KLAMATH / CENTRAL PACIFIC COAST ECOREGION

RESTORATION STRATEGY

VOLUME I - DESCRIPTION OF THE ECOREGION

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INTRODUCTION

This volume is the first of three volumes describing a strategy for restoring the function and health of the Klamath / Central Pacific Coast Ecoregion (Figure I-1), hereafter termed the "Klamath Ecoregion." In this volume, we describe the ecoregion from an ecosystem perspective and summarize some of the human forces that have caused or are continuing to cause ecosystem degradation.

In volume II, we describe the critical ecological issues of the ecoregion. These "ecoissues" are the result of human activities that are causing major disruption of the ecoregion's health and function.

In volume III, we describe a holistic strategy for addressing these ecoissues. This includes both a description of existing plans and programs for resolving ecoissues as well as proposals for new initiatives.

The boundaries of the ecoregion and the rationale for such delimitation are described in more detail in the following section. Basically a stretch of Pacific coastline forms one boundary and the watersheds draining along this coast define the region. However, the scope of this report is focused upon the terrestrial and freshwater landscape, with minimal attention to coastal issues. Thus the report deals with anadromous fish and shorebirds but does not attempt to deal with issues such as those of marine mammal or tidepool conservation. To do justice to these many coastal issues in even the most cursory way will require a report comparable to this one. We hope that such a report and strategy will be produced in the near future as it would provide a nice complement to this effort.

THE ECOREGION DEFINED

The Klamath Ecoregion is one of 52 ecoregions (Figure I-2) defined by the U.S. Fish and Wildlife Service[1]. It is located in northwestern California and south-central Oregon and consists of all the watersheds or hydrobasin that drain into the Pacific Ocean north to the Smith River (Figure I-3). Thus the ecoregional boundaries are defined in terms of watersheds rather than some other criteria such as geology or vegetation type.

Any ecoregional delineation is bound to be arbitrary. Some interactions occur between ecoregions and thus any delimitation of an area is not going to encompass all species or ecological processes. However, the Klamath Ecoregion boundaries are biologically meaningful in many ways. It encompasses most of the range of coast redwoods[2]. Mapping of potential natural vegetation of the ecoregion[3] indicates that it contains virtually all of the potential natural sites for one vegetation type (*Pine-Cypress forest*) and most of the sites for four others (*Redwood forest*, *California mixed evergreen forest*, *Montane chaparral, and Fescue-oatgrass*) (Figure I-4). Together, these five types make up more than 50% of the ecoregion.

The ecoregion also encompasses most of the Klamath Economic Zone (Figure I-5). The Klamath Economic Zone is based on the biology of salmon. Salmon are a keystone component of the ecoregion, not only ecologically but also economically and culturally[4]. The Klamath Economic Zone, which includes the Klamath Ecoregion as well as the Rogue River drainage to the north, is managed as one unit for purposes of allocating ocean salmon harvesting since stocks from these rivers are found together in the ocean fishery. The Klamath Economic zone is the most inclusive of the ecoregional designations--including all of the Klamath Basin, Klamath Province (as defined by the President's Forest Plan[5]) and Klamath Ecoregion as shown in Figure I-5.

Figure I-1. The Klamath / Central Pacific Coast Ecoregion (DEM Map).

Figure I-2. Ecoregions of the United States.

Figure I-3. The Klamath / Central Pacific Coast Ecoregion.

Figure I-4. Potential Natural Vegetation of the Klamath Ecoregion.

Figure I-5. The Klamath Economic Zone.

GEOLOGY AND LANDFORMS

The Klamath Ecoregion encompasses portions of four geologic provinces: Coast Ranges, Klamath Mountains, Cascade Range, and Modoc Plateau (Figure I-6)[6].

Coast Ranges Geologic Province

This province is located along the coastal portion of the ecoregion from Sonoma County to the Oregon border. It includes the entire watershed of most of the smaller coastal streams as well as portions of the Smith River and Klamath River hydrobasin. It consists of a system of north and northwest trending mountain ridges and valleys formed by folding and faulting. The geologic history of this province is complex. The exposed stratigraphy suggests long periods of marine deposition, plutonic intrusion, and intermittent volcanic activity and orogeny[7].

The predominant formation in the Coast Ranges is the Franciscan Complex of Upper Jurassic and Lower Cretaceous age. Franciscan Complex rocks include graywacke, metagraywacke, argillite, greenstone, chert, blueschist, and associated ultramafic rocks and serpentine. These rocks have undergone periods of intense folding, faulting, and deformation associated with the complex process of tectonic plate movement. The complex Franciscan Formation is divided into three northwest trending belts. They are an eastern belt of metaclastics, a central belt dominated by melange, and a coastal belt of graywacke, shale, and conglomerate. Cretaceous marine formations do form a zone along the coast and lie west of the Franciscan Complex. The Cretaceous marine formations are sandstone, shale and conglomerate. The rivers of this province mostly run south/north or north/south paralleling the underlying rock formations and fault lines.

Klamath Mountains Province

The Klamath Mountains geologic province covers an elongate north-trending area of approximately 12,000 miles square in northwestern California and southwestern Oregon. It includes many individual mountain ranges including the Yolla Bolly, Trinity, South Fork, Salmon, Trinity Alps, Scott, Scott Bar, Marble and Siskiyou Mountains. It has had a long and complex geological history described in detail by Irwin (1966).

This province contains a variety of metamorphic, sedimentary and igneous rocks of various ages. A principal feature of the Klamath Mountains Province that distinguishes it from the Coast Ranges Province is the presence of granitic intrusions of rocks that range from hornblende diorite to true granite in composition. Such rocks are lacking in the Coast Ranges.

Figure 6. Geology of the Klamath / Central Pacific Coast Ecoregion.

A principal feature of the Klamath Mountains is the presence of "peneplains" which are elevated land masses with flattish or gently rounded summits with an approximate accordance in the altitudes of even-crested ridges, given the appearance of a dissected plateau. These areas are particularly important biologically because many of them occur at relatively high altitudes and thus have not been subject to the periodic fresh or saltwater inundation typical of the Coast Ranges and the lower portions of the Klamath Mountains. As a result, species of plants and animals have remained in place or evolved over long periods in such areas, with resultant high degree of endemism and species richness.

The complex rock pattern and history of the Klamath Mountains have produced no well defined trend in stream drainage and ridge direction such as is found in the Coastal Mountain Province. The principal rivers of the Klamath Province cut transversely across it, running generally westward from the interior valleys, through deep canyons in the mountains themselves.

Cascade Range and Modoc Plateau Provinces

The upper Klamath River basin is within the geologic provinces of the Cascade Range and Modoc Plateau. The Cascade Range extends northward through Oregon and Washington into British Columbia and the Modoc Plateau extends into Oregon and southeastward into Nevada. Most of the Cascade Range is a fairly well defined province, but in the Upper Klamath Basin the separation between it and the Modoc Plateau becomes indefinite[8].

The outstanding characteristics of the Modoc region are: (1) the dominance of volcanism so recent that the volcanic landforms are still clearly preserved (the most well known being Crater Lake and Mount Shasta); and (2) the presence of broad inter-range areas of nearly flat basalt plains. The basalt plains have given rise to the designation "plateau," however, the region as a whole is not a high, undiversified plain as the name suggests.

The upper Klamath Basin region of the Modoc plateau supports some large and geologically old wetlands. The river systems of this area were once connected with both the Snake River drainage to the north and east, as well as to the Sacramento and San Jouquin drainage to the south.[9] Upper Klamath Lake is one of the oldest freshwater lakes in North America of its size. Frest and Johannes have stated: "Upper Klamath Lake is one of the few surviving Pliocene lakes and the only one with normal alkalinity and a large relict fauna. It is likely the best remaining window on environments prevalent in the interior West 2-17 million years ago."[10]

CLIMATE

The basic climate of the ecoregion may be characterized as Mediterranean with warm summers with little or no rain during summer and wet and cool winters. This pattern varies considerably from one portion of the ecoregion to another, particularly with regard to precipitation. Mean annual temperatures for eight locations (Santa Rosa, Ukiah, Covelo, Eureka, Crescent City, Weaverville, Yreka, Klamath Falls) within the ecoregion are shown in Table I-1. Mean annual precipitation and monthly precipitation distribution for six locations in the ecoregion are shown in Table I-2. Note that although total precipitation varies considerably from 70 inches in Crescent City to 14 inches in Klamath Falls, the annual pattern is quite similar.

The Coast Ranges generally have the most typical Mediterranean climate with cool wet winters, snow only at elevations above 2,000 feet or more and dry summers with virtually no rain during July and August and more than 70% of the precipitation coming between November and March. However, areas quite close to the coast may get summer precipitation and considerable amounts of fog and fog precipitation.

The Klamath Mountains as well as higher elevations throughout the ecoregion have a somewhat modified climate. They receive some summer precipitation from thunderstorms although this is often spotty. In addition, much of the winter precipitation may come in the form of snow, and higher elevations may accumulate considerable snow packs.

The Modoc Plateau sits in the rain shadow of the Klamath Mountains and as a result has substantially less rain than in the coast ranges as can be seen by comparing the precipitation for Klamath Falls with the coastal cities of Eureka or Crescent City. Summer temperatures also tend to be warmer for similar elevations, but because most of it sits at higher elevations, summer temperatures are generally cooler.

SOILS

Soils vary considerably throughout the ecoregion in both their fertility and their sensitivity to disturbance. A generalized soil map and soil sensitivity map are shown in Figures I-7 and I-8. Throughout much of the Coast Ranges, the sedimentary soils of Franciscan formation are notoriously fragile. Because of their complex geologic history, the Klamath mountains have a diversity of soils ranging from decomposed granitics to volcanic soils. In places there are quite old and deep soils due to long periods without inundation or glaciation. The volcanic soils of Modoc Plateau notoriously porous and by contrast to the Franciscan soils of the Coast Ranges are quite resistant to erosion from human activities.

Table I-1. Temperature Regimes for Eight Stations within the Klamath Ecoregion.[1]														
Station		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Santa Rosa, CA (Records from 1931 to 1998)	Av. Max[2]	57	62	65	70	75	80	83	83	83	77	67	58	72
	Av. Min	37	39	40	43	46	50	51	51	50	46	41	39	44
Ukiah, CA (Records from 1906 to 1998)	Av. Max	57	61	65	71	77	85	93	93	88	76	64	57	74
	Av. Min	36	38	39	41	46	50	54	52	49	43	38	36	43
Covelo, CA (Records from 1948 to 1998)	Av. Max	52	58	62	69	76	85	94	93	88	76	61	52	72
	Av. Min	30	33	35	37	42	47	51	50	45	39	34	31	39
Eureka, CA (Records from 1948 to 1998)	Av. Max	54	55	55	56	58	60	62	63	63	61	58	55	58
	Av. Min	42	43	43	45	48	51	52	53	52	49	45	42	47
Crescent City, CA (Records from 1948 to 1998)	Av. Max	55	56	56	58	61	64	66	66	67	64	59	55	61
	Av. Min	40	41	42	43	46	49	51	52	50	47	44	41	45
Weaverville, CA (Records from 1948 - 1998)	Av. Max	47	54	59	67	76	84	94	93	87	74	57	47	70
	Av. Min	27	29	30	34	40	45	49	48	42	35	32	28	37
Yreka, CA (Records from 1948 - 1998)	Av. Max	44	51	56	63	73	81	91	89	82	69	53	44	66
	Av. Min	24	27	30	35	41	47	52	51	45	37	30	26	37

[1] Source: Western Regional Climate Center

[2] Numbers are degrees Fahrenheit

Klamath Falls, OR (Records from 1928 - 1998)	Av. Max	39	45	51	59	68	76	85	84	76	64	48	40	61
	Av. Min	21	25	29	33	40	46	52	50	44	36	28	23	35

Table I-2. Mean monthly distribution of precipitation for eight stations within the Klamath Ecoregion.[3]

Station	Santa Rosa, CA	Ukiah, CA	Covelo, CA	Eureka, CA	Crescent City, CA	Weaverville, CA	Yreka, CA	Klamath Falls, OR
Period of Record	1/31-2/98	3/06-2/98	7/48-2/98	7/48-2/98	7/48-2/98	7/48-2/98	7/48-2/98	1/28 - 2/98
Mean Annual Precipitation (inches)[4]	30.3	37.1	42.2	38.8	69.56	41.4	19.4	13.6
	Distribution of Precipitation by Month as Percentage of Mean Annual Precipitation							
July	tr	tr	tr	tr	1	tr	2	2
August	tr	tr	2	1	1	tr	3	3
September	1	1	tr	2	3	2	3	4
October	6	5	6	7	8	6	7	8
November	12	12	13	14	14	14	13	13
December	18	19	19	17	17	18	19	16
January	21	22	21	18	17	21	17	15
February	17	17	15	14	13	15	11	10
March	14	13	14	13	13	12	9	10
April	7	6	6	7	7	6	5	6
May	3	3	3	4	5	3	5	7
June	1	1	1	2	2	2	5	6

[3] Source: Western Regional Climate Center

[4] Does not include “fog precipitation”

HYDROLOGY

S.E. Rantz described in detail patterns of precipitation and runoff for the ecoregion.[11] He presents four hydrographs (Figure I-9) which typify the differing hydrology as one moves from the Coast Ranges to the Klamath Mountains to the Modoc Plateau.

Hydrology of the Coast Ranges is typified by high winter runoff and/or infiltration and perennial streams that are groundwater fed. This is typified by the hydrograph for the Eel River (Figure I-9). With little or no summer precipitation the ability of the soil to capture and hold precipitation is quite critical to the hydrological cycle. It has been estimated, for example, that the soil of the Eel River Basin holds about 233 billion gallons of water, or about 120% of the amount in Lake Shasta when it is full.[12]

Another unique aspect of the hydrologic cycle in the Coast Ranges is the input of water from fog precipitation or "fog drip."[13] The fog belt, or region that receives regular fog, covers approximately 1/3 of the Coast Ranges (Figure I-10). Fog drip is the water that is physically captured by plants, especially large conifers such as redwoods. This is a critical form of precipitation for many plants including especially redwoods and associated flora[14]. Todd Dawson, for example has shown that water from 22-46% of the moisture input to the redwood ecosystem was due to the presence of redwood trees themselves[15]. He further demonstrated that some understory plants derive up to 100% of their water from fog drip and concluded that the presence of trees has a real influence on the magnitude of water input from fog.

Fog drip may also be a significant source of water for recharging aquifers and streams; although this aspect has not been studied in detail in the Klamath Ecoregion there is evidence from other regions that fog drip may be a significant source of groundwater recharge[16].

The hydrology of the Klamath Mountains is similar to that of the Coast Ranges except that there is no fog precipitation, and significant amounts of precipitation fall as snow rather than as rain. This storage of snow in the mountains and resultant snowmelt results in peak flows in April and May as typified by the hydrograph for the Trinity River (Figure I-9). In addition, there is some summer precipitation from thundershowers.

The Modoc Plateau differs from the other areas in that precipitation input is significantly lower due to the rainshadow effect of the Klamath Mountains and because of the good infiltration of water due to the presence of porous soils. In addition, the underlying rocks are not as permeable resulting in a high water table in many places. This results in a much flatter hydrograph as typified by Fall Creek and the Shasta River (Figure I-9).

Figure I-9. Mean monthly distribution of runoff at selected gaging stations (from Rantz 1964).

VEGETATION

The vegetation of the ecoregion is as diverse as the climate and landforms ranging from semidesert Great Basin types to coastal marshes and rainforests. Vegetation of a defined area can be described in many different ways depending on: (1) the scale at which the vegetation is being described, (2) the method of data collection; (3) the classification system used, and/or (4) the purposes for which the vegetation description is to be used. This often leads to much confusion among those who are not botanists or plant ecologists. We describe here the vegetation of the Klamath Ecoregion in three different ways, in terms of "potential natural vegetation" at the "formation" level, existing vegetation at the formation level, and existing vegetation at the "series" level. These represent represent two quite different levels of scale. In the following section on wildlife, we describe two additional systems for describing vegetation of the region in terms of its utility as habitat for wildlife.

Potential Natural Vegetation

Potential natural vegetation of the Klamath Ecoregion is shown in Figure I-4. These are the vegetation types that can or would theoretically occur in a region in the absence of both human and natural disturbance and without major climatic change. In reality, over long enough periods of time both disturbance and climatic change always occur and thus such a homogenous vegetation coverage is never attained at a single moment in time. However, such maps are useful in providing a statement about the potential of large regions to support different types of vegetation based upon geology, physiographic features, climate, and soils.

Major Vegetation Types (Formations)

Major vegetation types or "formations" represent coarse scale descriptions of vegetation across large regions (watersheds, basins, ecoregions). This classification is at the same scale as the potential natural vegetation of Kuchler but is intended to be used to describe existing vegetation. Thirteen major vegetation types occur within the Klamath/Central Pacific Coast Ecoregion based upon *Terrestrial Vegetation of California* (Barbour and Major 1988) and *Natural Vegetation of Oregon and Washington* (Franklin and Dyrness 1973).

Coastal Prairie and Northern Coastal Scrub. The fescue-oatgrass grassland, or coastal prairie, occurs along the California coast from Santa Cruz northward. Coastal prairie is a discontinuous grassland below 1,000m in elevation and seldom more than 100 km from the coast. Typically it occurs on the ridges and south-facing slopes, alternating with forest and scrub in the valleys and on north-facing slopes. The dominant perennial grasses in this type are Idaho fescue, red fescue, and California oatgrass. The dominant species of the coastal prairie vary from north to south and with distance inland from the ocean. The Northern Coastal Scrub community extends in a narrow coastal strip from southern Oregon to Point Sur, Monterey County. It is dominated by evergreen shrubs less than 2 m tall, but with an additional herbaceous element to the extent that the scrub is interrupted by patches of Coastal prairie. Important shrubs include coyote bush, seaside wooly sunflower, salal, varicolored lupine, monkey flower (*Mimulus aurantiacus*), and California blackberry. Perennial herbs and grasses are also prominent. This habitat type is relatively stable, with small-scale changes related to agricultural uses and some losses to urbanization in limited areas.

Beach and Dune. The flora, vegetation, and microenvironment of beach and dune are sufficiently different to warrant their separate classification. Beach is defined as the expanse of sandy substrate between mean tide and foredune or, in the absence of a foredune, to the inland reach of storm waves. The beach is characterized be a maritime climate, high exposure to salt spray and sand blast, and a shifting, sandy substrate with low water-holding capacity and low organic matter content. With the exception of sea rocket species, beach taxa are perennial. Many, but not all, share the following traits: herbaceous, evergreen, succulent, leaves entire, habit prostrate, leading to nearly complete burial in hillocks of sand. Dunes are defined to include the sandy, open habitat which extends from foredune to typically inland vegetation on stabilized substrate. Plant communities are generally characterized by the following habitats: moving dune, stabilized ridge, vernal pool hollow, and dune forest. In some areas, extent of beaches and dunes have increased over the past several decades. However, there is a general trend toward lower habitat quality due to increasing recreational use, invasion of exotic plants, and, in limited areas, urbanization.

Coastal Saltmarsh. Coastal saltmarshes are restricted to the upper intertidal zone of protected shallow bays, estuaries, and coastal lagoons. Physical conditions are dominated by the tides, and pronounced environmental gradients are established in response to elevational changes in frequency and duration of tidal flooding. Humboldt Bay is the principle site of coastal salt marshes in California. Dense-flowered cordgrass, an introduced species, remains the usual primary colonist of the tideflats but often shares dominance of the low marsh with common pickleweed. Although pickleweed remains abundant in the high marsh, it often occurs as a codominate with saltgrass and jaumea. During the past few decades, declines in coastal salt marshes have been arrested. Most coastal marshes are now in public ownership. Principal threats include non-point source pollution and susceptibility to oil spills.

Closed-Cone Pines and Cypress. Closed-cone pines and cypress are unique, disjunct plant communities scattered the length of California's coast, mountains, and islands. The relict species occur on infertile and sometimes unusual substrates. Most stands are influenced by maritime climate. A number of endemic species are associated with these communities, and general plant diversities and densities tend to be reduced on these impoverished sites. The reduced pine species occurring naturally within the Klamath Ecoregion include the knobcone pine, Bishop pine, beach pine, and pygmy pine. Cypresses of the region include 7 unique forms (McNab cypress, Sargent's cypress, Baker's cypress, Port Orford cedar (Lawson cypress), Gowen cypress, and pygmy cypress. The latter is largely confined to a narrow strip of the Mendocino coast and several of the others are relatively rare. The life cycle of these major species is intimately related to fire. They are characterized by a closed-cone habit or by serotinous cones, whereby the ovulate cones remain sealed after maturity, usually accumulating on the tree until opened by fire. Many of these habitats are in isolated areas or fragile, unproductive soils where there is little economic impetus for alteration. Consequently, these communities are relatively stable, and there has been little concern until recently about them. However, with increased encroachment for development upon the pigmy forest of the coastal zone, increased alteration from logging within habitat of the Port Orford cedar, and logging and alteration of fire regimes within the Klamath Mountains from logging and fire suppression, the security of many of these communities is increasingly threatened.[17]

Coastal Forest. Redwood forests are tall, dense, needle-leaved, and evergreen. Dominant species are redwood, Douglas fir and Sitka spruce. Broad-leaved evergreen medium tall trees gradually increase eastward. The coast redwoods are the tallest trees (112m), growing at rates near world maximum. Undergrowth is low and patchy with forbs mainly on alluvial sites, shrubs and low trees on the uplands. Redwoods are found mostly on the western side of Coast Ranges from Monterey county to just beyond the Oregon border. The redwood belt is usually only about 16-24 km wide, and corresponds well to the fog belt. The redwood "rainforest" is unique in that it resides on the edge of the Pacific Ocean within a region that has a basic Mediterranean climate--that is, most of the rain comes in the winter months. This forest is a relict of more widespread rainforests that once covered much of the West. For most of the region the months of June, July and August (at a minimum) are virtually without rainfall. Being near the ocean, however, the coastal redwood forest is regularly covered by fog during the summer months. Much of the effective precipitation in this redwood / fog belt comes from the phenomena of fog drip--the ability of the redwood trees to capture fog from the air and transport it to the ground where it is utilized by many other life forms.[18] When forests of the region are overcut they lose much of their capacity to capture moisture from fog during the hot, dry months of summer. This is in addition to the well-documented ecological effects of deforestation common to most forested regions (soil exposure, accelerated erosion, sedimentation of streams, etc.). Overall, with unstable soils and relictual forests with unique flora and fauna, the Coastal Forest of the Klamath ecoregion is highly sensitive to land use impacts. The industrial timberlands have been severely overcut and the watersheds degraded.[19]

California Chaparral. California chaparral is composed mainly of evergreen woody shrubs, and it forms extensive shrublands that occupy most of the hills and lower mountain slopes of California. It is adapted to drought and fire, passing endlessly through cycles of burning and regrowth. Even though chaparral has no commercial value, it forms the most highly valued watershed cover of any vegetation in the state. "Chaparral" is a word of Spanish origin (chaparro) that originally denoted a thicket of shrubby evergreen oaks. The geographic factors that influence chaparral development are slope, aspect, coastal-desert exposure, elevation, substrate, and fire. The dominant woody genera of the California chaparral, such as *Adenostoma* (chamise), *Arctostaphylos* (manzanita), *Ceonothus* (ceonothus), Heteromeles (toyon), and *Rhus* (sugar bush), are absent from other regions having a Mediterranean type climate. Since this common type is favored by fire suppression, it has probably increased in recent decades, and the proportion of its acreage in older successional stages has also increased.

Mixed Evergreen Forest. The term "mixed evergreen forest" describes a characteristic set of coastal California mountain communities. In the Klamath Ecoregion consists of Douglas fir-hardwood forests in the Klamath Mountains and North Coast Ranges. Douglas fir-hardwood forests form part of an extensive mosaic with northern oak woodland and coastal prairie in the southern and coastal portions of the region. As in the Klamath mountains, these forests show various combinations of Douglas fir, tanoak, and madrone dominance on deeper, well-drained soils. In southeastern portions of Humboldt and Mendocino Counties, ponderosa pine becomes a major codominant in forests and woodlands. At higher elevations, limber pine is of secondary importance, and to the south, coast live oak becomes an increasingly common associate.

