first and then the code name. Mean elevation for each subseries is noted in parenthesis. All scientific names are found in appendix 1. Refer to the text for discussion of each subseries.

The Hardwood Rangeland Cover Type Keys

The keys to the hardwood rangeland cover types were constructed using both dominant species and species that indicated differences in the environments between types. Attributes of the types that are easily recognizable in the field were used in the keys.

Users must know approximately a dozen plant species to use the keys to the hardwood rangeland subseries. Users should stand in a relatively homogeneous site when applying the keys. If the vegetation is homogeneous over the landscape, then it is appropriate for the user to apply the type label over that landscape. However, if the landscape is heterogeneous, the user should apply the key to the homogenous unit in which he or she is standing.

Since keys are only a tool in identifying the type, users should also read the type description to verify that the type has been correctly identified. If the description does not fit with what the user is seeing on the ground, the person should go back through the key and check alternative routes. The complete hardwood cover type descriptions are available from the Department of Forestry and Fire Protection, Sacramento, California. A comparison overview of the types, including mean basal area estimates, species information, and elevation follows the keys.

KEY TO THE SERIES

1a. Stand consists of single *Quercus* species.

Go to the:

Coast Live Oak Key:
Blue Oak Key:
Valley Oak Key:
Interior Live Oak Key:
Black Oak Key:
Scrub Oak Key:

1b. Stand consists of two or more *Quercus* species.

2a. Go to the key of the dominant oak species.

2b. If stand consists of three or more oak species, go to:

Mixed Oak Series Key:

KEY TO THE COAST LIVE OAK SUBSERIES

1a. Coast live oak (QUAG) is the only overstory tree. Understory species are rarely present with total cover that seldom exceeds 25%. Coast live oak basal area is usually high (>200 ft^2/acre).

Coast Live Oak

1b. Coast live oak may be the only overstory tree present and total understory cover exceeds 25%. Coast live oak basal area is less than 200 ft^2/acre.

2a. Understory grass cover generally exceeds 50%.

3a. Blue oak is present.

Blue Oak-Coast Live Oak/Grass

3b. Blue oak is absent.

Coast Live Oak/Grass

2b. Understory grass cover is less than 50%.

4a. The following shrubs are present individually or together in the understory: coffeeberry, ocean spray, blackberry, and hazelnut. Big leaf maple may be present in the tree layer. The shrubs toyon, chamise, coast sagebrush, and black sage are absent. California bay is absent.

5a. Bracken fern is present, baccharis is often present. Big leaf maple, madrone, snowberry, and hazelnut are absent.

Coast Live Oak/Blackberry/Bracken Fern

5b. Bracken fern and baccharis are absent.

6a. Madrone and hazelnut are present. Big leaf maple, ocean spray, and snowberry are absent.

Coast Live Oak-Madrone/Hazelnut-Blackberry

6b. Madrone and hazelnut are absent. Big leaf maple, ocean spray, and snowberry are present.

7a. Big leaf maple is present. Snowberry is absent.

Coast Live Oak-Maple/Coffeeberry-Ocean Spray

7b. Big leaf maple is absent. Snowberry is present.

Coast Live Oak/Ocean Spray-Snowberry

4b. Blackberry, hazelnut, and big leaf maple are absent. Coffeeberry and ocean spray may be present. The shrubs toyon, chamise, coast sagebrush, and black sage may be present. California bay may be present.

8a. Toyon is present. Redberry and California bay may be present. Black sage and coast sagebrush are absent.

9a. Other shrubs and trees are generally absent.

Coast Live Oak/Toyon-Poison Oak

9b. Coffeeberry, redberry, ocean spray, and California bay may be present. Chamise and wedgeleaf ceanothus may be present.

10a. Chamise is present; wedgeleaf ceanothus is often present. Coffeeberry, ocean spray, and California bay are absent.

Coast Live Oak/Toyon/Grass

10b. Chamise and wedgeleaf ceanothus are absent. Coffeeberry, redberry, and California bay are present.

11a. Coffeeberry and redberry are present. California bay and scrub oak are absent.

Coast Live Oak/Coffeeberry-Toyon

11b. Coffeeberry and redberry are absent. California bay and scrub oak are present.

Coast Live Oak-California Bay/Toyon-Scrub Oak

8b. Toyon is absent. Redberry and California bay are absent. Black sage and coast sagebrush may be present.

12a. Chamise, black sage, and coast sagebrush are present individually or together.

13a. Coast sagebrush is present with greater than 25% cover of grasses. Chamise and black sage are absent.

Coast Live Oak/Coast Sagebrush/Grass

13b. Coast sagebrush is absent. Chamise and black sage are present individually or together with less than 25% cover of grasses.

Coast Live Oak/Chamise-Black Sage

12b. Chamise, black sage, and coast sagebrush are absent.

14a. Poison oak is the dominant shrub cover. Grass cover is absent.

Coast Live Oak/Poison Oak

14b. Poison oak and grass both have high cover.

Coast Live Oak/Poison Oak/Grass

KEY TO THE BLUE OAK SUBSERIES

1a. Foothill pine is present in the stand.

2a. Foothill pine and interior live oak are present. Wedgeleaf ceanothus is often present.

3a. Whiteleaf manzanita is present.

Blue Oak–Foothill Pine/Whiteleaf Manzanita/Grass

3b. Whiteleaf manzanita is absent or occurs rarely.

4a. Understory interior live oak and blue oak are often present. Other shrubs may be present in the understory.

5a. Wedgeleaf ceanothus averages 18% cover and is always present. Redberry, poison oak, and other shrubs may be present.

Blue Oak/Wedgeleaf Ceanothus/Grass

5b. Wedgeleaf ceanothus, if present, averages 8% cover. Other shrubs are rare.

Blue Oak–Interior Live Oak/Grass

4b. Understory interior live oak and blue oak are not present. Shrubs are rare. Interior live oak is dominant in the stand.

Interior Live Oak–Blue Oak–Foothill Pine

2b. Foothill pine is present. Interior live oak is absent. Wedgeleaf ceanothus may or may not be present.

6a. Understory shrubs are rare, averaging $<10\%$ cover.

Blue Oak–Foothill Pine/Grass

6b. Understory shrubs such as wedgeleaf ceanothus, and/or mountain mahogany, and/or narrowleaf goldenbush are present.

Blue Oak–Foothill Pine/Wedgeleaf Ceanothus–Mt. Mahogany

1b. Foothill pine is absent or rare.

7a. Generally, other oaks are present in the stand with blue oak.

8a. Interior live oak may be present. Basal area of interior live oak is generally >10 ft^2/acre.

9a. The stand is dense with trees averaging >155 trees per acre, with basal area >100 ft^2/acre.

Interior Live Oak–Blue Oak–Foothill Pine

9b. The stand is relatively open, with basal area averaging 50 ft^2/acre.

10a. Wedgeleaf ceanothus, if present, averages $<10\%$ cover.

Blue Oak-Interior Live Oak/Grass

10b. Wedgeleaf ceanothus is present and averages $>10\%$ cover.

Blue Oak/Wedgeleaf Ceanothus/Grass

8b. Valley oak and/or coast live oak are present in the stand.

11a. Valley oak is codominant with blue oak.

12a. Coast live oak is absent.

Blue Oak-Valley Oak/Grass

12b. Both valley oak and coast live oak are present in the stand.

Blue Oak-Valley Oak-Coast Live Oak/Grass

11b. Valley oak is absent.

13a. Coast live oak is present. Coast sagebrush may also be present though shrubs are rare; elevation averages 1,000 ft.

Blue Oak-Coast Live Oak/Grass

13b. Shrubs are common. Elevation averages 2,500 ft.

Blue Oak-Foothill Pine/Wedgeleaf Ceanothus-Mt. Mahogany

7b. Generally blue oak is the only oak present in the stand.

14a. Narrowleaf goldenbush is present.

Blue Oak/Narrowleaf Goldenbush

14b. Narrowleaf goldenbush is absent. Grass is the primary understory species.

15a. Understory blue oaks are present.

Blue Oak-Understory Blue Oak/Grass

15b. Understory blue oaks are absent.

Blue Oak/Grass

KEY TO THE VALLEY OAK SUBSERIES

1a. Valley oak is the only tree species in the overstory.

Valley Oak/Grass

1b. Valley oak is mixed with other oak species.

2a. Black oak is present.

Black Oak-Valley Oak/Grass

2b. Black oak is absent.

3a. Blue oak is present; coast live oak is rarely present.

Blue Oak-Valley Oak/Grass

3b. Blue oak is sometimes present; coast live oak is present.

4a. Poison oak is present.

5a. Coffeeberry is present.

Mixed Oak-Valley Oak/Poison Oak-Coffeeberry

5b. Coffeeberry is absent.

Coast Live Oak-Valley Oak/Poison Oak

4b. Poison oak is absent.

Valley Oak-Coast Live Oak/Grass

KEY TO THE INTERIOR LIVE OAK SUBSERIES

1a. Yerba santa is present.

2a. Yerba santa averages >20% cover, grass averages 30%, and overstory tree cover may or may not be present.

Interior Live Oak/Yerba Santa/Grass

2b. Yerba santa averages <20% cover, whiteleaf manzanita and/or wedgeleaf ceanothus may be common. Interior live oak is present in the overstory.

Interior Live Oak/Whiteleaf Manzanita

1b. Yerba santa is absent or is rare, occurring at ≤ 5% cover.

3a. Madrone is present; grass is rare.

Interior Live Oak-Madrone/Poison Oak

3b. Madrone is absent.

4a. Grass is present; interior live oak is often present in the understory.

5a. Manzanita is common.

6a. Foothill pine and/or blue oak are present.

Interior Live Oak-Foothill Pine/Manzanita

6b. Foothill pine is rare; blue oak is absent.

Interior Live Oak/Whiteleaf Manzanita

5b. Manzanita is not common.

7a. Understory interior live oak may be present, blue oak is common, and toyon is rare.

Interior Live Oak-Blue Oak-Foothill Pine

7b. Understory interior live oak and toyon are present. Blue oak is rare.

Interior Live Oak/Toyon

4b. Grass is absent.

Interior Live Oak-Madrone/Poison Oak

KEY TO THE BLACK OAK SUBSERIES

1a. Coast live oak, valley oak, canyon live oak, madrone, and/or beach pine are present at >5 ft^2/acre of basal area.

2a. Canyon live oak is present.

3a. Canyon live oak and/or black oak are present in the understory at >5% cover. Deerbrush is absent, or present at <10% cover. Grass is absent.

Canyon Live Oak-Black Oak

3b. Canyon live oak and/or black oak are absent in the understory, or present at <5% cover. Deerbrush is often present at >10% cover. Grass is often present.

Black Oak-Canyon Live Oak/Poison Oak

2b. Canyon live oak is absent.

4a. Two of these three species are present: madrone, beach pine, ocean spray.

5a. Two of these three species are present: beach pine, ocean spray, coffeeberry. Toyon is absent.

Black Oak-Coast Live Oak-Beach Pine/Ocean Spray

5b. Two of these three species are absent: beach pine, ocean spray, coffeeberry. Toyon is usually present.

