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A SURVEY OF SELECTED HABITAT FEATURES OF 95 BALD EAGLE NEST SITES IN CALIFORNIA

by

Robert N. Lehman

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ABSTRACT

Forty-one physical and silvicultural features were classified and evaluated for 95 Bald Eagle nest sites in 54 nesting territories in California. Field work was conducted between December 7, 1977, and March 10, 1978. Data were processed by a Univac 1108 computer using a program written specifically for this study. Frequency distributions, means, ranges, and standard deviations were derived for each variable.

Ninety-one percent of the nest territories occurred in five counties in northern California. Forty-two percent of the territories contained alternate nests. Ponderosa and sugar pine were the predominate nest tree species. Nests were consistently found in trees of the highest canopy layer of the vertical forest structure, in live, dominant or co-dominant trees. Total canopy closure (percent cover) in the associated timber stand was usually below 40%. One-third of all nests surveyed were within 0.1 mile of a waterfront, and 87% were within one mile. Eighty-five percent had an unobstructed view to the associated water body. Seventy percent of the nests were associated with reservoirs.

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2/ Supported in part by U. S. Forest Service and by California Department of Fish and Game--Endangered Wildlife Program, E-W-2, Job V-1.51, Job Final Report.

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INTRODUCTION

Fifteen years ago little was known of the status and distribution of nesting Bald Eagles (Haliaeetus leucocephalus) in California. Bent (1937) described the species as resident statewide, yet Sprunt (1963) reported only two active nests with "some nesting in northern California." In view of the reproductive failure documented in several eastern populations (Broley 1950, 1951, 1958; Sprunt 1963; Sprunt and Ligas 1966; Sprunt et. al. 1973), an assessment of the species' status in California was clearly needed. Legal justification was provided when the Department of the Interior placed the Bald Eagle on its list of endangered species in 1967. Field inventories were begun to locate active Bald Eagle nests in California and to determine the status of the breeding population (Thelander 1973; Detrich 1977; and many unpublished reports). By 1978 we knew that a significant population of nesting Bald Eagles existed in California, nesting predominantly in the northern part of the state (Figure 1). Fifty-eight verified nesting territories have been located, all active at sometime in the last 15 years.

Northern California is growing rapidly as a recreation area and produces a significant percentage of the total timber output for the state. As the demand for recreation and timber increases in the mountainous areas of California, so will the demand on resource managers to provide for long-range requirements of nesting Bald Eagles. It is timely and appropriate, therefore, to assess their habitat needs. This is essential in order to develop a long-range management plan for the species in California, under Section 7 of the 1973 Endangered Species Act, with a full accounting of timber management and recreational planning relative to nesting Bald Eagles.

The purpose of this study was to generate baseline data for such a management plan, specifically:

I. To quantify physical and silvicultural habitat features for all verified Bald Eagle nest sites in California.

II. To develop criteria for delineation of essential habitat.

III. To make recommendations for managing that habitat on a long-range basis.

METHODS

Field work began on December 7, 1977, and ended March 10, 1978. Since most nests were observed from the ground, a winter study period was chosen to reduce the likelihood of disturbing the eagles at their nest sites. A four-wheel drive vehicle and cross-country skis were used to reach nest sites at higher elevations. Nests on Shasta Lake and Clair Eagle Lake were reached by motorboat.

All nest locations were compiled from the files of California Department of Fish and Game, U. S. Forest Service, Bureau of Land Management, and the California Bald Eagle Working Team. Only verified nest locations were included, "verified" meaning any location observed by the author or reported first-hand to the author by a reliable source, and where a stick nest

