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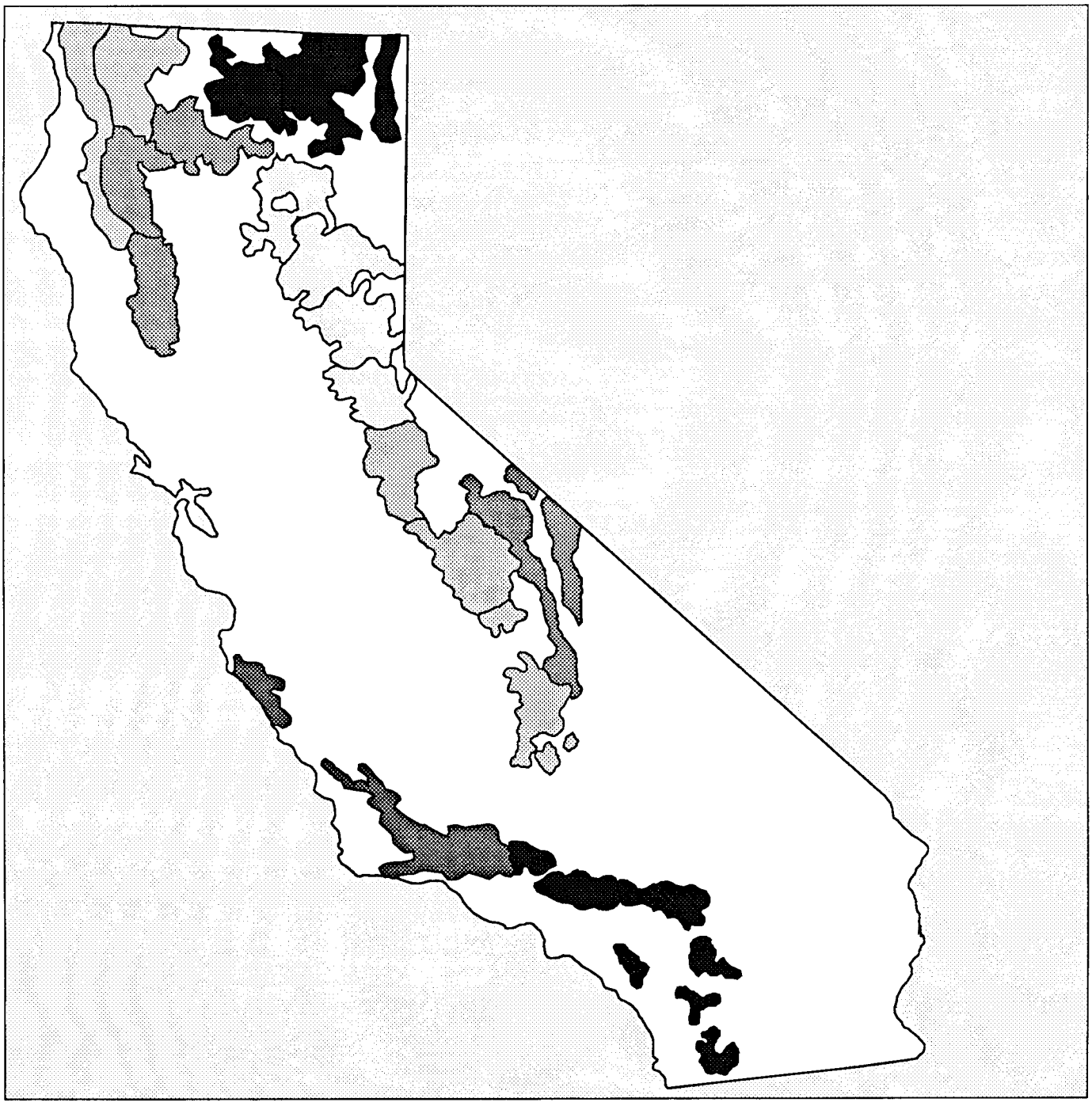
Ecological Type Classification for California: The Forest Service Approach

Barbara H. Allen



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INTRODUCTION

Classification systems of vegetation, soil, 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 widely or locally, or be based on multiple factors or on a single factor.