Black Oak-Madrone-Coast Live Oak

4b. Two of these three species are absent: madrone, beach pine, ocean spray.

6a. Valley oak is present and usually codominant with black oak.

Black Oak-Valley Oak/Grass

6b. Valley oak absent, or present at <15 ft^2/acre of basal area. Coast live oak is present.

Mixed Oak-Coast Live Oak/Poison Oak

1b. Coast live oak, valley oak, canyon live oak, and beach pine are absent. If present, each species is <5 ft^2/acre of basal area.

7a. Poison oak is present. Usually found in Shasta County or the Coast Range.

8a. Deerbrush, California storax, and/or grass-nut are present. Found mainly in Shasta County.

9a. Bracken fern is present. Grass-nut is absent. Usually above 2,000 ft. elevation.

Black Oak/Deerbrush-Poison Oak/Bracken Fern

9b. Bracken fern is usually absent. Grass-nut and/or California storax are often present. Usually below 2,000 ft. elevation.

Black Oak/Poison Oak-California Storax/Grass-nut

8b. Deerbrush, California storax, and grass-nut are not present. Found mainly in the Coast Range.

10a. Grass is >10% cover. Foothill pine is often present.

Black Oak/Poison Oak/Grass

10b. Grass is <10% cover. Foothill pine is absent.

Black Oak/Poison Oak

7b. Poison oak is absent. Usually found in the central and southern Sierra.

11a. Greenleaf manzanita and/or deerbrush are present.

12a. Greenleaf manzanita is present. Deerbrush is absent, or present at <25% cover.

Black Oak/Greenleaf Manzanita

12b. Greenleaf manzanita is absent. Deerbrush is present at >25% cover.

Black Oak/Deerbrush

11b. Greenleaf manzanita and deerbrush are absent.

13a. Grass is >5% cover.

Black Oak/Grass

13b. Grass is <5% cover.

Black Oak/Poison Oak

KEY TO THE SCRUB OAK SUBSERIES

1a. Blue oak is present in the overstory. Grass is dominant in the understory.

Scrub Oak-Blue Oak/Grass

1b. Blue oak is absent from the overstory.

2a. Grass is >25% cover.

Scrub Oak/Grass

2b. Grass is <25% cover.

Scrub Oak

KEY TO THE MIXED OAK SUBSERIES

1a. You are located in the Sierra Nevada Range.

2a. Understory interior live oak and/or toyon are present.

Interior Live Oak/Toyon

2b. Understory interior live oak and/or toyon are rare. Foothill pine is common.

Mixed Oak-Interior Live Oak-Foothill Pine

1b. You are located in the Coast Ranges.

3a. Mean elevation is greater than 2,500 ft; black oak and valley oak are common.

Black Oak-Valley Oak/Grass

3b. Mean elevation is less than 2,500 ft.

4a. Valley oak is the dominant oak species in the mix.

5a. Valley oak and coast live oak are codominants.

6a. Grass, poison oak, and coffeeberry may be present. Valley and coast live oak have mean basal area >60 ft^2/acre.

Mixed Oak-Valley Oak/Poison Oak-Coffeeberry

6b. Black oak is codominant with coast live oak and valley oak. Grass and poison oak are common.

Mixed Oak-Black Oak/Grass

5b. Valley and blue oak are codominants. Coast live oak is present.

Blue Oak-Valley Oak-Coast Live Oak/Grass

4b. Valley oak is not the dominant oak in the species mix. Coast live oak and/or blue oak and/or black oak is dominant.

7a. Coast live oak and black oak are common in the stand. Blue oak is absent or present at low constancy and cover.

8a. Baccharis and/or coffeeberry are common associates. Toyon may be present. Generally low elevation (mean = 1,000 ft).

Mixed Oak/Poison Oak-Baccharis

8b. Baccharis and coffeeberry are very rare. Poison oak is usually present. Generally middle elevation (mean = 1,500 ft).

Mixed Oak-Coast Live Oak/Poison Oak

7b. Blue oak is a common associate in the mixed oak stand.

9a. California buckeye is common. Grass cover averages 95%. Foothill pine is absent or very rare. Generally low elevation.

Mixed Oak-California Buckeye/Grass

9b. California buckeye is not common. Foothill pine may or may not be present.

10a. Foothill pine is absent. Black oak may be present. Low elevation sites.

Mixed Oak/Grass

10b. Foothill pine is present. Black oak is absent. Middle elevation sites.

Mixed Oak-Foothill Pine/Grass

Overview Description of the Hardwood Rangeland Cover Types

The overview consists of a comparison of the subseries contained within each Series. Figures 1 through 10 provide a visual comparison of the basal area of the dominant tree species between subseries within a Series. Arbitrarily, 50% constancy of a specific species was used as the cutoff point for including it on any particular figure. The only exception was for the Mixed Oak Series figure, where the 30% constancy rule, which defines the type, was employed. Note the differences in scale in the y axis (mean basal area in square feet per acre) between the different Series.

Interpretation of relationships between types within a Series is given. Environmental gradients are discussed, and commonly the types are graphically displayed along an elevational gradient. Subseries whose ranges are strictly Sierra Nevada or Coast Range are discussed separately within the Series. Moisture gradients when apparent are also discussed. Literature is cited comparing the subseries within this classification system to other types and systems.

THE CALIFORNIA COAST LIVE OAK SERIES

The latitudinal range of coast live oak in California extends from Sonoma County in the north to San Diego County in the south. It is the most coastal of California *Quercus*, seldom extending more than 60 miles inland from the Pacific Ocean (Griffin and Critchfield 1972). Bolsinger (1988) estimates that the total area of this series in California is 828,000 acres, 79% of which is in private ownership. Coast live oak stands, on average, contain the greatest basal area of oaks of any of the hardwood rangeland subseries.

The Coast Live Oak Series can be divided into 15 subseries (fig. 1), which can be further separated into mesic and xeric subseries, as they are in the key. There are seven mesic subseries, three of which occur below an average elevation of 910 ft and four above an average elevation of 1,250 ft (table 3). Five of the seven mesic types occupy aspects that predominately face north to northeast, but there are no consistent trends in slope. Species that characterize the mesic subseries include: bracken fern in the herb layer; coffeeberry, blackberry, creambush (ocean spray), snowberry, and hazelnut in the shrub layer; and big-leaf maple, California bay, madrone, and scrub oak in the tree layers (Campbell 1980, Bolsinger 1988).

The low-elevation (below 910 ft) mesic subseries types are: Coast Live Oak/Blackberry/Bracken Fern, Coast Live Oak–Madrone/Hazelnut–Blackberry, and Coast Live Oak/Poison Oak. The Coast Live Oak/Blackberry/Bracken Fern subseries has significantly less basal area of coast live oak than its other two low-elevation mesic associates (fig. 1). The Coast Live Oak–Madrone/Hazelnut–Blackberry is distinguished from the other two low-elevation mesic types by the presence of madrone, which averages 48 ft^2 of basal area per acre. All three low-elevation mesic subseries contain poison oak.

Ecological and management information on these low-elevation mesic subseries is scarce, but at least one type has been mentioned in the literature. The *Q. agrifolia*-dominated "oak woodland" described by McBride (1974) in a successional study in the Berkeley Hills is very similar to the Coast Live Oak/Blackberry/Bracken Fern subseries.

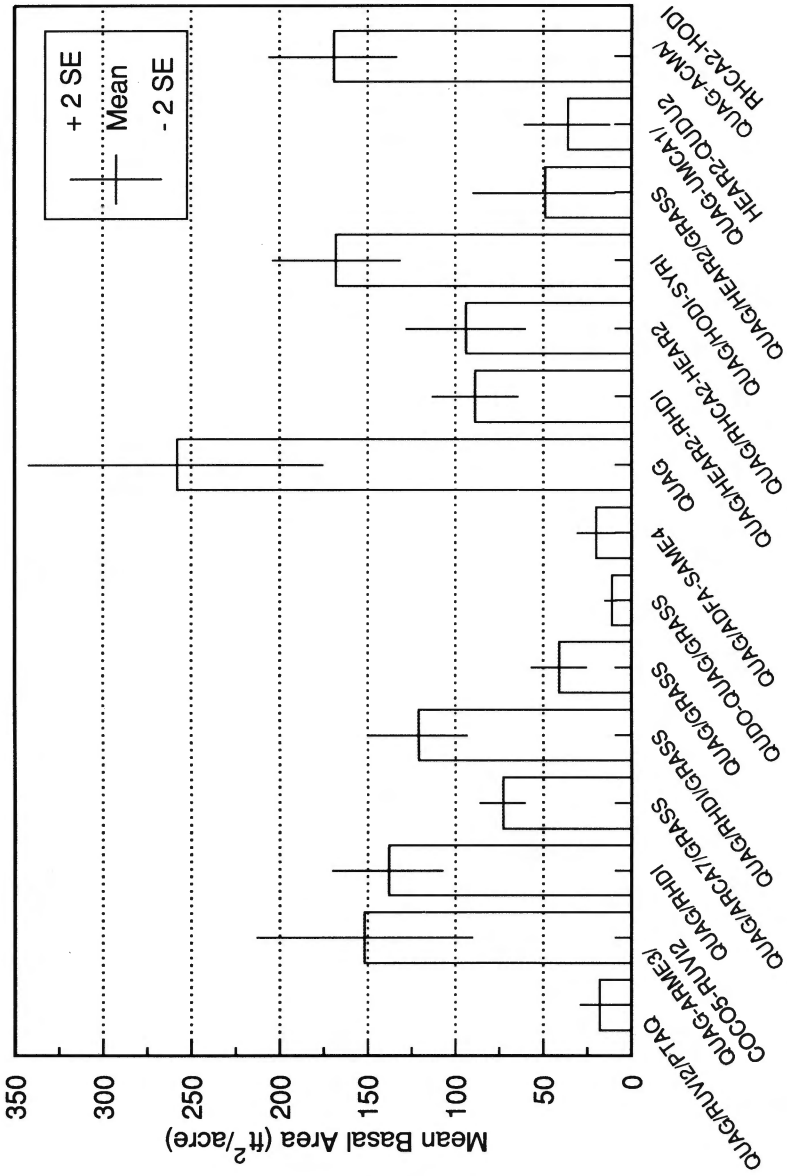

Fig. 1. Comparison of mean coast live oak basal area by coast live oak subseries. Bars represent the 95 percent confidence interval around the mean, approximately ± 2 standard errors. Note variety in mean basal area between coast live oak types.

He suggests that in this locale coast live oak woodland is the last sere before a California bay community.

Upper elevation (above 1,250 ft) mesic subseries include: Coast Live Oak/Ocean Spray–Snowberry, Coast Live Oak/Coffeeberry–Toyon, Coast Live Oak–California Bay/Toyon–Scrub Oak, and Coast Live Oak–Maple/Coffeeberry–Ocean Spray. Campbell (1980) describes a *Quercus agrifolia–Toxicodendron diversilobum* subcommunity in Santa Barbara County that falls clearly into the Coast Live Oak/Coffeeberry–Toyon subseries both in species composition and environmental setting. The Coast Live Oak–California Bay/Toyon–Scrub Oak subseries has significantly less mean basal area of coast live oak than its other upper elevation mesic associates (fig. 1). The remaining three upper elevation mesic types are distinguished from each other primarily by differences in understory shrubs.