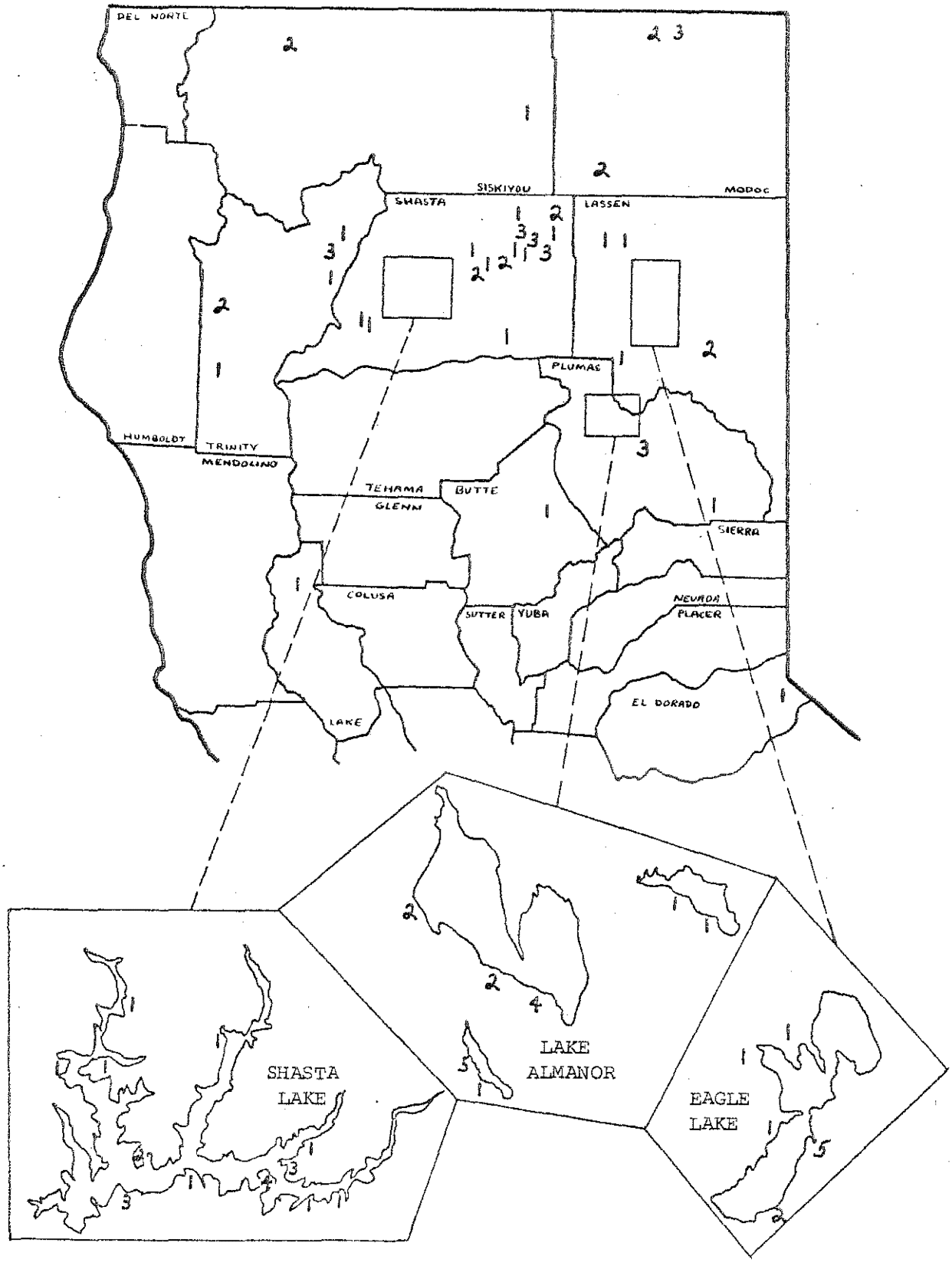

Figure 1. Distribution of 58 verified Bald Eagle nesting territories that have been active at sometime from 1963 to 1978 in California. Included are four recently discovered territories not included in this survey. Each number marks the location of a nesting territory and indicates the number of nests recorded for the territory.

currently exists or formerly existed. Reported locations of stick nests without observed Bald Eagle activity were excluded. At one site where the original nest was destroyed, the birds rebuilt the nest at a different location in the same tree. The two nests are included as two nest sites. When a nest was rebuilt in the same location in the tree, it is included as one nest site.

Ninety-five nest sites are included in this survey. These were delineated into 54 nesting territories on the basis of spatial distribution and history of use. Groups of nests within .25 mile of one another were placed in a single territory when the historic record of the nests suggested use by one pair of Bald Eagles.

Nest Site Parameters

Some of the terminology presented is similar to that used by Grubb (1976). All parameters were recorded for each nest site rather than for each territory. Since available data varied for each nest site, the sample size for each parameter is variable. Landownership was identified from existing nesting territory management plans or from the records of county assessor offices.

Nest Tree Parameters

For nest sites located and observed from the ground, and where the nest tree was intact, the species, form of top, tree class, vigor, and crown class (dominance) were determined by visual inspection. Each nest tree was placed in one of Dunning's Tree Classes as described in the R-5 Timber Management Handbook, U. S. Forest Service, Section 2420.48(1), April 1957. The vigor of each nest tree was recorded according to the Beetle Susceptibility Risk Classes developed by Hall and Pierce appearing in the R-5 Supplement No. 108 (September 1971) of the Forest Service Manual, Section 2471.23(3). Tree height was measured by clinometer, diameter at breast height by standard calibrated tree tape, and age by increment bore.

Nest Parameters

For each nest site located and observed from the ground, and where the nest was intact, the height of the nest above ground was measured by clinometer, position on the tree axis by compass, and amount of overhead and surrounding foliage by visual inspection. Line of sight visibility of water bodies was inferred on the basis of the height of the nest, the surrounding topography, and the distance of the nest from water.

Topographic Parameters

For all nest sites included in the survey, the following topographic parameters were derived from U. S. Geologic Survey topographic maps, 7.5 and 15 minute series: distance from water, elevation above sea level, elevation above high waterline, type of waterfront, aspect, and position on slope. Slope was measured by clinometer, and the body size of lakes and reservoirs was calculated using a standard dot grid.

