Ecological Integrity Assessment of The North Coastal Basin

Draft Report

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Introduction

One of Legacy's primary goals is to create a biodiversity conservation strategy for the California North Coastal Basin (NCB). This plan will highlight a network of areas within the region that stand out from the others due to their ecological function and conservation value. One step in the process of locating these areas is to understand the current level of ecological integrity within the major community types across the NCB.

Ecological Integrity Defined

We embrace the definition of Karr and Dudley (1981) "the capability of supporting and maintaining a balanced, integrated, adaptive community of organisms having a species composition, diversity , and functional organization comparable to that of natural habitats of the region."

To give this definition functional value we recognized six components of ecological integrity: 1. Ecosystem health; 2. Biodiversity; 3. Stability; 4. Sustainibility; 5. Naturalness; 6. Wildness. (Noss 1995).

Project Goals

1. To select multiple surrogates (species and attributes) for ecological integrity (EI) at two different scales (landscape and community) for each community type within the NCB.
2. To provide rough guidelines on how to sample for all species and attributes selected.
3. To provide methods to evaluate EI patterns for each community type based on surrogate sampling results.

Methods

A two tiered system was used to select focal species and attributes. The first step employed Lambeck's (1997) "focal species" approach with three additional categories (Keystone species, Narrow endemics, Special cases) recommended by Noss et al. (1997). The second step involved a stressor based approach (Noon unpubl. rept.) which links individual stressors within a landscape or community to the species or attribute most impacted by the impacts of the stressor. We defined stressors as "perturbations that alter resources or act as physiological disrupters such that responses are elicited from the biota, resulting in structural and compositional changes in the biota and detectable population responses" (Noon unpubl. rept.). Both processes were linked in a conceptual model (Fig. 1) which had several steps designed to "weed out" species or attributes that didn't show strong relationships to the stressor or would be too costly to measure in the field. In each case species and attributes best fitting the focal species criteria and those which show the strongest relationships between stressors were selected.

The current levels of knowledge about communities and species within the NCB vary considerably. In many cases the conceptual model asked several questions of potential focal species and attributes that we were not able to answer at this time. In these cases we made judgments based on the best available information. For several communities we chose to directly measure the extent of a stressor due to lack of strong measurable relationships to species or attributes.

Community Description and Distribution

Twelve vegetation and four aquatic types are described. Vegetative community divisions and descriptions were adapted from Barbour and Majors (1987). A vegetation crosswalk from the community types described below to vegetation series is provided in Appendix 1.

MIXED EVERGREEN

Introduction:

The term "mixed evergreen forest" describes a characteristic set of coastal California mountain communities. Many species assemblages and several physiognomic classes are included within this broad category. The closed stands and the broad-leaved, sclerophyllous nature of the dominants typify these forests, which may also contain a minor to significant conifer component. *Acer macrophyllum, Quercus chrysolepis,* and *Umbellularia californica* more or less range throughout this type. Characteristic dominants, at least in some phases, are *Arbutus menziesii, Lithocarpus densiflora, Quercus agrifolia, Q. chrysolepis,* and *Psuedotsuga menziesii*.

The mixed evergreen forest is bounded by a series of vegetation types. The mesic border is with coniferous forests of the Pacific Northwest (hemlock zone and Sitka spruce zone forests), redwood forests, and montane coniferous forests. The xeric border is with chaparral, oak woodland, and grassland communities. In northern California the mixed evergreen forest forms a complicated mosaic with northern oak woodland and coastal prairie. Central coast mountain phases continue to form this character mosaic with oak woodland, grassland, and coastal sage scrub, as well as with chaparral.

The mixed evergreen forest of the coast range can be referred to as the *Psuedotsuga*-hardwood forest. Within the mixed hardwood category it is convenient to recognize a low-elevation *Quercus agrifolia-Arbutus* forest and a redwood border *Lithocarpus-Arbutus-Quercus* forest.

Pseudotsuga-Hardwood Forest

Douglas fir dominates many phases and can be considered the major species of modal communities of the North Coast Range. Various combinations of *Psuedotsuga, Lithocarpus,* and *Arbutus* dominate on deeper, well-watered soils. In southeastern portions of Humboldt and Mendocino Cos., *Pinus ponderosa* becomes a major co-dominant in forests and woodlands. At higher elevations *P. lambertiana* is of secondary importance, and to the south Quercus agrifolia becomes an increasingly common associate.

This region has a long history of intensive grazing and more recently extensive logging. It would be hard to assess the role of land use practices in the extremely complicated vegetation patterns today.

Keep in mind the larger characteristic pattern of forest-woodland-prairie, so typical of the north coastal region. Stands with grassland species in the openings form a transition with oak woodland. Very old forests are hard to find in this very fire-prone landscape; on frequently burned slopes, the hardwood forest is reduced to low thickets. Nonsprouting conifers lose ground to the hardwoods after major fires.

Mixed Hardwood Forests (MHF)

MHF occupy the southern portion of the mixed evergreen forest region, where *Psuedotsuga menziesii* makes only a minor contribution to the mixture or is absent. Pure stands of evergreen hardwoods are locally present throughout the mixed evergreen forest region, but in the North Coast Ranges, pure hardwood stands are often fragmented transitions between *Pseudotsuga*-hardwood forest and northern oak woodland or coastal prairie. From Sonoma Co. southward, MHF stands are recognizable over a large portion of the forested landscape. The MHF understory tends to have many forest shrubs and perennial herbs and few grassland annuals, so typical of oak woodland.

MHF: *Quercus agrifolia-Arbutus* Forest

The lowest-elevational forms of the MHF are dominated by *Quercus agrifolia*, but away from the immediate coast *Arbutus menzeisii* and other hardwoods may be common.

MHF: *Lithocarpus-Arbutus-Quercus* Forest

Found in lower elevations within the coast range, considered a redwood border forest.

REDWOOD AND ASSOCIATED COASTAL FORESTS

Introduction

Redwood is the main species indigenous to the area, and the one that distinguishes the north coastal forests of California. In traversing these forests from moist to dry locations (as along the coast from Crescent city to Ukiah), one progresses from Sitka spruce-grand fir-hemlock in moist areas, to redwood mixed with other conifers, to redwood mixed with hardwoods, to Douglas fir-hardwoods, and finally to grassland-oak woodland mosaics in the driest situations. The zoning for these forest types is complex, roughly following both longitudinal and inland gradients.

The redwood belt is usually only about 16km wide, and is not always near the coast except as one approaches the southern limit. Hardwoods (except red alder) increase with distance inland.

Grand fir-Sitka Spruce-Douglas fir

These forests are found in greatest extent in the Wildcat Hills between the Bear River Ridge and the Eel River, south of Ferndale.

Redwood-Grand fir

This type progresses through a similar seral stage after logging or windthrow. Sitka spruce and western red cedar may show up in this type.

Threats

Redwood forest is estimated to have covered 800,000 ha 160 years ago (Stone et al. 1972; Leydet 1969). Today less than 5% of this virgin forest is left, and only half of that is in protected parkland. Moreover, protected stands that occupy only the lower slopes of watersheds can be endangered by the activities of private developers above them, so the degree of protection for some stands is relative at present. In addition, it is possible that redwood stands will not maintain their population sizes without natural or managed fire and flood cycles. It may be necessary to develop a 500-1000 year management plan for these parks if they are to remain well into the twenty-first century.

OAK WOODLANDS

Introduction

Species from adjacent grassland, chaparral, and forest communities associate with the "woodland" trees over a wide range of physiographical and climatic situations. Many endemics grow in the oak woodland, but often extend well beyond into other vegetation types. Physiognomic unity is also difficult to detect in vegetation with such variable combinations and densities of deciduous broad-leaved, evergreen broad-leaved, evergreen needle-leafed trees.

Open stands of deciduous "white oaks" characterize vast tracts of oak woodland, but evergreen "black oaks" (this evergreen form is a sub-genera of the normally deciduous black oak) are often present and sometimes dominant. Also, one species of pine may be scattered among the oaks. On the ground the oak woodland has significant grass cover under and between the trees. The combination of the interspersed grassland may be similar whether the oaks are of savanna (isolated trees) or woodland (>30% cover) density. The combination of partial deciduous oak canopy and grassy ground cover distinguishes the typical form of this vegetation.

Oak woodland (OW) can be viewed as a group of variable communities geographically placed between grassland or scrub and montane forests. The xeric lower border of OW is easily defined by the absence of trees--where the savanna form of OW becomes true grassland or scrub. The mesic upper boarder, where the increasingly dense woodland becomes forest, is more difficult to establish. The presence of the appropriate woodland indicator oaks is as important as the actual tree density. Where the proportion of live oaks becomes great, the OW can be only arbitrarily separated from interior forms of the mixed evergreen forest. Often the upper woodland border is obscured by a chaparral zone between the typical woodland and the forest above.