All classifications are artificial. The units are initially 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, as a subset of artificial classification, are generally regarded as those based on natural relationships and serving a larger number of purposes (Pfister and Arno 1980).

Why Classify Ecosystems?

Legislation such as the National Environmental Policy Act (1970), Federal Land Policy and Management Act (1976), and National Forest Management Act (1976) mandates the development and use of a structured ecological data base to improve resource decision making (Barnes 1982). The legislation has resulted in a 10-year effort in National Forest land management planning, and a requirement for site-specific productivity estimates and predictions of expected site response to management for FORPLAN modeling (Johnson and others 1986). These numbers mostly are unavailable for California ecosystems, or are available for only a part of the ecosystem (for example, the tree component) so that true interactions cannot be assessed.

At the same time, current national emphasis on increasing efficiency, eliminating duplicate data collection, and standardizing resource terminology have had these outcomes: new Forest Service policy on classification and inventory (USDA Forest Service 1986a); increased interest and cooperation between State and federal agencies in producing compatible, interchangeable resource assessments (USDA Forest Service 1984); and reactivation in California in 1983 of the Interagency Vegetation Classification Committee (1986) which is charged with meeting many of these national goals.

At State and Federal levels, agencies and functional specialists within agencies continue to collect resource data on uncommon units, which results in duplicate information and data gaps. In general, vegetation inventories--whether timber inventory, range analysis, or wildlife habitat surveys--have not included soil interpretations, so that maps of soil and vegetation produce a fragmented landscape when the information is combined on overlays. Resource managers have a difficult time interpreting the meaning of one inventory in terms of another because of different scales of resolution, different objectives, and different definitions for the same term or factor. In existing inventories a timber manager refers to a piece of ground by a different name than does the range manager, who refers to it differently than does the wildlife biologist, and so on.

Finally there is a lack of on-the-ground ecological data regarding the location and extent of forests and rangelands that will respond favorably to management. Most existing inventories and surveys are not multifunctional but are designed for specific functional purposes, or are not detailed enough to adequately address potentials, hazards, constraints, interactions and environmental effects for intensive management.

Alternative Classification Models

Classification models that use soil, vegetation, and physiographic variables are not new. Ecologically based, natural classification systems, such as habitat types (Daubenmire 1952) and plant community types (Hall 1973) have been used in Forest Service Regions (Northern, Rocky Mountain, Southwestern, and Pacific Northwest). The systems organize resource information, and provide information on productivity and expected response to treatment for National Forest planning, PROGNOSIS (Mouer 1985, Stage 1973) modeling, and project prescription writing. In addition, the classifications serve as a common labeling system to integrate functional resource inventories, reduce data gaps, and improve communication between functional resource specialists. Development of this type of classification tool by the Forest Service in California began in 1983.

Development of these habitat type, plant community, and forest site classification systems have required intensive, long-term data collection and analysis, and long-term on-site experience of an ecologist. Late seral, potential, or climax vegetation is the focus of the habitat type and plant community type classifications. The weak link in these systems has been the lack of integration of soil data and the existing soil database. In all these classification models, once the classification framework is established, the next step is to develop successional classifications by habitat type, plant community type, or ecological type.

Broader classification systems focusing on ecoregions (Bailey 1976, 1978), component classification for the United States (Driscoll and others 1984), or land cover types (Witmer 1978) are also widely used especially for broad level planning. Other systems widely used in California focus on describing existing vegetation (Barbour and Major 1977, Cheatham and Haller 1975, Eyre 1980, Munz and Keck 1975, Paysen and others 1980, USDA Forest Service 1981), combine soil and vegetation through mapping (Jensen 1947, State of California 1969, USDA Soil Conservation Service 1976, Weislander 1935) or describe and map broad units of existing (Matyas and Parker 1980) or potential (Kuchler 1977) vegetation.