Silvicultural Parameters

A detailed timber description was recorded within a 200 foot radius of all nest trees observed from the ground. The canopy structure was divided into three layers, and the following parameters were recorded for each layer: percent cover of layer, species composition, percent species composition, basal area, average number of stems per acre, average height, and average diameter at breast height (DBH). Basal area and average number of stems per acre were estimated using an angle gauge. Average height was measured by clinometer, and average diameter at breast height by standard tree tape. U. S. Forest Service color aerial photographs (scale 1:15840) were examined under a 2½ power stereoscope to estimate the total cover of all layers combined for each timber stand.

Computer Analysis

Data processing was performed by a Univac 1108 computer at the U. S. Forest Service central terminal in Fort Collins, Colorado. Data were keyed locally on tape using an ICL 1500 series data entry machine and were transmitted to Fort Collins over standard telephone lines. Analyses were controlled locally by a program written to specifications for this study.

RESULTS AND DISCUSSION

Distribution of Territories

Regional divisions were delineated according to general geographic and topographic patterns and by nest concentrations. The divisions are shown below with a frequency distribution for territory occurrence.

Division*	No. of territories	%
Almanor	10	18.5
Lassen	9	16.7
Pit	11	20.4
Modoc	3	5.6
Shasta	13	24.1
Trinity	5	9.3
Klamath	1	1.9
Mendocino	1	1.9
Tahoe	1	1.9
	54	

*The Almanor division includes Lake Almanor, Mountain Meadows Reservoir, Butt Valley Reservoir, Round Valley Reservoir, and the Feather River drainage; Lassen includes Eagle Lake, McCoy Flat Reservoir, Strayler Lake, and Big Jack Lake; Pit includes Lake Britton, Big Lake, Hat Creek, Little Egg Lake, and the Pit River drainage; Modoc includes the Upper Modoc Plateau; Shasta includes Lake Shasta and Whiskeytown Reservoir; Trinity includes Clair Engle Lake, Ruth Reservoir and the Trinity River drainage.

Territories are included in nine counties:

County	No. of territories	%
Butte	1	1.9
Eldorado	1	1.9
Lake	1	1.9
Lassen	11	20.4
Modoc	3	5.6
Plumas	6	11.1
Shasta	24	44.5
Siskiyou	2	3.7
Trinity	5	9.3
	54	

The management implications in terms of long-range planning for Bald Eagle are important. Nearly 45% of the territories surveyed occur in the most rapidly developing county in northern California, Shasta County. Eighty-five percent occur in four counties including Shasta, all of which hold great potential for future economic growth and development, especially in living space, recreation and timber. Bald Eagles often exhibit a high degree of tolerance to human activities; nonetheless, their threshold of tolerance and adaptability was surpassed in other areas of California where they no longer nest--the Channel Islands and the southern California coast, for example. Development pressure is not now critical in northern California outside Shasta County; however, it is not so far off, and the long-range requirements of Bald Eagles should be addressed now.

Alternate Nests

Of 54 nesting territories included in the survey, 23 (42.6%) included alternate nest sites. Thirty-one territories (57.4%) had one nest, 12 (22.2%) contained two, 8 (14.8%) included three, 2 (3.7%) included four, and 1 (1.8%) included five.

Numerous factors may cause nest abandonment including, in general, destruction or deterioration of the nest or nest tree, trauma to the birds at the nest, or major change in the local habitat (timber removal, road construction, etc.). As the preceding figures on alternate nests demonstrate, however, abandonment of the nest does not always result in abandonment of the territory. The frequent relocation of the nest as opposed to territory abandonment is indicative of a high degree of fidelity to the nesting territory. In management terms this fidelity may serve as a management tool. Where habitat delineation for nesting Bald Eagles is included in long-range area planning, the "cooperation" of the birds may be expected, that is, they will likely continue to nest in the areas designated for them if the integrity of the habitat is maintained.

Numerous potential relationships are suggested between nest or territory relocation and human disturbance, productivity, territory size, etc. For example, the distance from a formerly used nest to a relocated nest may be

indicative of the severity of the trauma which caused relocation. D. Smith (Wildlife Biologist, California Department of Fish and Game, pers. commun.) proposed that multiple nests may be an indication of a high degree of distress with consequent lowered productivity and increased potential for future territory abandonment.

Nest Site Parameters

Ownership

Only 21% of the nest sites surveyed were on private land; however, at 45% of the sites, the next largest land tract was owned privately. Sixty-eight percent of the sites occurred on lands administered by the U. S. Forest Service, the Forest Service being the sole landowner at 31% of the nest sites surveyed.