In a geographical context the OW is well known. Cattle ranches have occupied most of the community for over a century. The woodlands have been intensively prospected for minerals. Accessibility to the woodlands has always been relatively easy.

Foothill Woodland (FW)

FW has two major physiographical subdivisions. On deep soils, *Quercus lobata* often forms nearly pure stands of large trees with no woody understory (valley oak phase). Such *Q. lobata* savannas appear similar in structure on valley bottoms and rolling slopes over a wide range of elevations. A few coast live oaks (*Q. agrifolia*) may be scattered with this phase in Coast Range valleys. On shallower upland soils a more mixed-species community develops. *Quercus douglasii* and *P. sabiniana* are the most characteristic trees in the hillside woodlands (blue oak phase). Live oaks are far more important in the uplands. Throughout the blue oak phase *Q. lobata* may be present on deep soils. Nonsprouting chaparral shrubs are scattered about. In all regions there is an elevational gradient with increased tree and shrub density of evergreens at higher elevations.

Valley Oak Phase (VO)

Park-like *Q. lobata* stands are best developed on most recent alluvial terraces of large valleys, but they may extend onto older terraces and low rolling hills.

Blue Oak Phase (BO)

The western margin of the BO in the Coast Range is quite irregular, and local soil conditions often control woodland distribution. BO grow over many thousands of

hectares in SE Mendocino Co. The Hopland Field Station has BO with an average density of 500 tree/ha and avg. DBH of 20cm.

North Slope Phase (NS)

In the southern portion of the north Coast Ranges steep north facing slopes may have a dense canopy in which *Q. douglasii* in uncommon or absent. The deciduous Aesculus californica is often conspicuous in these thickets along with evergreens like *Umbulleria californica, Prunus ilicifolia,* and *Heteromeles arbutifolia* (Beneseler 1968). Very steep slopes of Putah and Cache creeks have this community where unburned. *P. sabiniana* tower over the dense, tall *Aesculus-Heteromeles-Fraxinus dipletata*.

NORTHERN OAK WOODLAND

Foothill Woodland Transition (FWT)

In a few North Coast Range localities, it seems appropriate to consider northern oak woodland as a continuation of foothill woodland with merely a change in the dominant white oak.

Bald Hills (BH)

BH not only have *Q. garryana* instead of *Q. douglasii* but also have a different structure. Although there is a superficial resemblance, the savannas have a more balanced mixture of *Q. douglasii* trees and grass, whereas on BH either *Q. garryana* or grass are dominant (Clark 1937). In part, this grass-tree mosaic reflects a soil mosaic. The best development of BH occurs on ridgetops in Mendocino and Humboldt Cos. up to 1600m in elevation.

CLOSED-CONE PINE AND CYPRESS

The closed-cone pines and cypress are unique, disjunct plant communities scattered the length of the NCB's coast and mountains. These 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 characteristic species are the closely related knobcone pine (*Pinus attenuata*), bishop pine (*P. muricata*), and possibly shore pine (*P. contorta* ssp. *contorta*) and pygmy pine (*P. contorta* ssp. *bolanderi*) (Knapp 1965). The cypresses include 3 species that are all endemic to California. They are MacNab cypress (*Cupressus macnabiana*), Mendocino cypress (*C. pygmaea*), and Sargent cypress (*C. sargentii*). The major species are intimately related to fire, 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.

Mendocino Cypress

This cypress is mainly confined to a narrow discontinuous strip up to several kilometers wide along the Mendocino coast. The strip lies approximately 2.4-3.2 km inland. Throughout its range *C. pygmaea* is a dominant member of the closed-cone pine forest. However, surrounding the pine barrens it is associated with dominant species of the north coastal coniferous forest, Douglas fir forest, and redwood forest. Common shrubs include *Arctostaphylos nummularia, A. columbainum, Vaccinium ovatum,*

Guatheria shallon, *Ledum glandulosum* ssp. *columbianum*, and *Rhododendron macrophyllum*.

Sargent Cypress

Confined to the inner and outer Coast Ranges, Sargent cypress ranges from Red Mt. in northern Mendocino Co. to southern Sonoma Co. within the NCB. It is commonly found along creeks and lower canyon slopes, most frequently associated with chaparral and foothill woodland communities. Throughout most of its range, *C. sargentii* is associated with *P. sabiniana, Ceanothus cuneatus, Quercus dumosa,* and *Q. durata* usually inhabiting ultra-mafic (serpentine) or ultra-basic soils.

Macnab Cypress

Scattered groves occur in the inner Northern Coast Ranges within Sonoma and Mendocino counties in the NCB. *C. macnabiana* is associated with chaparral and foothill woodland species. This species co-occurs with Sargent cypress, but is more likely to occupy ridgetops. It also occurs on ultra-mafic and ultra-basic sols as well as other soil types.

Closed-cone Pines

Knobcone pine grows commonly in the North Coast Range up to 1524m. Little is known about the vegetation of *P. attenuata* groves or forests. This conifer is apparently restricted to serpentine or other infertile substrates by the degree of plant competition or allelopathy found on nonspecialized soils (Whittaker 1954b; Horton 1960; Christensen and Muller 1975). It may also be interspersed with chaparral and sometimes mixed evergreen. Fire is the usual and necessary cone opener, simultaneously preparing a favorable seedbed. Reproduction is also absent in decadent stands where the majority of trees are senescent or dying, conditions sometimes created by fire prevention.

P. Attenuata occurs in even-aged stands that originate after fire (Newcomb 1962) and often forms mosaics of different aged stands (Vogel 1973). Trees that escape fire begin dying when they are about 50 yr. old; only a rare tree lives to 100 yr. Knobcone pine sites are subject to frequent fires, perhaps once every 33-50 years, because of their relationships to other fire type communities, edaphically dry sites, and early widespread senescence leading to favorable fuel conditions.

Bishop Pine

P. muricata is distributed discontinuously along the coast from Humboldt to Sonoma Cos. in the NCB (Duffield 1951; Griffin and Crutchfield 1972). The largest and greatest numbers of stands occur in Mendocino and Sonoma Cos. Bishop pine is remarkably variable from one disjunct population to the next and even varies within one stand. The species exists in a maritime climate, occupying headlands and low hills from near sea level to 400m elevation, usually within 12 km of the ocean. Additional moisture is provided by fogs and for drip, which may be particularly critical in the dry summer (Libby et al. 1968). Bishop pine stands occur in Douglas fir forest, mixed evergreen forest, redwood forest, coastal grassland, and pygmy forest. These forests are rich in ercads such as *Artstaphylos* spp., *Vaccinium ovatum, V. parvifolium, Gaultheria shallon, Arbutus menziesii, Rhododendron macrophyllum,* and *Ledum glandulosum* ssp. *columbianum* (Westman 1975).

Stands of *P. muricata* are characteristically even aged, originating after fires (Linhart et al. 1967; Cole 1974). Cones are usually opened by fire, but on rare occasion old cones

may open on a hot day. A fire-free period of 80+ years would allow trees to succumb to disease and die without reproducing.

Beach Pine

P. contorta ssp. contorta in found along the Pacific coast from Mendocino to southern Alaska, but is uncommon within the NCB. Although included with the closed-cone pines, there are still questions about whether this subspecies possesses a distinct closed-cone habit. Beach pine is confined to coastal dune and seaside bluff habitats in the NCB.

Pygmy Pine

P. c. ssp. bolanderi is endemic to the white plains or barrens of coastal Mendocino Co. Pygmy pine usually forms a dwarf forest with thickets of pygmy cypress and several endemic shrub species, including *Arctostaphylos nummularia*. Thickets of stunted trees are often apparently even aged, relating to the closed-cone habit and fire origin.

MONTANE-SUBALPINE FORESTS

The Klamath montane forests form a series of more or less discrete, island-like patches within a matrix of low-elevation forest and woodlands in the NCB. These forests grow mostly above low-elevation coniferous forests rather than chaparral, woodlands, or grasslands. Dominant species, such as *Psuedotsuga menziesii, Pinus ponderosa*, and *P. lambertiana*, are typical of low as well as montane elevations. The lower elevational limit of the montane zone may therefore be difficult to establish, or at best arbitrary. The occurrence of Abies concolor on mesic habitats has been recognized as the montane indicator. Within this definition the lower limit is about 600m within the NCB. Two of the four elevational zones are present within the NCB, and can be recognized according to the dominant climax trees of the mesic habitats. These are, with increasing elevation, *Abies concolor* and *A. magnifica* var. *shastensis*.