Each of these systems has value and uses in its own right, but none contains the site-specific productivity or expected response to management information specific to California

ecosystems. *Table 1* summarizes the differences between many of the common California classification systems, and their primary uses. Habitat types and plant community types are also included in the table, as much of the methodology used to develop those systems are incorporated in Forest Service policy (USDA Forest Service 1986a) and the Pacific Southwest Region's classification model.

This report describes an ecosystem-type classification system for California, which was begun by the Forest Service's Pacific Southwest Region in 1983. It presents the first two phases of the classification effort, reconnaissance and intensive sampling, and includes a sample ecological type description.

ECOLOGICAL TYPE CLASSIFICATION MODEL

The Ecological Type is the basic unit in the Pacific Southwest Region's (R5) classification model. This unit is defined as a classified category of land with a unique plant association and physical site characteristics, differing from other categories of land in its ability to produce vegetation and respond to management (RISC 1983, USDA Forest Service 1986a). Vegetation, soils, and physiographic data are classified into individually distinct ecological types using late seral, undisturbed, self-reproducing (stable) plant communities.

A classification system such as this holds time constant by focussing on a stable, predictable, self-reproducing vegetative state (Hall 1973, Pfister and Arno 1980, RISC 1983). This allows for the labeling and description of units around which seral plant community classification and predictive models can be developed. Such an ecologically based classification expresses the interrelationships between all vegetation and landforms, landforms and soils, and vegetation and soils (Barnes and others 1982). An ecological classification system based on the potential natural plant community provides the framework around which multiple-use resource management can be applied.

This framework does not mean that resource managers must manage land for potential vegetation, which they may never want to do. However, knowing the site potential and being able to recognize it in any state of seral development will allow predictions of productivity and site response to management through a stable classification system.

The identification of ecological and management information for each ecological type will be accessed through the use of a dichotomous key carried in pocket-sized booklets ready for field use. Maps will be prepared only on a case-by-case basis in support of specific project level work. Eventually much of the Region may be mapped, but--most likely--aggregates of ecological types will be the mapping unit.

Eight Forest Service ecologists are leading the ecological type classification effort on and around 16 of the 18 National Forests in California (*fig. 1*). Classification methodology is standardized and coordinated by the Regional Ecologist and Ecology Advisory Committee out of the Regional Office in San Francisco. The Regional Ecologist has these responsibilities for program direction: standardization of terminology and methodology, monitoring of classification development, and coordination between other Regions and other classification efforts to avoid duplication of types with different names.

The forest classification team leaders, who actually develop the ecological type classification systems, are skilled in plant ecology, soils, and management. They have the ability to interpret ecosystem processes through testing of hypotheses developed during several years of field data collection. The approach and methodology are spelled out (USDA Forest Service 1986b), but each team leader must interpret the directive using his or her own understanding and experience. Standardization and communication within the Region is maintained through yearly field training courses and yearly field monitoring by the Regional Ecologist.

Table 1--*Major vegetation/ecologically based classification systems in California*

Classification[1]	Unit scale	Vegetation	Soils	Other descriptors
SAF Forest cover types	Broad	Existing	No	Mappable, applies to forest types
SCS Range sites	Broad to narrow	Potential	Compared	Productivity applies to rangeland, mapped
Habitat types	Narrow	Potential	No	Widely used in Forest Service Regions, some methods used in ecological type approach
Plant community types	Site specific	Potential	Not most	R6, methods used in ecological type development
WHR Wildlife habitat types	Broad	Existing and potential	No	Ecological types will aggregate soils in descriptions
CALVEG	Hierarchical	Both	No	Lowest level not described, series groups mapped
Kuchler (1977)	Broad	Potential	No	Worldscale mapped
Munz and Keck (1975)	Broad	Existing	No	With book
Barbour and Major (1977)	Broad	Existing	No	With book
Jensen (1947)	Broad	Existing	No	With map, emphasis on commercial timber
California soil-vegetation survey	Broad to narrow	Existing	Yes	Map system, soil, main vegetation

[1]SAF = Society of American Foresters.
SCS = Soil Conservation Service.
WHR = Wildlife Habitat Relationships Program.
CALVEG = California Vegetation (Matyas and Parker 1980).