Xeric coast live oak subseries tend to be concentrated in the middle elevations between 1,000 and 1,300 ft. Species typical of this group include: grasses and forbs in the herb layer; toyon, chamise, coast sagebrush, black sage in the shrub layer; and blue oak in the tree layer. Of the eight xeric types, only the Coast Live Oak/Poison Oak/Grass and Coast Live Oak/Toyon–Poison Oak subseries are prevalent on north-facing aspects. These two subseries are moderately productive with a mean basal area of 125 ft^2/acre and 90 ft^2/acre, respectively (fig. 1). The remaining six types occur on a variety of aspects and, in general, on a variety of slope angles. These subseries include: Coast Live Oak/Coast Sagebrush/Grass, Coast Live Oak/Chamise–Black Sage, Coast Live Oak/Grass, Coast Live Oak, Blue Oak–Coast Live Oak/Grass, and Coast Live Oak/Toyon/Grass. The Coast Live Oak subseries is the densest of all the types with a mean basal area of 260 ft^2/acre and little to nothing in the understory.

Wells (1962) provided some of the most detailed information on plant communities in the xeric coast live oak subseries. He cataloged the plant communities on 15 different geologic substrata in the San Luis Obispo Quadrangle. In eight of these communities, coast live oak had a frequency of at least 60%. Of these, the Coast Live Oak/Chamise–Black Sage subseries was represented on at least three different geological substrata, the Coast Live Oak/Toyon/Grass and Coast Live Oak/Coast Sagebrush/Grass types on two and the Coast Live Oak type on one substratum. Wells discussed in considerable detail the composition of these coast live oak communities in relationship to the interaction of fire and geologic substatum. He provided some useful information on fire, which could be generally applied to several of the subseries.

THE CALIFORNIA BLUE OAK SERIES

The Blue Oak Series most closely fits the Foothill Woodland described by Griffin (1977). He described a blue oak phase of the Foothill Woodland dominated by blue oak and foothill pine. Associated oak species include coast live oak in the Coast Range, and interior live oak and black oak in the Sierra foothills.

This Series is the most extensive of the hardwood rangeland types in California, covering an estimated 2.9 million acres (Bolsinger 1988). Bolsinger also estimates that 75% of the Blue Oak Woodland is in private ownership, 14% in National Forest Systems, and the remaining in other state, county, and miscellaneous federal ownerships.

Blue Oak or Foothill Woodland is divided into 12 blue oak subseries in this classifica-

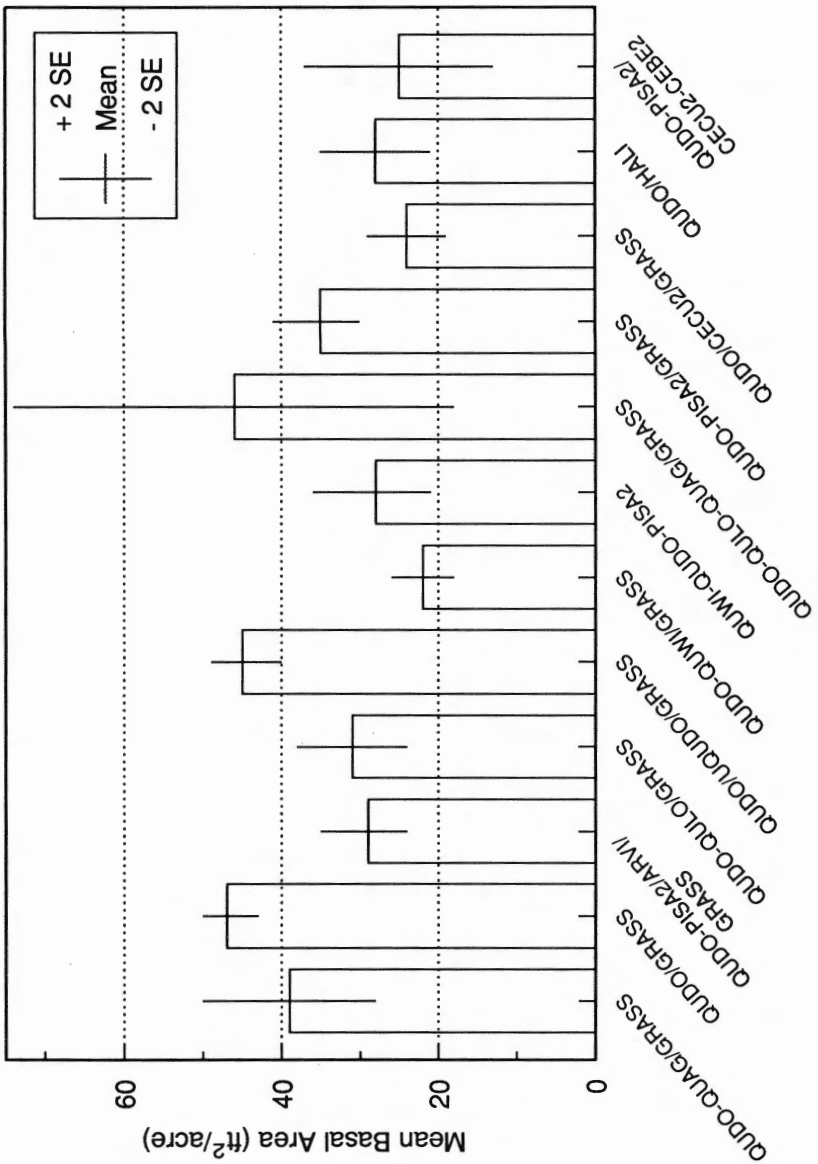

Fig. 2. Comparison of mean blue oak basal area by blue oak subseries. Bars represent the 95 percent confidence interval around the mean, approximately ± 2 standard errors. Note scale change between figures.

tion system as part of the Blue Oak Series. The types range in mean elevation from 1,054 ft to 2,526 ft (table 3). Mean basal area of blue oak also varies from an average of 23 ft^2/acre to 47 ft^2/acre (fig. 2).

Three blue oak subseries are found strictly in the coast ranges, while one type is restricted to the Sierra Nevada foothills. The Sierra Nevada type, Blue Oak–Foothill Pine/Whiteleaf Manzanita/Grass, occurs in Shasta County and in the Sierra Nevada foothills. Common understory associates include whiteleaf manzanita, wedgeleaf ceanothus, poison oak, grass, and other species of manzanita.

The three Coast Range blue oak subseries, Blue Oak–Valley Oak–Coast Live Oak/Grass, Blue Oak–Valley Oak/Grass, and Blue Oak–Coast Live Oak/Grass, are distinguished from each other primarily by their associated oak species, and are named to reflect the codominance of specific oak species. All three coastal types contain high constancies and cover of grass. In addition, the Blue Oak–Coast Live Oak/Grass type also may contain small amounts of coastal species, such as coast sagebrush and honeysuckle. The Blue Oak–Valley Oak–Coast Live Oak/Grass subseries contains the highest basal area of valley oak (averaging 55 ft^2/acre) of all the Blue Oak subseries.

The other eight Blue Oak subseries are found ringing the Central Valley in the foothills of the Sierra Nevada and Coast Ranges (table 3). Significant differences exist in mean basal area of blue oak and other associated oak species between the types. The Blue Oak/Grass and Blue Oak–Understory Blue Oak/Grass subseries have the highest blue oak basal areas, averaging 47 ft^2/acre and 46 ft^2/acre, respectively. Again, the names of the subseries reflect the codominance of species for the type.

Grass cover varies significantly among the types. Types with low grass cover, such as the Blue Oak–Foothill Pine/Wedgeleaf Ceanothus–Mountain Mahogany type, often contain shrubs in the understory. This latter type and the Blue Oak/Narrowleaf Goldenbush also contain high constancies of narrowleaf goldenbush (*Haplopappus linearifolius*).

THE CALIFORNIA VALLEY OAK SERIES

Valley oak dominated communities cover approximately 2.7% of the area of California (Bolsinger 1988). These communities generally occur on the rich loam soils of valleys and foothills below 2,400 ft, and can be found from the foothill woodland of the Central Valley and its borders, to the inner and middle Coast Ranges, to the San Fernando Valley and Los Angeles County. The northern limit of the type reaches from Lakehead above the Sacramento branch of Shasta Lake west to Laytonville in Mendocino County (Griffin and Critchfield 1972).

The Valley Oak Series is comprised of six subseries (fig. 3). All are found in the Coast Ranges and into the Central Valley, except for the Blue Oak–Valley Oak/Grass subseries, which is also found in the Sierra Nevada foothills. Two subseries, Black Oak–Valley Oak/Grass and Valley Oak/Grass, occur at significantly higher mean elevations (2,375 ft and 2,253 ft, respectively) than their other associates, which range in mean elevation from 1,101 ft to 1,477 ft (table 3).

The upper elevation subseries can be easily distinguished by the presence of black oak in the Black Oak–Valley Oak/Grass type, and the significantly greater mean basal area of valley oak in the Valley Oak/Grass subseries (fig. 3). The Valley Oak/Grass

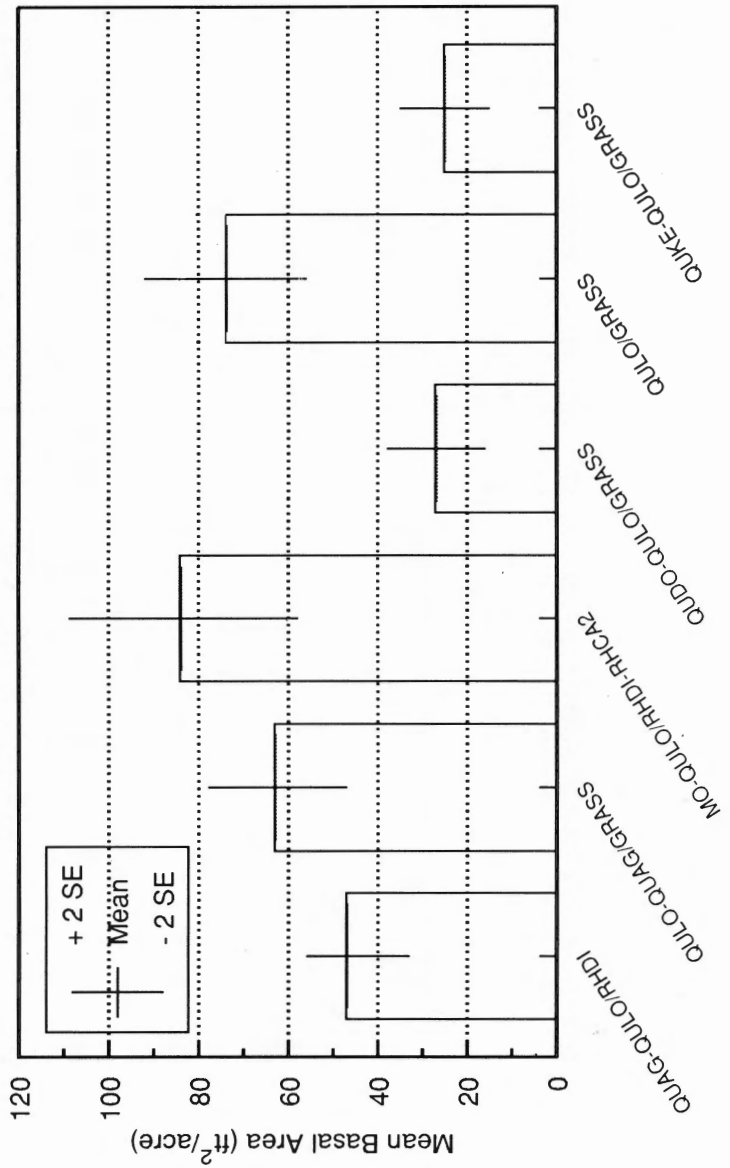

Fig. 3. Comparison of mean valley oak basal area by valley oak subseries. Bars represent the 95 percent confidence interval around the mean, approximately ± 2 standard errors.

subseries is also the only valley oak type where valley oak is the primary, dominating *Quercus* species. The higher elevation subseries occur on similar parent materials, on slopes generally less than 35%, and on all aspects.