		Owner of nest tree tract		Second largest owner	
Code	Ownership	Number of nest sites	%	Number of nest sites	%
0	No second landowner			38	40.0
1	U. S. Forest Service	65	68.4	9	9.5
2	Bureau of Land Mgmt.	5	5.3	4	4.2
3	State	3	3.2	1	1.1
4	National Park Service	2	2.1	0	0.0
5	Pacific Gas & Electric	8	8.4	5	5.3
6	Other Private	12	12.6	38	40.0
		95		95	

All combinations for first and second landowners are shown below:

Ownership codes		No. of nests	%	Ownership codes		No. of nests	%
First	Second			First	Second		
1	0	30	31.6	5	1	5	5.3
1	2	1	1.1	5	3	1	1.1
1	5	4	4.2	5	6	2	2.1
1	6	30	31.6	6	0	4	4.2
2	6	5	5.3	6	1	4	4.2
3	0	2	2.1	6	2	3	3.2
3	5	1	1.1	6	6	1	1.1
4	0	2	2.1			95	

Nest Tree-Species

Ninety-one percent of nest trees surveyed were pines:

Species	No. of trees	%
Douglas-fir (Pseudotsuga menziesii)	2	2.3
Incense cedar (Libocedrus decurrens)	4	4.6
Jeffrey pine (Pinus jeffreyi)	1	1.1
Lodgepole pine (Pinus contorta)	1	1.1
Ponderosa pine (Pinus ponderosa)	62	71.3
Sugar pine (Pinus lambertiana)	14	16.1
White fir (Abies concolor)	2	2.3
Western white pine (Pinus monticola)	1	1.1
	87	

The frequency distribution of nest tree species by the genus Pinus reflects, in general, the relative abundance of each in northern California. Ponderosa pine is the predominant pine in northern California, followed by sugar pine. Jeffrey pine and western white pine are equally suited for Bald Eagle nests; however, they are uncommon in northern California. Lodgepole pine is also uncommon but is less suited to Bald Eagle nesting as it usually lacks the heavy crown structure of the others when mature. The low occurrence of nests in Douglas-fir indicates a lower preference by Bald Eagles for nesting since it is equal to ponderosa pine in abundance in northern California. On San Juan Island in Washington, however, Retfalvi (1965) reported 100% occurrence of Bald Eagle nests in Douglas-fir. Therefore, Douglas-fir may be a potential nest tree species in areas lacking suitable pine species.

Nest Tree-Height

Eighty-one percent of all nest trees measured were 100 feet or more in height:

Height (ft.)	No. of trees	%
0-25	0	0.0
26-50	0	0.0
51-75	1	1.4
76-100	12	16.9
101-125	21	29.6
126-150	22	31.0
151-175	6	8.5
176-200	4	5.6
201-225	5	7.0
	71	

Mean: 131.1 ft.
Range: 69.209 ft.
Standard deviation: 33.5 ft.

Nest Tree-Crown Class

The apparent tendency for the birds to utilize tall trees for nesting is corroborated by the frequency of distribution for crown class:

Crown class	No. of trees	%
Dominant	35	47.3
Co-dominant	35	47.3
Suppressed	4	5.4
	74	

Ninety-five percent of the nest trees were dominant or co-dominant members of the upper forest canopy. Of the four suppressed nest trees, all ponderosa pines, one was dominated by a single, very old Douglas-fir, an apparently less suitable nest tree species; one was dominated by another ponderosa pine, which also contained a nest; one was located on a slight knoll, which elevated the tree crown over the crown of an adjacent dominant tree. Only one suppressed nest tree stood nearby a taller, apparently more suitable tree.

Nest Tree-Diameter

Bald Eagles nesting in California tend to select the more massive trees available in a given area, as indicated by the following measurements:

Diameter at breast height (inches)	No. of trees	%
0-20	0	0.0
21-40	36	50.7
41-60	30	42.3
61-80	3	4.2
81-100	2	2.8
	71	

Mean: 43.1 in.
Range: 25-82 in.
Standard deviation: 11.9 in.

Nest Tree-Class

All trees with a diameter at breast height of 40 inches or more were placed in Dunning's Tree Class 5, though some smaller trees were also placed in Class 5 when age, form, and other factors warranted.

Dunning's Tree Class	No. of trees	%
1	0	0
2	0	0
3	4	5.6
4	20	27.8
5	48	66.7
6	0	0
7	0	0
	72	

Again the tendency is evident for nesting Bald Eagles in California to utilize the largest, most mature trees in a timber stand. Sixty-seven percent of the trees surveyed were in the Class 5, the largest and oldest of the seven tree classes. All remaining trees surveyed were classified in the other two categories of large mature trees.

Nest Tree-Age

Cores for age estimation were taken from only 23 of the 71 nest trees surveyed. Cores were taken from trees that were less than 40 inches in diameter since accurate estimates were difficult to obtain from larger trees. Trees with fire girdle or center rot were not measured for age. Those cores taken proved to be helpful in classifying some nest trees into Dunning's Tree Classes.

Ages of trees ranged from 145 to 425 years, with a mean of 258.8 years (standard deviation, 63.8 years).

Nest Tree-Condition and Form of Top

Ninety-three percent of all nests surveyed were in live trees:

Condition and top	No. of trees	%
All dead, top intact	4	5.4
All dead, top broken	1	1.4
Live tree, top broken	4	5.4
Live tree, top intact and living	57	77.0
Live tree, top intact and dead	8	10.8
	74	

The predominance of nests in trees with living, intact tops indicates a need for cover over the nest. Of the five dead nest trees, only one was utilized by Bald Eagles in the 1976, 1977, and 1978 breeding seasons. The others were abandoned when the nest tree died.