In the Klamath Ecoregion, the mixed evergreen forest has been subjected to the same pressures from logging as the coastal forests with similar, but not identical results. As with the coastal forests, most of the old growth forest is gone and only a few remnant patches remain. However, since the logging has been primarily for the conifer species, the result has been that many acres of mixed conifer/hardwood forest has been converted into forests dominated by hardwoods.
stands are also harvested for firewood and cogeneration fuel.

Vernal Pools. Vernal pools are ephemeral wetlands forming in shallow depressions underlain by a substrate near the surface that restricts the percolation of water. They are characterized by a barrier to overland flow that causes water to collect and pond. These depressions fill with rainwater and runoff from adjacent areas during the winter and may remain inundated until spring or early summer.[20] As these depressions dry up in the spring, various annual plant species flower, often forming conspicuous concentric rings of showy colors. Pool vegetation is azonal, with edaphic factors more important than the regional climate which affects the surrounding vegetation. There are three general types of vernal pools: valley pools, terrace pools, and pools of volcanic areas. This remnant habitat type is concentrated within the Santa Rosa Plain, but vernal pools are found throughout the Klamath Ecoregion. Both agricultural conversion and urban/suburban development have caused substantial loss of these habitats. Endangered species protection and land-management planning have slowed the pace of habitat loss, but pressure for agricultural conversion and/or development is still strong.

Great Basin Desert including Sagebrush Steppe. The Great Basin desert is the most extensive desert in the U.S., stretching from southeastern Oregon and Wyoming, south to northern New Mexico, and west into extreme eastern California. Within the Klamath Ecoregion, Great Basin desert vegetation is found on the Modoc Plateau region of the upper Klamath River basin. Topography of the Great Basin Desert varies but generally consists of wide valley floors between 4,000 and 6,000 feet interrupted by mountains. Temperatures drop much lower than any other U.S. desert, with a short frost-free season and very cold winters, and precipitation ranges from 4 to 12 inches. Two major vegetation communities occur within this desert, both of which are structurally and floristically simple: (1) sagebrush, and (2) shadscale or saltbush associations. Species with evolutionary affinities to warmer climates such as rabbitbrush and blackbrush are also present in the Great Basin Desert. The sagebrush steppe consists of a series of generally treeless, shrub-dominated communities with a ground layer characterized by perennial bunch grasses including bluebunch wheatgrass and Idaho fescue. Within this type, many of the better sites on deeper soils have been converted to agricultural uses, particularly where irrigation water was present. Both livestock grazing and fire suppression have also played a role in converting the vegetation of this region. Overgrazing by livestock over time can result in the removal of the ground layer of perennial grasses or conversion of this layer into annual grasses and forbs. By contrast fire tends to set back the shrub layer while only temporarily setting back perennial grasses and forbs. Periodic fires in the past tended to produce patches of grassland within the shrubland. Fire suppression thus has tended to reduce the density of grassland patches. When the two (livestock grazing and fire suppression) are combined, this effect may be even more pronounced, because the removal of perennial grasses, retards the capability of the vegetation to carry fire. In some grassland areas, overgrazing has resulted in an introduced annual grass, cheatgrass, to dominate sites. Since this grass is well adapted to fire (it both spreads fire easily and is well adapted to reproduce after fire), on many sites it becomes dominant and it is difficult to reestablish the native[21] vegetation. A variety of other invasive annual forb species have invaded Great Basin grasslands that are subject to overgrazing.

Montane and Subalpine Vegetation of the Klamath Mountains. The Klamath montane forests form a series of more or less discrete, island-like patches within a matrix of low-elevation forests and woodlands in northwestern California and southwestern Oregon. Klamath montane forests grow mostly above low-elevation coniferous forests rather than chaparral, woodlands, or grasslands. Dominant species, such as Douglas fir, ponderosa pine, and sugar pine are typical of low as well as montane elevations. The habitat requirements, competitive ability, fire resistance, and colonizing ability of individual conifer species have determined their ecological positions in elevational zones and habitats throughout the montane forests of the Klamath region. Decades of timber harvest have reduced the amounts of old-growth montane forests; most significant remnants are now in semi-protected reserves on public lands. Fire suppression has resulted in increased stand density, high mortality on some sites, and increased likelihood of stand-replacing fires. The extent of noncommercial timber species near timberline remains largely unchanged.

Transmontane Coniferous Vegetation. The transmontane region of California traditionally includes the portions of the state lying east of the main crests of the Cascade-Sierra axis and of the southern ranges forming the divide between coastal and desert drainages. Within the Klamath Ecoregion, this type is restricted to the Modoc Plateau. Three broad categories of coniferous vegetation occur primarily in the transmontane region of California: northern juniper woodlands, pinon and juniper woodlands, and montane coniferous forests. The northern juniper woodland described by Munz and Keck (1949) is here interpreted to include two phases: a western juniper woodland in open, rolling country and a mountain juniper on ridges and mountain slopes. The western juniper woodland is characterized by open stands or scattered trees of western juniper. The understory may have a grassy understory, particularly where trees are close together, or they may have a shrub understory in more open stands. Understory shrubs, or interspersed stands of low shrubs, are primarily big (Great Basin) sagebrush on deep soils or well-drained slopes, and black sagebrush on heavy soils and rocky substrates. The mountain juniper woodland is characterized by scattered trees of western juniper, commonly in association with Jeffry pine, currleaf mountainmahogany, bitterbrush, and big sagebrush. Juniper woodlands represent the westernmost expression of widespread pinon/juniper vegetation types occurring in the Great Basin and Colorado Plateau regions. Fire suppression together with livestock grazing may be causing a continued expansion of juniper woodland in the extreme northeastern portion of the ecoregion, at the expense of shrubland and grassland.

Oak Woodland. The oak woodland has little floristic unity except the ubiquitous annuals in its ground cover. Species from adjacent grassland, chaparral, and forest communities associate with the "woodland" trees over a wide range physiographical and climatic situations. Open stands of deciduous "white oaks" characterize vast tracts of oak woodland, but evergreen "black oaks" are often present and sometimes dominant. Also, one or more species of pine may be scattered among the oaks. On the ground, the oak woodland has a significant grassland cover under and between the trees. Different oak species are involved regionally. Oak woodlands remain fairly stable, except in limited areas near urban regions, or where access for firewood cutting or cogeneration fuel concentrate impacts.

Tule Marshes and Wetlands. Wetlands are characterized by hydric soils and water-loving plants. Of the many diverse types of wetlands, marshes are the most widely distributed and the best-known form. They are dominated by emergent plants such as cattail, bulrushes, sedges, and water-tolerant grasses. Marshes often are complete entities, found in shallow basins. The term may also be used for any emergent hydrophyte community. Water is the driving force in determining wetland type and habitat quality. Water permanency and associated vegetation are key factors in classifying wetlands. Because water cycles are variable, marshes are rarely constant. These fluctuations induce "boom and bust" in wildlife numbers, but are essential to nutrient recycling. Although increased regulation has slowed the rate of decline, loss of freshwater wetlands continues on a localized level due to urban development and intensive agricultural practices.

Vegetation Communities

At a more detailed level, vegetation can be described in terms of plant communities. A plant community is “all of the plant species found growing together at one time in a given habitat or region.”[22] In order to classify and map plant communities, plant ecologists usually label them in terms of: (a) one or more dominant or codominant plants (e.g., beach pine forest); (b) the substrate, landform, or location (e.g., coastal dunes, bald hills prairie); or (c) combinations of the two (e.g., upland Douglas-fir forest; northern interior cypress forest). The actual descriptions of the type used in classification and mapping are usually based upon a few dominant and co-dominant plant species.

A system for classification at this level has been developed for California and it describes the vegetation of California in terms of 375 “natural communities.”[23] Natural communities as thus described are “tangible units that can be counted, protected, and managed."[24] They can also be mapped.

The plant communities within the ecoregion and their acreage within Northwestern California are listed in Appendix I. Most of the California portion of the ecoregion has been mapped at this level by Thorne (1997) and his work provides some indication of the relative percentages of the different community types in the region.

Vegetation Series

Vegetation can be described in more detail at the "series" level. A vegetation series is usually described in terms of one or more dominant plants. Thus plant series are usually relatively easy to recognize qualitatively in the field, although they may be very patchy. For a more complete description of the series level of description and its utility refer to Sawyer and Keeler-Wolf (1995:1-18). The series found within the ecoregion are listed in Appendix II. Note that some series descriptions correspond to Holland's plant community descriptions, while many others do not. They are cross referenced to the extent possible in Appendices I and II.

The relative rarity of various plant series and communities is described and discussed later in this volume as well as in volume II. In particular, emphasis is placed upon plant communities that have become rare or degraded as a result of human activity. Note, however, that the ranking system used in Appendix II does not distinguish between communities that are rare as a result of human activities and those that are rare for other reasons.

Wildlife

Vertebrate Fauna

Fish and wildlife species found within the Klamath Ecoregion are listed in Appendix III. The vertebrate fauna of the region is thoroughly described in many books[25] on the statewide, regional, and local level and we make no attempt here to summarize or abstract the wealth of information they contain.

In general, the vertebrate fauna is characterized by a high species richness and a high degree of endemism for most groups. At least 77 fish species have been reported from the region, of which 24 are nonnative[26] introduced species that have become established. Fish species from the region fall into three main groups: (1) Upper Klamath River species, (2)Lower Klamath River species, and (3) species from the other coastal rivers from the Smith River south to San Francisco Bay (Appendix II -Table AII-1). Both the coastal rivers and the lower Klamath support twelve species of native anadromous fish, including six species of salmon and steelhead; the upper Klamath formerly supported anadromous salmonids prior to being dammed. The fish fauna of the upper Klamath Basin contains several species endemic to the region including the Klamath largescale sucker, the Lost River sucker, and the shortnose sucker. The fish fauna of the upper and lower Klamath River are relatively distinct reflecting the relatively recent connection between the two systems in geologic time[27].

The region supports 24 species of amphibians and 24 species of reptiles. Several of the amphibian species are endemic to the region including the red-bellied newt and Dunn's salamander. The reptile fauna is more cosmopolitan with only one species, the northwestern garter snake, endemic to the region. We are aware of only one species of amphibian or reptile, the bullfrog (*Rana catesbeiana*), that has been introduced and become widely established within the region.

The region supports over 270 bird species, partially due to the richness and diversity of the habitats present but also because of its location on major migratory routes. The marshes and wetlands of the upper Klamath Basin are a major stopping point for waterfowl and shorebirds migrating along the Pacific flyway. Many other species move along the coast taking advantages of the beach habitat and the lagoons and estuaries for loafing, feeding, and roosting. Finally, birds migrating up and down the coastal mountains add to the bird diversity. Lastly many birds migrating up and down the Sierra Nevada and Cascades will cross the upper Klamath Basin. Many of these birds are neotropical migrants--species in which some populations migrate north from the tropical regions of North and South America. In addition to these migrants, there is a diversity of resident species as well as species such as band-tailed pigeons that tend to move around within the region. There are no birds endemic to the region. Six species of birds, the European starling (*Sturnus vulgaris*), the English or house sparrow (*Passer domesticus*), rock dove (*Columba livia*), wild turkey (*Meleagris gallopavo*), chukar (*Alectoris chukar*), and ring-necked pheasant (*Phasianus colchicus*) have been introduced and become widely established.

The mammalian fauna similarly contains few endemic species. The only truly endemic mammal is the redwood or yellow-cheeked chipmunk (*Tamias ochrogenys*) which is found in coastal Sonoma and Mendocino Counties. There are seven species of nonnative mammals that have been introduced and become widely distributed, Virginia opossum (*Didelphis virginiana*), black rat (*Rattus rattus*), Norway rat (*Rattus norvegicus*), house mouse (*Mus musculus*), wild pig (*Sus scrofa*), fallow deer (*Cervus dama*), and feral goat (*Capra hircus*).

Invertebrate Fauna

Much less is known about the invertebrate fauna of the region, and in many cases, even the description of the species present is incomplete. While it is widely believed that invertebrates are extremely critical in functioning of ecosystems[28] except in the case of endangered species, most efforts at invertebrate conservation rely upon habitat conservation. The assumption of such an approach is that if intact habitats that represent the full spectrum of types present in a region are left intact, then most invertebrate species will survive in such areas.

Wildlife Habitat

Since inventory or census of wildlife populations are time-consuming and expensive[29], most analyses of the wildlife resources of an area and/or their status rely upon some evaluation of the wildlife habitats present and their condition[30].

In California, a system called the California Wildlife Habitat Relationships (WHR) System has been developed. The habitat component of the system is composed of a habitat classification and vegetation description of the wildlife habitats in California[31] and a computer data base that includes species-habitat relationships models[32]. Wildlife habitats within the Klamath Ecoregion according to the California Wildlife Habitat Relationship System[33] are shown in Table I-3.

Note that the wildlife habitats listed in Table I-3 are for California; there is not a comparable system for

Oregon. However, we believe that all habitats within the upper Klamath Basin (the only portion of the ecoregion in Oregon) are covered by this classification. Note also, that the California Wildlife Habitat Relationship System is only for terrestrial vertebrates. There is no comparable system of classification of aquatic habitats and/or fish habitat relationships, much less any coverage of invertebrates and their habitats. Since wildlife species respond to vegetation structure as much as they respond to species composition, and because vegetation structure is correlated with the successional stage of the vegetation, wildlife habitat evaluation systems such as WHR usually include successional stage as one of the predictors. Thus, wildlife habitat maps such as in Figure I-11, show not only the vegetation type that is present, but also how much of it is in various seral stages. Thus, one can see, for example, how much late seral or old-growth habitat is left in an area relative to the total amount of habitat of that type of vegetation.

The question of how much habitat of each of these types is present in the ecoregion requires some modification of the system. The reason for this is that the only practical way of obtaining such estimates at the present time is through the use of remote sensing.[34] These habitat types have been mapped from aerial photography using 1993 Landsat Thematic Mapper images by Dr. Larry Fox and his students and coworkers at Humboldt State University. The wildlife habitat types that can be distinguished from Landsat are shown in Table I-4.

Figure I-11. Wildlife habitat types from Landsat thematic mapper ("Fox habitat types").

Table I-3. Wildlife habitat types represented in the Klamath Ecoregion.[5]

Wildlife Habitat Type	Where Found in Ecoregion	Typical / Dominant Plants:
Tree Dominated Habitats		
Subalpine Conifer	Higher elevations of Klamath Mountains and Modoc Plateau	Engelmann spruce, subalpine fir, mountain hemlock, western white pine, lodgepole pine, whitebark pine
Red Fir	Higher elevations of Klamath Mountains and Modoc Plateau	red fir
Lodgepole Pine	Higher elevations of Klamath Mountains and Modoc Plateau	lodgepole pine
Sierran Mixed Conifer	Mid elevations of Klamath Mountains and southern Cascades	white fir, Douglas-fir, ponderosa pine, sugar pine, incense-cedar, California black oak
White Fir	Between mixed conifer and red fir habitats in Klamath Mountains	white fir
Klamath Mixed Conifer	Klamath Mountains	white fir, Douglas fir, ponderosa pine, incense cedar, sugar pine
Douglas Fir	Entire length of Coast ranges within ecosystem (primarily at elevations of 500-2000 feet) and Klamath Mountains (primarily at elevations of 1000 to 4000 feet)	Douglas fir
Jeffrey Pine	Localized areas within Coast Ranges and Klamath Mountains	Jeffry pine
Ponderosa Pine	Warmer and drier sites of Klamath Mountains and Modoc Plateau	ponderosa pine

[5] From: Mayer and Laudenslayer (1988)

	Eastside Pine	Modoc Plateau and eastern side of Klamath Mountains	ponderosa pine with Jeffrey pine, lodgepole pine, white fir, incense cedar, Douglas fir, California black oak, western juniper
	Redwood	Coast Ranges for entire length of ecoregion primarily at lower elevations within fog belt	coast redwood
	Juniper	Drier warmer sites of the Modoc Plateau	western juniper
	Aspen	Higher elevations of the Klamath Mountains and Modoc Plateau	quaking aspen
	Closed-Cone Pine-Cypress	In patches along coast in Sonoma, Mendocino, and Humboldt County; Klamath Mountains	Varies considerably depending upon site; trees include MacNab and Sargent cypress, Bishop pine, Torrey pine, beach pine, knobcone pine
	Montane Hardwood-Conifer	Widely distributed throughout the ecoregion	ponderosa pine, Douglas-fir, incense cedar, California black oak, tanoak, Pacific madrone, Oregon white oak
	Montane Hardwood	Widely distributed in Coast Ranges and Klamath Mountains	canyon live oak
	Blue Oak Woodland	Localized areas of Mendocino County	blue oak
	Valley Oak Woodland	Drier, eastern portions of Mendocino and Sonoma counties	valley oak
	Coastal Oak Woodland	Inland portions of coast ranges from Sonoma County north through Humboldt County	Oregon white oak

	Blue Oak - Digger Pine	Patchily distributed in eastern Mendocino and Sonoma County	blue oak, digger pine
	Eucalyptus[6]	Southern portion of Sonoma County	Blue gum, red gum
	Montane Riparian	Widely distributed throughout the ecoregion	black cottonwood, bigleaf maple, white alder, thinleaf alder
	Valley Foothill Riparian	Widely distributed along Coast Ranges	cottonwood, valley oak
Shrub Dominated Habitats			
	Alpine Dwarf-Shrub	Higher elevations within Klamath Mountains and Modoc Plateau (Mt. Shasta)	varies considerably
	Low Sage	Scattered locations within Modoc Plateau	low sagebrush, black sagebrush
	Bitterbrush	Modoc Plateau	antelope bitterbrush
	Sagebrush	Modoc Plateau	big sagebrush
	Montane Chaparral	Inland portions of Coast Ranges to northern Mendocino County; Modoc Plateau and eastern side of Klamath Mountains	varies considerably
	Mixed Chaparral	Drier sites throughout the ecoregion	varies considerably
	Chamise-Redshank Chaparral	Drier sites throughout the ecoregion	
	Coastal Scrub	Discontinuous along entire length of coast	chamise
			varies considerably
Herbaceous Dominated Habitats			
	Annual Grassland	Drier sites within Sonoma	varies considerably

[6] Gum trees (Eucalyptus) are not native to North America.

		and Mendocino County	
	Perennial Grassland	Drier sites along coast ranges and on Modoc Plateau	California oatgrass, Pacific hairgrass, sweet vernalgrass
	Wet Meadow	Scattered throughout northern portion of Coast Ranges (Humboldt and Del Norte County), Klamath Mountains, and Modoc Plateau	Characteristic genera include Agrostis (bentgrass), Danthonia (danthonia), Juncus (rushes), Salix (willows), and Scirpus (bulrushes)
	Fresh Emergent Wetland	Scattered throughout ecoregion	varies considerably
	Saline Emergent Wetland	Patchily distributed along coast of Humboldt and Del Norte County	varies considerably
	Pasture[7]	Concentrated along: (1)Russian River drainage in Sonoma and Mendocino Counties; (2) Lower stretches Eel and Mad River drainage in Humboldt County; (3) Scott and Shasta Valley in Siskiyou County; and (4) Upper Klamath River in Oregon and northern Siskiyou County, California.	varies considerably
Aquatic Habitats			
	Riverine	Throughout	
	Lacustrine	Throughout	
	Estuarine	Patchily distributed along coast with largest estuaries in Marin, Humboldt, and Del Norte County.	
	Marine	Coast	

[7] The type refers to irrigated pasture

Developed Habitats			
	Cropland	Concentrated along: (1)Russian River drainage in Sonoma and Mendocino Counties; (2) Lower stretches Eel and Mad River drainage in Humboldt County; (3) Scott and Shasta Valley in Siskiyou County; and (4) Upper Klamath River in Oregon and northern Siskiyou County, California. The type refers to irrigated pasture	
	Orchard-Vineyard	Widely distributed from northern Mendocino County southward within ecoregion.	
	Urban	Widely distributed throughout ecoregion--but most concentrated in south--especially Marin and Sonoma County	

Table I-4. Vegetation Types Determined from Landsat Thematic Mapper Classified Into Wildlife Habitat Relationship (WHR) Classes.

GENERAL TREE TYPES

LANDSAT HABITAT TYPE	Symbol	Included WHR Types	Identified Stages (WHR tree size & closure[1])
(1) Mixed Conifer (Needle-leaf, <20% broad-leaf)	MCN	(SCN, RFR, SMC, WFR, KMC, RDW, DFR, JPN, PPN, EPN, CPC, LPN)	2S 2P 2M 2D 3S 3P 3M 3D 4S 4P 4M 4D 5S 5P 5M 5D
1A. Mixed Fir (Mapped when possible)	MCF	(SCN, RFR, SMC, WFR, KMC, RDW, DFR)	
1B. Mixed Pine (Mapped when possible)	MCP	(JPN, PPN, EPN, CPC, LPN)	
(2) Mixed Conifer-Hardwood (Mixed needle-leaf & broad-leaf, >50 % Needle-leaf)	MCH	(MHC, KMC, DFR, JPN, PPN, EPN, RDW, CPC)	
(3) Mixed Hardwood-Conifer (Mixed broad-leaf & needle-leaf, >50 % broad-leaf)	MHC	(MHC, MHW, BOP)	
(4) Mixed Hardwood (Broad-leaf, <20% needle-leaf)	MHW	(MHW, MHC, MRI, VRI, EUC, ASP)	
(5) Mixed Oak Woodland (Oak dominated broad-leaf)	MOW	(VOW, COW, BOW)	(see above)
(6) Mixed Juniper/Pinyon	MJN	(PJN, JUN)	(see above)

The above classes repeat for all four tree types. WHR tree size classes are:

Size Class	DBH Range (inches)
2	1 - 6
3	6 - 11
4	11 - 24
5	>24

WHR canopy closure classes are:

Closure Class	Canopy Closure (%)
S	10 - 24
P	25 - 39
M	40 - 59
D	60 - 100

GENERAL SHRUB TYPES

LANDSAT HABITAT TYPE	Symbol	Included WHR Types	Identified Stages (WHR shrub closure[8])			
Greenleaf Shrub (dominated by green leaves)	SHG	(ADS, MCP, MCH, CSC)	S (10-24)	P (25-39)	M (40-59)	D (60-100)
			Percent crown closure			
Deadstick Shrub (dominated by woody sticks)	SHD	(LSG, BBR, SGB, ASC MCH, CRC, CSC)	S	P	M	D
Soft Shrub (lacking stiff woody stems)	SHS	(BBR, LSG, SGB)	S	P	M	D

[8] We do not expect to discriminate WHR, "size" (actually maturity) classes for shrubs.

GENERAL HERBACEOUS TYPES

LANDSAT HABITAT TYPE	Symbol	Included WHR Types	Identified Stages (WHR herb. closure[9])			
Dead Grass/Forb (dominated by dead leaves)	GSD	(PGS, AGS, CRP, PAS)	S (2- 9)	P (10-39)	M (40-59)	D (60-100)
			Percentage of herbaceous cover			
Green Grass/Forb (dominated by live leaves)	GSG	(WTM, PGS, AGS, OVN, CRP, PAS)	S	P	M	D
Wet Meadow/Marsh	GSW	(WTM, FEW, SEW)	S	P	M	D

GENERAL BARREN TYPES

LANDSAT HABITAT TYPE	Symbol	Included WHR Types	Identified Zones[10]
Snow & Ice	BSI	(none defined)	(none defined)
Soil	BSL	(RIV, MAR, EST, LAC, URB)	2
Gravel/Rock/Talus (includes concrete and asphalt)	BGR	(RIV, MAR, EST, LAC, URB)	2

GENERAL AQUATIC TYPE

LANDSAT HABITAT TYPE	Symbol	Included WHR Types	Identified Zones[11]
Water	WTR	RIV, MAR, EST, LAC	1

[9] We do not expect to discriminate WHR height classes for herbaceous types.

[10] We combine WHR Zones 3 & 4 to form Zone 2 (exposed during satellite overpass). We do not expect to discriminate WHR substrates. BGR and BSL types occurring in or near rivers and lakes are spectrally identical to BGR and BSL types occurring on upland sites.