CLASSIFICATION METHODS

Field methodology as described in FSH 2090.11 (USDA Forest Service 1986b) is drawn heavily from Franklin and others

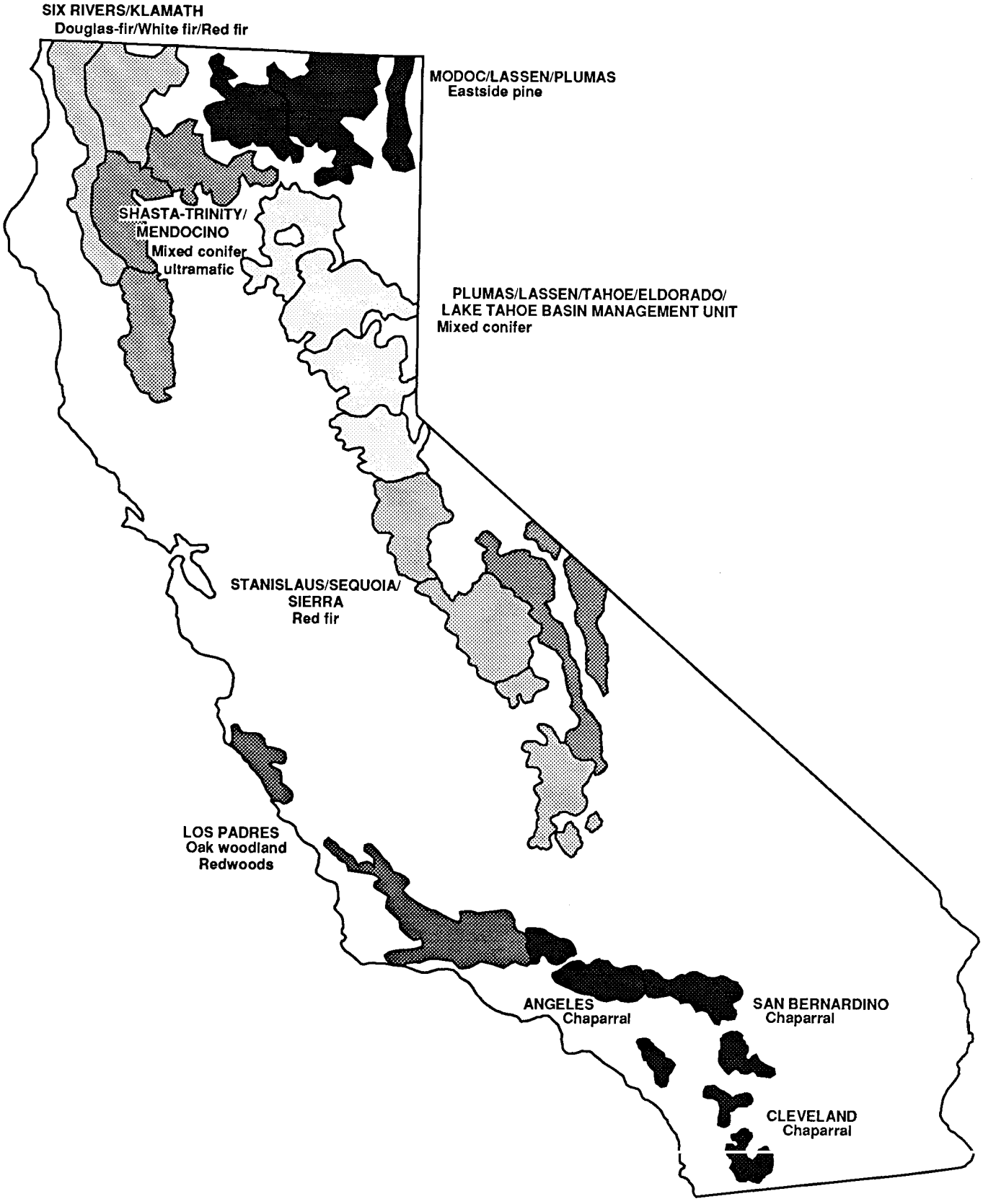

Figure 1--National Forests and target ecosystems currently being sampled for development of Ecological Type classification correspond to major areas of forest activity in California. Shading indicates individual team leader responsibility for that particular group of forests.