Nest Tree-Vigor

Risk class*	No. of trees	%
1. Low	0	0.0
2. Moderate	8	12.1
3. High	25	37.9
4. Very high	21	31.8
5. Mechanical	11	16.7
6. Disease	1	1.5
	66	100.0

*The first four of the six risk classes are based on the appearance and condition of the crown; Risk 5 is mechanical risk--trees 50% girdled by fire, trees leaning more than 30% from vertical, trees struck by lightening; Risk 6 is disease risk--infection by disease sufficient to cause death within 10 years.

Seventy percent of all trees surveyed were classified as highly or very highly susceptible to beetle infestation. This is an apparent function of the tendency towards the use of mature and overmature trees for nesting. This suggests one reason for frequent construction of alternate nests; the older the nest tree, the less chance there is for that tree surviving through subsequent breeding seasons. The implications for management are important: in delineating and preserving habitat for future use by nesting Bald Eagles, consideration must be given to the age and vigor of a given timber stand. Since the oldest trees in the stand eventually will not be available to nesting Bald Eagles, a sufficient number of thrifty mature and immature trees must be preserved for future use.

Nest-Height

Seventy-one percent of nests surveyed were between 75 and 125 feet high:

Height (ft.)	No. of nests	%
0-25	0	0.0
26-50	0	0.0
51-75	5	7.7
76-100	20	30.8
101-125	26	40.0
126-150	6	9.2
151-175	5	7.7
176-200	3	4.6
201-225	0	0.0
	65	

Mean: 111.9 ft.
Range: 64-191 ft.
Standard deviation: 29.3 ft.

Nest-Distance from Tree Top

Eighty-nine percent of the nests surveyed were in the top 30 feet of the tree:

Distance from tree top (ft.)	No. of nests	%
0-10	19	29.2
11-20	23	35.4
21-30	16	24.6
31-40	4	6.2
41-50	1	1.5
51-60	1	1.5
61-70	1	1.5
71-80	0	0.0
81-90	0	0.0
	65	

Mean: 17.9 ft.
Range: 3-66 ft.
Standard deviation: 11.4 ft.

All nests in the top 10 feet of the tree had some branches extending over the nest. These relationships of nest location to the tree top indicate a preference for at least partially shaded nests.

Nest-Overhead and Surrounding Foliage

The frequency distributions for overhead and surrounding foliage further imply a preference for some degree of shelter over and around the nest. Eighty-one percent of all nests surveyed had at least light cover overhead, and 79% of all nests had some degree of surrounding cover:

Overhead foliage	No. of nests	%
Open	12	18.5
Light to moderate	45	69.2
Dense	8	12.3
	65	

Nests with dense overhead foliage tended to be low in the tree or in thrifty mature trees (Dunning's class 3). Nests with no overhead cover tended to be in trees with dead or broken tops.

Surrounding foliage	No. of nests	%
Open	14	20.6
Light to moderate	38	55.9
Dense	16	23.5
	68	

Nest-Position Around Tree Axis

Bald Eagles apparently lack preference for nest placement with regard to compass direction about the tree axis. Position appears to be more a function of tree species and branch structure at the nest as opposed to site selection. The comparatively high rate of occurrence for nests in axial positions (41%) is probably related to the prevalence of pines as nest trees (79%). Ponderosa, sugar, and Jeffrey pine, when mature, commonly have radiating, stout branches below a flattened crown, providing ideal support for a heavy stick nest.

Direction	No. of nests	%
Axial	26	41.3
North	2	3.2
Northeast	3	4.8
East	2	3.2
Southeast	9	14.2
South	7	11.1
Southwest	2	3.2
West	8	12.7
Northwest	4	6.4
	63	

Nest-Line of Sight to Water

Most nests surveyed had an unobstructed view of a nearby water body:

Line of sight view of water body	No. of nests	%
Obstructed	14	15.0
Unobstructed	79	85.0
	93	

Of the 14 obstructed nests, 13 were obstructed because they were located too far from the waterfront. The other nest, located very low in the tree, was obstructed by the surrounding canopy.

Nest-Distance from Water

One third of all nests surveyed were within 0.1 mile of a waterfront, and 87% were within one mile:

Distance from water (miles)	No. of nests	%
0 - .1	31	33.3
.1 - .25	15	16.1
.25 - .5	22	23.7
.5 - .75	4	4.3
.75 - 1	9	9.7
1 - 2	12	12.9
> 2	0	0.0
	93	

During the drought years of 1976 and 1977 two nesting territories were occupied at dry lake beds. In both cases the nearest sizeable waterfront was at least seven miles away. At Little Egg Lake in Modoc County the eagles successfully raised young both years. At McCoy Flat Reservoir in Lassen County the birds were unsuccessful both years.