The other four valley oak subseries occur at similar elevations (table 3). The Coast Live Oak–Valley Oak/Poison Oak (1,101 ft) and Mixed Oak–Valley Oak/Poison Oak–Coffeeberry (1,443 ft) subseries have a higher mean basal area of coast live oak than any of the other valley oak subseries, averaging 85 ft^2/acre and 122 ft^2/acre, respectively. The Mixed Oak–Valley Oak/Poison Oak–Coffeeberry type also contains high mean basal areas of valley oak (82 ft^2/acre) and blue oak (30 ft^2/acre) in addition to coast live oak. It keys to the Mixed Oak Series because of the presence of three or more *Quercus* species at constancies of 30% or more. The Coast Live Oak–Valley Oak/Poison Oak subseries generally contains less overall basal area than the Mixed Oak–Valley Oak/Poison Oak–Coffeeberry type, although it occurs on wetter sites than the Mixed Oak–Valley Oak/Poison Oak–Coffeeberry subseries.

The Valley Oak–Coast Live Oak/Grass subseries also contains coast live oak, but at lower mean basal area (47 ft^2/acre) and lower constancy (84%) than the other types with coast live oak except for Blue Oak–Valley Oak/Grass, which contains an average of 18 ft^2/acre of coast live oak. The Valley Oak–Coast Live Oak/Grass subseries occurs primarily in the southern Coast Ranges along the San Joaquin Valley. Like its other valley oak associates, this type has few understory species other than grass.

Finally, the Blue Oak–Valley Oak/Grass subseries is distinguished from its other associates by the presence of blue oak. It is the driest of the valley oak types, occurring on all aspects, ringing the Central Valley in the foothills of the Sierra Nevada and Coast Ranges. This type was recognized by Griffin (1977) as a phase of the Foothill Woodland containing blue oak.

Grass species occur in all the Valley Oak subseries. However, the Coast Live Oak–Valley Oak/Poison Oak and Mixed Oak–Valley Oak/Coffeeberry types have significantly less cover of grass (76 and 54%, respectively) than any of the other Valley Oak types.

This classification system lacks representatives of the valley oak riparian forest communities. As described by McBride (1974) and Griffin (1973), the valley oak community takes on a strikingly different appearance along the large rivers on the eastside of the Central Valley. Only remnants of this once larger riparian woodland dominated by valley oak, cottonwoods (*Populus* spp.), willows (*Salix* spp.), grape (*Vitis* spp.) and interior live oak (Thompson 1961) now exist.

THE CALIFORNIA INTERIOR LIVE OAK SERIES

The Interior Live Oak series is comprised of six subseries. Four subseries are found in the Sierra Nevada and foothills, while two types are found in both the Sierra Nevada and Coast Ranges (table 3). Acreage of the Interior Live Oak Series is estimated at 884,000 acres, with about 82% in private ownership (Bolsinger 1988).

The two subseries, Interior Live Oak–Madrone/Poison Oak and Interior Live Oak–Blue Oak–Foothill Pine, which are found in both the Sierra Nevada and Coast Ranges, occur at similar mean elevations, 1,493 ft and 1,533 ft, respectively (table 3). They both contain significantly higher mean basal areas of interior live oak than any other

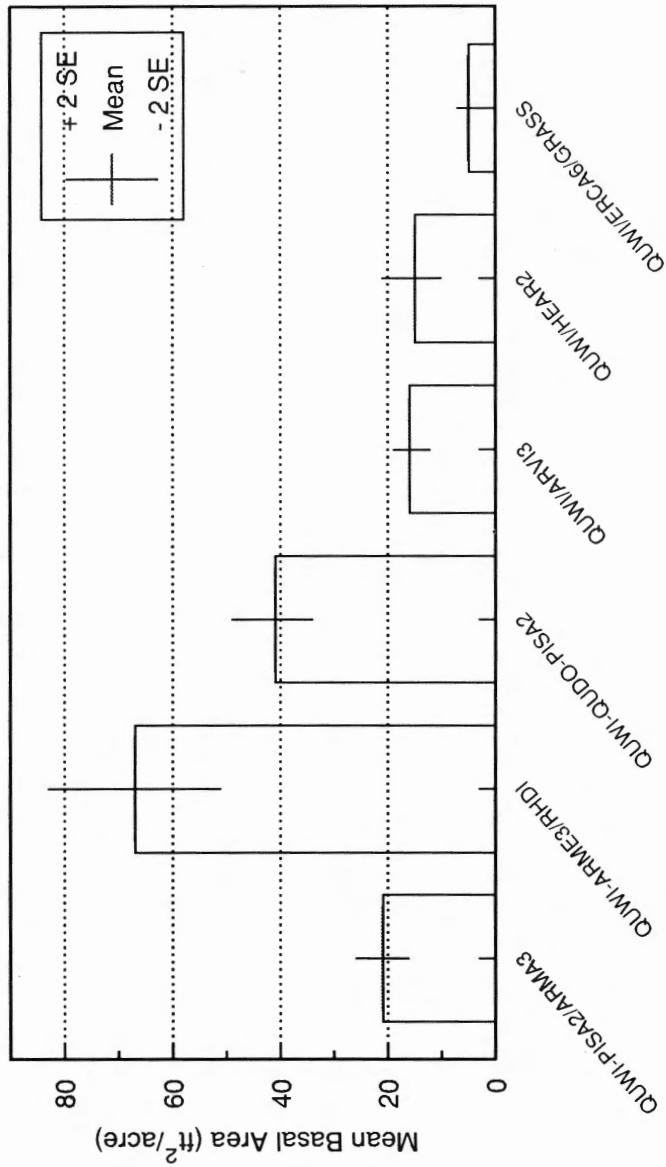

Fig. 4. Comparison of mean interior live oak basal area by interior live oak subseries. Bars represent the 95 percent confidence interval around the mean, approximately ± 2 standard errors. Note differences in productivity between types.

interior live oak subseries (fig. 4). Also, the Interior Live Oak-Madrone/Poison Oak has significantly higher mean basal area of interior live oak (68 ft^2/acre) than the Interior Live Oak–Blue Oak–Foothill Pine subseries (42 ft^2/acre).

The Interior Live Oak–Madrone/Poison Oak type can also be distinguished from all its other interior live oak associates by the presence of madrone and the absence of grass. The Interior Live Oak–Blue Oak–Foothill Pine type contains significantly higher mean basal area of blue oak (28 ft^2/acre) and higher grass cover (62%) than any other interior live oak associate.

The two Sierran/Coast Range subseries ring the Central Valley. The Interior Live Oak–Blue Oak–Foothill Pine type is found from Butte to Kern to San Benito Counties. The Interior Live Oak–Madrone/Poison Oak subseries is found from Shasta to El Dorado and Calaveras Counties, and Mendocino to Santa Cruz County.

The Sierra Nevada interior live oak types contain both the highest elevation type, Interior Live Oak/Yerba Santa/Grass at a mean elevation of 2,120 ft, and the lowest elevation type, Interior Live Oak–Foothill Pine/Manzanita at 1,144 ft (table 3). The other two Sierra Nevada types occur at mean elevations of 1,780 ft and 1,855 ft, for the Interior Live Oak/Whiteleaf Manzanita and Interior Live Oak/Toyon subseries, respectively.

Mean basal areas of interior live oak are significantly different between the interior live oak subseries (fig. 4). The Interior Live Oak–Foothill Pine/Manzanita subseries contains a significantly higher mean basal area of Foothill pine (33 ft^2/acre) than its other Sierra Nevada associates as well as more interior live oak than the Interior Live Oak/Yerba Santa/Grass subseries. It occupies sites on granitic, andesitic, serpentine, and hard sedimentary parent materials.

The highest elevation subseries, Interior Live Oak/Yerba Santa/Grass, has a low mean basal area of interior live oak (fig. 4) and the lowest constancy of interior live oak of all the types, although understory interior live oak is common. This type is found from Nevada to Madera Counties, on all aspects on granitic, igneous, or metamorphic parent materials. Yerba santa is the dominant species, in terms of constancy and cover, distinguishing it from its other associates.

The Interior Live Oak/Whiteleaf Manzanita subseries contains significantly more whiteleaf manzanita and significantly less toyon than its other Sierran associates. Finally, the Sierran subseries, Interior Live Oak/Toyon, can be distinguished from the other Sierran types because of its combination of species containing lower blue oak and foothill pine mean basal area, more toyon, and half as much whiteleaf manzanita as its other interior live oak Sierran associates.

Interior live oak is a prominent species in subseries within the Mixed Oak Series, occurring in both Sierra Nevada Mixed Oak subseries and several of the Coast Range Mixed Oak subseries. It is also a common associate in types in the Blue Oak Series, but rarely occurs in the Coast Live Oak, Valley Oak, or Black Oak Series.

Field testing of the interior live oak keys and descriptions resulted in the discovery of at least one "type" that was not described in the classification system. This type occurred in a riparian zone in the Sierra foothills, and was dominated by interior live oak, California bay, and coffeeberry. The type was confined to the riparian zone and abruptly changed to the Interior Live Oak/Toyon subseries on the east-facing slope, and the Interior Live Oak–Blue Oak–Foothill Pine type on the southwest-facing slopes. As more samples are taken in this type, it may be added to the keys and descriptions.

THE BLACK OAK SERIES

The Black Oak Series is comprised of 13 subseries (fig. 5). Four subseries are confined to the Coast Ranges, while four are confined to the Sierra. Four subseries are found in both the Coast Ranges and the Sierra, and one is found in both the Coast Ranges and the Transverse Range (table 3).