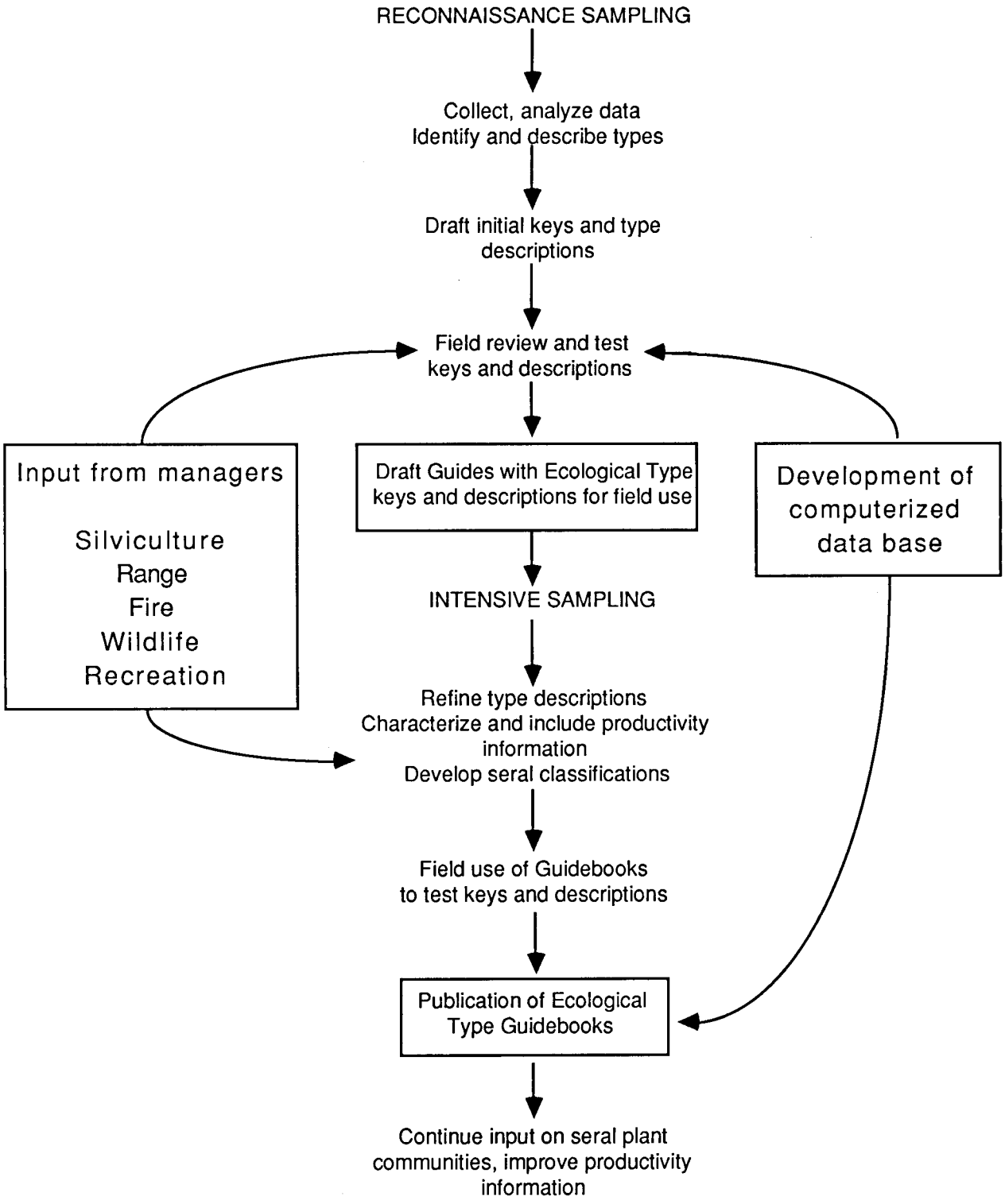

Figure 2--The six major steps in the development of an Ecological Type classification system are carried out by a team of ecologists, botanists, and soil scientists.