Topography-Elevation Above Water

A significant number of nest sites surveyed were located well above the associated waterbody--55% were 100 feet or more above:

Elevation above water at full pool (ft.)	No. of nest sites	%
0-50	24	26.4
51-100	16	17.6
101-200	20	22.0
201-300	11	12.1
301-500	6	6.6
501-750	7	7.7
751-1000	4	4.4
1000	3	3.3
	91	

Mean: 252.2 ft.
Range: 10-1120 ft.
Standard deviation: 285.2 ft.

Thelander (1973) reported that eagles nesting at Eagle Lake and Lake Almanor in northern California relocated their nest sites over a 50-year period by moving back from the shoreline and upslope, apparently in response to increasing shoreline development. The statewide figures for distance of the nest from water and height above full pool, in general, seem to support this suggestion; however, it is difficult to document the reason for this behavior.

Topography-Elevation Above Sea Level

Elevations of 94 nest sites surveyed ranged from 1,100 to 7,400 feet and averaged 3,357 feet (S.D., 1,662 feet). Elevation above sea level is a factor in site selection only insofar as inclement weather probably prevents selection of nest sites at altitudes over 8,000 feet. Bald Eagles in California often begin nesting in March, when winter conditions still prevail at high elevations.

Topography-Type of Waterfront

Type of waterfront	No. of nest sites	%
Reservoir: > 10,000 acres	31	32.6
Reservoir: 5,000 - 10,000 acres	0	0.0
Reservoir: 1,000 - 5,000 acres	22	23.2
Reservoir: 100 - 1,000 acres; persistent	8	8.4
Reservoir: 100 - 1,000 acres; ephemeral	1	1.1
Reservoir: < 100 acres; persistent	4	4.2
Reservoir: < 100 acres; ephemeral	0	0.0
Natural Lake: > 10,000 acres	10	10.5
Natural Lake: 5,000 - 10,000 acres	0	0.0
Natural Lake: 1,000 - 5,000 acres	0	0.0
Natural Lake: 100 - 1,000 acres; persistent	1	1.1
Natural Lake: 100 - 1,000 acres; ephemeral	4	4.2
Natural Lake: < 100 acres; persistent	0	0.0
Natural Lake: < 100 acres; ephemeral	2	2.1
River: Undeveloped	4	4.2
River: Hydro-electric development	6	6.3
Creek	2	2.1
None	0	0.0
	95	

Nearly 70% of all nest sites surveyed were associated with reservoirs. Only 18% were located on natural lakes and 13% were on rivers or creeks. Seven percent were located on ephemeral water bodies, which are often dry in years of below-normal rainfall. Nests were observed on water bodies ranging in size from 35 acres (Wild Horse Reservoir) to more than 30,000 acres (Shasta Lake).

Because the majority of nests are on reservoirs, several important questions are raised regarding the historic distribution of nesting Bald Eagles in California. Have the birds been able to continue nesting in traditional areas, after the dams were constructed, by exploting the new forage source (hatchery fish) after the former source (natural, unimpeded salmon runs) disappeared? Or did they shift from other habitats to the new habitat in response to the new forage source? The answers to these questions may provide wildlife managers with suggestions for future management of Bald Eagles in California. A knowledge of these adaptive patterns could suggest ways to induce Bald Eagles to nest in areas more commensurate with land use planning.

The majority of nest sites are located in "artificial" habitat with its related fishery. Thus, there is a need for much research into the fishery of California relative to nesting Bald Eagles. Essential habitat cannot be delineated effectively without consideration given to forage availability.

Topography-Percent Slope

Slope apparently is not a factor in nest site selection. The frequency distribution for percent slope shows no discernable pattern:

Percent slope	No. of nest sites	%
0	20	24.7
1-20	13	16.0
21-40	32	39.6
41-60	12	14.8
61-80	4	4.9
81-100	0	0.0
	81	

Mean: 27%
Range: 0-70%
Standard deviation: 20.1%

Topography-Position of Nest Site on Slope

No relationships are apparent with regard to position of nest sites on slopes:

Position of nest site on slope	No. of nest site	%
Ridge top	16	21.0
Top third	10	13.2
Middle third	13	17.1
Bottom third	29	38.2
Broken topography	8	10.5
	76	

Placement of each site in one of the above five categories was somewhat subjective as the upward slope of the land away from a water body often continues for several miles. Sites located more than 1/2 mile from water were difficult to classify.

Topography-Nest Site Aspect

Ninety-five nest sites were surveyed to determine the compass directions having unobstructed, line of sight views of the surrounding topography from each site. Forty-six percent of all sites surveyed were on ridgetops or flat terrain with an aspect of 360 degrees. The frequency distribution for nest sites located on slopes shows a majority in the north, northeast, east, and northwest aspects.

View direction*	No. of nest sites	Percent of all sites surveyed+
All directions	44	46.3
North	37	38.9
Northeast	37	38.9
East	33	34.7
Southeast	21	22.1
South	6	6.3
Southwest	13	13.7
West	22	23.2
Northwest	32	33.7

*Unobstructed, line of sight view from nest site
+95 sites were surveyed.