[11] We combine WHR Zones 1, 2 & 3 to form Zone 1 (submerged during satellite overpass). We do not expect to discriminate WHR substrates.

HUMAN HISTORY

First Nations

Native Americans have occupied the Klamath Ecoregion for at least 10,000 years. The native Americans of the region are from six separate linguistic groups (Figure I-12), thus suggesting that their origins were quite diverse. They lived in scattered temporary and permanent villages throughout the area. As best we understand it Native Americans associated with their villages and clans more than with their "tribe" as described by anthropologists of European origin. The anthropologists who studied native Americans, as well as the government officials attempting to deal with them, tried to categorize Indians into discrete tribes. An anthropological map of the Native American tribes of northern California is shown in Figure I-13.

Within this region the Native Americans had developed complex and diverse cultures, well-adapted to the localized landscape conditions and use of native plant and animal materials. Native Americans depended heavily upon salmon (in most of the region), suckers (in Upper Klamath Basin), shellfish (along coast), acorns (drier portions of ecoregion), and deer and elk (throughout the ecoregion). In addition, the native cultures made extensive use of hundreds of other species for food, housing, boat building, basketry, medicine, ceremony, and many other uses.

The native people maintained and subtly manipulated the landscape in a manner that has not been fully appreciated by non-Indians until recently[35] through practices such as burning and seeding. Blackburn and Anderson[36] (1993b) describe this process:

> "...it is important to emphasize the fact that the level of environmental management that was achieved in California was such that native peoples did not simply exercise a certain degree of 'control' over specific resources or 'modify the ecology' of particular biological communities. Instead, the domesticatory process here seems to have reached the point where important features of major ecosystems had developed as a result of human intervention, and many habitats (e.g., coastal prairies, black oak savannas, and dry montane meadows) were deliberately maintained by, and essentially dependent upon, ongoing human activities of various kinds. In fact, the various essays in this volume strongly suggest that the vertical structure, spatial extent, and species composition of the various plant communities that early European visitors to California found so remarkably fecund were largely maintained and *regenerated* over time as a result of constant purposive human intervention."

The most powerful, effective and widespread technique used was fire. However, many other techniques such as complex harvesting strategies were employed.

Figure I-12. Linguistic stocks of Native Americans of the Klamath Ecoregion.

Figure I-13. Tribes of Native Americans within the California portion of the Klamath Ecoregion.

Contact with European Culture (1700-1900)

The history of native American treatment upon contact with European culture mirrored that interaction in the rest of North America. Although the specifics differ, the various tribes were subjected to unkept promises, random and planned violence, and general mistreatment at the hands of government and citizen alike.

In 1851 a United States Indian Agent, Redick McKee embarked from Sonoma on a five hundred-mile journey that encompassed most of the ecoregion--at least the portion in California.[37] McKee gathered native Americans together and negotiated a series of treaties that would have forever guaranteed them a few prime sites in the region such as the lower Eel River, Hoopa Valley, Scott Valley, and the Klamath-Trinity region. As token an effort as it was--these treaties were never ratified by Congress.

The persecution of the native Americans continued for many years--with Indians being rounded up onto reservations, shipped to remote locations (e.g., the Modocs were sent to Oklahoma), and generally stripped of resources, power, and pride.

Early European / American Settlement (1700-1900)

The Klamath Ecoregion is somewhat unique in that the European invasions of the last 500 years came from quite different directions: the Russians moving across the Bering Strait and down the coast, the Spanish working their way up California from Mexico, and the Americans moving across the continent from the east.

The Russians were the first non-Indians to arrive in the region. They were primarily fur trappers and traders who had worked their way down the coast from Alaska. They were not, for the most part, interested in setting up permanent Russian settlements or colonies, i.e., bringing wives and families from Russia. Rather they set up trading posts, primarily along the coast. One of the first, Fort Ross, was established in 1812. Of all the immigrants of this period, however, the Russians probably left the least mark on the land. The Russians gradually withdrew from the Northwest, and with the purchase of Alaska from Russia by the United States in 1867 the Russians essentially ceded any interest in establishing settlements in North America. Not having established any permanent settlements in the Klamath Ecoregion, the Russians left only a few artifacts as evidence of their activities during this period.

The Spaniards and later Mexicans were to leave a more permanent mark on the ecoregion. Juan Rodriguez Cabrillo sailed north from Mexico in 1542 as far north as Point Mendocino and is widely credited as being the first European explorer to reach California. It was another 200 years, however, before Spanish and Mexican settlers began to enter California. In 1769 a small band of Spanish and Indians under the leadership of Don Gaspar de Portola journeyed from Baja California and established the first of many missions in San Diego. The following years were to see missions established further north eventually reaching Sonoma County within the ecoregion.

The Spanish influence during this period was largely limited to the southern portion of the ecoregion. Mission San Francisco Solano, commonly called Mission Sonoma was established in 1823 in the Sonoma Valley near what is now the city of Santa Rosa. This was the northernmost mission in California and for the most part marked the extent of Spanish / Mexican settlement during this period.

The "Americans" were the last to arrive in the region. The first Americans (from the United States) to explore the region were the fur trappers who arrived after 1800. In 1828, Jedediah Smith, an American fur trapper[38] and shortly thereafter the Hudson Bay Company ventured into the region to trade with the Indians[39]. However, few American settlements were established in the region until the massive migration that began around 1830. These settlers settled primarily in the more open valleys along the Russian River in what is now Sonoma and Mendocino Counties, as well as the upper reaches of the Klamath Basin along the Scott, Shasta, Williamson and Lost Rivers, where land was more suitable for agriculture. Other settlements developed along the coast where towns developed around the timber industry which could supply lumber via ship to the rapidly expanding settlements to the south, particularly San Francisco. The gold rush of 1850 brought a tremendous influx of gold seekers to California, initially to the Sierra Nevada, the site of the first major gold discovery. However, gold was discovered in the Klamath Basin in 1852 and this brought a wave of miners to this region. Overall, the period from 1850-1900 saw a tremendous influx of American settlers to the region, although it was for the most part it was concentrated on the coast and in the valleys suitable for agriculture.

During this period the major industries that were to dominate the ecoregion to this day were first established--ranching, mining, timber, fishing, and agriculture. These industries were, for the most part, widely scattered and of low intensity--resulting in limited or very localized impact upon the natural resources of the region. The exception, during this period was mining--in particular hydraulic mining which was in common use by the 1870s.

Twentieth Century Development (1900-1950)

The period from 1900 to 1950 in the Klamath Ecoregion was a period in which the basic patterns of immigration, settlement, human infrastructure and industry were continued and expanded. At the turn of the century, most cities and towns of the ecoregion were semi-isolated from each other. This changed dramatically with the widespread increase in motorized travel beginning around 1910. In 1917 the "Redwood Highway" was completed linking the coastal cities of Crescent City, Arcata and Eureka with those to the south such as Ukiah and Santa Rosa. This highway was good for commerce--but conservationists recognized right away that it would dramatically increase the amount of logging--particularly of the redwood forests.[40] Highway connections between the coast and the upper Klamath Basin remained primitive into the 1950s. With more people the demands and stresses upon natural resources increased. Timber harvest increased--particularly within the coastal redwood region. (Concerned with the imminent demise of the redwoods the "Save the Redwood League" was incorporated in 1920). However, elsewhere the combination of inaccessibility and low demand discouraged widespread exploitation of forests further inland.

During this period large scale water diversion from most of the rivers of the ecoregion was initiated. During the earlier period, prior to 1910, small water impounding dams had been built, but these were mostly small, located on tributaries, and often impermanent--being washed out with larger floods. (A wooden dam was built on the upper Klamath River at Klamathon in about 1889 for a large lumber mill there, but it was destroyed by fire in 1902.) By the early 1900s both the technology and infrastructure were available for bigger dams. So too, was the demand--at first for water then later for water and power. On the Klamath River, Copco dam (Copco #1) was completed in 1917.

It was during this period, however, that the so-called "reclamation" of the wetlands of the upper Klamath Basin was initiated. Beginning in 1905 the Bureau of Reclamation began the "Klamath Project" which ultimately resulted in draining 65 to 80% of the natural wetlands of the area and converting them into agricultural land. At the same time water was diverted to these and other drylands for agricultural purposes.

Recent Development (1950-1996)

The changes of the latter half of the twentieth century represent a continuation of many earlier trends--but more importantly an acceleration of many of the trends. Logging, once largely confined to the redwood forests was expanded to the higher elevation douglas fir and ponderosa pine forests. This post World War II boom in forestry was driven by demand for lumber for new housing. At the same time, it was facilitated by newer technology--namely improved gasoline powered chainsaws and crawler tractors for skidding logs.

Similar patterns occurred in other industries. Improved technology for fishing allowed more efficient and larger ocean harvest of salmon. And larger dams were now being built (Iron Gate completed in 1962; Trinity and Lewiston Dams in 1964). Most significantly, Trinity and Lewiston Dams, provided for massive water diversion from the Klamath River Basin into the Sacramento River where the water is used for agriculture. Other dams on the Eel and Russian rivers as well as many smaller streams provided for diversions within the ecoregion.

Human population increased steadily throughout most of the ecoregion, however, the most dramatic increase came in the southern end of the ecoregion in Sonoma County. The population of Sonoma County almost doubled from 1970 to 1990 going from 205,000 to 388,000. Thus, in 1990 based upon County population census data[41], more than one-half of the population of the ecoregion is found in the southern 10% of the region.

CURRENT SOCIO-ECONOMIC CONDITIONS

First Nations

The native American population has been drastically reduced in numbers and distribution. However, 34 tribes still reside within the ecoregion (Table I-8) of which 28 are Federally recognized. They are scattered on rancherias and reservations throughout the ecoregion as shown in Figure I-14.

Having had their land base drastically shrunk, these native Americans are struggling to adjust, socially and economically, to the new conditions in the ecoregion. Those tribes that have had the resources to pursue legal strategies for recovering some of their rights have had some success. And some of these legal decisions may have region-wide implications. In particular, the Hoopa and Yurok tribes have successfully sued to have water returned to the Trinity River adequate to support the traditional salmon fishery there. Implementation of this decision will result in less water diversion out of the ecoregion and a general improvement in the flow and water quality in the Trinity and lower mainstem Klamath. Similarly, the Klamath Tribes have sued to provide protection for the Short-nose and Lost River suckers, two endemic fish that provided traditional sustenance for the tribes and are now federally endangered, largely as a result of water diversion and associated agricultural activities.

Table I-8. Indian tribes within or from the Klamath Ecoregion.		
Federally Recognized Tribes		
	Big Lagoon Rancheria of Smith River Indians of California	
	Big Valley Rancheria of Pomo and Pit River Indians of California	
	Cahto Indian Tribe of the Laytonville Rancheria, California	
	Cloverdale Rancheria of Pomo Indians of California	
	Coast Indian Community of Yurok Indians of the Resighini Rancheria, California	
	Covelo Indian Community of the Round Valley Reservation, California	
	Coyote Valley Band of Pomo Indians of California	
	Dry Creek Rancheria of Pomo Indians of California	
	Elem Indian Colony of Pomo Indians of the Sulphur Bank Rancheria, California	
	Elk Valley Rancheria of Smith River Tolowa Indians of California	
	Hoopa Valley Tribe of the Hoopa Valley Reservation, California	
	Hopland Band of Pomo Indians of the Hopland Rancheria, California	
	Karuk Tribe of California	
	Kashia Band of Pomo Indians of the Stewarts Point Rancheria, California	
	Klamath Indian Tribe of Oregon	
	Manchester Band of Pomo Indians of the Manchester-Point Arena Rancheria, California	
	Modoc Tribe of Oklahoma	
	Pinoleville Rancheria of Pomo Indians of California	
	Quartz Valley Rancheria of Karuk, Shasta & Upper Klamath Indians of California	

	Redding Rancheria of Pomo Indians of California	
	Redwood Valley Rancheria of Pomo Indians of California	
	Robinson Rancheria of Pomo Indians of California	
	Santa Rosa Indian Community of the Santa Rosa Rancheria, California	
	Scotts Valley Band of Pomo Indians of California	
	Sherwood Valley Rancheria of Pomo Indians of California	
	Smith River Rancheria of California	
	Upper Lake Band of Pomo Indians of Upper Lake Rancheria of California	
Federally Non-recognized Indian Tribes[12] [13]		
	Federated Coast Miwok Tribe, California	
	Melochundum Band of Tolowa Indians, California	
	Shasta Tribe, California	
	Yokayo Tribe, California	
	Tolowa-Tututni Tribe, California and Oregon	
	Klamath Reservation[14]	

[12] These are tribes that the government considers extinct or terminated.

[13] Source: Professor Troy Johnson, California State University, Long Beach, CA (trj@csulb.edu); obtained over Internet

[14] The Klamath Reservation was terminated but the Klamath Tribe is still recognized.

Figure I-14. Location of rancherias and reservations of Indian tribes from the Klamath Ecoregion.

Demographics

Population densities for the ecoregion are shown in Figure I-15. Most of the population is concentrated in the southern end of the ecoregion, with more than half of the total population of the region found in Sonoma County (Table I-9). Sonoma County is also the fastest growing area within the ecoregion, having doubled in population from 1980 to 1990.

Table I-9. Total Population of Principal Counties within the Klamath Ecoregion in 1990.[15]

County	
Sonoma County, CA	388,222
Mendocino County, CA	80,345
Trinity County, CA	13,063
Humboldt County, CA	119,118
Del Norte County, CA	23,460
Siskiyou County, CA	43,531
Klamath County, OR	57,702

[15] From 1990 U.S. Census

Figure I-15. Human population densities for the Klamath Ecoregion.

Socio-Economic Status of Residents

Statistical measures are weak indicators of "socio-economic status" or the more nebulous "quality-of-life." However, bottom line measures such as income levels, unemployment rates, and level of education as shown in Tables I-10 through I-12 provide some indication of what is happening in a community. The income levels for most of the counties are quite comparable, with the noticeable exception of Sonoma County which has both higher household and per capita income. This is most likely a result of the types of jobs that are available in the more urban Sonoma County as opposed to the more rural counties to the north, as the levels of educational attainment shown in Table I-11are similar.

Table I-10. Income Level by County for the Klamath Ecoregion.[16, 17]

	Median Household Income	Per Capita Income
Sonoma County, CA	$36,299	$17,239
Mendocino County, CA	$26,443	$12,776
Humboldt County, CA	$23,586	$12,436
Del Norte County, CA	$22,917	$10,625
Trinity County, CA	$20,494	$10,781
Siskiyou County, CA	$21,921	$11,610
Klamath County, OR	$23,054	$11,138

[16] Source: U.S. Census

[17] Data are for 1989

Table I-11. Educational Attainment by County for the Klamath Ecoregion.[18][19]

	Less than High School Diploma		High School Graduate / No Bachelor's Degree		Bachelor's Degree or more	
	Number	Percent of Total Population	Number	Percent of Total Population	Number	Percent of Total Population
Sonoma County, CA	40,368	10%	154,891	39%	63,446	16%
Mendocino County, CA	11,206	14%	31,939	40%	9,344	12%
Humboldt County, CA	14,732	12%	45,747	38%	15,101	13%
Del Norte County, CA	4,384	19%	9,200	39%	1,506	6%
Trinity County, CA	2,296	18%	5,454	42%	1,143	9%
Siskiyou County, CA	6,565	15%	18,317	42%	4,109	9%
Klamath County, OR	8,791	15%	23,540	41%	4,583	8%

[18] Source: 1990 US Census Data

[19] Data are reported for persons 25 years and over; thus, percentages represent the number of persons 25 years and over with a given level of educational attainment divided by the total number of persons in the county.

Table I-12. Unemployment Rates by County for the Klamath Ecoregion (April 1998).			
Area[20]	Work Force	Unemployment	
		Number	Percent
Sonoma County, CA	242,500	8,100	3.3%
Mendocino County, CA	41,300	3,520	8.5%
Humboldt County, CA	60,900	4,500	7.4%
Del Norte County, CA	10,080	1,030	10.2%
Trinity County, CA	5,400	750	13.9%
Siskiyou County, CA	18,280	2,420	13.2%
California (Statewide)			5.7%
Klamath County, OR	23,770	2,163	9.1%
Oregon (Statewide)			5.3%
U.S.A.			4.1%

ECOSYSTEM PROCESSES

One of the keystone elements of modern thinking in ecology and conservation is to give equal attention to ecological processes rather just to composition and structure of ecosystems[42]. In this section, we describe briefly five of the critical or keystone ecological processes occurring at the ecosystem level. Ecosystems are complex systems with millions of ecological processes being played out in diverse and subtle ways at different spatial and temporal scales. Thus, any description of ecological processes must be selective. We emphasize here processes that are: (1) understood to at least some degree by humans and science, (2) known to be affected by human activities, or (3) unique to the Klamath Ecoregion. The latter would include processes such as "fog precipitation" which is not found in most inland ecoregions.

Energy Flow

The flow of energy through a system is so fundamental to maintaining its function that it is often ignored when considering effects on an ecosystem. Virtually all of the useful energy in most terrestrial ecosystems comes initially from the sun. This is true in the Klamath Ecoregion as there are no major net imports of

[20] Sources:
California Data: State of California, Employment Development Department, Labor Market Information Division
Oregon and US Data: State of Oregon Employment Department

energy other than from the sun[43]. However, within the ecoregion and its components, distribution of energy is quite uneven. Thus, the flows between these components are quite important. Solar energy is captured by plants through the process of photosynthesis and excess energy is stored, primarily in organic (carbon based) compounds such as carbohydrate and cellulose. This pool then becomes the source of energy for all other living organisms in the ecosystem. For example, dead and down woody material and litter is the primary energy source for soil microorganisms that keep soil processes active. Similarly, most of the energy for organisms that live in aquatic habitats comes from the uplands in the form of leaves, litter, and trees that fall into streams and lakes.

Biogeochemical / Nutrient Cycles

Cycling of chemicals or nutrients such as nitrogen, phosphorus, and sulfur is equally important in ecosystems, since these chemicals are not evenly distributed in the ecosystem. Two of the most important nutrients for ecological systems are nitrogen and phosphorus--and they serve well to illustrate differences in sources and sinks for such elements.

The major source of nitrogen in the global ecosystem is in the atmosphere. And the only way in which nitrogen is moved from the atmosphere to earth is through the action of nitrogen fixing bacteria and similar microorganisms--many of which live in symbiotic relationships on the roots of plants. Legumes are best known for their nitrogen fixing association but other plants such as alders (Alnus spp.), ceanothus (Ceanothus), and bitterbrush (Purshia), also harbor nitrogen fixers.[44] As all life forms require nitrogen, ecosystem function is ultimately dependent upon the action of these nitrogen fixers, as nitrogen is constantly being released back into the atmosphere. Thus without constant nitrogen fixing, ecosystems would be subject to a net loss of nitrogen and life within them would eventually die out.

Within the ecosystem, nitrogen is quite unevenly distributed. Nitrogen is often the nutrient most limiting for plant growth and most of the available nitrogen is stored in the top few inches of the soil. Similarly slight changes in nitrogen content of plant parts may determine whether such forage is adequate nutritionally for herbivores such as elk or antelope.

In contrast to nitrogen, the ultimate source of most phosphorus is in the rocks and soil. In spite of this, phosphorus can often be limiting in soils and plants. On the other hand, accelerated erosion can often put large amounts of soluble phosphorus into streams and lakes that have not evolved with such inputs. This in turn results in algal blooms, reduction in available oxygen, and other effects that are generally detrimental to native species, as is happening in Upper Klamath Lake.[45] As with other nutrients, wetlands play a key role in buffering the aquatic ecosystem from such pulses of phosphorus.[46]

A system like the Klamath Ecoregion is not, of course, a closed one and there are some net imports and exports of nutrients. Of particular importance is the net nutrient import as a result of spawning runs of anadromous fishes. It is well known that many species such as bears and eagles take advantage of these nutrient flows. At a more general level, however, these runs once represented a net import of roughly 1 pound per acre of “fish fertilizer” per acre for the entire ecosystem.[47] This amount may not be significant in a given year--but over centuries may be of some significance. Furthermore, the distribution of such fertilizer is far from uniform--with some areas receiving more than their share of “fertilizer.”

Soil Formation / Soil Erosion Dynamics

Conservation of topsoil is or should be the most basic and fundamental goal of any holistic or ecosystem level conservation effort. Topsoil has been likened to the balance wheel of the ecosystem[48]. It has also been called the placenta of life on earth[49]. It is critical in the hydrological cycle as will be discussed. For these reasons, topsoil has been likened to capital where trees, crops, forage and wildlife are the profit[50]. And of course the cardinal rule of capitalism is not to spend the capital and maybe even put some profit back into the capital account. Yet soil conservation is often neglected or poorly integrated into management or conservation plans and programs.

To understand and plan for soil conservation, one must recognize that topsoil present represents some sort of rough equilibrium between soil loss and soil development. A goal of zero soil loss is unrealistic; some movement or "loss" of soil through erosion, mass slumping, and so on is a normal ecological process upon which many species are dependent. For example, many riparian wetlands are continuously formed and/or replenished by suspended sediments moved downstream during periods of heavy flooding. Similarly, many estuarine plants and animals are adapted to capturing and stabilizing silt from upstream.

However, a goal of no "net loss" of soil or topsoil is fundamental to any program of ecosystem conservation or management. This implies that the rate of soil loss must not exceed the rate of soil development. For soils to develop, the rate of soil formation must exceed the rate of loss. Rates of soil erosion are known in a general way by soil scientists and are expressed as an erodability factor in soil surveys. The implicit assumption is that under normal conditions rates of soil development exceed that rate. Any evidence that rates of soil loss are exceeding this rate suggests that there is net soil loss and thus ecosystem degradation.

Background (historical) rates of soil erosion have been determined for certain portions of the ecoregion and are shown in Table I-13.

Table I-13. Erosion rates for selected sites in Klamath Ecoregion in geologic past.[21]

Area	Geologic Formation	Geologic Age	Age of beginning of erosion (years)	Erosion rate (inches per 100 years)
Crescent City	Wymer	Miocene	10,000,000	0.1
Fort Bragg	Highest marine terrace	Early Pleistocene	1,000,000	0.6
Eel and Mattole drainages	Shoreline beds at Covelo, etc.	Miocene	10,000,000	0.53
Annapolis plantation area (Sonoma County)	Ohlson Ranch	Late Pliocene	3,000,000	0.1

[21] From Wahrhaftig and Curry (1967)

Some portions of the ecoregion are inherently more susceptible to erosion and this affects or should affect management options. In general terms, the soils of the Coast Ranges, being derived from unconsolidated Franciscan sedimentary deposits, are most erodable, and those of the Modoc Plateau are least erodable.

Hydrologic Cycle

The hydrology of the Klamath Ecoregion has been outlined earlier. The general pattern of the hydrologic cycle varies little within the region. Moisture from the ocean is moved inland where it is deposited in the form of fog, rain, or snow depending upon the portion of the ecoregion. From there it is used by plants or evaporated (evapotranspiration) or it moves back toward the ocean.

Portions of it may infiltrate the ground and move as groundwater or can run across the surface of the land. Eventually it makes it way into small streams and eventually back to the sea. Although the general pattern applies across the region--the specifics may be quite different. For example, most of the summer moisture in coastal regions comes in the form of fog--whereas in the Klamath Mountains it comes in the form of summer thunderstorms.

During this cycle, there are several critical points where the hydrologic cycle may be quite sensitive to changes in the environment. For example, the point where rain comes in contact with the land surface is quite sensitive to changes in that surface. If the surface is covered with diverse vegetation and deep porous soils then most of the precipitation will eventually infiltrate into the ground and become groundwater. On the other hand, if vegetation is sparse or the soils are compacted then much more of the precipitation will evaporate or run off overground taking soil with it.

A list of critical points in the hydrologic cycle for particular portions of the ecoregion is shown in Table I-14.

Table I-14. Critical phenomena and points in the hydrologic cycle in the Klamath Ecoregion.