CHAPARRAL

California chaparral is composed primarily of evergreen woody shrubs, which can form extensive shrublands that occupy hill and lower mountain slopes within the NCB. It is adapted to drought and fire, passing endlessly through cycles of burning and regrowth. The physiognomy of chaparral is much the same throughout its range, yet there is a great amount of floristic diversity. Chaparral soils are highly porous in texture and are notoriously low in essential plant nutrients. Some chaparral grows on serpentine soils, particularly in Northern California (CA).

The Mediterranean climate is the overriding environmental factor in the ecology of CA chaparral. In the late summer and early autumn hot, dry winds add to the severity of the drought stress to which chaparral is exposed. In this desiccated state, conditions for fire in the chaparral are extraordinarily great.

Fire is a powerful force in the total ecology of CA chaparral. Most of the fires in CA natural areas are in chaparral, occurring with a frequency of once every 10-40 yr. (Muller et al. 1968). Fire maintains or assures the perpetuation of many chaparral species (Vogal 1970; Vogal and Schorr 1972).

Extensive variation and hybridization are rampant among certain genera of CA chaparral (Cooper 1922). There is also a high degree of CA endemism within chaparral, with some species considered rare or endangered by the CNPS (Powell 1974). In the NCB, chaparral is more widely scattered than in the other portions of its range in CA.

Chamise Chaparral

This is the dominant type of chaparral throughout CA, with chamise (*Adenostoma fasciculatum*) being the dominant member. It is associated with hot, xeric sites (south- and west-facing slopes and ridges), forming extensive stands in Mendocino county. Chamise chaparral is a dense, interwoven vegetation 1-2(3)m high at maturity, without understory (Horton 1960; Hanes 1971) and with scanty litter.

NORTH COASTAL SCRUB

This community extends in a narrow coastal strip through the NCB. It is dominated mainly by evergreen shrubs that are less than 2 m tall, but has an additional herbaceous element to the extent in which the scrub is interrupted by patches of coastal prairie. Important shrubs include *Baccharis pilularis* var. *consanguinea*, *Eriophyllum staechadifolium*, *Gualtheria shallon, Lupinus variicolor, Diplacus aurantiacus*, and *Rubus vitifolius*. There are two distinct phases of northern coastal scrub, one dominated by *Baccharis*, the other by *Lupinus*. The *Baccharis* phase dominates most of the range of northern coastal scrub in the NCB, with the *Lupinus* phase diping into the southern portion of Sonoma Co.

COASTAL PRAIRIE

The *Festuca-Danthonia* grassland, or coastal prairie, occurs intermittently along the coast of the NCB. The boundary between coastal prairie and valley grassland is unclear, but it probably lies near the inland side of the coast redwood type. The prairie is discontinuous grassland below 1000 m in elevation and seldom more than 100 km from the coast. Typically it occurs on south-facing slopes.

The dominant perennial grasses include *Festuca idahoensis*, *F. rubra*, and *Danthonia californica*. Coastal prairie is still dominated by perennials and will return on other areas under proper grazing practices.

RIPARIAN FORESTS (lowland riparian may be the focus)

Riparian forests occur along the lower stretches of the major rivers within the NCB, generally below 3000 ft in elevation. Cottonwoods, alders, and willows dominate this community type. The majority of these forests have been converted to pasture, agricultural fields, or structures (e.g. houses, industrial sites). These forests are important migration corridors and stop-over points for birds and bats.

COASTAL SALT MARSH

Coastal salt marshes 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 the frequency and duration of flooding. These gradients are frequently reflected in the vertical zonation of different halophytes across the salt marsh. Within the NCB, salt marsh habitat is found only in the Humboldt Bay, Eel River, Russian River, and Bodega Bay estuaries.

BEACH and DUNE

Introduction

Only 23% of California's 1326 km long coastline is occupied by beach and dune (Cooper 1967). Beach and dune type locations within the North Coastal Basin (NCB) include: Dillon Beach (in NCB?), Bodega Beach, Pt. Arena, Ft. Bragg, and Humboldt Bay. Of these the least altered, as of 1988, is Humboldt Bay.

Beach is defined as the expanse of sandy substrate between mean tide and the foredune or, in the absence of a foredune, to the furthest inland reach of storm waves. Because of occasional but reoccurring inundation by seawater, the beach is the logical extension of the intertidal zone.

Dune is defined here to include the sandy, open habitat that extends from the foredune to typically inland vegetation on stabilized substrate. Major differences between beach and dune in salt spray, soil salinity, and air and soil temperatures have been demonstrated (Johnson 1963, Barbour et al. 1973, Martin & Clements 1939, Purer 1963).

Introduced Taxa

European beach grass, or marram grass (*Ammophila arenaria*), has been widely planted along the Pacific coast in the last 100 years (and is established at ?? of the five locations within the NCB.) Cooper (1936,1967) believed that this species has changed the topography of dunes. Before its introduction, foredunes were low, rose gradually, and were dominated by *Elymus*; they led to a series of dunes alternating with swales which all were oriented roughly perpendicular to the coast, that is aligned with the prevailing onshore winds. Such a virgin dune system may still persist south of Trinidad Head. Most systems have been replaced by a steep, *Ammophila*-dominated foredune that gives way to a series of dunes and swales oriented parallel to the coast.

Historically, erosion management has been done by planting *Ammophila arenaria* or *A. breviligulata*. It is believed that the need for erosion management has been heightened in this century by human-caused trampling of dune vegetation. Other impacts include: grazing by livestock, attempts at cultivation, and recreation (hiking, walking, equestrian, and especially vehicular). Other introduced exotics include: Cakile edentula, C. maritima, Mesembryanthemum chilense, M. edule, Lupinus arboreus, as well as a number of annual grasses and forbs restricted to localized wet depressions.

Beach vegetation is low in species richness and plant cover. Generally, about five taxa compose the vegetation at any one beach, and only one or two contribute significantly to the amount of cover--usually *Ammophila arenaria.* In brief, Ammophila arenaria, Elymus mollis, Ambrosia chamissonis, and Cakile maritima, in that order, characterize beaches north of Pt. Reyes. Any one of the four may be dominant, but all four are usually present. *Abronia latifolia* and *Calystegia solandanella* are common subdominant associates. Dune vegetation may be broken into four plant communities characterized by habitat: moving dune, stabilized ridge, vernal pool hollow, and dune forest.

South of Arcata, climax dune forest is dominated by *Pinus muricata*, and just north of the town of Bodega Bay the climax shifts to a dune scrub. From Arcata north, climax dune forest is dominated by *Pinus contorta* and *Picea stitchensis.*

Vernal Pools (Questionable occurrence within the NCB).

A vernal pool or hogwallow is a small, hardpan-floored depression in a valley grassland mosaic that fills with water during the winter. As it dries up in the spring, various annual plant species flower, often in conspicuous concentric rings of showy colors. Vernal pool

vegetation is unique, included as one of the eight regions of rich endemism. Vernal pools are only located in the vicinity of Humboldt Bay and (see distrib. map to determ. other location) within the NCB.

AQUATIC HABITATS

The aquatic habitats of the North Coastal Basin (NCB) have been divided into four categories: (1) riverine (streams with orders >=2), (2) estuarine, (3) lakes & ponds, and (4) springs, marshes, and streams (with orders <=1).

Riverine

The riverine habitat of the NCB is defined as the freshwater portion of all streams and extends from the estuarine/freshwater interface upstream to the confluence of all tributaries with orders less than or equal to one. These streams collectively drain the portion of the coast range from Redwood Creek in the north to the Russian River in the south. The upper reaches of most riverine habitats in the NCB have moderate to extreme gradients, while the lower reaches have gentle gradients as the rivers cruise through the coastal plain en route to the ocean. Although many of these streams are small, several are large enough to be named as rivers and include the Little, Mad, Elk, Eel, Van Duzen, Salt, Bear, Mattole, Ten Mile, Noyo, Big, Albion, Navarro, Garcia, Gualala, and Russian Rivers, respectively.

The annual hydrologic pattern can be described as being relatively dry in the beginning of the water year from July through September, with many of the smaller streams having no surficial flow. Strong precipitation events usually begin to arrive in October, and as the soils become saturated the potential for flooding increases. Peak discharges typically occur between November and March, and the number of flood events produced depends on the frequency, timing, and magnitude of precipitation events within a season. Precipitation amounts begin to taper off in April, and by June most of the water entering the basin is extracted from fog.