(1970), Hall (1973) and Pfister and Arno (1980). Intensive sampling methodology has been borrowed and modified from Arno and others (1985), Atzet and Wheeler (1984), Hall (1983), Pfister and Arno (1980) and Steele (1984). *Figure 2* schematically describes the overall classification process.

Reconnaissance Sampling

The first phase, which takes 2 to 5 years in the identification of ecological types is accomplished through reconnaissance sampling. Measurements from late seral stage plots are taken to encompass the total variability of vegetation, soils, and landforms within the target ecosystem or geographic area. Once plot data have been analyzed and classified into ecological types and field checked, each type is described and its distinguishing attributes incorporated into a dichotomous key for field use.

Reconnaissance plots are 1/10th acre (0.04 ha) and are selected "systematically without preconceived bias" (Mueller-Dombois and Ellenberg 1974). On every plot, detailed environmental and location data are recorded. Plots are marked on the ground and on aerial photographs so that they can be located again.

The percent cover of all plant species is recorded, since initially the ecologist doesn't know which plant species will be most helpful in identifying the type. Tree basal diameters, age, and average height are recorded to characterize stand structure and provide gross estimates of volume. Shrub height by species is recorded in addition to cover, allowing the team leader to examine shrub structure and calculate crude volumes. Unknown species are collected for later identification.

A soil pit is dug to 40 inches (102 cm), and thickness, texture, and color of the surface and subsurface horizons are recorded. Parent material, total depth, available waterholding capacity (AWC), and pH are recorded or calculated to aid in the classification of the soil to series.

Intensive Sampling

The second sampling phase, intensive sampling, takes 3 to 10 years and makes the ecological type the focal point of data collection. The objectives are twofold: First, to describe the seral stages and successional pathways of the type following natural and management related perturbations; and second, to characterize the potential of the type, such as the capability to produce vegetation (forage, timber) or to provide wildlife habitat.

All species of vegetation are recorded on a 1/10th acre (0.04 ha) plot (USDA Forest Service 1986b). A complete soil pit is dug using standard soil inventory procedures (USDA Soil Conservation Service 1981), and the soil profile is described and classified. On forest sites, specific stands are sampled for timber productivity with standard forest inventory techniques (USDA Forest Service 1976). Age, known management history, and environmental and location parameters are recorded for every plot. Shrub and herbaceous production for key forage species are also taken on both forest and chaparral communities.

At the end of the field season, the data are analyzed using statistical and multivariate analyses. The primary analysis packages include Computer Analyses of Ecological Data (Volland and Connelly 1978), DECORANA (Hill 1979a), and TWINSPAN (Hill 1979b). Consistency of data analysis is maintained through training sessions and year-round coordination.

PRODUCTS FOR USERS

Two usable products will result from reconnaissance sampling: draft field keys to the ecological types,[1] and eight General Technical Reports describing the types for the major areas of forestry activities in California.[2] Draft keys and ecological type descriptions are available for chaparral, southcoast redwoods, Klamath mountain red fir and westside mixed conifer, at this writing.

In the appendix is an example of a Chamise-White Sage--Cieneba (SC-CH-5 1) Ecological Type developed on the Cleveland National Forest (White 1985). The description is based on reconnaissance sampling and input from field managers. Information on fire ecology and behavior, range productivity, and suitability for type conversion comes from the team leader's field experience and observations, other managers' input, and research.

The information in the sample description and corresponding key is currently being field tested by Regional and Forest resource specialists. The key is applied to a variety of plant communities to see if it leads the user to the correct type description. Information in the description is tested through field observation of the plant community and analysis of the accuracy of the predictions of plant community response to treatment. Intensive sampling and field input through the use of the keys and descriptions will lead to the refinement of information on management treatment response. Information, such as that on wildlife, will be refined as additional information is obtained.