Phenomena	Critical Points	Portion of Ecoregion	Vulnerability	Description	Human Activities with Potential Effects
Timing of runoff from snow	Forest / vegetation cover in snowfall regions	Higher mountainous regions of upper Klamath Basin and Klamath Geologic Province	Removal of forest / vegetation cover	Vegetation, especially tree cover, slows down the spring and summer snowmelt and thus dampens spring runoff and late spring and summer flows.	Logging / vegetation {tree} removal
Amount of infiltration as opposed to runoff	Earth surface and its cover	Coast Ranges and Klamath Mountain Geologic Provinces (less important in regions of Modoc Plateau with porous soils)	Loss of vegetation cover; amount of dead material on ground (litter and dead and down woody material); compaction of soil	Vegetation and dead material on ground intercepts precipitation dampening the energy of rainfall and allowing increased infiltration; soil compaction decreases the amount of infiltration.	Logging (removal of vegetation cover; soil compaction; denudation of areas for landings, etc.); - road building (denudation; compaction); - overgrazing (removal of vegetation cover; compaction from livestock; decrease in litter cover) - urbanization (removal of vegetation cover)
Timing of runoff (winter / spring versus summer)	Earth surface	Coast Ranges and Klamath Mountains Geologic Provinces (less important in	Loss of vegetation cover; amount of dead material on ground (litter and dead and	Result of increased infiltration above; infiltration slows down movement of water	Logging (removal of vegetation cover; soil compaction; denudation of areas for landings, etc.); - road building (denudation; compaction); -

		regions of Modoc Plateau with porous soils)	down woody material); compaction of soil	compared to runoff thus extending the water flow later into the season	overgrazing (removal of vegetation cover; compaction from livestock; decrease in litter cover) - urbanization (removal of vegetation cover)
Timing of river flow	Riparian zone	All	Loss of riparian vegetation cover and riparian zone soils	Riparian zones intercept and dampen water flows and allow riparian zone soils to absorb water and release it slowly.	Logging (removal of riparian cover); - overgrazing (loss of riparian cover; disturbance of riparian zone soils) - channelization (removal of riparian vegetation)
Fog Interception	Land surface	Coastal fog zone (redwood zone)	Loss of tree cover	Without tree cover fog is not captured and effective precipitation is reduced	Logging (loss of tree cover)
Fog Generation	Land surface	Coastal fog zone (redwood zone)	Loss of tree cover	Loss of tree cover causes warming of land surface and reduces amount of fog generated? [22]	Logging (loss of tree cover)

Disturbance Regimes / Succession

Major natural (non-human) disturbance regimes within the Klamath Ecoregion include fire, wind, and flooding. Evidence from upland areas of the Klamath Mountains suggest that fire is the most common disturbance in forest stands with wind being next most important.[51] Fire accounted for over 80 percent of the disturbances with wind accounting for roughly another 10 percent.

[22] This relationship is more speculative than the others but is supported by some empirical data and is based upon accepted meteorological principles.

The importance of fires as agents of disturbance has been recognized for many years. However, historic fire patterns have only been characterized for a few vegetation types within the ecoregion. Historic fire patterns can be characterized by "mean fire interval" (equivalent to "mean fire return interval") and by "fire frequency". The former is the arithmetic average of all fire intervals in a designated area during a designated time period.[52] "Fire frequency" is the number of fires per unit time in some designated area.[53] Both of these measures are scale dependent in that the number will vary depending upon the size of the "designated area". Thus, comparisons of such measures of fire history from different studies can be misleading. Nevertheless, they do provide some utility in comparing historic fire patterns among different sites and vegetation types and in assessing how humans have changed historic fire patterns. Reported fire return intervals for forest types found within the Klamath Ecoregion range from 15 years for Ponderosa Pine to 500 years for coastal redwood forest.

Along rivers, flooding can also be an important disturbance regime--and calculations provided by Rantz (1964) allow calculation of frequency of flood events of a given magnitude for any given river in the ecoregion. The greatest known floods in the ecoregion are those of the winter of 1861-62. The peak discharge for the Klamath River in December 1961 was computed as 450,000 cfs compared to a mean annual flood of 152,000 cfs. The floods of 1955 were of comparable magnitude, however, with a peak discharge of 425,000 cfs recorded for the Klamath River on December 22, 1955.

Succession refers to the change in plant communities following natural or human disturbance. The pathways of succession, i.e., the plant communities and their composition and their pattern of replacement are more or less predictable and have been described for many vegetation types. For example, brush fields that have been burned will first be invaded by annual grasses and forbs, then by perennial grasses and forbs, then eventually by shrub species that will come to dominate the site. Actual shrub species present will vary depending upon the characteristics of the site such as soils, slope, elevation and so on. It will also vary depending upon the type and severity of the disturbance. For example, some shrubs will sprout quickly from live roots after light fires. In such circumstances they will return to dominate the site much faster than when the fire is so hot that the roots are killed.

Succession is thus thought to be more or less predictable. However, current thinking in both forestry and range management is suggesting that if disturbances are beyond a certain threshold, the plant communities will not necessarily return to their original state.[54] This newer understanding of succession has important implications with regard to how biotic communities respond to human activities. If true, it suggests that some human activities may cause irreversible effects on plant communities or effects that are reversible only over long (geologic) time periods or by investment of large amounts of human energy and resources for restoration.

Table I-15. Reported fire return intervals for some forest types found within the Klamath Ecoregion.

Vegetation Type	Fire Cycle (average return interval)	Location / Elevation	Source
Redwood - moist, coastal sites	500 yrs	California	Viers (1996:10)
Cedar / spruce hemlock	400	Oregon	Agee (1993:13)
Redwood - intermediate sites	100-250 yrs	California	Veirs (1982)
Douglas fir	150	Oregon	Means (1982); Morrison and Swanson (1990)
Mountain Hemlock	115	California / Oregon	Atzet and Martin (1992)
Tanoak	90	California / Oregon	Atzet and Martin (1992)
Lodgepole pine	80	California / Oregon	McNeil and Zobel (1980); Atzet and Wheeler (1982); Agee (1991)
Western hemlock	65	California / Oregon	Atzet and Martin (1992)
Port-Orford cedar	50	California / Oregon	Atzet and Martin (1992)
Jeffrey pine	50	California / Oregon	Atzet and Martin (1992)
Red fir	40	California / Oregon	Atzet and Martin (1992)
Redwood - interior sites	33-50 yrs	California	Veirs (1982) Veirs (1996)
Douglas fir	30	California / Oregon	Atzet and Martin (1992)
White fir	25	California / Oregon	Atzet and Martin (1992)
Ponderosa pine	15	Oregon	Weaver (1959); Bork (1985)

HUMAN MODIFICATION OF THE ECOSYSTEM

In this section we describe how humans have modified the ecosystem. In the first section we describe the major activities that have impacted the system such as timber harvest and water diversion. In the second section, we describe effects these activities have had on the ecosystem or ecosystem level functions. Finally, in the third section we describe how these activities have affected wild species or species groups.

Activities

We describe here major human activities affecting the ecosystem along with some of the obvious effects on ecological function. Most human activities involve a complex suite of actions. Thus, for example, under "timber harvesting" we include not only the cutting and removal of trees but also road building, fire suppression, herbicide application, and monoculture--all activities that are typically carried out as part of a timber harvest industry.

Timber Harvesting. Decades of timber harvesting have impacted the carrying capacity of the natural resources of the ecoregion. Timber harvest and associated road building has exposed highly erodible soils leading to siltation of streams and rivers. Such siltation degrades aquatic habitat and diminishes spawning of fish and other aquatic functions.[55] Over harvesting of timber has also reduced and fragmented old growth that is needed by many wildlife species.[56] Silvicultural practices, including herbicide application and single species reforestation, have changed species composition and reduced diversity.[57] Lastly, suppression of natural wildfires has resulted in high fuel loading with resultant change in fire regimes tending toward fewer but hotter fires.

Dams and other Water Diversions. Water diversions reduce habitat for aquatic species by reducing discharge in rivers and streams. Changes in natural discharge patterns reduce or eliminate channel maintenance flows and impact water quality, particularly during low flow periods.[58] Dams hinder or prevent fish passage to important habitats. This has been a particular problem for anadromous salmonids and other fish in the ecoregion. Major diversions on the Klamath, Trinity, Russian, and Eel Rivers have caused degradation of much fish habitat and prevented access to hundreds of miles of stream habitat. Large storage reservoirs have also inundated important upland habitats.

Mining. Mining activities in the ecoregion started in the mid 1800s with large areas affected by gold prospecting and extraction. Many of these areas have not been reclaimed and they continue to contribute to sedimentation and pollution of streams and rivers.[59] Current suction mining not only can cause sedimentation but may also impact fish directly.

Livestock Grazing. Poorly managed livestock grazing: (1) reduces upland and riparian vegetation for waterfowl, upland game and song bird nesting cover; (2) changes the structure and diversity of vegetative communities; (3) physically alters stream systems to the detriment of fish populations; (4) increases competition with native wildlife; and (5) contributes to loss of wetlands.[60]

Agriculture. Agricultural activities affect ecosystem structure and function in four primary ways: (1) direct conversion of habitat (from wild or semi-wild land to monoculture); (2) diversion and use of water; (3) soil loss and siltation of waterways; and (4) use of pesticides, fertilizers and other chemicals that contaminate soil, air and water.[61] Of these four, direct conversion of land is certainly among the most critical impacts, yet it is often one of the least observable, since many of the conversions have been in existence for a long time and/or are occurring slowly. For example, conversion of wetland to farmland has resulted in a loss of over 75% of historic wetland areas in the upper Klamath Basin alone. Yet, even to a long time resident, little change is evident from day to day. Irrigation projects throughout the ecoregion have resulted in the construction of hundreds of miles of canals, drains, ditches, and dikes. Siltation reduces productivity of adjacent marshes and topsoil loss is significant on fallowed farmland. Water removed from reservoirs is used for farming activities with resultant reduction in water quality and quantity in the river systems of the ecoregion. Finally, a wide variety of pesticides, fertilizers, and other chemical contaminants are used in agriculture. These chemicals end up in air, in waters, and in soils with many deleterious effects on wild flora and fauna as well as on human health.

Contaminants. Contaminants associated with domestic uses, livestock waste, agricultural drainage waters, chemical spills and industrial effluents, cause chronic to catastrophic impacts to fish and wildlife and their habitats.[62]

Overharvest / Overexploitation. Some species of plants and animals have been harvested or exploited at unsustainable levels. Many of the early hunting and fishing laws and regulations were enacted to ensure that sport or commercial harvest did not overexploit these resources.[63] Some species such as the grizzly bear and gray wolf have been deliberately extirpated from the ecoregion. In other cases, local populations of species such as elk and bighorn sheep have been extirpated through combinations of habitat degradation and overharvest of remaining animals. For example, anadromous fish populations have dwindled over the past several decades due to several reasons. Excessive depletion of remaining fish stocks by the combination of commercial, sport, and Native American harvest has exacerbated the situation. As human demands for new resources change, plant and animal species are often suddenly exploited at high rates with little or no regulatory mechanism to ensure that such exploitation is sustainable. For example, Pacific yew was reduced to low numbers of mature trees a few years ago when sudden demands for a chemical from its bark encouraged unsustainable harvesting before protective measures could be enacted.[64]

Urbanization. The increase in human populations has led to the conversion of wildlife habitat to agriculture and home sites. As with agriculture, the impacts on wild species are multifaceted. Three major effects are: (1) loss of habitat; (2) new environmental impacts associated with human activity, and (3) increased fragmentation of existing wildlands.[65] There is an increased demand for water removal for human use. Waste water and storm water can lead to increased water quality problems. There is an increased demand for all natural resources, creating competition. Urbanization is most pronounced in the southern portion of the ecoregion in Sonoma County--but it is a factor around all the major cities and towns in the ecoregion.

Road Building. Building of roads has had many unexpected and frequently unintended effects.[66] Roads fragment habitat, allow easy human entry into formerly semi-protected areas, prevent use of habitat by certain species, facilitate invasion of exotic plants and animals.

Introduction of Exotic Species. Many exotic species have arrived in the ecoregion as unintended side-effects of other human activities such as agriculture and road building. However, many species such as Eucalyptus and brook trout were deliberately introduced into the environment--often with dramatic and unintended consequences to the ecosystem and to other species.[67]

Alteration of Disturbance Regimes. Humans have drastically altered pre-European settlement disturbance regimes, particularly fire and flooding regimes. This alteration can have many negative and often long term effects on ecosystem structure and function.[68] Many areas were regularly burned by Native Americans. Following European settlement much energy has gone into preventing both human-caused and natural fires from burning. This has generally resulted in a decrease in low intensity fires. Similarly, through dams and diversions, humans have dampened the effects of flooding along most of the rivers of the ecosystem.

Ecological Effects of Human Activities

We describe here some of the ecological effects of the human activities described above, with emphasis upon ecosystem and community level effects.

Soil Loss. Human activities, particularly logging and associated forest practices in the Coast Ranges and Klamath Mountains have resulted in accelerated soil loss from the ecoregion. This has been documented for several sites, particularly the Mad and Eel Rivers. Over 30 years two geologists from the University of California compared geologic and current erosion rates for this region and reported to the State Legislature as follows:

> "The sediment discharge data...indicate that the land surface in the entire drainage basin of the Eel River is presently lowering at a rate of 3.33 inches per century (computed as solid rock, specific gravity 2.5) or 5.85 inches per century (computed as soil, specific gravity 1.4). Similar figures for the Mad River are 1.25 and 2.30 inches per century. These figures are approximately 10 to 20 times the rates of erosion reported for comparable climates in other parts of the world. The figures for the Eel and the Mad are for suspended sediment only, and do not include data for the flood years 1955 and 1964, whereas the worldwide figures include bedload, dissolved solids, and flood data. Thus, the differences reported here are less than the actual differences.
>
> Geologic analysis of selected areas in the North Coast Ranges shows that the rate of erosion in this area, measured over time spans of 1,000,000 to 10,000 years, is 0.1 inch to 0.6 inch per century. The more reliable geologic data give the lower figures. These geologic figures are comparable to worldwide rates of erosion and are 1/30 to 1/5 the present rate of erosion measured from sediment discharge data.
>
> Studies on the marine terraces of the North Coast Ranges show that the weathered rock in these terraces has formed at rates of approximately 0.05 inch to 0.1 inch per century. Thus, the rate of soil regeneration is 1/10 to 1/100th the rate of destruction of soil in the North Coast Ranges.
>
> The measured rates of erosion in the Eel and Mad River drainages are clearly not normal, and are presumably caused by the activities of man. We do not know where all this sediment is coming from. Part of it is undoubtedly coming from landslides, but landslides cannot account for all of it. Part may be from hillside creep, but geologic, physiographic, and vegetational evidence is lacking for creep on a scale to account for this as a long-term process over the entire drainage basin. A significant part must be from accelerated erosion following logging and road-building. Since only a part of the basins of these two streams is currently being affected by these activities, the rate of erosion for the parts affected may be many times the average rates reported here.
>
> The implications of these data are that, unless this phenomenal rate of erosion is arrested, the bulk of the topsoil (upper 4 feet of weathered rock) in which the Douglas Fir and Redwood are rooted on hillsides will be destroyed over large parts of the Eel and Mad River drainages within a few hundred years. These areas may then become barren rocky hillsides. Regeneration of the forest under these conditions will be difficult if not impossible in the present climate, and both the forest industry and the water storage capability of the region will be seriously impaired."

We have found no evidence from the last 30 years to contradict their conclusions. In fact, the accumulating evidence suggests that most all of the coastal basins within the North Coast Geologic Province south of the Smith River are eroding at rates that far surpass the rate of soil formation.

Hydrologic Disruption. Soil erosion has been accompanied by significant disruption of the hydrologic cycle. This has come about in several ways. The effects of human activities on hydrologic function are complex and do not lend themselves to simple generalizations or "cookbook" analysis procedures.[69] Thus it is difficult to generalize about what is happening over a broad ecoregion. The following description thus represents an overview of how humans have affected hydrologic function across the ecoregion; some particular effects will apply to a given hydrobasin while others may not.

Hydrologic function is disrupted when critical phenomena is affected by human activities as outlined in Table I-14. Major functions affected include decrease in fog precipitation, timing of snow runoff, amount of infiltration (as opposed to runoff), general alteration of hydrograph (timing of river flows), and change in magnitude and frequency of flood flows.

The widespread cutting of forests appears to have decreased the amount of fog precipitation along the coast through both decreasing the fog frequency and decreasing the capacity of the vegetation to capture "fog drip". While this has not been conclusively demonstrated on a watershed or basin scale, the preponderance of evidence from stand level studies of fog precipitation suggests that removal of tree cover will reduce effective fog precipitation. There is no reason to think that the effect would not be working at larger geographic scales. This effect would only affect the north coast redwood / fogbelt portion of the ecoregion

Cutting of forests can also significantly affect the timing of runoff from snow. Snow that has accumulated in clearcut areas tends to melt earlier, thus causing increased severity of spring floods.[70] Equally significant, overcutting of forests and overgrazing of rangelands have decreased the ability of the vegetation to intercept precipitation, thus resulting in decreased infiltration into the soil (and water table) and increased overland flow. In general, removal of vegetation can alter the hydrograph of a stream (i.e., the timing and magnitude of flows). It is hard to generalize about this phenomenon, however, because the same activity may have effects that work in opposite directions. For example, removal of the overstory canopy may decrease water infiltration into the soil but at the same time it decreases water loss to the atmosphere from transpiration.

Perhaps the most significant of all the pure hydrologic effects of humans is the alteration of the flooding regimes of rivers. This can occur indirectly from overcutting forests, overgrazing rangelands, or urbanizing wildlands. Or it can occur directly by the building and operation of dams and diversions. Floods are important events in maintaining river systems. Changing the pattern of flooding and other dynamics of the river system is detrimental to the river ecosystem.[71] Thus "flood control" may be beneficial to some elements of human society but it can be deadly to fish, amphibians, and many other species dependent upon aquatic and riparian habitats.

There is little doubt that the major dams in the ecoregion have played a major role in altering the stream and stream side habitat of these rivers.

Water Pollution. Water pollution is typically a result of a number of effects operating simultaneously--influx of sediments and/or contaminants, decreased seasonal water flow, increased temperature of water as a result of loss of stream side vegetation or release of warmed water. Under provisions of the Clean Water Act waters which are so polluted as to prevent beneficial uses of the waters need to be declared "impaired" by the state water quality control board. It is indicative of the degree of pollution of the streams of the north coast that virtually all the major rivers south of the Smith have been declared impaired (Table I-16).

In most of the North Coast streams cases the pollutant is sediment, although the streams at the southern end of the ecoregion such as Stemple Creek are impaired by nutrients, presumably from non-point source agricultural discharge. Those streams impaired by sediment tend to be those of the Coast Range Geologic province where there has been severe logging on unstable sedimentary-derived Franciscan soils. Some of the larger rivers including the Klamath, Eel and Mattole are also impaired by high temperatures, and the streams of the upper Klamath Basin (Oregon portion of the watershed) are impaired by a variety of pollutants--mostly as a result of the intensive agricultural operations in that region.

Table I-16. List of Impaired Waterbodies of the Klamath Ecoregion.[23] [24]

WATERBODY	RIVER BASIN	POLLUTANT[25]
CALIFORNIA		
Stemple Creek	Stemple Creek	Nutrients
Estero de San Antonio	Stemple Creek	Nutrients
Americano Creek	Americano Creek	Nutrients
Estero Americano	Americano Creek	Nutrients
Gualala River	Gualala River	Sediment
Garcia River	Garcia River	Sediment
Navarro River	Navarro River	Sediment
Albion River	Albion River	Sediment
Big River	Big River	Sediment
Noyo River	Noyo River	Sediment
Mattole River	Mattole River	Sediment, Temperature
Eel River	Eel River	Sediment, Temperature

[23] Source: California Water Quality Control Board (1996); Oregon Department of Envirnmental Quality

[24] Impaired waters are water bodies that cannot reasonably be expected to attain or maintain applicable water quality standards.

[25] The state agencies responsible for making determinations about pollutants (California Water Quality Control Board and Oregon Department of Environmental Quality) make determinations in quite different manner. The California Board, for the most part, specifies the pollutant for the entire river system (e.g. the Eel River), wheras the Oregon Department specifies specific stream reaches for each particular pollutant. The data reported here for Oregon are generalized for the entire sub-basin. Thus, for example, not all of the Sprague River is impaired by pH but only certain segments or tributaries.

Tomki Creek	Eel River	Sediment
Van Duzen River	Eel River	Sediment
Mad River	Mad River	Sediment, Turbidity
Redwood Creek	Redwood Creek	Sediment
Klamath River	Klamath River	Temperature, Nutrients
Scott River	Klamath River	Sediment, Temperature
Shasta River	Klamath River	Dissolved Oxygen, Temperature
Beaughton Creek	Klamath River	Discharge of Wastes
Trinity River	Klamath River	Sediment
South Fork Trinity River	Klamath River	Sediment
OREGON		
Lost River	Klamath River	Chlorophyll a, Dissolved Oxygen, Temperature, Fecal Coliform, pH
Sprague River	Klamath River	Temperature, Dissolved Oxygen, pH
Upper Klamath	Klamath River	Temperature, Sediment, Chlorophyll a, Dissolved Oxygen, pH, Sediment
Upper Klamath Lake (Sub Basin)	Klamath River	Chlorophyll a, Dissolved Oxygen, pH, Temperature
Williamson River	Klamath River	Temperature

Habitat Loss. Direct loss of habitat from urbanization, suburbanization, and agricultural development is an easily observable effect in the ecoregion, although, to our knowledge it has not been quantified. It is most pronounced in the southern end of the ecoregion where the population is doubling roughly every 10 years. Most of the good agricultural lands within the ecoregion have already been developed. Thus, conversion of wildlands to agricultural land is not a major impact within most of the ecoregion. However, there are two major exceptions. In Sonoma and Mendocino Counties large acreages of wildlands are being cleared and converted to vineyards. And in various portions of the forested lands, wild forests are being converted into tree farms.

Habitat Degradation. Less dramatic but more pervasive is the degradation of habitat as a result of such things as loss of habitat structure. For example, the removal of standing dead trees ("snags") from a forest stand will make it unsuitable for bird species that nest in cavities in such snags. Habitat degradation can come about in an almost endless variety of ways and is a result of many human activities such as timber harvest, livestock grazing, water diversion, off-road vehicle use and so on. In fact, most human activities will contribute to habitat degradation for some wild species to some degree. The challenge to conservation is not to eliminate all degradation but rather to control it or zone it in both space and time so that the overall health of the larger regional ecosystem remains intact.

Habitat Fragmentation. Habitat fragmentation is the process by which habitats are increasingly subdivided into smaller units or patches resulting in loss of continuity or connectedness with other patches. It is usually accompanied by habitat loss, although certain human constructs such as highways and canals can fragment habitat with only minimal overall loss of habitat area. Furthermore, fragmentation typically results in an increase in "edge" habitat--that habitat that is found in the ecotone or area of gradation from one type to another, such as the edge of a forest. Fragmentation typically results in larger contiguous populations of species being divided up into several smaller populations with little or no interchange between them. And this, in turn, can lead to local extirpation of these populations for a variety of reasons including[72]:

(1) the vulnerability of small populations to being extirpated by a chance event such as flood or fire;

(2) the loss of viability of the population due to inbreeding or other genetic problems;

(3) the vulnerability to extirpation as a result of random variation in demographic parameters (birth rates, death rates, sex-ratios);

(4) combinations of these and other factors.

Within the Klamath Ecoregion the habitat fragmentation is occurring as a result of the following activities.

Timber Harvest - Extensive timber harvest has resulted in landscapes with only fragmented patches of late-seral or old-growth forests as for example with the redwood forests. In more extreme cases, only fragments of mid-seral forest remain as for example has occurred in the Douglas fir and redwood forests of Sonoma and Mendocino Counties.

(Sub)Urbanization - Building of housing tracts, parking lots, malls and so on has fragmented much of the remnant wildlands, particularly in Sonoma County and around the larger towns and cities in the region.

Highways - Major highways, especially when fenced with cyclone or other fence, provide barriers to movement of many species large and small.

Dams - Dams, both big and small, provide barriers to upstream and downstream movement of many fish species. In addition to problems caused by the dams themselves, the reservoirs are often stocked with predatory fish that pose another barrier to successful movement past the dam.