Silvicultural Parameters

Detailed descriptions of the timber stand within a 200-foot radius of each nest tree were taken at 71 nest sites. The top three layers of the vertical canopy structure were described for each timber stand. Fifty-four (76%) of the stands surveyed consisted of three layers or more; 17 (24%) consisted of two layers. The nest tree occurred in the highest layer (Layer 1) in 69 (97%) of the nest sites surveyed. Two nest trees occurred in the second layer.

Layer I

Percent cover	No. of nest sites	%
20	59	83.1
20-39	12	16.9
40-69	0	0.0
69	0	0.0
	71	

Tree species diversity	No. of nest sites	%
1 species	43	60.5
2 species	20	28.2
3 species	8	11.3
	71	

Dominant species	No. of nest sites	%
Douglas-fir	3	4.2
Incense cedar	2	2.8
Jeffrey pine	1	1.4
Lodgepole pine	1	1.4
Sugar pine	9	12.7
Ponderosa pine	46	64.8
White fir	3	4.2
None dominant	6	8.5
	71	

Height range of trees in Layer 1 (ft.)	No. of nest sites	%
0-25	0	0.0
26-50	0	0.0
51-75	0	0.0
76-100	15	21.1
101-125	12	16.9
126-150	32	45.1
151-175	6	8.5
176-200	1	5.6
201-225	5	2.8
	71	

DBH range of trees in Layer 1 (in.)	No. of nest sites	%
0-10	0	0.0
11-20	0	0.0
21-30	8	11.3
31-40	27	38.0
41-50	27	38.0
50	9	12.7
	71	

Stems/Acre

In Layer 1, for the 71 nest sites surveyed, number of stems per acre ranged from 1 to 30 and averaged 8.5 (S.D. 5.1).

Summary-Layer 1

The frequency distributions for nest tree height, nest tree D.B.H., and nest tree species are very similar to the distributions of each for Layer 1. This was expected since all but 2 of the 71 nest trees occurred in Layer 1.

The similarity of the frequency distribution for nest tree species and dominant species in Layer 1 implies that Bald Eagles tend to nest in the most available suitable tree species in a given area; however, it also suggests that nest tree species is not a critical factor in site selection. The prevalence of ponderosa pine in currently used habitat may be a function of circumstance, other more critical factors being well suited in the ponderosa pine forests of northern California.

The low mean for stems/acre and the frequency distribution for crown cover indicate that a forest with a dense upper canopy is not an absolute requirement for nesting Bald Eagles. The percent cover for Layer 1 for 83% of the nest sites surveyed was less than 20%. A potential compatibility between timber harvest and habitat management is implied; timber management in Bald Eagle habitat might include careful, selective removal of overstory trees if adequate attention is given to the need for a suitable number of perch trees and alternate nest trees within a sufficient area.

The 10 chain buffer prescribed by the U. S. Forest Service is not an adequate solution as it allows the possibility of complete overstory removal outside the zone. Thirty-one acres (the area in a circle of 10 chains) is not a sufficient base for ensuring a continuous supply of mature, overstory trees for future use. Complete overstory removal outside the zone with no removal inside is probably more detrimental, in the long run, than selective removal inside and outside the zone.

Further investigation is required to determine safe removal levels and adequate sizes for buffer zones. Analysis of data for occupied and successful nests, percent cover and stems/acre, and evaluation of the behavior responses of California's Bald Eagle (nesting failure, abandonment, etc.) in regard to recent logging operations may provide further insight.

Layer II

Percent cover	No. of nest sites	%
20	16	22.5
20-39	37	52.1
40-69	15	21.1
69	3	4.2
69	71	

Tree species diversity	No. of nest sites	%
1 species	14	19.7
2 species	33	46.5
3 species	24	33.8
	71	

Dominant species	No. of nest sites	%
California black oak (*Quercus kelloggii*)	9	12.7
California juniper (*Juniperus occidentalis*)	3	4.2
Digger pine (*Pinus sabiniana*)	1	1.4
Douglas-fir	12	16.9
Incense cedar	2	2.8
Jeffrey pine	1	1.4
Lodgepole pine	1	1.4
Oregon white oak (*Quercus garryana*)	2	2.8
Ponderosa pine	26	36.8
Sugar pine	2	2.8
White fir	8	11.3
None dominant	4	5.6
	71	

Trees in Layer 2 (ft.)	No. of nest sites	%
0-25	3	4.2
26-50	19	26.8
51-75	16	22.5
76-100	22	31.0
101-125	5	7.0
126-150	6	8.5
151-175	0	0.0
176-200	0	0.0
201-225	0	0.0
	71	

D.B.H. range of trees in Layer 2 (in.)	No. of nest sites	%
0-10	11	15.5
11-20	23	32.4
21-30	31	43.7
31-40	6	8.4
41-50	0	0.0
50	0	0.0
	71	

Stems/Acre

In Layer 2, for 45 nest sites surveyed, number of stems per acre ranged from 5 to 99, averaging 35 (S.D. 23.3).

Summary-Layer 2

A greater species diversity occurred in Layer 2 than in Layer 1. In Layer 1 a single species dominated the layer in 60% of the nests surveyed. In Layer 2 a single species was dominant in only 20% of the nests surveyed.