Most of these drainages are characterized by topography of steep relief and are underlain by Franciscan soils that are susceptible to high rates of weathering. This unstable characteristic of local geology is exacerbated by the widespread land-use practices of logging and livestock grazing that denude the landscape of natural cover and expose extensive areas of land to the elements. Consequently, the majority of north coastal streams are impacted by excessive amounts of sediment and debris that are deposited into streambeds during precipitation events of large magnitude.

The riverine community of aquatic species is quite complex owing to the substantial area and diverse physical attributes encompassed by this habitat. The vertebrate component is largely an assembly of fish species, which are obviously confined to the aquatic zone, coexisting with a smaller component of amphibians that have the ability to survive outside of water. The riverine habitat also contains a large assemblage of exotic fish species that have successfully established populations within the large area covered by this freshwater zone.

Estuarine

The estuarine habitat of the NCB is defined as the brackish water portion of all streams that flow into the ocean, and extends from the seawater/brackish-water interface upstream to the brackish-water/freshwater interface. Although most streams in the NCB have an

estuary or lagoon, some do not flow into the ocean, such as the Van Duzen River, and thus do not contain an estuarine habitat.

The estuarine habitat is characterized by very gentle gradients, as the water elevation is similar to sea level, thus allowing freshwater and seawater to blend. The salinity gradient present in the estuarine zone supports a high diversity of aquatic species and is one of the primary factors responsible for the substantial productivity associated with this habitat.

The occurrence of an aquatic species within the estuarine zone is contingent on its ability to tolerate salinity. Many native fishes of the NCB have evolved to tolerate both saline and freshwater, and the fish communities that utilize both the estuarine and riverine habitats are therefore quite similar. Although amphibians are less common in the estuarine habitat than the riverine habitat due to their general low tolerance of salinity, they are able to utilize the edges of this environment where freshwater is in greater abundance. Although some exotic species are present in the estuarine habitat, most exotic species introduced to the NCB are fishes that also do not posses the ability to tolerate salinity, and since they must remain in water they are mostly found in freshwater environments.

Lakes & Ponds

The lakes & ponds aquatic habitat of the NCB is defined as inland bodies of freshwater containing no apparent flow. This definition encompasses all inland waterbodies visible on 7.5 minute U.S.G.S topographic maps, but generally excludes stillwater lengths of large riverine bodies that simulate a lacustrine environment. All waterbodies greater than or equal to one acre in surface area are classified as lakes, while ponds are less than one acre in surface area. Although these two subhabitats differ by surface area, they can often be similar in depth, temperature, elevation, water chemistry, and productivity, and thus generally have the potential to contain similar communities of aquatic species.

The lakes & ponds aquatic habitat is primarily characterized by a large assemblage of amphibians. Native fishes generally were not able to naturally colonize this habitat but are present mainly through transplants, and are thus considered exotic species along with a diverse array of non-native fish species that have also been introduced.

Springs, Freshwater marshes & Streams

The springs, marshes, and streams aquatic habitat of the NCB is defined as a collection of inland waterbodies collectively comprising seeps, springs, wet meadows, swamps, marshes, and streams with orders less than equal to one. All of these subhabitats are composed of freshwater, have the potential to lose their surface water during part of the annual water cycle, and are generally unable to be utilized by most fish, especially the larger native salmonids that are so prevalent within the NCB.

This habitat is also primarily characterized by a large assemblage of amphibians. Although some smaller fishes have the ability to colonize the stream subhabitat, these collective subhabitats are generally absent of fish due to their shallow depths and their capacity to have high water temperatures.

EXTRINSIC STRESSORS

A single stressor has the ability to affect one to many of the habitats and species of the NCB. The following stressors have been identified to be major factors affecting the decline in integrity of habitats in the NCB, and thus the decline in abundance of many species' populations.

1) ROAD BUILDING: Road building (primarily unpaved dirt roads) is widespread throughout the NCB and often occurs on steep terrain containing soils prone to erosion. Since these roads are mainly built in areas that are eventually logged, future precipitation events cause many to fail. The primary negative effects that road building can have on habitats and native species are: direct habitat loss, fragmentation, increased edge effects, increase in erosion and sedimentation of aquatic habitats, loss of interior patch habitat, and increased vehicle and human access to remote areas.

a) creation of the potential for depositing massive amounts of sediment and debris into aquatic habitats. Excessive amounts of sedimentation prevent the successful reproduction of many fishes native to the NCB, and has been identified as a major factor affecting their declines.

2) TIMBER HARVEST: Timber harvest is a widespread land-use practice in the NCB that affects large parcels of land due to the extensive holdings owned by timber companies. The effects that canopy removal from timber harvest can have on communities and native species are: increasing rates of erosion and sedimentation of aquatic habitats, loss of late seral forest, loss of large woody structure (terrestrially and in aquatic communities), fragmentation, change in soil moisture regimes, increased precipitation runoff rates and thus increasing flooding potentials, increasing temperatures of aquatic habitats, and increasing the potential for exotic plant invasion.

a) Exposing slopes of land (that are often quite steep) to precipitation, and thus increasing rates of erosion and sedimentation into aquatic habitats.

b) Reducing the amount of riparian habitat that can buffer aquatic habitats from flooding and sedimentation.

c) Increasing temperatures of aquatic habitats, having a negative effect on native fish growth while favoring the growth of many exotic fishes

3) GRAZING: Grazing by livestock animals is prevalent within the NCB and has multiple negative effects on native species including: riparian habitat degradation, competition with native herbivores, inhibiting or depressing regeneration of native plants (e.g. oaks), favoring exotic plant species (e.g. exotic graminoids vs. natives), increases human caused mortality for medium and large carnivores, increased erosion, and simplification of vegetative structure.

a) Degrades the quality of riparian vegetation and increases the potential for erosion and thus sedimentation into aquatic habitats.

b) Reduces the amount of riparian habitat that can buffer aquatic habitats from flooding and sedimentation.

4) WATER PROJECTS: Water projects include the presence of dams, channelization measures, and water diversions that have the following effects on native aquatic species:

a) Dams reduce the downstream volume of water in aquatic habitats thus reducing the amount of breeding and rearing (suitable) habitat available to species

b) Dams disrupt the natural hydrologic regime of aquatic habitats thus inducing rates of channelization with corresponding losses of riparian and suitable habitat

c) Dams prevent the passage of migrating fish species where adequate fish ladders are absent.

d) Channelization measures restrict natural meandering of watercourses thus reducing aquatic and riparian habitat and increased scouring of the current watercourse channel, reducing habitat quality.

e) Diversions reduce the downstream volume of water in aquatic habitats thus reducing the amount of suitable habitat available to species.

5) URBANIZATION: Urbanization includes the loss of natural habitat to a variety of development activities (conversion to homes, agriculture, pasture, etc.) that affect native species by: reducing the amount of habitat available to species (especially in lowlands, valleys, and the coastal plain), increasing fragmentation effects, increasing exotic species introduction, and increased pollution.

6) POLLUTION: Pollution includes many forms of degradation (e.g. chemical runoff, excess sediment loads, thermal) mainly caused by industrial and agricultural activities that affect native species by depositing large amounts of contaminants into aquatic habitats, degrading water quality enough to negatively alter the growth, reproduction, and survival of many species.

7) MINING: Two major types of mining occur in the NCB: gravel and mineral mining. Gravel mining involves the removal of substrate from aquatic habitats faster than it can be replaced by natural processes which reduces the amount of suitable habitat available mainly to fishes. Mineral extraction occurs at various scales, targeting multiple types of minerals (e.g. nickel, gold) within the NCB. The major effects of these types of mining include habitat destruction and hazardous chemical deposition.

8) OVER-HARVESTING: Over-harvesting involves the removal of individuals from a population of species faster than they can be replaced by natural reproduction. This reduces the abundance of species and thus the number of individuals available to participate in reproductive activities required for the continued persistence of the species.

9) ESTUARINE DEGRADATION: Estuarine degradation involves the general degradation of estuarine habitats, mainly from pollution, urbanization, and dredging activities that affect native aquatic species by decreasing the amount of suitable habitat available. Estuaries represent critical stopover habitat for many species of waterbirds and play a variety of roles for multiple fish species.

10) EXOTIC INTRODUCTIONS: Introductions of exotic species (mostly plants and fish) have occurred throughout the NCB with the following effects on native species: competition with and replacement of native species reducing their growth, survival, and reproduction and changing the structure and composition of several communities.