These are but a few of the types of fragmentation that can and is occurring in the ecoregion. Fragmentation can have an effect at many different scales. Large predatory species such as mountain lions are often the first to be affected by fragmentation since they require large blocks of contiguous habitat for survival. However, smaller species may be affected locally by such things as irrigation ditches or two-lane paved roads.

Successional Disruption / Altered Disturbance Regimes. Successional disruption occurs when the patterns of disturbance and subsequent succession are altered resulting in a changed proportion of seral or successional stages in the landscape. The cases of coast redwoods and valley oaks represent two different extremes of this sort of phenomena. With coast redwoods, late seral or old-growth once likely comprised at least 90 to 95 percent of the forest; with the accelerated cutting of the redwood forest, now less than 4 percent of the landscape consists of late seral stages. There are lots of very small redwood trees but very few big, old ones. With valley oaks, human activities such as grazing and other agricultural practices have prevented the regeneration of young oaks with the result that there are quite a number of remnant, big, old oaks but very few small or medium size trees coming along to replace them.

In both cases the natural distribution or mix of seral stages of the community has been truncated or replaced by some sort of lopsided distribution. Since many species are associated only with certain seral stages, this is accompanied by extensive loss of species--particularly those that are obligates on a particular seral stage that has been lost or drastically reduced.

Air Pollution. The effects of air pollution on ecosystem function and health are arguably less well understood than many other ecosystem level effects. Pollutants in air are known to affect species and communities in a variety of ways. For example, many amphibian species are especially sensitive to pollutants including acid rain. The same is true for many lichen species. We are not aware of any ecosystem level effects of air pollution that have been documented for the Klamath Ecoregion.

Displacement by Exotics. Exotic species displace native species in a variety of ways. In particular an exotic can cause decline or extirpation of native species by:

(1) exotic species out competing a native species for a resource that is limiting, e.g., starling use of cavities in snags previously used by native western bluebirds;

(2) exotic species preying upon native species, e.g., Sacramento River squawfish (introduced into Eel River) preying upon small native fish including young salmon; or

(3) an exotic disease organism or parasite causing debilitation or death of native species, e.g., loss of native bighorn sheep from Lava Beds National Monument from exotic diseases transmitted to them by domestic sheep.

Numerous examples of all three types of displacement have been observed or documented within the Klamath Ecoregion.

Examples of community or ecosystem level effects are less well understood or documented, but many have been described. Exotic species can alter disturbance regimes. For example, cheatgrass can change the disturbance (fire frequency) regime for a plant community. In other cases, herbivorous species such as wild pigs may alter the plant species composition of a community.

Overexploitation / Persecution. Direct loss of species and communities from overexploitation or persecution remains a problem in the Klamath Ecoregion in spite of the fact that most natural resource professions such as forestry, range management, and particularly wildlife management have developed theory and practice to alleviate such practices. Examples from the past of species removed from the ecoregion from persecution include the gray wolf and the grizzly bear. Others, which may have been reduced in numbers from overexploitation (together with habitat degradation) include the pine marten and the fisher.

Species Loss or Endangerment

The ultimate effect of many human activities, whether they affect ecosystem structure, function or health or affect species directly, is loss or endangerment of species. The status of species loss in the Klamath Ecoregion is summarized below, and described in more detail in Volume II - Description of the Ecological Issues.

Plants. At least 62 individual vascular plant species are "at risk" within the Klamath Basin, including one that is federally endangered.

Invertebrates. One species of invertebrate (the Trinity Bristle Snail) is listed as endangered under state law. Knowledge of most invertebrates and their status is minimal.

Fish. Forty-nine stocks of anadromous salmonids (15 of chinook salmon, 20 of coho salmon, 10 of steelhead, and 4 of coastal cutthroat) have been identified as at some degree of risk. Furthermore, four non-salmonid native anadromous fish (Pacific lamprey, green sturgeon, white sturgeon, eulachon) are declining, presumably for same reasons as for anadromous salmonids. Thus, most of the native anadromous fish of the region are in decline.

The situation for resident fish is not much better. For example, seven out of twenty (35%) of the native resident fish species of the Klamath Basin are endangered or at risk. This includes the short-nosed sucker and Lost River sucker found in the upper Klamath Basin, which are listed as federally endangered.

Amphibians and Reptiles. Ten out of fifty-two (20%) of the amphibians and reptiles of the Klamath basin are at risk, and this ratio is approximately the same for the entire ecoregion. Within the ecoregion, the California red-legged frog has been listed as federally threatened.

Birds. Many groups of birds have declined within the ecoregion:

- Waterfowl - Waterfowl populations have declined dramatically, particularly in the upper Klamath Basin where populations are only about 1/6th of what they once were.

- Seabirds - Seabirds have declined along the coast although the extent of the decline is poorly understood.

- Colonial waterbirds - Several species of colonial waterbirds are thought to be declining in the region.

- Raptors - Eighteen out of twenty-eight (64%) of the raptors of the ecoregion are endangered, at risk, or of special concern.

- Marsh and Shorebirds - Four species within the Klamath Basin are declining (western least bittern, long-billed curlew, western snowy plover, and tricolored blackbird).

- Neotropical Migrants - Neotropical migrants are declining nationwide; 40% of species declining in Oregon; 50% of the species declining in California. These same percentages hold for the Klamath Ecoregion.

- Upland Game Birds - Three out of eight (38%) of native bird species of the Orders Galliformes (quail and grouse) and Columbiformes (pigeons and doves) in the Klamath Basin, are declining and considered to be at risk.

Mammals. As with other groups a surprisingly high number of mammalian species are to some degree at risk of extinction. These include:

- Carnivores - Three out of 21 (14%) of native species of mammalian carnivores have been extirpated from the ecoregion; another 3 (14%) are considered at risk.

- Rodents - One species, a rare coastal rodent subspecies (the Point Arena mountain beaver) is federally endangered.

- Bats - At least four of the fourteen species (29%) of bats within the Klamath Ecoregion are considered at risk.

- Ungulates - One of the four native ungulates of the Klamath Ecoregion (bighorn sheep) has been extirpated from the ecoregion and two others have been eliminated from a large portion of their range within the region.

CONCLUSIONS

The relationship between human activities, ecological effects, and species loss or endangerment is not always well understood. However, the dramatic increase in endangerment and loss of species is real and serious and is in large part a result of human activities carried out for other purposes with no direct intention of causing species loss. With more humans and resultant increase in human activity the trend is likely to continue unless we make a more concerted effort to minimize the impact of these activities. As will be discussed in **Volume III - A Holistic Strategy for Restoration of the Ecoregion**, putting all the effort on saving species once they are already at risk is unlikely to be efficient or effective in the long run. Rather it is important that we also look at and change the root causes of such endangerment--the human effects on the ecosystem.

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APPENDIX I. PLANT COMMUNITIES OF THE KLAMATH ECOREGION AND ACREAGE WITHIN NORTHWESTERN CALIFORNIA

Table I-1. Plant Communities of the Klamath Ecoregion and their relative abundance and status.[26]

Holland Code	Holland Type[27]	NDDB Rank	Status 1 %	Status 2 %	Status 3 %	Status 4 %	Total Area (km^2)	Percent of Region[28]
11100	Urban		0.1	0.5	6.1	93.3	829.3	1.48%
11200	Agricultural		0	0	0.9	99.1	1.2	0.00%
11201	Irrigated Rox and Field Crops		0	0	6.5	93.5	168.1	0.30%
11202	Irrigated Haybield		0	0	0.7	99.3	183.1	0.33%
11206	Pasture		0.3	3.9	0.3	95.4	149.1	0.27%
11210	Orchard or Vineyard		0	0.1	0.9	99.0	193.7	0.35%
11213	Vineyard		0.6	0	0	99.4	79.6	0.14%
11510	Stream / River		0	11.2	0	88.8	15.5	0.03%
11520	Lake		0	1.7	5.1	93.2	186.0	0.33%
11530	Reservoir		0	48.1	30.7	21.2	228.9	0.41%
11540	Bay		17.8	50.2	0	32.0	29.7	0.05%
11730	Sandy Area		0	23.1	1.9	75	25.3	0.05%
11740	Bare Rock		73.8	0.4	18.9	6.8	251.8	0.45%
11750	Quarry		0	0	46	54	5.0	0.01%
11760	Transitional Bare Areas		3.4	0	42	54.6	41.0	0.07%
11770	Mixed Barren Land		0	0	58.8	41.2	19.4	0.03%
								0.00%
21210	Northern Foredunes	S2.1	8.4	7.5	0	84.1	3.2	0.01%
21310	Northern Dune Scrub	S1.2	3.4	7.3	0.2	89.1	112.6	0.20%
32100	Northern (Franciscan) Coastal Scrub		1.6	1.1	0.8	96.4	41.8	0.07%
32110	Northern Coyote Brush Scrub	S4	0	0	6.7	93.3	59.1	0.11%
35210	Big Sagebrush Scrub	S4	0	0	8.0	92.0	10.8	0.02%
37110	Northern Mixed Chaparral	S4	0.1	0	24.5	75.4	243.8	0.44%
37200	Chamise Chaparral	S4	1	0	36.5	62.5	710.9	1.27%
37510	Mixed Montane Chaparral	S4	40.5	2.4	44.2	13	216l8	0.39%

[26] Based on Thorne's (1997) description of plant communities of Northwestern California.

[27] From Holland (1986)

[28] These percentages represent the percentage of the area within Northwestern California as described by Thorne (1997).

37520	Montane Manzanita Chaparral	S4	30.2	0	47.2	22.5	214.7	0.38%
37520	Montane Ceanothus Chaparral		50	7.3	29.6	13.1	149.1	0.27%
37531	Deer Brush Chaparral	S4	0	0	51.9	48.1	29.2	0.05%
37533	Tobacco Brush Chaparral	S3.3	2.4	0	95.2	2.4	6.0	0.01%
37540	Montane Scrub Oak Chaparral		40.2	0	49.5	10.3	23.0	0.04%
37542	Huckleberry Oak Chaparral	S3.3	30.1	0	51.3	18.6	109.3	0.20%
37550	Bush Chinquapin Chaparral	S3.3	62.2	0	37.8	0	21.0	0.04%
37600	Serpentine Chaparral		0	0	31.2	68.8	117.9	0.21%
37810	Buck Bush Chaparral	S4	0.5	4.7	42.1	52.7	225.4	0.40%
37820	Blue Brush Chaparral*****	S4	0	0	0	100.0	6.0	0.01%
37900	Scrub Oak Chaparral	S3.3	0	0	98.1	1.9	16.4	0.03%
37C10	Northern Maritime Chaparral	S1.2	0	0	0	100	2.5	0.00%
37E20	Southern North Slope Chaparral	S3.3	21.5	0.2	34.7	43.6	175.2	0.31%
42100	Native grassland	S3.1	0	0	1.6	98.4	9.3	0.02%
42220	Non-Native Grassland	S4	1.3	0.9	9	88.8	1,643.9	2.94%
45100	Montane Meadow	S3.2	31.6	0	20.4	48	34.5	0.06%
52110	Northern Coastal Salt Marsh	S3.2	1.3	33	0	65.8	4.4	0.01%
52220	Coastal Brackish Marsh	S2.1	0.9	2.9	0	96.2	43.5	0.08%
52410	Coastal and Valley Freshwater Marsh	S2.1	16.5	81.6	0	1.9	6.3	0.01%
61110	North Coast Black Cottonwood Riparian Forest	S1.1	0	1.4	37.6	61	9.6	0.02%
61130	Red Alder Riparian Forest	S2.2	5.4	12.5	1.1	81	18.0	0.03%
61410	Great Valley Cottonwood Riparian Forest	S2.1	0	0	48.9	51.1	2.3	0.00%
61420	Great Valley Mixed Riparian Forest	S2.2	0	0	0.9	99.1	1.0	0.00%
63100	North Coast Riparian Scrub	S3.2	0.9	2.6	8.2	88.3	95.0	0.17%
63110	Woodwardia Thicket	S3.1	12.7	0	0	87.3	4.3	0.01%
71110	Oregon Oak Woodland	S3.3	0.2	0.7	22.6	76.6	954.7	1.71%
71120	Black Oak Woodland	S3.2	1.7	0.9	31.1	66.3	630.9	1.13%
71130	Valley Oak Woodland	S2.1	0	0.3	0.4	99.3	350.0	0.63%
71140	Blue Oak Woodland	S3.2	0.1	0.9	18.5	80.5	2,716.9	4.86%
71150	Interior Live Oak Woodland	S3.2	0	0	20.3	79.7	219.0	0.39%
71160	Coast Live Oak Woodland	S4	0	0	0.1	99.9	87.9	0.16%
71210	Open Foothill Pine Woodland	S4	2.2	0.2	28.7	68.9	235.7	0.42%
71320	Foothill Pine-Chaparral Woodland		0	5.9	47.3	46.8	81.3	0.15%
71321	Serpentine Foothill Pine-	S3.2	0.1	1.6	41.1	57.1	722.4	1.29%

	Chaparral Woodland							
71322	Non-Serpentine Foothill Pine-Chaparral Woodland	S4	1.3	1.4	33.5	63.8	369.8	0.66%
71410	Foothill Pine-Oak Woodland	S4	1.1	0.9	13.9	84.1	3,022.3	5.41%
71420	Mixed North Slope Cismontane Woodland	S3.2	0.8	0.9	20.1	78.1	1,005.2	1.80%
72110	Northern Juniper Woodland	S4	0	0	20.8	79.2	577.0	1.03%
81100	Mixed Evergreen Forest	S4	4.9	2	27.6	65.4	2,963.0	5.30%
81200	California Bay Forest	S3.2	0	1.5	0	98.5	4.0	0.01%
81310	Coast Live Oak Forest	S4	1.3	1.5	7	90.2	790.9	1.41%
81320	Canyon Live Oak Forest	S4	4.5	1.4	31.9	62.2	475.1	0.85%
81330	Interior Live Oak Forest	S4	0.5	0.4	7	92.1	917.7	1.64%
81340	Black Oak Forest	S4	4.8	1.7	41.3	52.2	3,519.3	6.29%
81350	Oregon Oak Forest		3.6	0.5	39.8	56.1	948.8	1.70%
81400	Tanoak Forest	S4	6.2	0.8	35.3	57.7	1,735.2	3.10%
82100	Sitka Spruce-Grand Fir Forest	S1.1	10.4	11.6	0.1	78	339.3	0.61%
82310	Alluvial Redwood Forest	*****	1.3	3.6	8.1	87	742.0	1.33%
82320	Upland Redwood Forest	S2.3	4.9	5.5	4.5	85.2	4,607.7	8.24%
82410	Coastal Douglas-Fir-Western Hemlock Forest	S2.1	1.4	7	29.4	62.2	32.4	0.06%
82420	Upland Douglas-Fir Forest	S3.1	7.9	1.9	17.2	73	294.6	0.53%
82500	Port Orford Cedar Forest	S2.1	88.2	0	10.7	1.1	5.5	0.01%
83110	Beach Pine Forest	S2.1	0	32.0	0	68.0	14.0	0.03%
83121	Northern Bishop Pine Forest	S2.2	1.1	4.8	3.3	990.8	136.1	0.24%
83161	Mendocino Pygmy Cypress Forest	S2.1	4.3	6.2	10.7	78.9	10.5	0.02%
83210	Knobcone Pine Forest	S4	1.2	0.5	61	37.3	268.6	0.48%
84110	Coast Range Mixed Coniferous Forest	S4	11.7	2.9	48.5	36.8	13,545.3	24.23%
84131	Upland Coast Range Ponderosa Pine Forest	S3.2	6.9	17.2	31.2	44.7	435.9	0.78%
84160	Ultramafic White Pine Forest	S3.2	51.5	0	24.4	24.1	22.2	0.04%
84171	Northern Ultramafic Jeffrey Pine Forest	S3.2	24.4	0	51.4	24.1	483.3	0.86%
84180	Ultramafic Mixed Coniferous Forest	S4	8.3	0.6	81.3	9.8	238.3	0.43%
84210	Westside Ponderosa Pine Forest	S2.1	30.4	0.3	44.5	24.9	1,254.7	2.24%
84220	Eastside Ponderosa Pine Forest	S2.1	55.5	0	26.4	18.1	23.6	0.04%
84230	Sierran Mixed Coniferous Forest	S4	19.8	0.7	46.2	33.3	1,762.2	3.15%
84240	Sierran White Fir Forest	S4	57.4	0	37.6	5	284.6	0.51%

85100	Jeffrey Pine Forest	S4	1.5	0.3	88.5	9.8	16.9	0.03%
85210	Jeffrey Pine - Fir Forest	S4	17.4	0	67.0	15.6	369.2	0.66%
85310	Red Fir Forest	S4	56.2	0	34.8	9	316.5	0.57%
85410	Siskiyou Enriched Coniferous Forest	S1.2	44.3	0	48.5	7.2	245.1	0.44%
85420	Salmon-Scott Enriched Coniferous Forest	S1.2	55.1	0	31.5	13.4	1,047.1	1.87%
86100	Lodgepole Pine Forest	S4	10.1	0.5	78.7	10.8	21.2	0.04%
87200	Upper Cismontane Mixed Conifer-Oak Forest		0	0	1.0	39.0	11.3	0.02%
91110	Klamath-Cascade Fell-Field	S4	100	0	0	0	5.0	0.01%
	TOTAL FOR REGION		9.2	2.3	30.6	58.1	55,908.0	

APPENDIX II. PLANT SERIES FOUND IN KLAMATH ECOREGION AND THEIR RELATIVE RARITY.

Table AII-1. Plant Series found in the Klamath Ecoregion.

Table AII-2. The Nature Conservancy Heritage Program Status Ranks.

Table AII-1. Plant Series found in the Klamath Ecoregion.[29]

	Natural Diversity Database Information				
	Name[30]	Holland [31] Type	All or part[32]	Status[33]	
Series Dominated by Herbaceous plants					
Ashy ryegrass series	Great Basin grasslands	43000	in part	G1	S1.1
Beaked sedge series	Meadows and seeps	45000			
Beaked sedge series	Wet montane meadow	45110	in part	G3	S3
Beaked sedge series	Freshwater seep	45400	in part	G4	S4
Bluebunch wheatgrass series	Great Basin grasslands	43000	in part	G1	S1.1
Bulrush series	Marsh and swamp	52000			
Bulrush series	Coastal brackish marsh	52200	in part	G2	S2.1
Bulrush series	Cismontane alkali marsh	52310	in part	G1	S2.1
Bulrush series	Transmontane alkali marsh	52320	in part	G3	S2.1
Bulrush series	Coast and valley freshwater marsh	52410	in part	G3	S2.1
Bulrush series	Transmontane freshwater marsh	52420	in part	G3	S2.2
Bulrush series	Montane freshwater marsh	52430	in part	G3	S3
Bulrush-cattail series	Marsh and swamp	5200			
Bulrush-cattail series	Coastal brackish marsh	52200	in part	G2	S2.1
Bulrush-cattail series	Cismontane alkali marsh	52310	in part	G1	S1.1
Bulrush-cattail series	Transmontane alkali marsh	52320	in part	G3	S2.1
Bulrush-cattail series	Coast and valley freshwater marsh	52410	in part	G3	S2.1
Bulrush-cattail series	Transmontane freshwater marsh	52420	in part	G3	S2.1

[29] Based on Sawyer and Keeler-Wolf (1995); their descriptions are for series within California, however, we are not aware of any additional series found only within the Oregon portion of the ecoregion.

[30] From Holland (1986); in many cases the series descriptions from Sawyer and Keeler-Wolf (1995) include several types described by Holland (1986). In such cases all corresponding "Holland types" are listed.

[31] Based on Holland (1986)

[32] In many cases a "Holland type" corresponds to portions of several Sawyer and Keeler-Wolf (1995) series; in such cases the Holland type will include the qualifier "in part".

[33] The Nature Conservancy Heritage Program Status Ranks are shown in Table AII-2.

Bulrush-cattail series	Montane freshwater marsh	52430	in part	G3	S3
Bur-reed series	Marsh and swamp	5200			
Bur-reed series	Montane freshwater marsh	52430	in part	G3	S3
California annual grassland series	Valley and foothill grasslands	4200			
California annual grassland series	Non-native grassland	42200		G4	S4
California annual grassland series	Wildflower field	42300		G2	S2.2
California oatgrass series	Coastal prairies	41000			
California oatgrass series	Coastal terrace prairie	41100	in part	G2	S2.2
California oatgrass series	Bald Hills prairie	41200	in part	G2	S2.1
California oatgrass series	Great Basin grassland	43000		G1	S1.1
Cattail series	Marsh and swamp	5200			
Cattail series	Coastal brackish marsh	52200	in part	G2	S2.1
Cattail series	Cismontane alkali marsh	52310	in part	G1	S1.1
Cattail series	Transmontane alkali marsh	52320	in part	G3	S2.1
Cattail series	Coast and valley freshwater marsh	52410	in part	G3	S2.1
Cattail series	Transmontane freshwater marsh	52420	in part	G3	S2.2
Cattail series	Montane freshwater marsh	52430	in part	G3	S3
Cheatgrass series	Great Basin grassland	43000			
Common reed series	none				
Cordgrass series	Marsh and swamp	52000			
Cordgrass series	Northern coastal salt marsh	52110	in part	G3	S3.3
Cordgrass series	Southern coastal salt marsh	52120	in part	G2	S2.1
Creeping ryegrass series	Valley and foothill grasslands	42000			
Creeping ryegrass series	Valley wildrye grassland	42140		G2	S2.1
Crested wheatgrass series	Great basin grassland	43000			
Darlingtonia series	Bog and fen	51000			
Darlingtonia series	Darlingtonia bog	51120		G4	S3
Ditch-grass series	Marsh and swamp	52000			
Ditch-grass series	Coastal brackish marsh	52200	in part	G2	S2.1
Ditch-grass series	Cismontane alkali marsh	52300	in part	G2	S2.1
Ditch-grass series	Transmontane alkali marsh	52320	in part	G3	S2.1
Ditch-grass series	Alkali seep	45320	in part	G3	S2.1
Duckweed series	Marsh and swamp	52000			
Duckweed series	Coastal and valley freshwater marsh	52410	in part	G3	S2.1

Duckweed series	Transmontane freshwater marsh	52420	in part	G3	S2.1
Duckweed series	Montane freshwater marsh	52430	in part	G3	S3
European beachgrass series	Coastal dunes	52100		G3	S2.1
European beachgrass series	Northern foredunes	21210	in part	G2	S2.1
European beachgrass series	Northern foredune grassland	21211	in part	G1	S1.1
Foothill needle grass series	Valley and foothill grasslands	42000			
Foothill needle grass series	Serpentine bunchgrass	42130	in part	G2	S2.2
Giant reed series	none				
Green fescue series	Meadow and seep	45000			
Green fescue series	Dry subalpine or alpine meadow	45220	in part	G3	S3
Iceplant series	none				
Idaho fescue series	Coastal prairies	43000			
Idaho fescue series	Great Basin grasslands	43000		G1	S1.1
Idaho fescue series	Bald hills prairie	41200	in part	G2	S2.1
Idaho fescue series	Serpentine bushgrass	42130	in part	G2	S2.2
Introduced perennial grassland series	Coastal prairies	41000			
Introduced perennial grassland series	Great Basin grasslands	43000			
Kentucky bluegrass series	Coastal prairies	41000			
Kentucky bluegrass series	Valley and foothill grasslands	42000			
Kentucky bluegrass series	Great Basin grasslands	43000		G1	S1.1
Kentucky bluegrass series	Meadows and seeps	45000			
Mosquito fern series	Marsh and swamp	52000			
Mosquito fern series	Coastal and valley freshwater marsh	52410	in part	G3	S2.1
Mosquito fern series	Transmontane freshwater marsh	52420	in part	G3	S2.2
Mosquito fern series	Montane freshwater marsh	52430	in part	G3	S3
Native dunegrass series	Coastal dunes	21000			
Native dunegrass series	Northern foredune grassland	21211		G1	S1.1
Nebraska sedge series	Meadows and seeps	45000			
Nebraska sedge series	Wet montane meadow	45110	in part	G3	S3
Nebraska sedge series	Freshwater seep	45400	in part	G4	S4
Nodding needlegrass series	Valley and foothill grasslands	42000			
Nodding needlegrass series	Valley needlegrass grassland	42110	in part	G3	S3.1
One-sided bluegrass series	Valley and foothill grasslands	42000			