APPLICATIONS OF THE CLASSIFICATION SYSTEM

Classification models meeting specific user needs are numerous. The proposed ecological type classification being developed in R5 will provide common labels and common site descriptions for use by all types of resource managers. Site-specific productivity data will be available because this classification system includes the entire vegetation/soil/physiographic unit.

The ecological type classification system is only a tool, a framework within which to organize information. It is ecologically based, not use-oriented, allowing users to make their own interpretations. It is a tool that can be used to improve communication between functional resource specialists.

[1]The keys are available on request from the Supervisor's Offices of the 16 National Forests shown in *figure 1*.

[2]For information on availability and for copies of the General Technical Reports, write to: Director, Pacific Southwest Forest and Range Experiment Station, P.O. Box 245, Berkeley, CA 94701, Attention: Publications Distribution.

As others have so appropriately stated (Barnes and others 1982, Hall 1983), resource managers need to know six attributes of a site to manage it effectively:

1. Productive potential and expected response to management treatments.
2. Existing vegetation.
3. Land situation, such as geomorphic classification, steepness of slope, aspect.
4. Juxtaposition to other land types and ownerships.
5. Current use.
6. Soil situation (taxonomy).

The ecological type classification and information addresses only the first item. However, an ecological type classification system, based on years of site specific data collection and evaluation, can be used in many ways by resource managers including these:

• It can guide foresters in deciding which species to plant on a given site, and which site treatment to use under differing circumstances. Once completed the classification can be applied to determine potential stand productivity, potential site productivity, optimum expected growth, fertilization requirements, tree species, and the best season for harvesting.

• For wildlife and range managers, ecological type classification can be used to determine above-ground biomass production, stocking rates, carrying capacities, and habitat critical to wildlife survival.

• In conservation, it can guide the selection of ecological reserves and research natural areas by identifying unique or threatened ecosystems.

• In watershed management, potential soil erosion, water interception and use, and soil fertility can be determined.

• To recreation, it offers guidelines for land use assessment and development of interpretive programs.

• In planning, the information in the classification system can be used to weigh land-use allocation alternatives.

• In research it can focus efforts on areas where research is needed as well as provide the common site labeling system for application of research results.

• In engineering the classification can provide critical site and soil information.

FUTURE OF THE CLASSIFICATION EFFORT

The Pacific Southwest Region of the Forest Service is committed to completing an ecological type classification system for the lands it manages in California. However, its commitment and support to the ecological type approach extends beyond lands managed by National Forests. The Forest Service is part of the State of California Interagency Vegetation Classification Working Group, whose charge is to keep lines of communication open between State and Federal agencies and to standardize terminology and methodology. The Forest Service is also working closely with the Soil Conservation Service, U.S. Department of Agriculture, in evaluating range site descriptions--which are widely used in California--for modification and incorporation into an ecological type concept. The National Range Handbook (USDA Soil Conservation Service 1976) already incorporates many of the concepts described here for ecosystem classification.

Further, cooperation between the California Department of Forestry, the Pacific Northwest Forest and Range Experiment Station Forest Survey and research is evidenced by open communication and evaluation of proposed R5 classification methodologies. This cooperation will continue to promote the development and completion of a standardized, ecological type classification for the State of California.

APPENDIX

Sample Type Description

CHAMISE-WHITE SAGE--CIENEBA ECOLOGICAL TYPE (SC-CH-51) (ADFA-SAAPI-CIENEBA)

Description

The Chamise-White Sage--Cieneba Ecological Type is characteristic of the most xeric low elevation sites. It is often transitional to the coastal sage type especially on south slopes at the lower end of the elevational range. A characteristic stand is dominated by chamise *(Adenostoma fasciculatum)* with either white sage *(Salvia apiana)* or California buckwheat *(Eriogonum fasciculatum)* present in the understory, usually making up 5-10 percent cover in combination. Scrub oak is absent from the stand or occurs with very low cover.

Cieneba soils have coarse to moderately coarse textures and are somewhat excessively drained. They are derived mostly from granitic parent materials. The underlying bed rock is softly weathered and occurs within 50 centimeters of the surface. Plant roots are capable of penetrating deeply into the substratum, and typically have low fertility and organic matter content. The thin soil mantles have low water holding capacities and plant roots obtain needed moisture from the substratum.