11) HATCHERY EFFECTS: Many native aquatic species (primarily fish populations) are "enhanced" through hatchery activities that increase the number of individuals available to both recreation and reproduction, but effect native aquatic species by introducing fish that: increase competition with native stocks and reduce the genetic integrity of native stocks (Hatchery fish are usually produced from stocks that are not native to the aquatic habitat they are planted in. These individuals usually have a genetic quality that is inferior to those of the native individuals, and after successful interbreeding occurs, offspring are produced that are less capable of maintaining the species into the future).

12) HUMAN DISTURBANCE: Many habitats often receive large amounts of recreational pressure, such as rafting, catch-and-release fishing, and off highway vehicle (OHV) use. These disturbances can have dramatic (e.g. OHV degradation of sensitive dune communities) or subtle (e.g. snowy plover abandonment of beach and dune sites due to human disturbance) effects. Disturbance of individuals can cause abandonment of key sites or reduction in the amount of time they spend feeding, resting, and reproducing, potentially reducing their growth and survival. .

13. FIRE SUPPRESSION: This includes the direct suppression of fire as well as landscape alterations designed to decrease fire potential and intensity (e.g. fire and fuel brakes in chaparral). Fire suppression has different effects ranging from threatening the existence of entire communities, such as closed-cone cypress, to causing forests to become much denser with younger trees.

FOCAL SPECIES and ATTRIBUTES

Landscape Scale

The following attributes should be measured (sampled) for use at the landscape level as well as for scaling down to individual communities for innerspecific comparisons of patches.

Road density

The presence of roads degrades any natural area in a variety of ways including destabilizing slopes, increasing erosion, increasing exotic seed introduction/spread, direct loss of habitat, fragmenting habitats, increasing unwanted edge effects, increasing unwanted human activities, and increasing animal mortality. Different types of roads have different levels of effects on the surrounding habitats. A detailed inventory and classification (i.e. paved-1, 2,4 lane, gravel, unimproved) of all roads will be an important component of the EI analysis. This information will be both useful at the landscape and community level. To be useful at both scales, information should be mapped by habitat, then calculated (# miles/area) for each section and watershed.

Fragmentation Metrics

Several major extrinsic stressors such as road building, timber harvest, and development have fragmented most of the semi-aquatic and terrestrial habitats of the NCB. Following the theory of Island Biogeography, small patches of habitat far from each other have much lower value than large contiguous or closely spaced patches. Useful metrics for landscape and community level analysis include patch size, shape, and density as well as patch connectivity (nearest neighbor) (McGarigal and Marks 1995). To

be of use at the community and landscape level, the patch size and density of each class (e.g. late seral) of habitat within and among community types should be calculated. Connectviy should be quantified in the same manner. Connectivity will evaluate the distances between similar patch types, allowing us to understand the community and landscape configuration.

Land Use

Mapping the current use patterns of the lands across the NCB will be important to understand how lands are managed currently and potentially into the future. It would also provide a better understanding of potential conservation opportunities, especially on private lands.

Community Scale

For each community type the major stressors and the focal species and attributes (surrogates) are listed. Major stressors are simply listed; additional information is included where stressors have unique or especially important impacts on a community. Minor stressors, Historical focal species information (e.g. locations, nesting sites) as well as new information, where needed, should be mapped and calculated (number/unit area of potentially suitable habitat) by section (following USGS section delineation) and watershed (CA watershed and major watershed scales).

Historical information from 1988 or earlier should represent only potential locations of species and if possible new surveys in these areas should be conducted as needed to determine the current status of the species in that location. Focal attribute information should be collected, mapped, and calculated at section and watershed levels. For several community types a list of additional species is included. These species were candidate focal species, rare species, or regional endemics that warrant additional attention.

Redwood and Associated Coastal Forests

Extrinsic Stressors

1. **Timber harvest**
2. **Fragmentation**
3. **Road building**
4. **Urbanization**
5. **Fire suppression**
6. **Exotic plant introduction**
7. **Herbicide spraying**

Focal Species/Attributes

1. **Old growth**: mapped as per cent per section, sub-watershed, and major watershed (need to decide on a definition of OG within this community type.).
2. **Marbled murrelet**, *Brachyramphus marmoratus*. Nesting and occupied locations. Any new surveys should use the survey protocol of the Pacific Seabird group (Ralph et al. 1994).
3. **Northern spotted owl**, *Strix occidentalis caurina*. Nesting and occupied locations. (New surveys should follow the protocol in **?CITE.**)
4. **Pacific fisher**, *Martes pennanti pacificus*. Existing information (confirmed detections and trapping records) should be mapped. Fisher sightings are not considered

confirmed, but should still be mapped to identify areas to prioritize for future survey. New surveys will be required to provide presence/absence information on previously unsurveyed portions of the NCB.
Systematic track-plate surveys to determine presence/absence is the recommended technique for new surveys.

5. **Tailed frog**, *Ascaphus truei*. Occupied watercourses should be mapped. New surveys will be required to porvide complete coverage of previously unsurveyed portions of the NCB. For new information time constrained surveys to determine occupancy of a watercourse is the recommended method. Determination of occupancy above and below watercourse sections bisected by roads is also recommended. Timing of the surveys (both annually and within each survey day) will need to be determined.

8. **Southern Torrent salamander**, *Rhyacotriton variegatus*. Occupied locations should be mapped. New surveys should use time-constrained techniques to survey suitable habitat to determine occupancy.

9. **Clouded salamander**, *Aneides ferreus*. Occupied locations should be mapped. New surveys should use time-constrained techniques to survey suitable habitat.

Additional species: American marten (*Martes americana humboldensis*), Black Salamander (*Aneides flavipunctatus*), White-footed vole (*Arborimus albipes*), Pileated Woodpecker (*Dryocopus pileatus*), Red Tree vole (*Arborimus pomo*), shrew-mole (*Neurotrichus gibbsii*) Northern flying squirrel (*Glaucomys sabrinus*), varied thrush (*Ixoreus naevius*), Pacific giant salamander (*Dicamptodon tenebrosus*), Del Norte salamander (*Plethodon elongatus*), Mountain lion (*Felis concolor*), all bat species, Cooper's hawk (*Accipiter cooperi*) nesting sites, Sharp-shinned hawk (*Accipiter straitus*) nesting sites.

Mixed Evergreen

Extrinsic Stressors

1. **Timber harvest**
2. **Road building**
3. **Fire suppression**
4. **Exotic plant introduction**
5. **Herbicide spraying**
6. **Grazing**

Focal Species/Attributes

1. **Old growth**.
2. **Northern spotted owl**.
3. **Pacific Fisher**.
4. **Tailed frog**.
5. **Southern Torrent Salamander**.
6. **Clouded salamander**.

* **Red-bellied newt** (Not certain of occurrence in this community)

Additional species: Humboldt marten, Black salamander, Ringtail, Northern Flying Squirrel, Mountain. Lion, Red Tree vole, shrew mole, Rubber boa, Pt. Arena Mt.Beaver (not certain of occurrence in this community) (*Aplondontia rufa phaea*), Marbled murrelet (not certain of occurrence in this community), all bat species, Northern Goshawk

(*Accipiter gentilis*) nesitng sites, Cooper's hawk nesting sites, Sharp-shinned hawk nesting sites.

Oak woodlands

Extrinsic Stressors

1. **Grazing**
2. **Road building**
3. **Habitat conversion** (to agriculture, pasture, urbanization, especially in lowland oak woodland).
4. **Exotic plant introduction** (especially graminiods)
5. **Fire suppression**
6. **Fragmentation**

Focal species/attributes

1. **Grazing**. Areas should be mapped at the smallest possible scale (individual ownership) and assigned one of five broad categories: 1. No current or historical grazing occurred. 2. No current grazing (or scheduled to be ever), historical grazing occurred. 3. Currently grazed, low intensity. 4. Currently grazed, moderate intensity. 5. Currently grazed high intensity. The latter three categories will need to be defined.
2. **Exotic plant/native plant ratios for graminiods**. Sample plots in oak savannas should be surveyed within each section dominated by 25% or more of this version of the community.
3. **Oak age class structure**. Plots should be distributed systematically and should measure the extent of younger oak cohort recruitment. In many areas a variety of factors (fire suppression, grazing, exotic graminoids) have combined to restrict or inhibit the regeneration of oaks, leaving only older trees.
6. Red-bellied newt, *Taricha rivularis*. Historically occupied sites should be mapped. Time constrained surveys are recommended for surveying new areas.
7. **American badger**, *Taxidea taxus*. Confirmed locations should be mapped. Additional surveys will be required to understand the current distribution of this species within the NCB. Systematic track-plate surveys are the recommended survey method. Probable burrow locations should be mapped and followed up with track-plate surveys.