Types that occur only in the Coast Ranges are generally lower in elevation than other types. The Black Oak–Madrone–Coast Live Oak subseries, with a mean elevation of 1,293 ft, and the Mixed Oak–Coast Live Oak/Poison Oak type, with a mean elevation of 1,465 ft, are significantly lower in elevation than all Sierran types except the Black Oak/Poison Oak–California Storax/Grass–nut type. The Coast Range types, Black Oak–Coast Live Oak–Beach Pine/Ocean Spray and Black Oak–Valley Oak/Grass, occur at 1,691 ft and 2,375 ft, respectively.

The four types found in both the Coast and Sierra Nevada Ranges are generally middle elevation types within the Black Oak Series (table 3). The Black Oak/Poison Oak type occurs at a mean elevation of 2,486 ft, the Black Oak/Poison Oak/Grass type at 2,746 ft, the Black Oak–Canyon Live Oak/Poison Oak type at 2,963 ft, and the Canyon Live Oak–Black Oak type at 3,231 ft, all significantly higher than all strictly Coast Range types except for the Black Oak–Valley Oak/Grass type.

The four types found strictly in the Sierra Nevada have a wide range of mean elevation. The Black Oak/Poison Oak–California Storax/Grass–nut type averages 1,484 ft, significantly lower than all other Sierra types. Mid-elevation types include Black Oak/Deerbrush-Poison Oak/Bracken Fern at 2,527 ft mean elevation and Black Oak/Deerbrush at 3,435 ft. The highest subseries is Black Oak/Greenleaf Manzanita, significantly higher than all other black oak subseries at 5,647 ft mean elevation. The Black Oak/Grass subseries, which occurs in both the Transverse and Coast ranges, is also a high elevation type (table 3).

Mean basal area of black oak for the four Coast Range subseries ranges from 38 ft^2/acre in the Mixed Oak–Coast Live Oak/Poison Oak type to 53 ft^2/acre in the Black Oak–Coast Live Oak–Beach Pine/Ocean Spray type, with no significant differences (fig. 5). The Black Oak–Madrone–Coast Live Oak type is distinguished from its coastal associates by the presence of significantly more basal area of madrone and significantly less coast live oak. The Black Oak–Valley Oak/Grass type contains valley oak with a mean basal area of 32 ft^2/acre, significantly more than any other black oak type. The Mixed Oak–Coast Live Oak/Poison Oak type is distinguished from the Black Oak–Coast Live Oak–Beach Pine/Ocean Spray type by the absence of ocean spray and beach pine, and significantly less grass than the Black Oak–Valley Oak/Grass type.

Five subseries occur in both the Coast and Sierra Nevada Ranges, and Coast and Transverse Ranges (table 3). Mean basal area of black oak is 115 ft^2/acre for the Black Oak/Poison Oak type significantly higher than any other black oak subseries (fig. 5). The Black Oak/Poison Oak type can be further distinguished from the Black Oak/Poison Oak/Grass subseries by the absence of grass. The Black Oak–Canyon Live Oak/Poison Oak type and the Canyon Live Oak–Black Oak type can be distinguished from other black oak subseries by the presence of canyon live oak as a codominant species. The Black Oak–Canyon Live Oak/Poison Oak type has a significantly higher mean basal area of black oak and significantly less cover of understory canyon live oak than the Canyon Live Oak–Black Oak type.

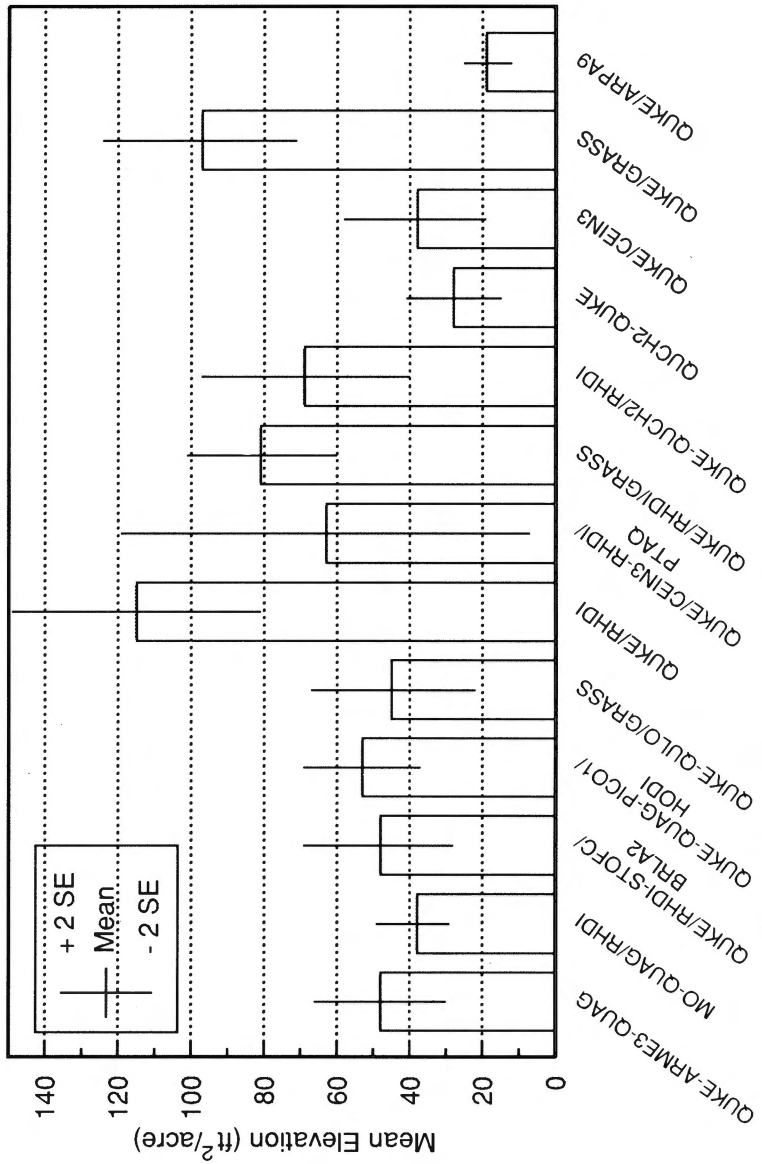

Fig. 5. Comparison of mean black oak basal area by black oak subseries. Bars represent the 95 percent confidence interval around the mean, approximately ± 2 standard errors. Note wide range of productivity among types.

The Black Oak/Grass type is found in both the Coast Range and the Transverse Range. Black oak mean basal area is 97 ft^2/acre, significantly higher than all types occurring strictly in the Coast Range (fig. 5).

In the Sierra Nevada types, black oak mean basal area ranges from 19 ft^2/acre for the Black Oak/Greenleaf Manzanita type to 63 ft^2/acre for the Black Oak/Deerbrush–Poison Oak/Bracken Fern type, with only these two types being significantly different from each other. The Black Oak/Poison Oak–California Storax/Grass-nut type has significantly more cover of poison oak than all other black oak types. The Black Oak/Deerbrush–Poison Oak/Bracken Fern type and the Black Oak/Deerbrush types are distinguished from each other by significantly higher mean cover of deerbrush in the latter, and the presence of bracken fern in the former.

THE CALIFORNIA SCRUB OAK SERIES

The Scrub Oak Series is comprised of cover types that have scrub oak as a dominant or codominant species in the overstory (fig. 6). This series is comprised of three subseries, all found at a mean elevation of about 1,400 ft on northerly facing slopes in the central coastal ranges, in San Benito, Monterey, and San Luis Obispo Counties. Parent material of the soils of these sites is mostly shale, with some sandstone.

The Scrub Oak-Blue Oak/Grass subseries has both scrub oak and blue oak in the overstory, which distinguishes this type from the other two types that have no blue oak. Scrub oak and blue oak are usually codominant; mean basal area of scrub oak is 34 ft^2/acre, compared with 21 ft^2/acre for blue oak. Scrub oak occurs in the understory with 64% constancy, but averages only 5% cover. Grass averages 85% cover with 100% constancy. This type is more likely to be found on clay loam soils than the other types.

The Scrub Oak/Grass subseries has scrub oak as the only dominant overstory species, averaging 50 ft^2/acre of basal area. Scrub oak is usually present in the understory as well, averaging 9% with 87% constancy. Grass is the only other major component of the understory, averaging 78% with 100% constancy.

The Scrub Oak subseries has scrub oak as the only major species present. Mean basal area of scrub oak (73 ft^2/acre) is significantly higher in this type than in the Scrub Oak–Blue Oak/Grass type (fig. 6). Understory scrub oak cover, averaging 21% with 91% constancy, is also significantly higher in this type than in the Scrub Oak–Blue Oak/Grass type. Grass occurs with only a 45% constancy, and averages 10% cover, significantly less than the other two types. Litter is common, with 91% constancy and 60% mean cover, while it is rare in the other types. Toyon and/or hollyleaf cherry can be found more than one-third of the time in the understory. Most of the soils for this type have a gravelly or rocky component.

THE CALIFORNIA MIXED OAK SERIES

The Mixed Oak series is comprised of cover types that contain three or more species of *Quercus* with constancies of 30% or more. This series is comprised of 11 subseries; nine types are found in the Coast Ranges and two types are found in the Sierra Nevada (table 3).

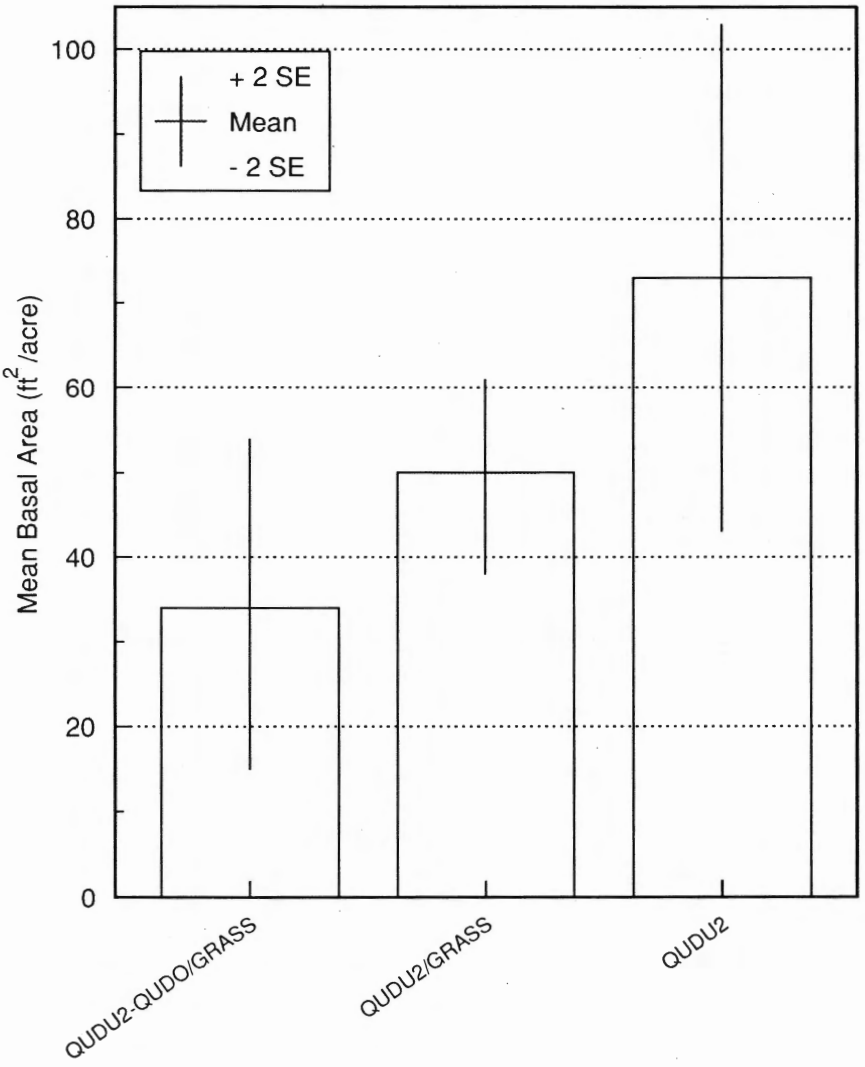

Fig. 6. Comparison of scrub oak mean basal area by type. Bars represent the 95 percent confidence interval around the mean, approximately ± 2 standard errors. The QUDU2–QUDO/GRASS subseries also contains blue oak with a mean of 21 ft²/acre.