One-sided bluegrass series	Great Basin grasslands	43000			
One-sided bluegrass series	Valley grassland	42110	in part	G3	S3.1
One-sided bluegrass series	Pine bunchgrass	42130	in part	G2	S2.1
One-sided bluegrass series	Pine bunchgrass grassland	42150	in part	G3	S2.2
Pacific reedgrass series	Coastal prairies	41000			
Pacific reedgrass series	Coastal prairies	41100	in part	G2	S2.2
Pampas grass series	none				
Pickleweed series	Marsh and swamp	52000			
Pickleweed series	Northern coastal salt march	52110	in part	G3	S3.2
Pickleweed series	Northern coastal salt march	52120	in part	G2	S2.1
Pondweeds with floating leaves series	Marsh and swamp	52000			
Pondweeds with floating leaves series	Coast and valley freshwater marsh	52410		G3	S2.2
Pondweeds with floating leaves series	Transmontane freshwater marsh	52420		G.	S2.2
Pondweeds with floating leaves series	Montane freshwater marsh	52430	in part	G3	S3
Pondweeds with submerged leaves series	Marsh and swamp	52000			
Pondweeds with submerged leaves series	Coast and valley freshwater marsh	52410		G3	S2.2
Pondweeds with submerged leaves series	Transmontane freshwater marsh	52420		G3	S2.2
Pondweeds with submerged leaves series	Montane freshwater marsh	52430	in part	G3	S3
Purple needlegrass series	Valley and foothill grasslands	42000			
Purple needlegrass series	Valley needlegrass grassland	42110	in part	G3	S3.1
Quillwort series	Marsh and swamp				
Quillwort series	Freshwater marsh	52400	in part	G4	S4
Rocky Mountain sedge series	Meadows and seeps	45000			
Rocky Mountain sedge series	Wet montane meadow	45110	in part	G3	S3
Rocky Mountain sedge series	Freshwater seep	45400	in part	G4	S4
Saltgrass series	Meadow and seep	45000			
Saltgrass series	Alkali meadow	45310		G3	S2.1
Saltgrass series	Northern coastal salt march	52110	in part	G3	S3.3
Saltgrass series	Southern coastal salt march	52120	in part	G2	S2.1
Sand-verbena - beach bursage series	Coastal dunes	21000			
Sand-verbena - beach bursage series	Active coastal dunes	21100		G3	S2.2
Sand-verbena - beach bursage series	Northern foredunes	21210		G2	S2.1
Sedge series	Meadows and seeps	45000			
Sedge series	Alpine boulder and rock field	91000			

Sedge series	Wet montane meadow	45110	in part	G3	S3
Sedge series	Freshwater seep	45400	in part	G4	S4
Sedge series	Wet subalpine or alpine meadow	45210		G3	S3
Sedge series	Dry subalpine or alpine meadow	45220		G3	S3
Sedge series	Vernal marsh	54500		G2	S2.1
Sedge series	Klamath Cascade fell field	91110		G4	S4
Shorthair reedgrass series	Meadows and seeps	45000			
Shorthair reedgrass series	Wet montane meadow	45110	in part	G3	S3.2
Shorthair reedgrass series	Dry montane meadow	45120	in part	G3	S3.2
Shorthair reedgrass series	Wet subalpine or alpine meadow	45210	in part	G3	S3.3
Shorthair reedgrass series	Dry subalpine or alpine meadow	45220	in part	G3	S3.3
Spikerush series	Meadows and seeps	45000			
Spikerush series	Wet montane meadow	45110	in part	G3	S3
Spikerush series	Freshwater seep	45400	in part	G4	S4
Spikerush series	Vernal marsh	52500		G2	S2.1
Tufted hairgrass series	Coastal prairies	41000			
Tufted hairgrass series	Meadows and seeps	45000			
Tufted hairgrass series	Coastal terrace prairie	41100	in part	G2	S2.1
Tufted hairgrass series	Wet subalpine and alpine meadow	45210		G3	S3.2
Yellow pond-lily series	Marsh and swamp	52000			
Yellow pond-lily series	Coast and valley freshwater marsh	52410		G3	S2.1
Yellow pond-lily series	Transmontane freshwater marsh			G3	S2.1
Yellow pond-lily series	Montane freshwater marsh	52430	in part	G3	S3
Series Dominated by Shrubs					
Big sagebrush series	Great Basin scrubs	35000			
Big sagebrush series	Great Basin mixed scrub	35100	in part	G4	S4
Big sagebrush series	Big sagebrush	35210		G4	S4
Big sagebrush series	Sagebrush steppe	35300		G2	S2.1
Bitterbrush series	Great Basin scrubs	35000	in part		
Bitterbrush series	Great Basin mixed scrub	35100	in part	G4	S4
Bitterbrush series	Big sagebrush	35210	in part	G4	S4
Bitterbrush series	Sagebrush steppe	35300	in part	G2	S4
Black sagebrush series	Great Basin scrubs	35000			

Black sagebrush series	Pavement plain communities	47000			
Black sagebrush series	Subalpine sagebrush scrub	35220	in part	G3	S3.2
Black sagebrush series	Pebble plain scrub	35220	in part	G1	S1.1
Blue blossom series	Coastal bluff scrub	31000			
Blue blossom series	Chaparral	37000			
Blue blossom series	Northern coastal bluff scrub	31100		G2	S2.2
Blue blossom series	Blue brush chaparral	37820		G4	S4
Blue blossom series	Northern maritime chaparral	37C10	in part	G1	S1.2
Blue blossom series	Poison-oak chaparral	37F00	in part	G4	S4
Brewer oak series	Chaparral	37000			
Brewer oak series	Shin oak brush	37541		G3	S3
Broom series	None				
Bush chinquapin series	Chaparral	37000			
Bush chinquapin series	Mixed montane chaparral	37510	in part	G4	S4
Bush chinquapin series	Bush chinquapin chaparral	37540		G3	S3.3
Buttonbush series	Riparian scrubs	63000			
Buttonbush series	Buttonbrush scrub	63430		G1	S1.1
Chamise series	Chaparral	37000			
Chamise series	Gabbroic northern mixed chaparral	37111	in part	G2	S2.1
Chamise series	Chamise chaparral	37200		G4	S4
Chamise series	Upper Sonoran manzinita chaparral	37B00	in part	G4	S
Chamise series	Northern maritime chaparral	37C10	in part	G1	S1.2
Chamise series	Northern north slope chaparral	37E10	in part	G3	S3
Chamise series	Poison-oak chaparral	37F00	in part	G3	S3.3
Chamise-wedgeleaf ceanothus series	Chaparral	37000			
Chamise-wedgeleaf ceanothus series	Chamise chaparral	37200		G4	S4
Chamise-wedgeleaf ceanothus series	Upper Sonoran manzanita chaparral	37B00	in part	G4	S4
Coyote brush series	Coast dunes	21000			
Coyote brush series	Coastal bluff scrubs	31000			
Coyote brush series	Coastal scrubs	32000			
Coyote brush series	Northern dune scrub	21321	in part	G2	S1.2
Coyote brush series	Northern (Franciscan) coastal bluff scrub	31100	in part	G2	S2.2
Coyote brush series	Northern coyotebrush scrub	32100		G3	S3
Deerbrush series	Chaparral	37000			

Deerbrush series	Deer brush chaparral	37531		G4	S4
Deerbrush series	Mixed montane chaparral	37510	in part	G4	S4
Deerbrush series	Montane ceanothus chaparral	37520		G4	S4
Deerbrush series	Poison-oak chaparral	37F00	in part	G3	S3.3
Dune lupine-goldenbush series	Coastal dunes	21000			
Dune lupine-goldenbush series	Central dune scrub	21320		G2	S2.2
Eastwood manzanita series	Chaparral	37000			
Eastwood manzanita series	Northern mixed chaparral	37110	in part	G3	S3.3
Eastwood manzanita series	Upper Sonoran manzanita chaparral	37B00	in part	G4	S4
Greenleaf manzanita series	Chaparral	37000			
Greenleaf manzanita series	Mixed montane chaparral	37510	in part	G4	S4
Greenleaf manzanita series	Montane manzanita chaparral	37520	in part	G4	S4
Greenleaf manzanita series	Upper Sonoran manzanita chaparral	37B00	in part	G4	S4
Hairyleaf ceanothus series	Chaparral	37000			
Hairyleaf ceanothus series	Upper Sonoran ceanothus chaparral	37800		G3	S3.3
Holodiscus series	None				
Huckleberry oak series	Chaparral	37000			
Huckleberry oak series	Mixed montane chaparral	37510	in part	G4	S4
Huckleberry oak series	Huckleberry oak chaparral	37542		G3	S3
Interior live oak shrub series	Chaparral	37000			
Interior live oak shrub series	Interior live oak chaparral	37A00		G3	S3.3
Interior live oak shrub series	Northern north slope chaparral	37E10	in part	G3	S3.3
Interior live oak shrub series	Poison-oak chaparral	37F00	in part	G3	S3.3
Iodine bush series	Chenopod scrubs	36000			
Iodine bush series	Alkali playa communities	46000	in part	G3	S2.1
Iodine bush series	Desert sink scrub	36120	in part	G3	S2.1
Iodine bush series	Desert greasewood scrub	36130	in part	G3	S2.1
Leather oak series	Chaparral	37000			
Leather oak series	Mixed serpentine chaparral	37610		G2	S2.1
Leather oak series	Leather oak chaparral	37620		G3	S3.2
Low sagebrush series	Great Basin scrubs	35000			
Low sagebrush series	Alpine boulder and rock field	9100			
Low sagebrush series	Suballpine sagebrush scrub	35220		G3	S3.2

Mountain alder series	Riparian scrubs	63000			
Mountain alder series	Montane riparian scrub	63500	in part	G4	S4
Mountain heather-bilberry series	Meadows and seeps	45000			
Mountain heather-bilberry series	Riparian scrubs	63000			
Mountain heather-bilberry series	Wet montane meadow	45110		G3	S3.2
Mountain heather-bilberry series	Wet alpine and subalpine meadow	45210		G3	S3.2
Mountain heather-bilberry series	Montane riparian scrub	63500	in part	G4	S4
Mountain whitethorn series	Chaparral	37000			
Mountain whitethorn series	Mixed montane chaparral	37510	in part	G4	S4
Mountain whitethorn series	Montane ceanothus chaparrals	37530	in part	G3	S3
Mountain whitethorn series	Whitethorn chaparral	37532		G4	S4
Mountain whitethorn series	Upper Sonoran manzanita chaparral	37B00	in part	G4	S4
Mulefat series	Riparian scrubs	63000			
Mulefat series	Mulefat scrub	63310		G4	S4
Narrowleaf willow series	Riparian forests	61000			
Narrowleaf willow series	Riparian scrubs	63000			
Narrowleaf willow series	Modoc-Great Basin cottonwood-willow riparian fores	61610	in part	G3	S2.1
Narrowleaf willow series	North Coast riparian scrub	63100	in part	G3	S3.2
Parry rabbitbrush	Great Basin scrubs	35000			
Parry rabbitbrush	Mono pumice flat	35410		G1	S1.1
Rubber rabbitbrush	Great Basin scrubs	35000			
Rubber rabbitbrush	Rabbitbrush scrub	35400		G5	S5
Sadler oak series	Chaparral	37000			
Sadler oak series	Mixed montane chaparral	37510	in part	G4	S4
Salal-black huckleberry series	Coastal bluff scrubs	31000			
Salal-black huckleberry series	Coastal scrubs	32000			
Salal-black huckleberry series	Chaparral	37000			
Salal-black huckleberry series	Northern (Franciscan coastal bluff scrub	32110	in part	G2	S2.2
Salal-black huckleberry series	Northern salal scrub	32120		G3	S3.2
Salal-black huckleberry series	Northern silk-tassel scrub	32130		G3	S3.2
Salal-black huckleberry series	Poison-oak chaparral	37F00	in part	G3	S3.3
Sandbar willow series	Riparian scrubs	63000			
Sandbar willow series	North Coast riparian scrub	63100	in part	G3	S3.2

Scrub oak series	Chaparral	37000			
Scrub oak series	Northern maritime chaparral	37C10	in part	G1	S1.2
Scrub oak series	Poison-oak chaparral	37F00	in part	G3	S3.3
Shadscale series	Chenopod scrubs	36000			
Shadscale series	Shadscale scrub	36140		G4	S3.2
Sitka alder series	Riparian scrubs	63000			
Sitka alder series	Montane riparian scrub	63500	in part	G4	S4
Tamarisk series	Riparian scrub	63000			
Tamarisk series	Tamarisk scrub	63810		G5	S4
Tobacco brush series	Chaparral	37000			
Tobacco brush series	Mixed montane chaparral	37510	in part	G4	S4
Tobacco brush series	Tobacco brush chaparral	37533		G3	S3.3
Wedgeleaf ceanothus series	Chaparral	37000			
Wedgeleaf ceanothus series	Mixed montane chaparral	37510	in part	G4	S4
Wedgeleaf ceanothus series	Buck brush chaparral	37810		G4	S4
Wedgeleaf ceanothus series	Poison-oak chaparral	37F00	in part	G4	S4
Whiteleaf manzanita series	Chaparral	37000			
Whiteleaf manzanita series	Mixed montane chaparral	37510	in part	G4	S4
Whiteleaf manzanita series	Montane manzanita chaparral	37520	in part	G4	S4
Whiteleaf manzanita series	Serpentine chaparral	37600	in part	G2	S2.1
Whiteleaf manzanita series	Upper Sonoran manzanita chaparral	37B00	in part	G4	S4
Yellow bush lupine series	Coastal dunes	21000			
Yellow bush lupine series	Coastal bluff scrubs	31000			
Yellow bush lupine series	Coastal scrubs	32000			
Yellow bush lupine series	Northern dune scrub	21210	in part	G2	S1.2
Yellow bush lupine series	Northern coastal bluff scrub	31100	in part	G2	S2.2
Series Dominated by Trees					
Arroyo willow series	Riparian forests	61000			
Arroyo willow series	Riparian woodlands	62000			
Arroyo willow series	Riparian scrubs	63000			
Arroyo willow series	North Coast riparian srub	63100	in part	G3	S3.2
Aspen series	Riparian forests	61000			
Aspen series	Broadleaved upland forests	81000			

Aspen series	Aspen riparian forest	61520		G4	S3.2
Aspen series	Aspen forests	81B00		G5	S3.2
Beach pine series	Closed-cone coniferous forests	83000			
Beach pine series	Beach pine forest	83110		G4	S2.1
Birchkeaf mountain-mahogany series	Chaparral	37000			
Birchkeaf mountain-mahogany series	Cismontane woodlands	71000			
Birchkeaf mountain-mahogany series	Broadleaved upland forests	81000			
Bishop pine series	Closed-cone coniferous forests	83000			
Bishop pine series	Northern Bishop pine forest	83121		G2	S2.2
Black cottonwood series	Riparian forests	61000			
Black cottonwood series	North Coast black cottonwood riparian forest	61110			S1.1
Black cottonwood series	North Coast black cottonwood riparian forest	61530		G4	S3.2
Black oak series	Cismontane woodlands	71000			
Black oak series	Broadleaved upland forests	81000			
Black oak series	Lower montane coniferous forests	84000			
Black oak series	Black oak woodland	71120		G3	S3.3
Black oak series	Black oak forest	81340		G4	S4
Black willow series	Riparian forests	61000			
Black willow series	Riparian scrubs	63000			
Blue oak series	Cismontane woodlands	71000			
Blue oak series	Blue oak woodland	71140		G3	S3.2
Blue oak series	Open digger pine woodland	71310	in part	G4	S4
Blue oak series	Digger pine-oak woodland	71410	in part	G4	S4
California bay series	Califoronia bay sole or dominant tree in canopy	98100			
California bay series	California bay forest	81200		G3	S3.2
California bay series	Silktassel forest	81900		G3	S3
California buckeye series	Broadleaved upland forests	81000			
California buckeye series	Mixed noth slope forest	81500		G4	S4
California buckeye series	Mainland cherry forest	81820	in part	G1	S1.1
Canyon live oak series	Riparian forests	61000			
Canyon live oak series	Broadleaved upland forests	81000			
Canyon live oak series	Canyon live oak ravine forest	61350		G3	S3.3
Canyon live oak series	Canyon live oak forest	81320		G4	S4
Coast live oak series	Riparian forests	61000			

Coast live oak series	Cismontane woodlands	71000			
Coast live oak series	Broadleaved upland forests	81000			
Coast live oak series	Coast live oak woodland	71160		G4	S4
Coast live oak series	Coast live oak forest	81310		G4	S4
Curleaf mountain-mahogany series	Broadleaved upland forests	81000			
Douglas-fir series	North Coast coniferous forests	82000			
Douglas-fir series	Lower montane coniferous forests	84000			
Douglas-fir series	Upland Douglas-fir forest	82420		G4	S2.1
Douglas-fir series	Coast range mixed coniferous forest	84110	in part	G4	S4
Douglas-fir - ponderosa pine series	Lower montane coniferous forests	84000			
Douglas-fir - ponderosa pine series	Coast Range mixed coniferous forest	84110	in part	G4	S4
Douglas-fir - tanoak series	Broadleaved upland forests	81000			
Douglas-fir - tanoak series	North Coast coniferous forests	82000			
Douglas-fir - tanoak series	Mixed evergreen forest	81100	in part	G4	S4
Douglas-fir - tanoak series	Tanoak forest	81400	in part	G4	S4
Douglas-fir - tanoak series	Upland Douglas-fir forest	82420	in part	G4	S3.1
Englemann spruce series	Upper montane coniferous forests	85000			
Englemann spruce series	Salmon-Scott enriched conifer forests	85420	in part	G1	S1.2
Eucalyptus series	None				
Foothill pine series	Cismontane woodlands	71000			
Foothill pine series	Serpentine digger pine chaparral	71321		G3	S3
Foothill pine series	Non-serpentine digger pine chaparral	71322		G4	S4
Foxtail pine series	Subalpine coniferous forests	86000			
Foxtail pine series	Foxtail pine forest	96300		G3	S3
Fremont cottonwood series	Riparian forests	61000			
Fremont cottonwood series	Modoc-Great Basin cottonwood-willow riparian forest	61610		G3	S2.1
Grand fir series	North Coast coniferous forests	82000			
Grand fir series	Sitka spruce-grand fir forest	82100	in part	G4	S1.1
Hooker willow series	Marshes and swamps	52000			
Hooker willow series	Riparian forests	61000			
Hooker willow series	Riparian scrubs	63000			
Hooker willow series	Freshwater swamp	52600	in part	G1	S1
Hooker willow series	Red alder riparian forest	61130	in part	G3	S2.2

Hooker willow series	North Coast riparian scrub	63100	in part	G3	S3.2
Incense-cedar series	Lower montane coniferous forests	84000			
Incense-cedar series	White fir forest	84240	in part	G4	S4
Interior live oak series	Cismontane woodlands	71000			
Interior live oak series	Broadleaved upland forests	81000			
Interior live oak series	Interior live oak woodland	71150		G3	S3.2
Interior live oak series	Digger pine-oak woodland	71410	in part	G4	S4
Interior live oak series	Interior live oak forest	81220		G4	S4
Jeffrey pine series	Lower montane coniferous forests	84000			
Jeffrey pine series	Upper montane coniferous forests	85000			
Jeffrey pine series	Northern ultramafic Jeffrey pine forest	84171		G3	S3
Jeffrey pine series	Ultramafic mixed coniverous forest	84180		G4	S4
Jeffrey pine series	Jeffrey pine forest	85100		G4	S4
Jeffrey pine series	Jeffrey pine-fir forest	85210		G4	S4
Jeffrey pine-ponderosa pine series	Lower montane coniferous forests	84000			
Jeffrey pine-ponderosa pine series	Upper montane coniferous forests	85000			
Jeffrey pine-ponderosa pine series	Jeffrey pine forest	85100	in part	G4	S4
Jeffrey pine-ponderosa pine series	Jeffrey pine-white fir forest	85210	in part	G4	S4
Jeffrey pine-ponderosa pine series	Eastside ponderosa pine forest	84220	in part	G4	S4
Knobcone pine series	Closed-cone coniferous forests	83000			
Knobcone pine series	Knobcone pine forest	83210		G4	S4
Lodgepole pine series	Subalpine coniferous forests	86000			
Lodgepole pine series	Lodgepole pine forest	86100		G4	S4
Lodgepole pine series	Whitebark pine-lodgepole pine forest	86220	in part	G4	S4
McNab cypress series	Closed-cone coniferous forests	83000			
McNab cypress series	Northern interior cypress forest	83220	in part	G2	S2.2
Mixed conifer series	Lower coniferous forests	84000			
Mixed conifer series	North Range mixed coniferous forest	84110	in part	G4	S4
Mixed oak series	Cismontane woodlands	71000			
Mixed oak series	Broadleaved upland forests	81000			
Mixed oak series	Digger pine-oak woodland	71410	in part	G4	S4
Mixed subalpine forest series	Subalpine coniferous forests	86000			
Mixed subalpine forest series	Whitebark pine-mountain hemlock forest	86210		G4	S4

Mixed subalpine forest series	Whitebark pine-lodgepole pine forest	86220		G4	S4
Mixed willow series	Marshes and swamps	52000			
Mixed willow series	Riparian forests	61000			
Mixed willow series	Riparian scrubs	63000			
Mixed willow series	Freshwater swamp	52600	in part	G1	S1.1
Mixed willow series	Red alder riparian forest	61130	in part	G3	S2.1
Mixed willow series	Modoc-Great Basin cottonwood-willow riparian forest	61610	in part	G2	S2.1
Mixed willow series	North Coast riparian forest	63100	in part	G3	S3
Mountain hemlock series	Subalpine coniferous forests	86000			
Mountain hemlock series	Whitebark pine-mountain hemlock forest	86210	in part	G4	S4
Mountain juniper series	Pinyon and juniper woodlands	72000			
Mountain juniper series	Great Basin juniper woodland and scrub	72123		G4	S4
Oregon white oak series	Cismontane woodlands	71000			
Oregon white oak series	Oregon oak woodland	71110		G3	S3
Oregon white oak series	Mixed north cismontane woodland	71421	in part	G3	S3.2
Pacific willow series	Marshes and swamps	52000			
Pacific willow series	Riparian forests	61000			
Pacific willow series	Riparian scrubs	63000			
Pacific willow series	Freshwater swamp	52600	in part	G1	S1.1
Pacific willow series	Red alder riparian forest	61130	in part	G3	S2.2
Ponderosa pine series	Lower montante coniferous forests	84000			
Ponderosa pine series	Upland Coast Range ponderosa pine forest	84131		G3	S3.2
Ponderosa pine series	Westside ponderosa pine forest	84210		G3	S2.1
Ponderosa pine series	Eastside ponderosa pine forest	84220		G4	S2.1
Ponderosa pine series	Ponderosa dune forest	84221		G1	S1.1
Port Orford-cedar series	North Coast coniferous forests	82000			
Port Orford-cedar series	Port Orford-cedar forest	82500		G3	S2.1
Pygmy cypress series	Closed-cone coniferous forests	83000			
Pygmy cypress series	Mendocino pygmy cypress forest	83161		G2	S2.1
Red alder series	Riparian forests	61000			
Red alder series	Riparian scrubs	63000			
Red alder series	Broadleaved upland forests	81000			
Red alder series	Red alder riparian forest	61330		G3	S3.2