Additional species: Arboreal salamander (*Aneides lugibrus*), California tiger salamander (*Ambystoma tigrinum californica*) (not certain of presence within the NCB), Golden Eagle (*Aquila chrysaetos*), Mountain Lion (*Felis concolor*), all bat species.

Closed-cone pine and cypress

Extrinsic Stressors

1. **Fire suppression** Fire is the only effective reproductive agent in opening cones and creating conditions for re-establishment, other chance reproduction cannot be expected to perpetuate groves and species. Cypress groves are not always completely burned, resulting in a mosaic of differently aged stands of uniform height and density. Many groves are presently stagnated or declining without fire, it needs to be returned to facilitate regeneration, if not they will disappear.

2. **Road density**
3. **Loss of mid and top predators** may allow squirrels to increase and eat all the seeds in a stand, porcupines may also play a role.
4. **Historical logging** may have seriously affected some areas, cutting for fire wood and fence posts may be a problem
5. **Grazing.** Young plants are vulnerable; heavy grazing pressure can inhibit regeneration and force extinction of populations. Pines generally more impacted than cypresses.
6. **Urbanization** of its popular range (SEASIDE), including homes & golf courses.
7. **Mining** (sand and gravel)

Focal species/attributes

1. **Burn potential and burn need**. Without fire, this community will not be able to reproduce and eventually disappear. A complete assessment of the burn potential for all areas of this community should look at the factors that would inhibit the return of fire (e.g. distance to homes/urban areas, willingness of land owner/manger to allow fire). Looking at the structure of the stand, using information from 3 categories should assess burn need. Three categories of burn need are 1. Site is stagnated or declining, fire is currently needed for continuation of the community at the site. 2. Site will need burning within the near future; it is not currently critical. 3. Site is stable and is or has recently shown regeneration of new cohorts.
2. **Grazing** (see oak woodlands)
3. **Stand recruitment**. Systematic plots should measure presence and age classes of younger cohorts of pines and cypresses and the presence of viable seeds for each.

Chaparral

Extrinsic Stressors

1. **Fire suppression**. Chaparral communities cycle through burning and regenerating.
2. **Fire brakes**: strips of cleared vegetation a few meters wide that encompasses a block of vegetation, each year they are denuded to mineral soil mechanically or by hand (density, width, area they maintained-by what means-how frequently)
   -**Fuel Brakes**: wider (65-200m), more extensive in scope, and clothed with an herbaceous cover.
3. **Road and trail densities**
4. **Exotic plant introduction**

Focal species/attributes

1. **Burn potential and burn need** (see closed-cone pine and cypress). Any specific modifications to chaparral areas (e.g. thinning) to decrease burn potential should be included in this assessment.
2. **Fire/fuel brakes**. The density and types of brakes should be inventoried. This information along with road density should be used together for the fragmentation assessment. Also the extent to which exotics invade brake areas should be measured (sample plots).

Northern Coastal Scrub (need more information on this community)

Extrinsic stressors
1. **Habitat conversion**
2. **Fire suppression**

Focal species/attributes
1. **Point Arena Mountain Beaver**, *Aplodontia rufa phaea*. Known locations should be mapped. All adjacent areas with suitable habitat should be surveyed. Surveys should focus on looking for burrows and sign.

Vernal Pools

This community type has questionable occurrence within the NCB.

Coastal Salt Marsh

Extrinsic stressors
1**. Habitat conversion**
2**. Pollution**
3. **Exotic plant introduction**
4. **Human disturbance**

Focal species/attributes
1. **Native/exotic plant ratios**. Multiple survey plots should be surveyed to estimate this ratio, identify the current plant species at the site.
2. **Patch size**. Measurements of the remaining patches of coastal salt marsh relative what has been lost within each area of occurrence (e.g. Humboldt Bay).

Montane and sub-alpine forests (includes serpentines)

Extrinsic stressors
1**. Timber harvest**
2**. Road building**
3**. Fire suppression**

Focal species/attributes
1. **Patch size** (it is believed that these types only occur in isolated portions of the highest mountain tops on the eastern extent of the NCB.
2. **Old growth**.
3. **Pacific Fisher**.
Additional species: Northern Goshawk, Northern flying squirrel, Mountian lion, Northern spotted owl, Cooper's Hawk (breeding sites), Sharp-shinned hawk (breeding sites), all bat species.

Coastal Prairie

Extrinsic Stressors
1. **Grazing**
2. **Exotic plant invasion**
3. **Fire suppression**
4. **Road building**

Focal Species/attributes
1. **Native/exotic plant species ratios** (see oak woodlands).
2. **Burn potential** (see closed cone-pine and cypress) and level of prairie encroachment by Douglas fir. The level of encroachment should be assessed by walking a fixed length transect along prairie edges and counting invading Douglas firs.
3. **Grazing** (see oak woodlands)
4. **American badger** (in large prairie systems).

Additional species: Golden Eagle.

Beach and Dune

Extrinsic stressors
1. **Exotic plant introduction**
2. **Recreational use ohv, hiking, etc.**
3. **Urbanization**
4. **Road building**

Focal species/attributes
1. **Exotic species invasion extent** (native/exotic ratios)
2. **Level of human disturbance** (ohv and hiking measured separately)
3. **Level of disturbance of dunes and dune vegetation**.
4. **Western snowy plover**, *Charadrius alexandrinus nivosus*. Known nesting and wintering locations should be mapped. Surveys during the breeding season and winter should be conducted in all suitable areas. Surveys should be conducted according to California Department of Fish & Game's protocol.

Additional species: Pt. Arena Mt. Beaver

Lowland Riparian forest (<3000 ft.?, need to determine cutoff between montane & lowland)

Extrinsic stressors
1. **Habitat conversion (agriculture, pasture)**
2. **Grazing (see Oak woodlands)**
3. **Recreational use--OHV**
4. **Water projects (increase channelization, change flow dynamics)**
5. **Urbanization**

Focal species/attributes

1. **Forest structure and age classes** (e.g. mature cottonwood/alder with well-developed understory). All alluvial/floodplain forest patches (those at the lower and estuary regions of major river systems) should be completely described and mapped. For long continuous forest, plots will be necessary. Classification can be accomplished through ocular examination of forest structure and dominant species.
2. **Patch size and shape**. Where conversion has occurred, a detailed assessment of the remnant patch sizes and their shapes is recommended.
3. **Grazing** (see oak woodlands).
4. **Presence and relative density of obligate riparian birds during the breeding season**. Obligate riparian birds include: Yellow-breasted chat, Yellow warbler, **OTHERS?.** Point counts conducted according to the guidelines in Ralph et al. (1995) are recommended.
5. **Level of ohv use in riparian forest** (especially in alluvial/floodplain forest)
The length of ohv trails per unit area should be assessed with plots or direct mapping.
Additional species: ardeid roosts/colonies, all bat species.

Riverine

Extrinsic stressors

1. **Road building**
2. **Timber harvest**
3. **Water projects**
4. **Pollution**
5. **Grazing**
6. **Urbanization**
7. **Gravel mining**
8. **Overharvesting**
9. **Exotic introductions**
10. **Hatchery effects**
11. **Human disturbance**

Focal species/attributes For all fish species, all current data on the distribution and population estimates within each river system will be used. We will rely on the current efforts by agencies to fill in any data gaps.

1. **Coho salmon,** *Oncorhynchus kisutch*
2. **Summer steelhead**, *Oncorhynchus mykiss irideus*
3. **Pink salmon**, *Oncorhynchus gorbuscha*
4. **Chum salmon**, *Onchorhynchus keta*
5. **Northwestern pond turtle**, *Clemmys marmorata marmorata*
6. **Foothill yellow-legged frog**, *Rana boylii*
7. **Northern red-legged frog**, *Rana aurora draytonii*
8. **River lamprey,** *Lampetra ayresi*
9. **Coastal cutthroat trout**, *Oncorhynchus clarki clarki*
10. **California freshwater shrimp**, *Syncaris pacifica*
11. **Green sturgeon**, *Acipenser medirostris*
12. **Russian river tule perch**, *Hysterocarpus traskii pomo*
13. **California roach** subspecies: Gualala roach, *Lavinia symmetricus parvipinnis*; Navarro roach *L. s. navarroensis*.
14. **Hardhead**, *Mylopharodon conocephalus*

15. **Winter steelhead**, *Oncorchynchus mykiss irideus*
16. **Red-bellied newt,** *Taricha rivularis.* See oak woodlands.
17. **Tailed frog**, *Ascaphus trueii*. See Coastal forests.