The two Sierra Nevada types, Mixed Oak–Interior Live Oak–Foothill Pine and Interior Live Oak/Toyon, exist at similar elevations (1,900 ft) from Placer County in the northern Sierra to Madera County in the south. Both types are dominated by interior live oak (fig. 7), but also contain black oak and blue oak. The Mixed Oak–Interior Live Oak–Foothill Pine type has a significantly higher mean basal area of foothill pine and blue oak, and no understory interior live oak. Overall mean basal area is higher for this type. In addition, this type contains significantly more grass cover, averaging 78%, compared to an average of 42% grass cover for the Interior Live Oak/Toyon type.

There are three Coast Range lower elevation mixed oak subseries (fig. 8). The Mixed Oak–California Buckeye/Grass type tends to occur on the driest sites of the three lower elevation subseries at an average of 872 ft elevation. The Mixed Oak/Grass type occurs in the middle of the moisture gradient at an average of 1,019 ft elevation, while the Mixed Oak/Poison Oak–Baccharis type tends to occur on the moister end at an average of 950 ft. The Mixed Oak–California Buckeye/Grass type is generally found in the central coast from Napa to San Benito Counties. Compared to its other two lower elevation mixed oak associates, this type tends to be found on the central valley side of the Coast Ranges on sandy and gravelly loams. The Mixed Oak/Grass and Mixed Oak/Poison Oak–Baccharis types tend to have a wider geographic range, occurring from Napa to Santa Barbara Counties.

The Mixed Oak/Poison Oak–Baccharis subseries has less mean basal area of blue oak and more valley oak than its other two coastal low-elevation associates. It also has significantly more cover of coffeeberry than the other two subseries. The Mixed Oak–California Buckeye/Grass type is distinguished from its low-elevation associates by its high constancy (though low overall mean basal area) of California buckeye. The Mixed Oak–California Buckeye/Grass type also has significantly more grass cover (97%) than its associates; the Mixed Oak/Grass type also has a higher mean grass cover (64%) than the Mixed Oak/Poison Oak–Baccharis type (24%).

The Coast Range middle elevation subseries include the Mixed Oak–Foothill Pine/Grass, Mixed Oak–Valley Oak/Poison Oak–Coffeeberry, Mixed Oak–Coast Live Oak/Poison Oak, and Mixed Oak–Black Oak/Grass types (fig. 9). Each subseries is named for the dominant oak species in oak species mixture. The Mixed Oak–Foothill Pine/Grass type tends to be the driest of the four middle elevation types. It occurs primarily in the Coast Ranges from Contra Costa to Santa Barbara and Kern Counties, at a mean elevation of 1,526 ft. Slopes are commonly less than 35% and this type is located primarily on sandstone and shale parent materials on northwest to east aspects.

The Mixed Oak–Valley Oak/Poison Oak–Coffeeberry type is distinguished from its middle-elevation associates by its significantly higher mean basal areas of valley oak (84 ft^2/acre) and coast live oak (108 ft^2/acre). Valley oak is present 100% of the time, and coast live oak has a constancy of 99% in this type. There is also a noticeable absence of black oak in this subseries. The type may be found from Marin and Contra Costa Counties to San Luis Obispo County at mean elevations of 1,443 ft. The Mixed Oak–Valley Oak/Poison Oak–Coffeeberry subseries is found on a wide range of slopes (flat to very steep), and aspects (including 40% on south to west aspects). Parent material is primarily shale, but this type is also found on granitics, serpentine, and sandstones, among others.

The Mixed Oak–Coast Live Oak/Poison Oak type is distinguished from the Mixed Oak–Black Oak/Grass type by the absence of blue oak in the type, and its significantly

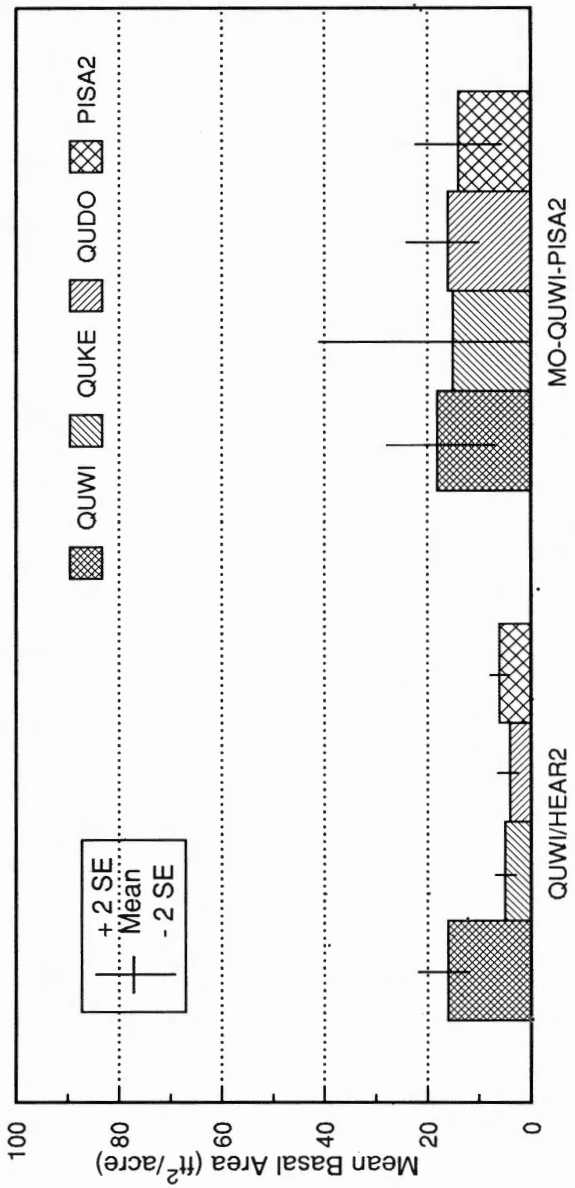

Fig. 7. Comparison of mean basal area of major tree species contained within the mixed oak subseries found in the Sierra Nevada. Bars represent the 95 percent confidence interval around the mean, approximately ± 2 standard errors. Note foothill pine and interior live oak are not major species in the other oak types (figs. 8-10).

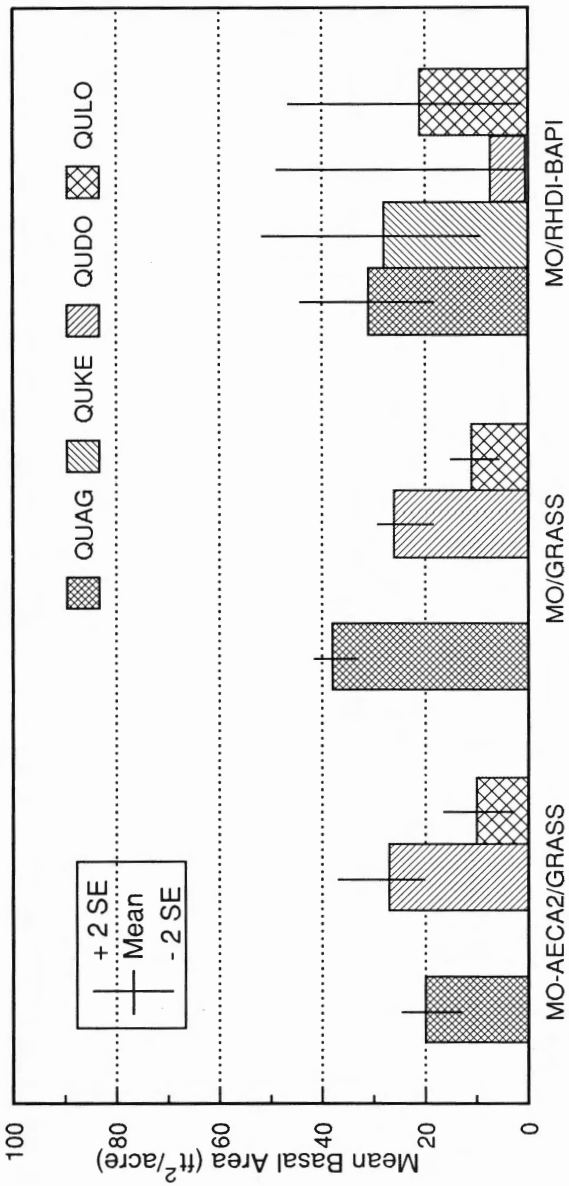

Fig. 8. Comparison of major tree species' mean basal area for mixed oak subseries found in the Coast Ranges at low elevations. Bars represent the 95 percent confidence interval around the mean, approximately ± 2 standard errors.