CONSTANCY TABLE (N= 13 plots)

Dominant Species	Constancy	Range	Average cover
		Percent	
Chamise	100	22-89	44
Whitesage	83	1-12	5
California	50	1-20	7
Nolina	59	1-3	1
Mission manzanita	27	1-15	9
Cieneba Soil Series	100		

Site characteristics	Average	Minimum	Maximum
Elevation (m)	625	390	950
Slope (pct)	26	8	60
Solar insulation (PASI)	295	282	305
Vegetation cover (pct)	62	50	90
Bare ground (pct)	15	1	74
Gravel (pct)	11	1	30
Rock (pct)	9	0	50
Litter (pct)	54	15	98
Litter depth (mm)	16	12	28
Soil depth (cm)	4	2	7
A Horizon depth (cm)	4	2	7
AWC (mm)	35	4	59

Management Interpretations

Fire Ecology

Average fire frequencies range from 20 to 30 years (Countryman and Philpot 1970). On the Cleveland National Forest the historical average fire frequency for this type was 32 years (White 1982). Due to the proximity of the coastal sage type in most areas a higher fire frequency can be expected in transitional areas especially on sites with a high ignition frequency in the coastal sage (Hanes 1971). A high portion of 1-hour fuels due to the white sage and buckwheat understory make this type more flammable at an early age than pure chamise stands found at higher elevations. Fires in 15-year-old stands are common. Frequent fires could lead to an increase in the sage and buckwheat component, which in turn would lead to higher fire frequencies. White sage inhibits establishment of chamise seedlings in mature stands (Went, Juhren and Juhren 1952). All associated shrub species are strong post-fire sprouters. The lack of seeding species may be due to the relatively high fire frequency or simply the xeric site conditions (Minnich and Howard 1984).

Fire Behavior

A high percentage of fine fuel (1 to 10 h) is characteristic of this type. The buckwheat and white sage understory mentioned above, in addition to chamise, makes these sites extremely flammable at a relatively young age. Flammability is locally reduced on sites that are very sparse with a low percent cover of sage and buckwheat, but this is the exception rather than the rule. With little to no litter fires have to carry in the crowns, which makes crown continuity especially important in predicting fire behavior in this type. Fires burn out quickly due to the high percentage of fine fuel and little large diameter dead material. Humidity recovery control of prescribed fires is effective unless a continuous cover of sage or buckwheat is present to carry fire under high humidity conditions. Spotting is a problem due to the high percentage of fine dead fuel in most areas.

Range Productivity

Shallow coarse textured soils and low rainfall make this a poor range site. Average annual forage production on recently burned areas is estimated to be less than 96 kilograms per hectare.

Wildlife

WEIR Cover Type = Chamise-Redshank Chaparral

Chamise and associated shrubs in this type are of low palatability when mature. Chamise is utilized for 2 to 3 years following bums (based on field observations, high use by rabbits, no wood rats, open stand structure, and poor cover for deer).

Suitability for Type Conversion

Physical limitations	None
Water yield potential	Low
Range production	Low
Fuelbreak	High

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National legislation has mandated the development and use of an ecological data base to improve resource decision making, while State and Federal agencies have agreed to cooperate in standardizing resource classification and inventory data. In the Pacific Southwest Region, which includes nearly 20 million acres (8.3 million ha) in California, the Forest Service, U.S. Department of Agriculture, has begun a long term project to develop an ecosystem type classification system. It will identify and describe vegetation/soil/ physiographic units called ecological types, which are site-specific units distinguished from each other by significant differences in species composition, soils, productivity, and expected response to management; and which are identifiable in the field in any seral stage. The classification will provide resource managers a useful tool for organizing complex arrays of resource information, a common labeling system and site-specific ecological information to improve predictions of site productivity and expected response to management. Methodology described for classification development includes reconnaissance and intensive sampling. An ecological type description developed on the Cleveland National Forest is an example of the products that will be available to users.

Retrieval Terms: classification, ecological type, ecosystem, Forest Service, California