Estuarine

Extrinsic stressors

1. **Road building**
2. **Timber harvest**
3. **Water projects**
4. **Pollution**
5. **Grazing**
6. **Urbanization**
7. **Gravel mining**
8. **Overharvesting**
9. **Exotic introductions**
10. **Hatchery effects**
11. **Human disturbance**
12. **Estuarine degradation**

Focal species/attributes

1. **Coho salmon**, *Oncorhynchus kisutch*
2. **Summer steelhead**, *Oncorhynchus mykiss irideus*
3. **Pink salmon**, *Oncorhynchus gorbuscha*
4. **Chum salmon**, *Onchorhynchus keta*
5. **Tidewater** goby, *Eucycloglobius newberryi*
6. **River lamprey**, *Lampetra ayresi*
7. **Coastal cutthroat trout**, *Oncorhynchus clarki clarki*
8. **Green sturgeon**, *Acipenser medirostris*
9. **Russian river tule perch**, *Hysterocarpus traskii pomo*
10. **California roach** subspecies: Gualala roach, *Lavinia symmetricus parvipinnis*; Navarro roach *L. s. navarroensis*.
11. **Hardhead**, *Mylopharodon conocephalus*
12. **Winter steelhead,** *Oncorchynchus mykiss irideus*

Lakes & Ponds

Extrinsic stressors

1. **Exotic predators** (bullfrogs, exotic fishes)
2. **Water pollution**
3. **Grazing**
4. **Exotic plants** (e.g. *Typha sp.*and *Hydrocotyl sp.*)
5. **Water projects**
6. **Road building**
7. **Timber harvest**

Focal species/attributes

1. **Northwestern pond turtle**, *Clemmys marmorata marmorata*. Presence and breeding sites. Time constrained searches may not be sufficient, if so turtle live-traps with standardized trapping effort should be utilized.
2. **Grazing** (See oak woodlands)
4. **Diversity and density of selected native breeding amphibians**: Red-legged frog, Brown Salamander (*Ambystoma gracile gracile*), California newt (*Taricha tarosa*), Western toad (*Bufo boreas*), Foothill yellow-legged frog. Shoreline transects should be conducted during the breeding season to detect adults, larvae, and egg masses.
5. **Prescience of bullfrogs**, *Rana catesbiana* and **exotic fishes** (e.g. large-mouth bass). Bullfrogs will be detected with the same methods for 4. Sampling for fish species will require gill netting.
6. **Naturalness**. Is the lake/pond natural or human-made?

Springs, Freshwater Marshes, Streams

Springs and freshwater marshes will be considered "special features" and evaluated within the surrounding dominant vegetation community. Streams will simply be included within the surrounding dominant vegetation community.

Extrinsic stressors

1. **Habitat conversion**
2. **Grazing**
3. **Exotic plant introduction**
4. **Timber harvest**
5. **Road building**
6. **Urbanization**
7. **Water projects**

Focal species/attributes

1. **Northwestern pond turtle**, see lakes & ponds.
2. **Foothill yellow-legged frog** (see #4 for lakes & ponds for this and the next two species).
3. **Northern red-legged frog.**
4. **Western toad.**
5. **Southern torrent salamander** (see redwood and coastal forests).

Evaluation of Ecological Integrity Patterns

To evaluate ecological integrity patterns across the NCB and to aid in guiding data collection, we need to divide the region into systematic subunits. We believe that using sections as the basic subunits for data collection and analysis is the best option. The section also allows for easy changing of scales to suit any particular focal species' or attribute's needs (e.g. the sampling unit for fishers is a four section area). The vegetative communities recognized in this document do not follow section lines in their distributions. For the many instances where more than one community type occupies a given section, the section should be simply divided along the communities' border and the resulting polygons evaluated separately just as an entire section would.

In order to understand the integrity within community types across the NCB, a method to categorize the overall integrity for subunits of each community is needed. This is not easy, due to the complex nature of comparing areas of similar vegetative composition

across large areas. We propose a broad ranking method with four categories: 1. Excellent 2. Good 3. Fair 4. Poor. Each category represents one quarter (25%) of a 0 to 100 numeric ranking (exellent 76-100, good 51-75, fair 26-50, poor 0-25). This numeric ranking score is calculated from the following equations:

1 / x = k (total percentage each focal species/attribute contributes to the total integrity score for an individual community type)

k(n1) + k(n2) + k(n3) +k(n.....) = Total integrity score for one community subunit where x is the number of focal species and attributes to be measured within a single community type. N represents the numeric value that a specific focal species or attribute received within a community subunit. How these scores are derived will be unique for each focal species and attribute. For example we may decide that road density values go from 100, no roads within the subunit, to 0 where there is >20 miles of road within the subunit. To continue the example, let's say that we have just measured road density for one oak woodland subunit and found no roads. This subunit's n value for road density would then be 100. The oak woodland community had 10 focal species and attributes (x=10), thus the k value for each is 0.1. The contribution of the road density value to the total integrity score for this subunit is then 0.1(100)=10.

It may be decided that some focal species or attributes are stronger indicators of ecological integrity than the others within a specific community type. In these situations, the stronger indicators could be weighted with higher potential k values.

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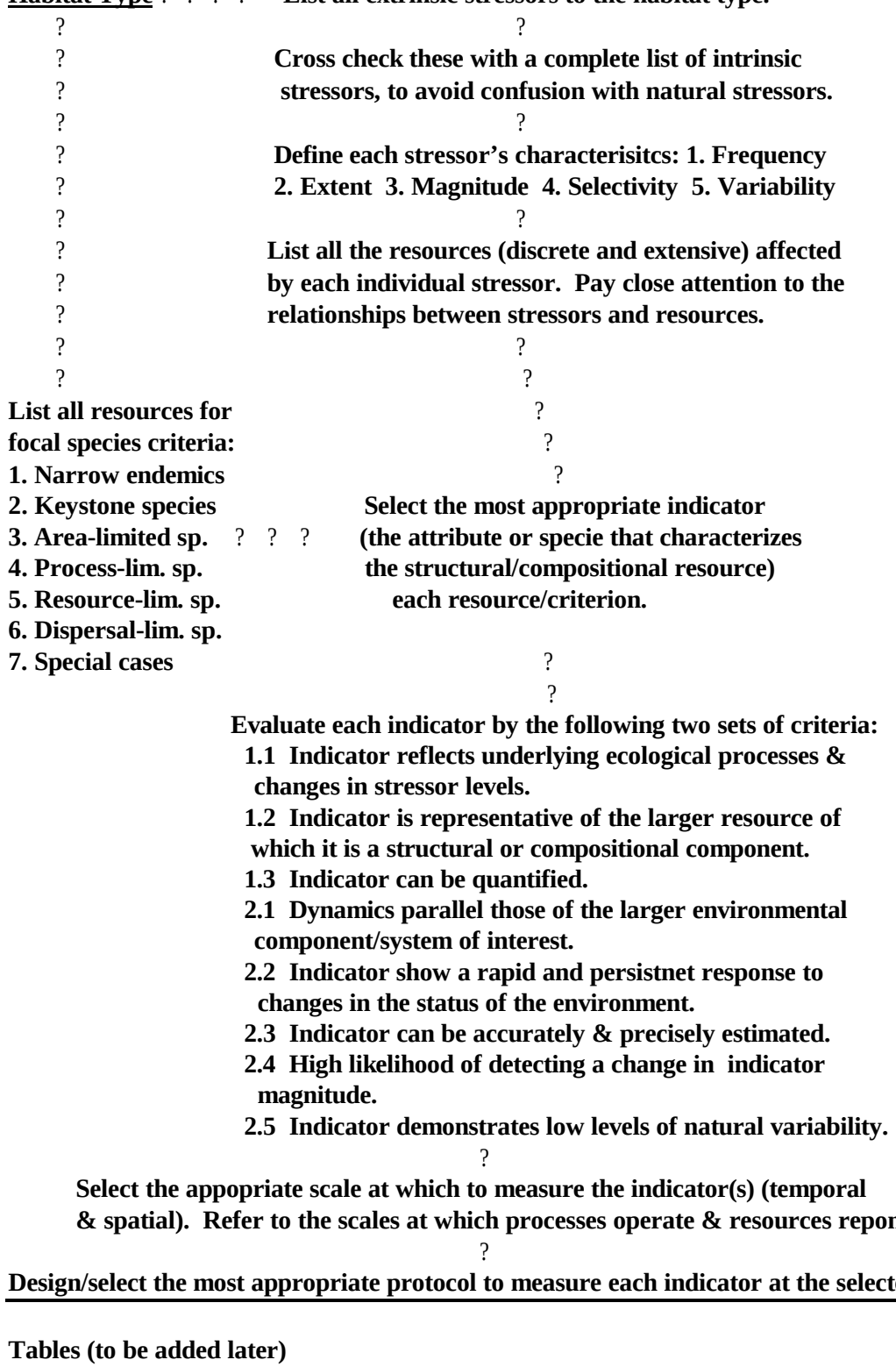
Figure 1. Conceptual model for habitat specific Ecological Integrity indicator selection.