The frequency distribution for dominant species shows a less prominent occurrence of ponderosa pine in Layer 2 than in Layer 1. In terms of timber management this means that at a significant number of nest sites the trees that will dominate the future upper canopy are less preferred tree species for nesting Bald Eagles. Ponderosa pine was dominant at 66% of the nest sites in Layer 1 and only 37% in Layer 2. Consideration should be given to culling less preferred tree species in the lower layers of those timber stands to ensure adequate numbers of preferred species at all times in Layer 1.

Layer 2 contains a much greater amount of cover than Layer 1. The percent cover for Layer 1 was greater than 20% for 71% of the nest sites surveyed. In timber stands with a dense second layer the growth of future nest trees may be inhibited. A second effect of the culling procedure would be inducement of more rapid growth in the preferred species because of decreased competition for space.

Layer III

Percent cover	No. of nest sites	%
20	4	7.6
20-39	7	13.2
40-69	30	56.6
69	12	22.6
	53	

Tree species diversity	No. of nest sites	%
1 species	9	17.0
2 species	13	24.5
3 species	23	43.4
3 species	8	15.1
	53	

Dominant species	No. of nest sites	%
California black oak	3	5.7
California juniper	2	3.8
Canyon live oak (*Quercus chrysolepis*)	3	5.7
Douglas-fir	8	15.1
Incense Cedar	3	5.7
Manzanita (*Arctostaphylus* spp.)	3	5.7
Oregon white oak	2	3.8
Ponderosa pine	11	20.7
White fir	13	24.5
None dominant	5	9.4
	53	

Height range of trees in Layer 3 (ft.)	No. of nest sites	%
0-25	30	57.7
26-50	16	30.8
51-75	5	9.6
76-100	0	0.0
101-125	0	0.0
126-150	1	1.9
151-175	0	0.0
176-200	0	0.0
201-225	0	0.0
	52	

D.B.H. range of trees in Layer 3 (in.)	No. of nest sites	%
0-10	40	81.6
11-20	8	16.3
21-30	1	2.0
31-40	0	0.0
41-50	0	0.0
50	0	0.0
	49	

Summary-Layer 3

The considerations described for Layers 1 and 2 are appropriate for Layer 3, but planning must be more long-range. Management in Layer 3 should be considered in terms of providing the suitable base for a future Layer 2, with emphasis given to fostering the continuous growth and supply of suitable nest tree species.

All Layers Combined

Total crown cover was estimated from aerial photos for 81 nest sites, 75% of which had less than 40% cover. The indication, again, is that dense forest is not a prime requirement for nesting Bald Eagles in California.

Percent cover	No. of nest sites	%
20	31	38.3
20-39	30	37.0
40-69	18	22.2
69	2	2.5
	81	

A significant number of all timber stands examined (42%) were dominated by a single species. In 28 (93%) of the single species stands ponderosa pine was the dominate species. Species diversity apparently is not a factor in nest site selection.

Tree species diversity (commercial timber species)	No. of nest sites	%
1 species	30	42.3
2 species	15	21.1
3 species	11	15.5
4 species	11	15.5
5 species	4	5.6
	71	

LITERATURE CITED

Bent, A. C. 1937. Life histories of North American birds of prey. Part I. U. S. Nat'l. Mus. Bull. 167, 409 pp.

Broley, C. L. 1950. The plight of the Florida bald eagle. Audubon Mag. 52(1):42-69.

_____. 1951. Bald eagle nesting failures continue. Audubon Mag. 53:208.

_____. 1958. The plight of the American bald eagle. Audubon Mag. 60(4):162-163, 171.

Detrich, P. J. 1977. Bald eagle management study; Shasta-Trinity National Forest; Shasta and Trinity Counties, California. Calif. Dept. Fish and Game Admin. Rept. 34 pp.

Grubb, G. 1976. A survey and analysis of bald eagle nesting in western Washington, M. S. Thesis. Univ. of Wash., 87 pp.

Retfalvi, I. 1965. Breeding behavior and feeding habits of the bald eagle (Haliaeetus leucocephalus) on San Juan Island, Washington, M. S. Thesis. Univ. of British Columbia, Vancouver. 193 pp.

Sprunt, A., IV. 1963. Bald eagles aren't producing enough young. Audubon Mag. 65(1):32-35.

_____, and F. J. Ligas. 1966. Audubon bald eagle studies, 1960-1966. Nat'l. Audubon Soc., New York. 6 pp.

_____, W. B. Robertson, Jr., S. Postupalsky, R. J. Hensel, C. E. Knoder, and F. J. Ligas. 1973. Comparative productivity of 6 bald eagle populations. Trans. No. Amer. Wildl. and Nat. Res. Conf. 38: 96-106.

Thelander, C. G. 1973. Bald eagle reproduction in California, 1972-1973. Calif. Dept. Fish and Game, Wildl. Mgmt. Branch Admin. Rept. No. 73-5. 17 pp.