Red alder series	North Coast riparian scrub	63100		G3	S2.2
Red alder series	Woodwardia thicket	63110		G3	S3.2
Red alder series	Red alder forest	81A00		G4	S3.2
Red fir series	Upper montane coniferous forests	85000			
Red fir series	Red fir forest	85310		G4	S4
Red willow series	Riparian forests	61000			
Red willow series	Riparian scrubs	63000			
Red willow series	Modoc-Great Basin cottonwood-willow riparian forest	61610	in part	G3	S2.1
Redwood series	Riparian forests	61000			
Redwood series	North Coast coniferous forests	82000			
Redwood series	North coast alluvial redwood forest	61220		G2	S2.2
Redwood series	Alluvial redwood forest	82310		G2	S2
Redwood series	Upland redwood forest	82320		G4	S2.3
Sargent cypress	Closed-cone forest	83000			
Sargent cypress	Northern interior cypress forest	83220	in part	G2	S2.2
Sitka spruce series	Marsh and swamp	52000			
Sitka spruce series	North Coast coniferous forests	82000			
Sitka spruce series	Freshwater swamp	52600	?in part	G1	S1.1
Sitka spruce series	Sitka spruce-grand fir forest	82100		G4	S1.1
Sitka willow series	Marshes and swamps	52000			
Sitka willow series	Riparian forests	61000			
Sitka willow series	Riparian scrubs	63000			
Sitka willow series	Freshwater swamp	52600	in part	G1	S1
Sitka willow series	North Coast riparian forest	63100	in part	G3	S3.2
Subalpine fir series	Upper montane coniferous forests	85000			
Subalpine fir series	Salmon-Scott enriched coniferous forest	85420		G1	S1.2
Tanoak series	Broadleaved upland forests	81000			
Tanoak series	Mixed evergreen forest	81100	in part	G4	S4
Tanoak series	Tanoak forest	81400		G4	S4
Valley oak series	Riparian forests	61000			
Valley oak series	Valley oak woodland	71130		G2	S2.1
Water birch series	Riparian forests	61000			
Water birch series	Riparian scrubs	63000			

Water birch series	Modoc-Great Basin cottonwood-willow riparian forest	61610	in part	G2	S2.1
Western hemlock series	North Coast coniferous forests	82000			
Western hemlock series	Western hemlock forest	82200		G4	S3
Western hemlock series	Douglas-fir - western hemlock forest	82410		G4	S2.1
Western juniper series	Pinon and juniper woodlands	72000			
Western juniper series	Northern juniper woodland	72110		G4	S4
Western juniper series	Northern juniper woodland	72123		G4	S4
Western white pine series	Lower montane coniferous forests	84000			
Western white pine series	Upper montane coniferous forest	85000			
Western white pine series	Ultramafic western white pine forest	84160		G3	S3
White alder series	Riparian forests	61000			
White alder series	Riparian woodlands	62000			
White alder series	White alder riparian forest	61510		G3	S3
White fir series	Lower montane coniferous forests	84000			
White fir series	Upper montane coniferous forests	85000			
Whitebark pine series	Subalpine coniferous forests	86000			
Whitebark pine series	Whitebark pine-mountain hemlock forest	86210	in part	G4	S4
Whitebark pine series	Whitebark pine-lodgepole pine forest	86220	in part	G4	S4
Whitebark pine series	Whitebark pine forest	86600	in part	G4	S4
Unique Stands[34]					
Alaska yellow-cedar stands	Upper montane coniferous forests	85000			
Alaska yellow-cedar stands	Siskiyou enriched coniferous forest	85410		G1	S1.2
Baker cypress stands	Closed-cone coniferous forests	83000			
Baker cypress stands	Northern interior cypress forest	83220	in part	G2	S2.2
Enriched stands in the Klamath Mountains	Upper montane coniferous forests	85000			
Enriched stands in the Klamath Mountains	Salmon Scott enriched coniferous forest	85420		G1	S1.2
Enriched stands in the Klamath Mountains	Siskiyou enriched conifer forest	85410		G1	S1.2
Pacific silver fir stands	Upper montane coniferous forests	86000			

[34] For distinction between series and "unique stands" see Sawyer and Keeler-Wolf (1995325-326)

[35] For distinction between habitats and series see Sawyer and Keeler-Wolf (1995:348)

Habitats[35]					
Alpine habitat	Meadows and seeps	45000			
Alpine habitat	Alpine boulder and rock fields	91000			
Alpine habitat	Wet subalpine or alpine meadow	45210		G3	S3
Alpine habitat	Dry subalpine or alpine meadow	45220		G3	S3
Alpine habitat	Klamath Cascade fell field	91110		G4	S4
Alpine habitat	Alpine glacier	91200		G5	S2.3
Alpine habitat	Wet alpine talus and scree slope	91210		G5	S4
Alpine habitat	Dry alpine talus and scree clope	91220		G5	S4
Alpine habitat	Alpine snowfield	93100		G5	S4
Fen habitat	Bogs and fens	51000			
Fen habitat	Marshes and swamps	52000			
Fen habitat	Sphagnum bog	51110		G3	S1.1
Fen habitat	Fen	51120		G2	S1.2
Fen habitat	Ledum swamp	5251A		G2	S2.1
Montane meadow habitat	Meadows and seeps	45000			
Montane meadow habitat	Wet montane meadow	45110		G3	S3
Montane meadow habitat	Dry montane meadow	45120		G3	S3
Montane wetland shrub habitat	Riparian scrubs	63000			
Montane wetland shrub habitat	Montane riparian scrub	63500	in part	G4	S4
Subalpine meadow habitat	Meadows and seeps	45000			
Subalpine meadow habitat	Wet subalpine or alpine meadow	45110		G3	S3
Subalpine meadow habitat	Dry subalpine or alpine meadow	45220		G3	S3
Subalpine upland shrub habitat	Montane dwarf scrub	38000			
Subalpine upland shrub habitat	Meadow and seep	45000			
Subalpine upland shrub habitat	Alpine boulder and rock field	91000			
Subalpine upland shrub habitat	Montane dwarf scrub	38000		G3	S3.2
Subalpine upland shrub habitat	Dry subalpine or alpine meadow	45220	in part	G3	S3.2
Subalpine wetland shrub habitat	Riparian scrubs	63000			
Subalpine wetland shrub habitat	Montane riparian scrub	63500	in part	G4	S4
Vernal Pools[36]					

[36] For distinction between vernal pools and series see Sawyer and Keeler-Wolf (1995)

Northern basalt flow vernal pools	Vernal pool	44000			
Northern basalt flow vernal pools	Northern basalt flow vernal pool	44131		G1	S2.1

Table AII-2. The Nature Conservancy Heritage Program Status Ranks.[37]

Rank		Definition
Global Ranks		
	G1	Fewer than 6 viable occurrences worldwide and/or 2,000 acres
	G2	6-20 viable occurrences worldwide and/or 2,000-10,000 acres
	G3	21-100 viable occurrences worldwide and/or 10,000-50,000 acres
	G4	Greater than 100 viable occurrences worldwide and/or greater than 50,000 acres
	G5	Community demonstrably sercure due to worldwide abundance
State Ranks		
	S1	Fewer than 6 viable occurrences statewide and/or 2,000 acres
	S2	6-20 viable occurrences statewide and/or 2,000-10,000 acres
	S3	21-100 viable occurrences statewide and/or 10,000-50,000 acres
	S4	Greater than 100 viable occurrences statewide and/or greater than 50,000 acres
	S5	Community demonstrably secure statewide
Threat Ranks		
	0.1	Very threatened
	0.2	Threatened
	0.3	No current threats known

[37] From Sawyer and Keeler-Wolf (1995:22)

APPENDIX III. VERTEBRATE SPECIES OF THE KLAMATH ECOREGION.

TABLE AIII-1. Fish species of the Klamath Ecoregion.

TABLE AIII-2. Terrestrial vertebrates of the Klamath Ecoregion.

Table AIII-1. Fish Species of the Klamath Ecoregion (from Moyle 1976)

	Common Name	Scientific Name	Location and Status			Legal Status									Notes
	Pacific lamprey	Lampetra tridentata	NA	N	NA										
	River lamprey	Lampetra ayresi	?		NA										
	Pacific brook lamprey	Lampetra pacifica	NR		NR										
	Pit-Klamath brook lamprey	Lampetra lethophaga		N											
	Modoc brook lamprey	Lampetra folletti	NR												
	Miller Lake Lamprey*****	Lampetra minima		NR											
	White sturgeon	Acipenser transmontanus	NA	NR	NA										
	Green sturgeon	Acipenser medirostris	NA		NA										
	Pacific herring	Clupea harengus pallasi	O?		O										
	American shad	Alosa sapidissima	IA		IA										
	Threadfin shad	Dorosoma petenense	IR		IR										
	Eulachon	Thaleichthys pacificus	NA		NA										
	Surf smelt	Hypomesus pretiosus	O		O										
	Longfin smelt	Spirinchus thaleichthys	O?		N										
	Pink salmon	Oncorhynchus gorbuscha	NA		NA										
	Chum salmon	Oncorhynchus keta	NA		NA										
	Coho salmon	Oncorhynchus kisutch	NA		NA										
	Chinook salmon	Ochorhynchus tschawytscha	NA		NA										
	Sockeye salmon	Oncorhynchus nerka	OA		OA										
	Inland redband trout	Oncorhynchus mykiss		NR											

		gibbsi		?											
	Kokanee	Oncorhynchus nerka	IR												
	Brook trout	Salvelinus fontanalis	IR	IR	IR										
	Coast Dolly Varden **** see McGinnies Probably not here	Salvelinus malma	?		?										
	Bull trout	Salvelinus confluentus		NR											
	Cutthroat trout	Salmo clarki	NA		NA										
	Brown trout	Salmo trutta	IRI A	IR	IR										
	Rainbow trout	Salmo gairdneri	NA NR	NR	NA NR										
	Arctic grayling	Thymallus arcticus	IR												
	Carp	Cyprinus carpio			IR										
	Goldfish	Carassius auratus	IR		IR										
	Golden shiner	Notemigonus crysoleucas	IR	IR	IR										
	Sacramento blackfish	Orthodon microlepidotus			IR										
	Hardhead	Mylopharodon conocephalus			IR										
	Hitch (*** native s. or SF.)	Lavinia exilicauda			IR										
	Sacramento squawfish	Ptychocheilus grandis			NR										
	Blue chub	Gila coerulea	(N R)	NR											
	Tui chub	Gila bicolor	(N R)	NR											
	California roach	Hesperoleucus symmetricus			NR										
	Speckled dace	Rhinichthys osculus	NR	NR	NR										
	Lost River sucker	Catostomus luxatus		NR											
		Catostomus	(N												

	Shortnose sucker	brevirostrus	R)	NR											
	Klamath smallscale sucker	Catostomus rimiculus	NR												
	Klamath largescale sucker	Catostomus snyderi	(N R)	NR											
	Sacramento sucker	Catastomus microps		I?	NR										
	Channel catfish	Ictalurus punctatus	IR		IR										
	Yellow bullhead	Ictalurus natalils	IR	IR											
	Brown bullhead	Ictalurus nebulosus	IR	IR	IR										
	Black bullhead	Ictalurus melas	IR	IR	IR										
	California killifish	Fundulus parvipinnis			O										
	Mosquitofish	Gambusia affinis	IR		IR										
	Topsmelt	Atherinops affinis	O		O										
	Mississippi silverside	Menidia audens			IR										
	Threespine stickleback	Gasterosteus aculeatus	NR		NR										
	Bay pipefish	Syngnathus leptorhynchus			NR										
	Striped bass	Morone saxatilis			IR										
	Sacramento perch	Archoplites interruptus		IR	IR?										
	Black crappie	Pomoxis nigromaculatus		?	IR										
	White crappie	Pomoxis annularis		IR											
	Green sunfish	Lepomis cyanellus	IR	IR	IR										
	Bluegill	Lepomis macrochirus	IR	IR	IR										
	Pumpkinseed	Lepomis gibbosus	IR	IR											
	Largemouth bass	Micropterus salmoides	IR	IR	IR										
	Smallmouth bass	Micropterus dolomieui	IR		IR										
	Shiner perch	Cymatogaster aggregata	O		O										
		Eucyclogobius													

	Tidewater goby	newberryi			NR										
	Yellowfin goby	Acanthogobius flavimanus			IR										
	Arrow goby	Clevelandia ios	O		O										
	Yellow perch	Perca flavescens	IR	IR											
	Penpoint gunnel	Apodichthys flavidus	?		O										
	Saddleback gunnel	Pholis ornata	?		O										
	Sharpnose sculpin*****	Clinocottus acuticeps	O		O										
	Pacific staghorn sculpin	Leptocottus armatus	NR		NR										
	Slender sculpin	Cottus tenuis		NR											
	Coastrange sculpin	Cottus aleuticus	NR		NR										
	Prickly sculpin	Cottus asper	NR		NR										
	Marbled sculpin	Cottus klamathensis	NR	NR											
	Riffle sculpin	Cottus gulosus			NR										
	Starry flounder	Platichthys stellatus	NR		NR										

TABLE AIII-2. TERRESTRIAL VERTEBRATES OF THE KLAMATH ECOREGION.[38]

	COMMON NAME	SCIENTIFIC NAME	STATUS										NOTES
			FE	FT									
1	Northwestern slamander	Ambystoma gracile											
2	Long-toed salamander	Ambystoma macrodactylum											
3	California tiger salamander	Ambystoma tigrinum											
4	Pacific giant salamander	Dicamptodon tenebrosus											
5	California giant salamander	Dicamptodon ensatus											
6	Southern torrent salamander	Rhyacotriton variegatus											
7	Routh-skinned newt	Taricha granulosa											
8	California newt	Taricha torosa											
9	Red-bellied newt	Taricha rivularis											
10	Del Norte salamander	Plethodon elongatus											
11	Dunn’s salamander	Plethodon dunni											
12	Siskiyou Mountains salamander	Plethodon stormi											
13	Ensatina	Ensatina eschscholtzi											
14	Black salamander	Aneides flavipunctatus											
15	Clouded salamander	Aneides ferreus											
16	Arboreal salamander	Aneides lugubris											
17	California slender salamander	Batrochoseps attenuatus											

[38] The species list is based upon information provided by the California CWHR database (Timossi et al.1994, modified by the authors to include status in Oregon and newer information on taxonomy or nomenclature, etc. where available.

	COMMON NAME	SCIENTIFIC NAME	STATUS										NOTES
			FE	FT									
18	Tailed frog	Ascaphus trueii											
19	Western toad	Bufo boreas											
20	Pacific treefrog	Hyla regilla											
21	Red-legged frog	Rana aurora											
22	Spotted frog	Rana pretiosa											
23	Cascades frog	Rana cascadae											
24	Foothill yellow-legged frog	Rana boylei											
REPTILES													
1	Western pond turtle	Clemmys marmorata											
2	Western fence lizard	Sceloporus occidentalis											
3	Sagebrush lizard	Sceloporus graciosus											
4	Side-blotched lizard	Uta stansburiana											
5	Coast horned lizard	Phrynosoma coronatum											
6	Short-horned lizard	Phrynosoma douglassi											
7	Western skink	Eumeces skiltonianus											
8	Western whiptail	Cnemidophorus tigris											
9	Southern alligator lizard	Elgaria multicarinatus											
10	Northern alligator lizard	Elgaria coeruleus											
11	Rubber boa	Charina bottae											
12	Ringneck snake	Diadophis punctatus											
13	Sharp-tailed snake	Contia tenuis											
14	Racer	Coluber constrictor											
15	California whipsnake	Masticophis lateralis											
16	Striped whipsnake	Masticophis taeniatus											
17	Gopher snake	Pituophis melanoleucus											

	COMMON NAME	SCIENTIFIC NAME	STATUS										NOTES
			FE	FT									
18	Common kingsnake	Lampropeltis getulus											
19	California mountain kingsnake	Lampropeltis zonata											
20	Common garter snake	Thamnophis sirtalis											
21	Western terrestrial garter snake	Thamnophis elegans											
22	Western aquatic garter snake	Thamnophis couchi											
23	Northwestern garter snake	Thamnophis ordinoides											
24	Western rattlesnake	Crotalus atrox											
BIRDS													
1	Red-throated loon	Gavia stellata											
2	Common loon	Gavia immer											
3	Pacific loon	Gavia arctica											
4	Pied-billed grebe	Podilymbus podiceps											
5	Horned grebe	Podiceps suritus											
6	Red-necked grebe	Podiceps grisegena											
7	Eared grebe	Podiceps nigricollis											
8	Western grebe	Aechmophorus occidentalis											
9	Clark-s grebe	Aechmophorus slarkii											
10	American white pelican	Pelecanus erythrorhynchos											
11	Brown pelican	Pelecanus occidentalis											
12	Double-crested cormorant	Phalacrocorax autritus											
13	Brandt’s cormorant	Phalocrocorax penicillatus											
14	Pelagic cormorant	Phalacrocorax pelagicus											
15	American bittern	Botaurus lentiginosus											
16	Least bittern	Ixobrychus exilis											

	COMMON NAME	SCIENTIFIC NAME	STATUS										NOTES
			F E	F T									
17	Great blue heron	Ardea herodias											
18	Great egret	Casmerodius albus											
19	Snowy egret	Egretta thula											
20	Cattle egret*****	Bubulcus ibis											
21	Green heron	Butorides striatus											
22	Black-crowned night heron	Nycticorax nycticorax											
23	White-faced ibis	Plegadis chihi											
24	Turkey vulture	Cathartes aura											
25	Tundra swan	Cygnus columbianus											
26	Greater white-fronted goose	Anser albifrons											
27	Snow goose	Chen caerulescens											
28	Ross' goose	Chen rossii											
29	Brant	Branta bernicla											
30	Canada goose	Branta canadensis											
31	Wood duck	Aix sponsa											
32	Green-winged teal	Anas crecca											
33	Mallard	Anas platyrhynchos											
34	Northern pintail	Anas acuta											
35	Blue-winted teal	Anas discors											
36	Cinnamon teal	Anas cyanoptera											
37	Northern shoveler	Anas clypeata											
38	Gadwall	Anas strepera											
39	Eurasian wigeon	Anas penelope											
40	American wigeon	Anas americana											
41	Canvasback	Aythya valisineria											

	COMMON NAME	SCIENTIFIC NAME	STATUS									NOTES
			F E	F T								
42	Redhead	Aythya americana										
43	Ring-necked duck	Aythya collaris										
44	Greater scaup	Aythya marita										
45	Lesser scaup	Aythya affinis										
46	Harlequin duck	Histrionicus histrionicus										
47	Oldsquaw	Clangula hyemalis										
48	Black scoter	Melanitta nigra										
49	Surf scoter	Melanitta perspicillata										
50	White-winted scoter	Melanitta fusca										
51	Common goldeneye	Bucephala clangula										
52	Barrow’s goldeneye	Bucephala islandica										
53	Bufflehead	Bucephala albeola										
54	Hooded merganser	Lophodytes cucullatus										
55	Common merganser	Mergus merganser										
56	Red-breasted merganser	Mergus serrator										
57	Ruddy duck	Oxyura jamaicensis										
58	Osprey	Pandion haliaetus										
59	Black-shouldered kite	Eleanus caeruleus										
60	Bald eagle	Haliaeetus leucocephalus										
61	Northern harrier	Circus cyaneus										
62	Sharp-shinned hawk	Accipiter striatus										
63	Cooper’s hawk	Accipiter cooperii										
64	Northern goshawk	Accipiter gentilis										
65	Red-shouldered hawk	Buteo lineatus										
66	Swainson’s hawk	Buteo swainsoni										
67	Red-tailed hawk	Buteo jamaicensis										

	COMMON NAME	SCIENTIFIC NAME	STATUS										NOTES
			F E	F T									
68	Ferruginous hawk	Buteo regalis											
69	Rough-legged hawk	Buteo lagopus											
70	Golden eagle	Aquila chrysaetos											
71	American kestrel	Falco sparverius											
72	Merlin	Falco columbarius											
73	Peregrine falcon	Falco peregrinus											
74	Prairie falcon	Falco mexicanus											
75	Ruffed grouse	Bonasa umbellus											
76	Sage grouse	Centrocercus urophasianus											
77	Blue grouse	Dendragapus obscurus											
78	California quail	Callipepla californica											
79	Mountain quail	Oreortyx pictus											
80	Virginia rail	Rallus limicola											
81	Sora	Porzana carolina											
82	American coot	Fulica americana											
83	Sandhill crane	Grus canadensis											
84	Black-bellied plover	Pluvialis squatarola											
85	Snowy plover	Charadrius alexandrinus											
86	Semipalmated plover	Charadrius semipalmatus											
87	Killdeer	Charadrius vociferus											
88	Black oystercatcher	Haematopus bachmani											
89	Black-necked stilt	Himantopus mexicanus											
90	American avocet	Recurvirostra americana											
91	Greatern yellowlegs	Tringa malanoleuca											
92	Lesser yellowlegs	Tringa flavipes											
93	Willet	Catoptrophorus semipalmatus											

	COMMON NAME	SCIENTIFIC NAME	STATUS										NOTES
			F E	F T									
94	Wandering tattler	Heteroscelus incanus											
95	Spotted sandpiper	Actitis macularia											
96	Whimbrel	Numenius phaeopus											
97	Long-billed curlew	Numenius americanus											
98	Marbled godwit	Limosa fedoa											
99	Ruddy turnstone	Arenaria interpres											
100	Black turnstone	Arenaria interpres											
101	Surfbird	Aphriza virgata											
102	Red knot	Calidris canutus											
103	Sanderling	Calidris alba											
104	Western sandpiper	Calidris mauri											
105	Least sandpiper	Calidris minutilla											
106	Rock sandpiper	Calidris ptilocnemis											
107	Dunlin	Calidris alpina											
108	Long-billed dowitcher	Limnodromus scolopaeceus											
109	Common snipe	Gallinago gallinago											
110	Wilson’s phalarope	Phalaropus tricolor											
111	Bonaparte’s gull	Larus philadelphia											
112	Mew gull	Larus canus											
113	Ring-billed gull	Larus delawarensis											
114	California gull	Larus californicus											
115	Herring gull	Larus argentatus											
116	Thayer’s gull	Larus thayeri											
117	Western gull	Larus occidentalis											
118	Glaucous-winted gull	Larus glaucescens											
119	Caspian turn	Sterna caspia											

	COMMON NAME	SCIENTIFIC NAME	STATUS									NOTES
			FE	FT								
120	Elegant tern	Sterna elegans										
121	Common tern	Sterna hirundo										
122	Black tern	Chlidonias niger										
123	Common murre	Uria aalge										
124	Pigeon guillemot	Cepphus columba										
125	Marbled murrelet	Brachyramphus marmoratus										
126	Ancient murrelet	Synthliboramphus antiquus										
127	Cassin's auklet	Ptychoramphus aleuticus										
128	Rhinoceros auklet	Cerorhinca monocerata										
129	Tufted puffin	Fratercula cirrhata										
130	Band-otailed pigeon	Columba fasciata										
131	Mourning dove	Zenaida macroura										
132	Barn owl	Tyto alba										
133	Flammulated owl	Otus flammeolus										
134	Western screech owl	Otus kennicottii										
135	Great horned owl	Bubo virginianus										
136	Northern pygmy-owl	Glaucidium gnoma										
137	Burrowing owl	Athene cunicularia										
138	Spotted owl	Strix occidentalis										
139	Long-eared owl	Asio otus										
140	Short-eared owl	Asio flammeus										
141	Northern saw-whet owl	Aegolius acadicus										
142	Common nighthawk	Chordeiles minor										
143	Common poorwill	Phalaenoptilus nuttallii										
144	Black swift	Cypseloides niger										
145	Vaux's swift	Chaetura vauxi										

	COMMON NAME	SCIENTIFIC NAME	STATUS										NOTES
			F E	F T									
146	White-throated swift	Aeronautes saxatalis											
147	Black-chinned hummingbird	Archilochus alexandri											
148	Anna’s hummingbird	Calypte anna											
149	Costa’s hummingbird	Calypte costae											
150	Calliiope hummingbird	Stellula calliope											
151	Rufous hummingbird	Selasphorus rufus											
152	Allen’s hummingbird	Selasphorus sasin											
153	Belted kingfisher	Ceryle alcyon											
154	Lewis’ woodpecker	Melanerpes lewis											
155	Acorn woodpecker	Melanerpes formicivorus											
156	Red-breasted sapsucker	Sphyrapicus ruber											
157	Williamson’s sapsucker	Sphyrapicus thyroideus											
158	Nuttall’s woodpecker	Picoides nuttallii											
159	Downy woodpecker	Picoides pubescens											
160	Hairy woodpecker	Picoides villosus											
161	White-headed woodpecker	Picoides albolarvatus											
162	Black-backed woodpecker	Picoides arcticus											
163	Northern flicker	Colaptes auratus											
164	Pileated woodpecker	Dryocopus pileatus											
165	Olive-sided flycatcher	Contopus borealis											
166	Western wood-pewee	Contopus sordidulus											
167	Willow flycatcher	Empidonax traillii											
168	Hammond’s flycatcher	Empidonax hammondii											
169	Dusky flycatcher	Empidonax oberholseri											