Tables (to be added later)

Appendix 1 Series-level Vegetation

Each of the broadly defined community types treated in this document can be further divided into a number of series that rank lower in the vegetation hierarchy. *Vegetation* consists of all the plant species in an area and the way they are arranged. A *series* is a unit of vegetation named after the plant species (or genus) that is dominant in the layer with the greatest amount of cover. This layer consists of **trees** in forests and woodlands, **shrubs** in chaparral and scrub communities, and **herbaceous** plants in grasslands and other non-woody ground covers (Sawyer and Keeler-Wolf 1995).

The series is a fundamental unit in the California Native Plant Society's (CNPS) floristically driven system of vegetation classification. The CNPS system has been accepted as the new standard for the state by the U.S. Forest Service, Bureau of Land Management, Biological Resources Division of the U.S.G.S., U.S. Fish and Wildlife Service, and the California Biodiversity Council (Keeler-Wolf and Barbour1997). While series constitute meaningful units of floristic diversity at a relatively fine scale, their use in landscape-level assessments has been limited by financial, technological, and theoretical constraints.

Initial efforts to inventory, protect, and restore native plant communities at the series-level should emphasize rare and/or threatened vegetation (indicated by asterisks in the following lists). Methods of incorporating series-level diversity into broader ecological assessments need to be explored. For instance, broadly defined community types such as Oak Woodlands and Mixed Evergreen Forests may be characterized (in part) by the composition and arrangement of the series they include. Assessments should also consider the presence of exotic series, rare and threatened series, and other series of special concern.

The utility of the CNPS classification is that it enables us to quantitatively define floristic units of vegetation and distinguish between them. In doing so, the system creates a standard language for discussing and assessing vegetation diversity. Yet the problems of scale and fuzzy boundaries inherent to vegetation classification persist. "How large must a patch of Knobcone pine be before it is considered distinct from surrounding series such as Chamise and Wedgeleaf ceanothus? How can we best distinguish between the California oatgrass, Idaho fescue, and Oregon white oak series where they co-occur in a mosaic of Coastal Prairie and Oak Woodland? Where do we draw the line between Douglas-fir – tanoak and Redwood series in mixed forests?" Ambiguity is resolved at the series-level, but it is not eliminated.

The following pages classify series based on the broadly defined habitat/vegetation types treated in this document. Lists are intended as a useful guide to the series which commonly characterize particular habitat/vegetation types. Asterisks ("*") indicate series considered rare and threatened by Legacy-The Landscape Connection and/or the Natural Heritage Division of the California Department of Fish and Game.

Series Associated with Each Community Type

BEACH AND DUNE

Herbaceous series	Shrub series	Tree series
European beachgrass (exotic)	Coyote brush	Beach pine*
Iceplant (exotic)	Yellow bush lupine	Sitka spruce*
Native dunegrass*		
Sand-verbena – beach bursage*		

COASTAL SALT MARSH (includes brackish salt marsh associated with estuarine wetlands)

Herbaceous series	Shrub series	Tree series
Bulrush*	Uncommon	Uncommon
Bulrush – cattail		
Cattail		
Cordgrass (exotic)		
Ditch-grass		
Pickleweed*		
Saltgrass		
Sedge		

CLOSED-CONE PINE AND CYPRESS FOREST

Herbaceous series	Shrub series	Tree series
Uncommon	series listed under Chaparral	Beach pine*
		Bishop pine*
		Knobcone pine
		McNab cypress*
		Pygmy cypress*
		Sargent cypress*

MIXED EVERGREEN FOREST

Herbaceous series	Shrub series	Tree series
Uncommon	Uncommon	Black oak
	(series listed under Chaparral)	California bay*
		California buckeye
		Canyon live oak
		Coast live oak
		Douglas-fir
		Douglas-fir ponderosa pine*
		Douglas-fir tanoak
		Interior live oak
		Knobcone pine
		Mixed conifer

		Mixed oak Oregon white oak Ponderosa pine Tanoak

OAK WOODLAND

Herbaceous series	Shrub series	Tree series
California annual grassland; (native and exotic species) California oatgrass* Cheatgrass (exotic) Idaho fescue* Introduced perennial grassland; (exotic) Purple needlegrass	Uncommon (series listed) under chaparral)	Black oak Blue oak CA buckeye Coast live oak Foothill pine Interior live oak Mixed oak Oregon white oak Valley oak*

CHAPARRAL

Herbaceous series	Shrub series	Tree series
Uncommon	Blue blossom Brewer oak (montane) Bush chinquapin (montane) Chamise Chamise – Wedgeleaf ceonothus Coyote brush Deerbrush Eastwood manzanita Greenleaf manzanita (montane) Hairyleaf ceanothus Holodiscus (montane) Huckleberry oak (montane) Interior live oak scrub Interior live oak – canyon live oak scrub Interior live oak – chaparral whitethorn shrub Interior live oak – scrub oak shrub Leather oak Mountain whitethorn Scrub oak Tobacco brush Wedgeleaf ceanothus (montane) Whiteleaf manzanita (montane)	Foothill pine Knobcone pine McNab cypress* Sargent cypress*

RIPARIAN

Herbaceous series	Shrub series	Tree series
Bulrush*	Montane wetland shrub habitat	Arroyo willow
Bulrush – cattail	Mountain alder (montane)*	Black cottonwood*
Cattail	Narrowleaf willow	California bay*
Sedge*	Sandbar willow	Fremont cottonwood*
	Sitka alder (montane)*	Hooker willow*
	Tamarisk (exotic)	Mixed willow*
		Pacific willow*
		Red alder
		Red willow
		Sitka spruce*
		Sitka willow*
		White alder (montane)*

REDWOOD AND ASSOCIATED COASTAL FORESTS

Herbaceous series	Shrub series	Tree series
Pampas grass (exotic)	Blue blossom	California bay*
		Douglas-fir – tanoak
		Grand fir*
		Red alder
		Redwood
		Sitka spruce*
		Western hemlock*

MONTANE AND SUBALPINE VEGETATION (includes series on ultrabasic soils)

Herbaceous series	Shrub series	Tree series
Montane meadow	habitat Brewer oak	Douglas-fir
	Bush chinquapin	Douglas-fir –
	Greenleaf manzanita	Ponderosa pine
	Holodiscus	Foxtail pine
	Huckleberry oak	Incense cedar
	Montane wetland shrub	Jeffrey pine
	habitat	Knobcone pine
	Wedgeleaf ceanothus	Mixed conifer
	Whiteleaf manzanita	Ponderosa pine
		Red fir
		White fir

COASTAL PRAIRIE

Herbaceous series	Shrub series	Tree series
California annual grassland; (native and exotic species)	Yellow bush lupine	Oregon white oak (on Bald Hills)
California oatgrass*		
Cheatgrass (exotic)		
Idaho fescue*		
Introduced perennial grassland (exotic)		
Kentucky bluegrass (exotic)		
Pacific reedgrass*		
Purple needlegrass		
Tufted hairgrass*		

NORTHERN COASTAL SCRUB

Herbaceous series	Shrub series	Tree series
Pacific reedgrass*	Blue blossom	Sitka spruce*
	Coyote brush	
	Salal – black huckleberry*	
	Yellow bush lupine	

WETLANDS (includes riverine wetlands, lacustrine wetlands, and ponds; see Coastal Salt Marsh section for series occupying estuarine wetlands)

Herbaceous series	Shrub series	Tree series
Beaked sedge	Montane wetland shrub habitat	Arroyo willow
Bulrush*	Sitka alder (montane)*	Black cottonwood*
Bulrush – cattail		California bay*
Bur-reed		Fremont cottonwood*
Cattail		Hooker willow*
Duckweed		Mixed willow*
Fen habitat*		Pacific willow*
Mosquito fern		Red alder
Pondweeds with floating leaves*		Red willow
Pondweeds with submerged leaves*		Sitka spruce*
Common reed (exotic)		Sitka willow *
Giant reed (exotic)		White alder (montane)
Kentucky bluegrass		
Montane meadow habitat		
One-sided bluegrass*		
Quillwort (montane)		
Rocky Mountain sedge (montane)		
Sedge		
Spikerush		
Yellow pond-lily		