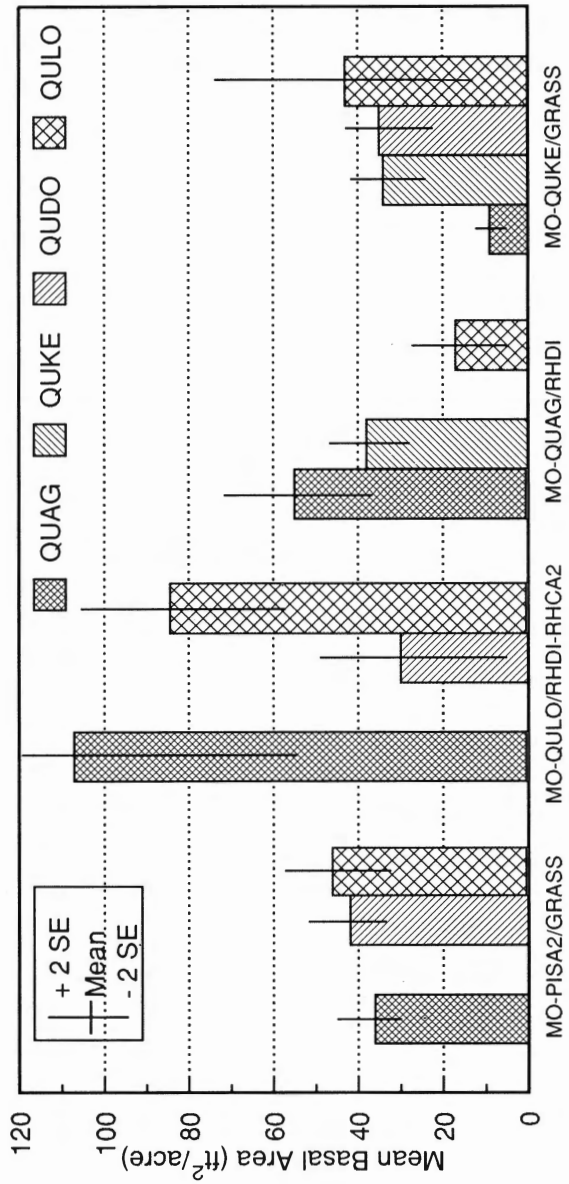

Fig. 9. Comparison of mean basal area of major tree species for coastal middle elevation mixed oak subseries. Bars represent the 95 percent confidence interval around the mean, approximately ± 2 standard errors.

higher mean basal area of coast live oak (fig. 9). Additionally, the Mixed Oak–Coast Live Oak/Poison Oak type has significantly less grass cover than the Mixed Oak–Black Oak/Grass type.

The Mixed Oak–Coast Live Oak/Poison Oak type tends to occur on steeper slopes than its other middle-elevation associates, and occurs on all soil textures and a wide range of parent materials from Sonoma to Monterey Counties. The Mixed Oak–Black Oak/Grass subseries occurs primarily on soft sedimentary sandstone parent material, although it also may occur on shales, metamorphic, and other parent materials. Although primarily a coast range type, 10% of the samples representing the Mixed Oak–Black Oak/Grass subseries are found in the Sierra Nevada.

The Blue Oak–Valley Oak–Coast Live Oak/Grass subseries occurs at a mean elevation of 1,567 ft (fig. 10). It is distinguished from its other coastal middle and upper-elevation associates by the lack of black oak and foothill pine, and the high constancy and cover of grass as the only understory species.

The Black Oak–Valley Oak/Grass subseries is distinguished from all its other coastal associates by elevation. It is the highest of the Mixed Oak Series types with a mean elevation of 2,375 ft. Black oak and grass are always present in the type, with very few other species in the understory. Coast live oak is a common associate occurring on 47% of the plots representing this type.

DISCUSSION

The hardwood rangeland classification system for California provides private landowners, land managers, and researchers a unifying framework from which known ecological and management information can be retrieved. Standardization of type names facilitates the exchange of information on hardwood rangelands within and among agencies, landowners, and universities. The dichotomous keys to the type descriptions ensure that the system is easily accessible, field oriented, and user-friendly.

The classification system is more detailed than any existing hardwood rangeland classification system. Unlike other systems, this classification incorporates environmental information, in addition to floristics, in distinguishing types. This results in a natural classification system useful for a number of management and research purposes (Allen 1987; Pfister and Arno 1980).

Land managers can use the classification framework for labelling management units, thus facilitating communication between functional specialists. For example, a wildlife biologist may label a site using the wildlife habitats classification system (Mayer and Laudenslayer 1988), which is general in nature. A forester may look at the same piece of ground and label the site using the Society of American Forester forest cover type designation (Eyre 1980) based on dominant (often commercial) tree species. On the other hand, the range conservationist may label the site using range sites (Soil Conservation Service 1986) based on the potential to graze livestock or some other more general system. The hardwood rangeland cover type system provides a common labelling system for all these specialists, is specific in nature, and is not tied to any particular use. Additionally, the system provides crosswalks to other classifications so that the user can access information from these systems.

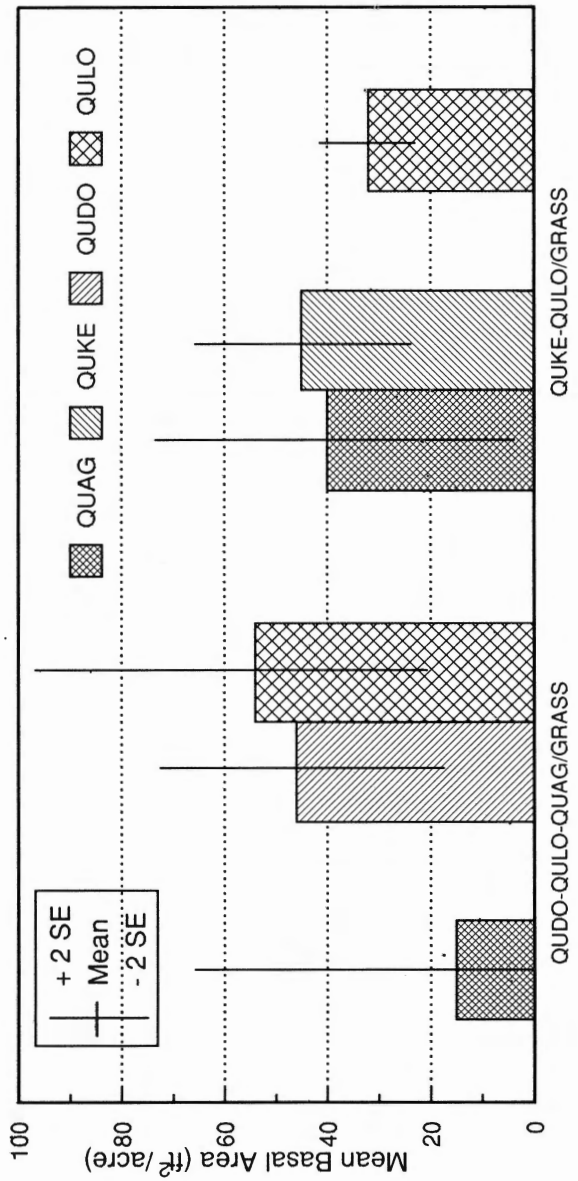

Fig. 10. Comparison of mean basal area of major tree species for coastal upper elevation mixed oak subseries. Bars represent the 95 percent confidence interval around the mean, approximately ± 2 standard errors.

Researchers can use the hardwood rangeland cover type classification for labelling research sites and thus facilitate the transfer of information. Information on production of trees, shrubs, and herbaceous species can be stored and retrieved by type. Similarly, research information on wildlife habitat, suitability for grazing or harvesting, or other kinds of research results can be accessed if researchers identify their research sites using these common labels. As more information is collected, the successional relationships between types can be identified, making the hardwood rangeland cover type system a stronger, integrated, hierarchical system.

The hardwood rangeland classification system was developed from attributes of vegetation and environment that were contained within an existing data set (the VTM data set). Thus, the classification system is constrained by the data elements available. One of the most obvious weaknesses in the data set is the lack of soils information and the incomplete list of grass and other graminoid species. Even so, field checking and discussion with oak woodland experts indicate that the classification should apply to at least 80% of the possible oak woodland subseries cover types comprising the Series presented here. This applicability is comparable to detailed ecological site classification systems based on complete species lists and detailed soils information.

New types will be added to the hardwood rangeland system as appropriate, as documented by field work and additional analysis. Existing types will be refined, as appropriate, as users make suggestions. Information on tree and understory productivity, wildlife habitat, and potential responses to management treatments for existing types will be added as information becomes available from the literature and research. Meanwhile, the classification system will provide common labels, and a storage and retrieval system for researchers and managers alike.

APPENDIX 1: PLANT SPECIES CODES WITH SCIENTIFIC NAMES AND COMMON NAMES FROM MUNZ AND KECK (1968) AND POWELL (1987)

VEGCODE	GENUS	SPECIES	VARIETY	COMMON NAME
ABCO	ABIES	CONCOLOR	-0-	White fir
ACMA	ACER	MACROPHYLLUM	-0-	Bigleaf maple
ADFA	ADENOSTOMA	FASCICULATUM	-0-	Chamise
AECA-2	AESCULUS	CALIFORNICA	-0-	California buckeye
AMCA-2	AMORPHA	CALIFORNICA	-0-	Mock locust
AMUT	AMELANCHIER	UTAHENSIS	-0-	Utah serviceberry
APCA	APOCYNUM	CANNABINUM	-0-	Indian hemp
ARCA-5	ARCTOSTAPHYLOS	CANESCENS	-0-	Hoary manzanita
ARCA-7	ARTEMISIA	CALIFORNICA	-0-	Coast sagebrush
ARCO-6	ARCTOSTAPHYLOS	COLUMBIANA	-0-	Hairy manzanita
ARGL-5	ARCTOSTAPHYLOS	GLAUCA	-0-	Bigberry manzanita
ARMA-3	ARCTOSTAPHYLOS	MANZANITA	-0-	Common manzanita
ARMA-4	ARCTOSTAPHYLOS	MARIPOSA	-0-	Mariposa manzanita
ARME-2	ARCTOSTAPHYLOS	MEWUKKA	-0-	Indian manzanita
ARME-3	ARBUTUS	MENZIESII	-0-	Madrone
AROB-2	ARCTOSTAPHYLOS	OBISPOENSIS	-0-	Serpentine manzanita
ARPA-9	ARCTOSTAPHYLOS	PATULA	-0-	Greenleaf manzanita
ARPRD	ARCTOSTAPHYLOS	PRINGLEI	drupa	Pink-bracted manzanita
ARPU-6	ARCTOSTAPHYLOS	PUNGENS	-0-	Mexican manzanita
ARTO-2	ARCTOSTAPHYLOS	TOMENTOSA	-0-	Shaggy barked manzanita
ARTR	ARTEMISIA	TRIDENTATA	-0-	Basin sagebrush
ARVI-3	ARCTOSTAPHYLOS	VISCIDA	-0-	Whiteleaf manzanita
BAPI	BACCHARIS	PILULARIS	-0-	Baccharis
BRLA-2	BRODIAEA	LAXA	-0-	Grass-nut
CASE-3	CASTANOPSIS	SEMPERVIRENS	-0-	Bush chinquapin
CEBE-2	CERCOCARPUS	BETULOIDES	-0-	Birchleaf mountain-mahogany
CECO-2	CEANOTHUS	CORDULATUS	-0-	Mountain whitethorn
CECU-2	CEANOTHUS	CUNEATUS	-0-	Wedgeleaf ceanothus
CEIN-3	CEANOTHUS	INTEGERRIMUS	-0-	Deerbrush
CELE-2	CEANOTHUS	LEUCODERMIS	-0-	Chaparral whitethorn
CEOC	CERCIS	OCCIDENTALIS	-0-	California redbud

(*Continued on next page.*)

APPENDIX 1 (*Continued*)