	COMMON NAME	SCIENTIFIC NAME	STATUS										NOTES
			F E	F T									
170	Gray flycatcher	Empidnoax wrightii											
171	Pacific-slope slycatcher	Empidonax difficilis											
172	Black phoebe	Sayornis nigricans											
173	Say's phoebe	Sayornis saya											
174	Ash-throated flycatcher	Myiarchus cinerascens											
175	Western kingbird	Tyrannus verticalis											
176	Eastern kingbird	Tyrannus tyrannus											
177	Northern shrike	Lanius excubitor											
178	Loggerhead shrike	Lanius ludovicianus											
179	Hutton's vireo	Vireo huttoni											
180	Warbling vireo	Vireo gilvus											
181	Gray jay	Perisoreus canadensis											
182	Steller's jay	Cyanocitta stelleri											
183	Western scrub-jay	Aphelocoma coerulescens											
184	Pinyon jay	Gymnorhinus cyanocephalus											
185	Clark's nutcracker	Nucifraga columbiana											
186	Black-billed magpie	Pica pica											
187	American crow	Corvus brachyrhynchos											
188	Common raven	Corvus corax											
189	Horned lark	Eremophila alpestris											
190	Purple martin	Progne subis											
191	Tree swallow	Tachycineta bicolor											
192	Violet-green swallow	Tachycineta thalassina											
193	Northern rough-winged swallow	Stelgidopteryx serripennis											
194	Bank swallow	Riparia riparia											

	COMMON NAME	SCIENTIFIC NAME	STATUS										NOTES
			FE	FT									
195	Barn swallow	Hirundo rustica											
196	Cliff swallow	Hirundo pyrrhonota											
197	Black-capped chickadee	Parus atricapillus											
198	Mountain chickadee	Parus gambeli											
199	Chestunt-backed chickadee	Parus rufescens											
200	Oak titmouse	Parus inornatus											
201	Bushtit	Psaltriparus minimus											
202	Red-breasted nuthatch	Sitta canadensis											
203	White-breasted nuthatch	Sitta carolinensis											
204	Pygmy nuthatch	Sitta pygmaea											
205	Brown creeper	Certhia americana											
206	Rock wren	Salpinctes obsoletus											
207	Canyon wren	Catherpes mexicanus											
208	Bewick’s wren	Thryomanes bewickii											
209	House wren	Troglodytes aedon											
210	Winter wren	Troglodytes troglodytes											
211	Marsh wren	Cistothorus palustris											
212	American dipper	Cinclus mexicanus											
213	Golden-crowned kinglet	Regulus satrapa											
214	Ruby-crowned kinglet	Regulus calendula											
215	Blue-gray gnatcatcher	Polioptila caerulea											
216	Western bluebird	Sialia mexicana											
217	Mountain bluebird	Sialia currucoides											
218	Townsend’s solitaire	Myadestes townsendi											
219	Swainson’s thrush	Catharus ustulatus											

	COMMON NAME	SCIENTIFIC NAME	STATUS										NOTES
			F E	F T									
220	Hermit thrush	Catharus guttatus											
221	American robin	Turdus migratorius											
222	Varied thrush	Ixoreus naevius											
223	Wrentit	Chamaea fasciata											
224	Northern mockingbird	Mimus polyglottos											
225	Sage thrasher	Oreoscoptes montanus											
226	California thrasher	Toxostoma redivivum											
227	American pipit	Anthus rubescens											
228	Cedar waxwing	Bombycilla cedrorum											
229	Orange-crowned warbler	Vermivora celata											
230	Nashville warbler	Vermivora ruficapilla											
231	Yellow warbler	Dendroica petechia											
232	Yellow-rumped warbler	Dendroica coronata											
233	Black-throated gray warbler	Dendroica nigrescens											
234	Townsend's warbler	Dendroica townsendi											
235	Hermit warbler	Dendroica occidentalis											
236	Macgillivray's warbler	Oporornis tolmiei											
237	Common yellowthroat	Geothlypis trichas											
238	Wilson's warbler	Wilsonia pusilla											
239	Yellow-breasted chat	Icteria virens											
240	Western tanager	Piranga ludoviciana											
241	Green-tailed towhee	Pipilo chlorurus											
242	Spotted towhee	Pipilo erythrophthalmus											
243	California towhee	Pipilo crissalis											
244	Rufous-crowned sparrow	Aimpphila ruficeps											

	COMMON NAME	SCIENTIFIC NAME	STATUS										NOTES
			FE	FT									
245	Chipping sparrow	Spizella passerina											
246	Brewer's sparrow	Spizella breweri											
247	Vesper sparrow	Pooecetes gramineus											
248	Lark sparrow	Chondestes grammacus											
249	Black-throated sparrow	Amphispiza bilineata											
250	Savannah sparrow	Passerculus sandwichensis											
251	Grasshopper sparrow	Ammodramus savannarum											
252	Fox sparrow	Passerella iliaca											
253	Song sparrow	Melospiza melodia											
254	Lincoln's sparrow	Melospiza lincolnii											
255	White-crowned sparrow	Zonotrichia leucophrys											
256	Golden-crowned sparrow	Zonotrichia atricapilla											
257	Dark-eyed junco	Junco hyemalis											
258	Lapland longspur	Calcarius lapponicus											
259	Black-headed grosbeak	Pheucticus melanocephalus											
260	Lazuli bunting	Passerina amoena											
261	Red-winged blackbird	Agelaius phoeniceus											
262	Tricolored blackbird	Agelaius tricolor											
263	Western meadowlark	Sturnella neglecta											
264	Yellow-headed blackbird	Xanthocephalus zanthocephalus											
265	Brewer's blackbird	Euphagus cyanocephalus											
266	Browh-headed cowbird	Molothrus ater											
267	Bullock's oriole	Icterus galbula											
268	Gray-crowned rosy-finch	Leucosticte arctoa											
269	Purple finch	Carpodacus purpureus											

	COMMON NAME	SCIENTIFIC NAME	STATUS										NOTES
			FE	FT									
270	Cassin's finch	Carpodacus cassinii											
271	House finch	Carpodacus mexicanus											
272	Red crossbill	Loxia curvirostra											
273	Pine siskin	Carduelis pinus											
274	Lesser goldfinch	Carduelis psaltria											
275	American goldfinch	Carduelis tristis											
276	Evening grosbeak	Coccothraustes vespertinus											
MAMMALS													
1	Vagrant shrew	Sorex vagrans											
2	Pacific shrew	Sorex pacificus											
3	Ornate shrew	Sorex ornatus											
4	Water shrew	Sorex palustris											
5	Marsh shrew	Sorex bendirii											
6	Trowbridge's shrew	Sorex trowbridgii											
7	Merriam's shrew	Sorex merriami											
8	Shrew-mole	Neurotrichus gibbsii											
9	Townsend's mole	Scapanus townsendii											
10	Coast mole	Scapanus orarius											
11	Broad-footed mole	Scapanus latimanus											
12	Little brown myotis	Myotis lucifugus											
13	Yuma myotis	Myotis yumanensis											
14	Long-eared myotois	Myotis evotis											
15	Fringed myotis	Myotis thysanodes											
16	Long-legged myotis	Myotis volans											
17	California myotis	Myotis californicus											
18	Hoary bat	Lasiurus cinereus											

	COMMON NAME	SCIENTIFIC NAME	STATUS										NOTES
			F E	F T									
19	Western red bat	Lasiurus borealis											
20	Silver-haired bat	Lasionycteris noctivagans											
21	Western pipistrelle	Pipistrellus herperus											
22	Bib brown bat	Eptesicus fuscus											
23	Townsend’s big-eared bat	Plecotus townsendii											
24	Pallid bat	Antrozous pallidus											
25	Brazilian free-tailed bat	Tadarida brasiliensis											
26	American pika	Ochotona princeps											
	Brush rabbit	Sylvilagus bachmani											
	Mountain cottontail	Sylvilagus nuttallii											
	Desert cottontail	Sylvilagus audubonii											
	Snowshoe hare	Lepus americanus											
	White-tailed hare	Lepus townsendii											
	Black-tailed hare	Lepus californicus											
	Mountain beaver	Aplodontia rufa											
	Least chipmunk	Tamias minimus											
	Yellow-pine chipmunk	Tamias amoenus											
	Yellow-cheeked chipmunk	Tamias ochrogenys											
	Allen’s chipmunk	Tamias senex											
	Siskiyou chipmunk	Tamias siskiyou											
	Sonoma chipmunk	Tamias sonomae											
	Yellow-bellied marmot	Marmota flaviventris											
	Belding’s ground squirrel	Spermophilus beldingi											
	California ground squirrel	Spermophilus beecheyi											
	Golden-mantled ground squirrel	Spermophilus lateralis											

	COMMON NAME	SCIENTIFIC NAME	STATUS										NOTES
			F E	F T									
	Western gray squirrel	Sciurus griseus											
	Douglas' squirrel	Tamiasciurus douglasii											
	Northern flying squirrel	Glaucomys sabrinus											
	Botta's pocket gopher	Thomomys bottae											
	Northern pocket gopher	Thomomys talpoides											
	Western pocket gopher	Thomomys mazama											
	Mountain pocket gopher	Thomomys monticola											
	Great Basin pocket mouse	Perognathus parvus											
	California kangaroo rat	Dipodomys californicus											
	American beaver	Castor canadensis											
	Western harvest mouse	Reithrodontomys megalotis											
	Deer mouse	Peromyscus maniculatus											
	Canyon mouse	Peromyscus crinitus											
	Brush mouse	Peromyscus boylii											
	Pinyon mouse	Peromyscus truei											
	Northern grasshopper mouse	Onychomys leucogaster											
	Dusky-footed woodrat	Neotoma fuscipes											
	Bushy-tailed woodrat	Neotoma cinerea											
	Western red-backed vole	Clethrionomys californicus											
	Heather vole	Phenacomys intermedius											
	White-footed vole	Phenacomys albipes											
	California red tree vole	Phenacomys longicaudus											
	Montane vole	Microtus montanus											
	California vole	Microtus californicus											
	Townsend's vole	Microtus townsendii											

	COMMON NAME	SCIENTIFIC NAME	STATUS										NOTES
			F E	F T									
	Lont-tailed vole	Microtus longicaudus											
	Creeping vole	Microtus oregoni											
	Common muskrat	Ondatra zibethicus											
	Western mumping mouse	Zapus princeps											
	Pacific jumping mouse	Pacific jumping mouse											
	Common porcupine	Erithizon dorsatum											
	Coyote	Canis latrans											
	Red fox	Vulpes vulpes											
	Gray fox	Urocyon cinereoargenteus											
	Black bear	Ursus americanus											
	Northern sea lion	Eumetopias jubatus											
	California sea lion	Zalophus californianus											
	Harbor seal	Phoca vitulina											
	Northern elephant seal	Mirounga angustirostris											
	Ringtail	Bassariscus astutus											
	Raccoon	Procyon lotor											
	American marten	Martes americana											
	Fisher	Martes pennanti											
	Ermine	Mustela erminea											
	Long-tailed weasel	Mustela frenata											
	Mink	Mustela vison											
	Wolverine	Gulo gulo											
	American badger	Taxidea taxus											
	Western spotted skunk	Spilogale gracilis											
	Striped skunk	Mephitis mephitis											
	Northern river otter	Lutra canadensis											

	COMMON NAME	SCIENTIFIC NAME	STATUS										NOTES
			FE	FT									
	Mountain lion	Felis concolor											
	Bobcat	Felis rufus											
	Elk	Cervus elaphus											
	Mule deer	Odocoileus hemionus											
	Pronghorn	Antilocapra americana											
	Mountain sheep*****	Ovis candensis											

APPENDIX IV. COMMON AND SCIENTIFIC NAMES OF PLANT SPECIES MENTIONED IN TEXT.

Common Name	Scientific Name
Arroyo willow	*Salix lasiolepis*
Ashy ryegrass	*Leymus cinereus*
Aspen	*Populus tremuloides*
Baker cypress	*Cupressus bakeri*
Beach pine	*Pinus contorta contorta*
Beaked sedge	*Carex utriculata*
Big sagebrush	*Artemisia tridentata*
Bishop pine	*Pinus muricata*
Bitterbrush	*Purshia tridentata*
Black sagebrush	*Artemisia nova*
Black willow	*Salix gooddingii*
Blackbrush	*Coleogne spp.*
Blue Blossom	*Ceanothus thrysiflorus*
Bluebunch wheatgrass	*Agropyron spicatum*
Brewer oak	*Quercus garryana var. breweri*
Bulrushes and cattails	*Scirpus spp. and Typha spp.*
Bulrushes	*Scirpus spp.*
Buttonbush	*Cephalanthus occidentalis*
California blackberry	*Rubus ursinus*
California buckeye	*Aesculus californica*
California bay	*Umbellularia californica*
California oatgrass	*Danthonia californica*
Cattails	*Typha spp.*
Ceonothus	*Ceonothus spp.*

Chamise	*Adenostoma fasciculatum*
Cheatgrass	*Bromus tectorum*
Coast live oak	*Quercus agrifolia*
Common pickleweed	*Salicornia virginica*
Common reed	*Phragmites australis*
Cordgrasses	*Spartina spp.*
Coyote bush	*Baccharis pilularis*
Creeping ryegrass	*Leymus triticoides*
Crested wheatgrass	*Agropyron desertorum*
Curlleaf mountain-mahogany	*Cercocarpus ledifolius*
Dense-flowered cordgrass	*Spartina densiflora*
Ditch-grasses	*Ruppia spp.*
Douglas-fir	*Pseudotsuga menzeiesii*
Duckweeds	*Lemna spp.*
Eastwood manzanita	*Arctostaphylos glandulosa*
Engelmann spruce	*Picea engelmannii*
Eucalyptus	*Eucalyptus spp.*
Fescue	*Festuca spp.*
Foxtail pine	*Pinus balfouriana*
Fremont cottonwood	*Populus fremontii*
Giant reed	*Arundo donax*
Gowan cypress	*Cupressus goveniana goveniana*
Grand fir	*Abies grandis*
Grand fir	*Abies grandis*
Green fescue	*Festuca viridula*
Hooker willow	*Salix hookeriana*
Iceplant	*Mesembryanthemum spp.*
Idaho fescue	*Festuca idahoensis*
Incense-cedar	*Calocedrus decurrens*

Interior live oak	*Quercus wislizenii*
Iodine bush	*Allenrolfea occidentalis*
Jaumea	*Jaumea carnosa*
Jeffrey pine	*Pinus jeffreyi*
Kentucky bluegrass	*Poa pratensis*
Knobcone pine	*Pinus attenuata*
Leather oak	*Quercus durata*
Lodgepole pine	*Pinus contorta murrayana*
Madrone	*Arbutus menziesii*
McNab cypress	*Cupressus macnabiana*
Monkeyflower	*Mimulus aurantiacus*
Mosquito ferns	*Azolla spp.*
Mountain alder	*Alnus incana*
Mulefat	*Bacharis salicifolia*
Narrowleaf willow	*Salix exigua*
Native dunegrass	*Leymus mollis*
Nebraska sedge	*Carex nebrascensis*
Oatgrass	*Danthonia spp.*
Ocean spray / rock-spirea	*Holodiscus spp.*
Pacific silver fir	*Abies amabilis*
Pacific reedgrass	*Calamagrostis nutkaensis*
Pampas grass	*Cortaderia spp.*
Parry rabbitbrush	*Chrysothamnus parryi*
Pickleweed	*Salicornia spp.*
Ponderosa pine	*Pinus ponderosa*
Port-Orford cedar	*Cupressus lawsoniana*
Purple needlegrass	*Stipa pulchra*
Pygmy cypress	*Cupressus goveniana pygmeae*
Pygmy pine	*Pinus contorta bolanderi*

Red alder	*Alnus rubra*
Red fescue	*Festuca rubra*
Red willow	*Salix laevigata*
Redwood	*Sequoia sempervirens*
Rubber rabbitbrush	*Chrysothamnus nauseosus*
Sadler oak	*Quercus sadleriana`*
Sagebrush	*Artemisia spp.*
Salal	*Gaultheria shallon*
Saltbush	*Atriplex spp.*
Saltgrass	*Distichlis spicata*
Sandbar willow	*Salix sessilifolis*
Sargent cypress	*Cupressus sargentii*
Scrub oak	*Quercus berberidifolia*
Sea rocket	*Cakile spp.*
Seaside wooly sunflower	*Eriophyllum staechadifolium*
Sedges	*Carex spp.*
Shadscale	*Atriplex confertifolia*
Sitka willow	*Salix sitchensis*
Sitka alder	*Alnus viridis*
Sitka spruce	*Picea sitchensis*
Spikerushes	*Eleocharis spp.*
Subalpine fir	*Abies lasiocarpa*
Sugar bush	*Rhus ovata*
Sugar pine	*Pinus lambertiana*
Tamarisks	*Tamarix spp.*
Tanoak	*Lithocarpus densiflora*
Toyon	*Heteromeles arbutifolia*
Tufted hairgrass	*Deschampsia cespitosa*
Valley oak	*Quercus lobaba*

Varicolored lupine	*Lupinus varricolor*
Water birch	*Betula occidentalis*
Western white pine	*Pinus monticola*
Western juniper	*Juniperus occidentalis occidentalis*
Western hemlock	*Tsuga heterophylla*
White fir	*Abies concolor*
Whitebark pine	*Pinus albicaulis*
Yellow pond-lily	*Nuphar luteum*
Yellow bush lupine	*Lupinus arboreus*
Yellow cypress	*Cupressus nootkatensis*

ENDNOTES

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1. U.S. Fish and Wildlife Service (1994)

2. Coastal redwoods extend a few miles north of the ecoregion into Oregon; There are also scattered patches as well as some larger stands of redwood south of San Francisco Bay.

3. Kuchler (1964)

4. For a discussion of the role of salmon as keystone species see Wilson and Halupka (1995). Salmon fishing was once an important industry in the ecoregion. Although it has declined with the decline of the salmon, locally it is an important source of food and income. Culturally, salmon have always been important to native Americans in the region and remain so today. Newer settlers to the region also place great importance upon salmon.

5.Forest Ecosystem Management Assessment Team (1993)

6. Bailey (1966)

7. Page (1966)

8. Macdonald (1966)

9. Taylor (1985); Taylor and Bright (1987)

10. Frest and Johannes (1995)

11. Rantz (1964); Rantz (1967); Rantz (1968)

12. Furniss (1995)

13. Azevedo and Morgan (1974); Dawson (1996); Ingraham and Matthews (1995); Ingwersen (1985)

14. Dawson (1996); Ingraham and Matthews (1995)

15. Dawson (1996)

16. Ingraham and Matthews (1988); Ingwersen (1985)

17. See,for example, Barbour et al.(1993:64-69); Goheen et al. (1997); Jimmerson and Creasy (1997); Martin (1997); Thornburgh (1977); and Zobel (1997);

18. Dawson (1996)

19. Burkhardt (1995); Cooperrider et al. (1998); Fox (1996); Jensen et al. (1990);

20. Sawyer and Keeler-Wolf (1995:359)

21. The term “native” is used here to describe plants or plant communities consisting of species that are not present in a region as a result of human action--deliberate or otherwise. The “non-natives” or “exotic” species are those that arrived as a result of human action. The terms “non-native”, “introduced”, and “exotic” are used interchangeably in the text and all mean the same thing.

22. Art (1993)

23. Holland (1986)

24. Holland (1986)

25. For more detailed information see: Moyle (1976) and McGinnis (1984)on fish; Stebbins (1954) and Zeiner et al. (1988) on amphibians and reptiles; Small (1974), Zeiner et al. (1990a), and Harris (1991) for birds: and Ingles (1965), Zeiner et al (1990b), and Jameson and Peeters (1988) for mammals.

26. The term “native” is used here to describe plants or plant communities consisting of species that are not present in a region as a result of human action--deliberate or otherwise. The “non-natives” or “exotic” species are those that arrived as a result of human action. The terms “non-native”, “introduced”, and “exotic” are used interchangeably in the text and all mean the same thing.

27. Moyle (1976:14)

28. For a most eloquent statement of the importance of invertebrates see Wilson (1987).

29. See Cooperrider et al.(1986); Jones (1986)

30. Cooperrider (1986); Patton (1992); Morrison et al. (1992)

31. Mayer and Laudenslayer (1988)

32. See Timossi et al. (1994) for a user’s manual for Version 5.0 and 5.2 of the program; note that Version 6.0 of the program is in operation, but a user’s manual is not available as of May 1998.

33. Mayer and Laudenslayer (1988)

34. See Cooperrider et al. (1998) for a discussion of the utility of remote sensing in ecosystem management in general and in habitat typing in particular.

35.Blackburn and Anderson 1993a

36. Blackburn and Anderson (1993b)

37. Raphael (1993)

38. Hurtado (1988:41)

39. Hurtado (1988:118)

40. Angle-Franzini (1996); Grant (1973:150); Leydet (1969);

41. County lines do not coincide with those of the ecoregion. Del Norte, Humboldt, and Mendocino Counties (California) are entirely within the ecoregion; portions of Klamath County (Oregon) and Siskiyou, Trinity, and Sonoma Counties (California) lie outside the ecoregion. Small portions of Josephine County, Oregon and Marin and Lake County, California lie within the ecoregion.

42.See for example, Willson (1996); Noss and Cooperrider (1994:41-48); Ricklefs et al. (1984)

43. A certain amount of energy is imported into the region, in particular by animals returning from the ocean such as salmon; however, these and other imports are probably a very small percentage of the energy flow, even though it may be very important in terms of nutrient flow.

44. Perry (1994:372)

45. Gearheart et al. (1995)

46. Mitsch and Gosselink (1993:140) cited in Gearheart et al. (1995:14)

47. This number is based upon a rough estimate of 2 million fish at an average of 10 pounds per fish (equaling 20 million pounds) spread over an ecoregion of roughly 20 million acres.

48. Furniss (1994)

49. Nathaniel Shaler (cited in Perry [1996:267])

50. Furniss (1994)

51. Aztet and Martin (1991)

52. Romme (1980)

53. Martin and Sapsis (1991)

54. Archer and Smeins (1992); Niering (1987); Noss and Cooperrider (1994:46-49); Perry et al (1989); Schlesinger et al. (1990); Jensen et al. (1990:89-93);

55. For a concise summary of many of the effects of logging and associated practices on aquatic habitat see Mount (1995:227-245).

56. See Thomas et al. (1988)

57. See Noss and Cooperrider (1994:75)

58. For more detailed description of effects of dams and diversions see Mount (1995: 313-336); Collier et al. (1996); Jensen et al. (1990:72-82)

59. For a detailed description of mining impacts on waters see Mount (1995:202-226).

60. For a general description of grazing impacts on biodiversity see Fleishner (1994); Society for

Conservation Biology (1994); Noss and Cooperrider (1994:230-247); Cooperrider and Wilcove (1996:67-80), and Chaney et al. (1990).

61. Although individual impacts of particular agricultural practices (e.g. water diversion) are widely recognized, the cumulative impacts of agriculture have rarely been addressed in comprehensive and unbiased fashion. For general discussions see Dasmann (1984:177-231); *****

62. See, for example, Colborn et al. (1996); Jensen et al. (1990:95-109); Sparks (1993); Lightstone (1993);

63. See Noss and Cooperrider (1994:69-71)

64. See Hartzell (1991)

65. See Jensen et al. (1990:62-72)

66. See Noss and Cooperrider (1994:54-57)

67. See Office of Technology Assessment (1993); Mooney and Drake (1986); Mooney et al. (1986); Wagner (1993); McKnight (1993)

68. See Noss and Cooperrider (1994:43-47); Hobbs and Huenneke 1992);

69. Reid (1993)

70. Reid (1993); Christner and Harr (1982)

71. Trush (1994)

72. The results of fragmentation and the vulnerability of small populations to local extinction or extirpation are explored and explained in detail in Hunter (1996); Meffe and Carrol (1994); Primack (1993); Primack (1995); and Soule (1987)).