VEGCODE	GENUS	SPECIES	VARIETY	COMMON NAME
CEPA-3	CEANOTHUS	PAPILLOSUS	-0-	Warty-leaved ceanothus
CEPA-5	CEANOTHUS	PARVIFOLIUS	-0-	Littleleaf ceanothus
CEPR	CEANOTHUS	PROSTRATUS	-0-	Squaw carpet
CESO-3	CEANOTHUS	SOREDIATUS	-0-	Jim brush
CESP	CEANOTHUS	SPINOSUS	-0-	Greenbark ceanothus
CETH	CEANOTHUS	THYRSIFLORUS	-0-	Blueblossom ceanothus
CETO	CEANOTHUS	TOMENTOSUS	-0-	Woollyleaf ceanothus
CHFO-2	CHAMAEBATIA	FOLIOLOSA	-0-	Mountain misery
COCA-8	CORETHROGYNE	CALIFORNICA	-0-	-0-
COCO-5	CORYLUS	CORNUTA	-0-	Hazelnut
CONU-2	CORNUS	NUTTALLII	-0-	Pacific dogwood
COROC	CORYLUS	ROSTRATA	calif	-0-
CRCA-2	CROTON	CALIFORNICUS	-0-	California croton
DERI	DENDROMECON	RIGIDA	-0-	Tree poppy
DIAU-1	DIPLACUS	AURANTIACUS	-0-	Bush monkeyflower
ERCA-6	ERIODICTYON	CALIFORNICUM	-0-	California yerba santa
ERCI-2	ERODIUM	CICUTARIUM	-0-	Red-stem filaree
ERCO-7	ERIOPHYLLUM	CONFERTIFLORUM	-0-	Yellow yarrow
ERCR-2	ERIODICTYON	CRASSIFOLIUM	-0-	Thick-leaf yerba santa
ERFA	ERIOGONUM	FASCICULATUM	-0-	California buckwheat
ERPA-3	ERIOGONUM	PARVIFOLIUM	-0-	Dune eriogonum
ERWR	ERIOGONUM	WRIGHTII	-0-	Buckwheat
FRCA-2	FREMONTIA	CALIFORNICA	-0-	Flannel bush
FRDI	FRAXINUS	DIPETALA	-0-	Foothill ash
GAEL	GARRYA	ELLIPTICA	-0-	Coast silktassel
GAFLP	GARRYA	FLAVESCENS	palli	Ashy silktassel
GAFR	GARRYA	FREMONTII	-0-	Fremont silktassel
GAVE-2	GARRYA	VEATCHII	-0-	Veatch silktassel
GR2				Grass
HAAR	HAPLOPAPPUS	ARBORESCENS	-0-	Goldenfleece
HALI	HAPLOPAPPUS	LINEARIFOLIUS	-0-	Narrowleaf goldenbush
HASQ-2	HAZARDIA	SQUARROSA	-0-	Sawtooth goldenbush

(*Continued on next page.*)

APPENDIX 1 (*Continued*)

VEGCODE	GENUS	SPECIES	VARIETY	COMMON NAME
HEAR-2	HETEROMELES	ARBUTIFOLIA	-0-	Toyon, christmas berry
HODI	HOLODISCUS	DISCOLOR	-0-	Ocean spray, Creambush
HYPE	HYPERICUM	PERFORATUM	-0-	Klamath weed
JUCA-3	JUNIPERUS	CALIFORNICA	-0-	California juniper
JUCA-4	JUGLANS	CALIFORNICA	-0-	Southern black walnut
LECA-3	LEPECHINIA	CALYCINA	-0-	Woodbalm
LIDE-2	LITHOCARPUS	DENSIFLORUS	-0-	Tan-oak
LIDE-3	LIBOCEDRUS	DECURRENS	-0-	Incense-cedar
LOIN-3	LONICERA	INTERRUPTA	-0-	Chaparral honeysuckle
LOSC	LOTUS	SCOPARIUS	-0-	Lotus
LOSU-3	LONICERA	SUBSPICATA	-0-	Southern honeysuckle
LUAL-3	LUPINUS	ALBIFRONS	-0-	Silver lupine
LUP-5	LUPINUS	SP. WOODY SHRUB	-0-	Bush lupine
MECH	MESEMBRYANTHEMUM	CHILENSE	-0-	Iceplant
MYCA	MYRICA	CALIFORNICA	-0-	Pacific wax-myrtle
PECO-3	PENSTEMON	CORDIFOLIUS	-0-	-0-
PESP-2	PENSTEMON	SPECTABILIS	-0-	Showy penstemon
PHLEC	PHILADELPHUS	LEWISII	californicus	California mock orange
PIAT-1	PINUS	ATTENUATA	-0-	Knobcone pine
PICO-1	PINUS	CONTORTA	-0-	Beach (lodgepole) pine
PICO-2	PINUS	COULTERI	-0-	Coulter pine
PIJE	PINUS	JEFFREYI	-0-	Jeffrey pine
PILA	PINUS	LAMBERTIANA	-0-	Sugar pine
PIMO-2	PINUS	MONOPHYLLA	-0-	One-needle pinyon pine
PIMU-1	PINUS	MURICATA	-0-	Bishop pine
PIPO	PINUS	PONDEROSA	-0-	Ponderosa pine
PIQU	PINUS	QUADRIFOLIA	-0-	Four-needle pinyon pine
PIRA	PINUS	RADIATA	-0-	Monterey pine
PISA-2	PINUS	SABINIANA	-0-	Foothill pine
PLRA	PLATANUS	RACEMOSA	-0-	Western sycamore
POMU-1	POLYSTICHUM	MUNITUM	-0-	Sword fern
PREM	PRUNUS	EMARGINATA	-0-	Bitter cherry

(*Continued on next page.*)

APPENDIX 1 (*Continued*)

VEGCODE	GENUS	SPECIES	VARIETY	COMMON NAME
PRIL-1	PRUNUS	ILICIFOLIA	-0-	Shrub hollyleaf cherry
PRSU-2	PRUNUS	SUBCORDATA	-0-	Sierra plum
PRVID	PRUNUS	VIRGINIANA	demissa	Western choke-cherry
PSMA-2	PSEUDOTSUGA	MACROCARPA	-0-	Big-cone spruce
PSME	PSEUDOTSUGA	MENZIESII	-0-	Douglas-fir
PSPH	PSORALEA	PHYSODES	-0-	California tea
PTAQL	PTERIDIUM	AQUILINUM	lanuginosum	Bracken fern
PTAQP	PTERIDIUM	AQUILINUM	pubescens	Bracken fern
QUAG	QUERCUS	AGRIFOLIA	-0-	Coast live oak
QUCH-2	QUERCUS	CHRYSOLEPIS	-0-	Canyon live oak
QUDO	QUERCUS	DOUGLASII	-0-	Blue oak
QUDU-2	QUERCUS	DUMOSA	-0-	California scrub oak
QUEN-1	QUERCUS	ENGELMANNII	-0-	Engelmann oak
QUGA-2	QUERCUS	GARRYANA	-0-	Oregon oak, garry oak
QUGAB	QUERCUS	GARRYANA	breweri	Brewer oak
QUKE	QUERCUS	KELLOGGII	-0-	California black oak
QULO	QUERCUS	LOBATA	-0-	Valley oak
QUMO	QUERCUS	MOREHUS	x quwiw & qukek	Oracle oak
QUVA	QUERCUS	VACCINIFOLIA	-0-	Huckleberry oak
QUWI	QUERCUS	WISLIZENII	-0-	Interior live oak
RHCA-2	RHAMNUS	CALIFORNICA	-0-	California coffeeberry
RHCR	RHAMNUS	CROCEA	-0-	Redberry
RHDI	RHUS	DIVERSILOBA	-0-	Poison-oak
RHLA	RHUS	LAURINA	-0-	Laurel sumac
RHRU	RHAMNUS	RUBRA	-0-	Sierra coffeeberry
RHTR	RHUS	TRILOBATA	-0-	Squaw bush
RIAU	RIBES	AUREUM	-0-	Golden currant
RIB	RIBES	SP. WOODY SHRUB	-0-	Gooseberry, currant
RICA-1	RIBES	CALIFORNICUM	-0-	Hillside gooseberry
RIMA-1	RIBES	MALVACEUM	-0-	Chaparral currant
RIQU	RIBES	QUERCETORUM	-0-	Foothill gooseberry
RIRO	RIBES	ROEZLII	-0-	Sierra gooseberry

(*Continued on next page.*)

APPENDIX 1 (*Continued*)

VEGCODE	GENUS	SPECIES	VARIETY	COMMON NAME
RISA	RIBES	SANGUINEUM	-0-	Red flowering currant
RISP	RIBES	SPECIOSUM	-0-	Fuchsia-flower gooseberry
ROCA-1	ROSA	CALIFORNICA	-0-	California wild rose
ROGY	ROSA	GYMNOCARPA	-0-	Wood rose
ROS	ROSA	SP. WOODY SHRUB	-0-	Rose
RUPA-2	RUBUS	PARVIFLORUS	-0-	Western thimbleberry
RUVI-1	RUMEX	VIOLASCENS	-0-	-0-
RUVI-2	RUBUS	SP. SHRUB	-0-	Blackberry
SAAP-1	SALVIA	APIANA	-0-	White sage
SACA-4	SAMBUCUS	CAERULEA	-0-	Mountain blue elderberry
SAL-11	SALIX	SP. WOODY SHRUB	-0-	Willow
SALE-2	SALVIA	LEUCOPHYLLA	-0-	Purple sage
SAME-4	SALVIA	MELLIFERA	-0-	Black sage
SAME-6	SAMBUCUS	MEXICANA	-0-	Blue elderberry
SASP	SALVIA	SPATHACEA	-0-	Pitcher sage
SESE-2	SEQUOIA	SEMPERVIRENS	-0-	Coast redwood
STOFC	STYRAX	OFFICINALIS	californica	California storax
SYMO	SYMPHORICARPOS	MOLLIS	-0-	Creeping snowberry
SYRI	SYMPHORICARPOS	RIVULARIS	-0-	Upright snowberry
UMCA-1	UMBELLULARIA	CALIFORNICA	-0-	California laurel, bay tree
VAOV	VACCINIUM	OVATUM	-0-	California huckleberry
XYBI	XYLOCOCCUS	BICOLOR	-0-	Mission manzanita
YUWH	YUCCA	WHIPPLEI	-0-	Chaparral yucca

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the USDA Forest Service, Pacific Northwest Research Station in the 1970s and 1980s. The base information on species composition, percent cover by species, tree stand structure, and environment was collected on 1/5-acre plots. Species cover was determined from a 33′ by 66′ belt transect on each plot.

The classification structure was developed using TWINSPAN, a polythetic, divisive classification program developed by Hill (1979a). Further analyses were performed using DECORANA, and frequencies, regression, and analysis of variance. The information contained in the final type descriptions was developed from VTM data only.

The keys and type descriptions have been field tested and verified at several locations in the State, such as Hopland Field Station, Sierra Field Station, Hastings Reserve, and the San Joaquin Experiment Station. The tests were conducted by individuals familiar with hardwood rangeland ecosystems and those who were not. Ongoing use of the keys and descriptions in other parts of the State will provide information for further refinement of keys and descriptions. Additional information on potential productivity and response to management will be incorporated into the descriptions by users as they identify the types that they are working in by the classification subseries names.

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