Chapter 3

Environment and Habitat

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3 ENVIRONMENT AND HABITAT

3.1 Introduction

In order to evaluate the proposed conversation measures of our plan, you need an understanding of the past and present state of the plan area. Chapter 3, in effect, outlines where we have come from and where we are today. The conservation measures in Chapters 8-11 will focus on where we want to go.

In reviewing the past and current conditions in the plan area, we distinguish between aquatic and terrestrial habitat.

DEFINITION

Habitat is the place where a specific species is commonly found because it provides the physical and biological resources required for its survival and reproduction.

In the first half of this chapter, we examine environmental variables and physical processes related to aquatic habitat, as well as the conditions of such habitat in the plan area. Initially, we describe the environmental context of our landscape, including climate, geological features, pollution sources, stream temperatures, and mass wasting associated with roads and hillslope failure. Next, we focus on specific parameters related to riparian zone, canopy, LWD within stream channels, instream sediment, aquatic wildlife, and hydrology

In the second half of the chapter, we turn our attention to terrestrial habitat, addressing topics such as natural communities, their distribution in California and in the plan area, and their ecological factors. After examining these broader habitat issues, we zero in on specific habitat elements—old growth, wildlife trees, downed wood, rocky outcrops, wetlands—and highlight their importance for covered species in our plan. These elements provide foraging, denning, and roosting sites; cover from predators; and other day-to-day needs for species survival.

For management purposes, we may never fully and scientifically understand the relationship of any one species to all the environmental variables and processes we study on our landscape. However, we can sometimes manage or create what has been identified as its habitat and, in doing so, maintain or increase its numbers. This is a main thrust of our HCP/NCCP—to improve the quantity and quality of both aquatic and terrestrial habitat.

3.2 Environmental Context

3.2.1 Climate and hydrology in the plan area

3.2.1.1 Climate

The climate of the plan area is Mediterranean, with warm dry summers and moderate winters. Mean annual precipitation ranges from 40 in. along the coast at Fort Bragg and Point Arena to 50 in. at Willits. Based on climate records,[1] approximately 95% of the precipitation occurs during October through May. January is on average the wettest month, when about 18% of total annual precipitation is recorded. The driest month is July, with less than 1% of total annual precipitation. Precipitation occurs predominately in the form of rain. A small portion of precipitation falls as snow, but it rarely remains long. Snowmelt and rain-on-snow are not hydrologically significant in the plan area.

[1] The records are from climate stations in Standish Hickey State Park (Station No. 8490), Willits 1NE (Station No. 9684), and Point Arena (Station No. 7009).

3.2.1.2 Stream flow and peak flow

3.2.1.2.1 Rain and flooding

Stream flow in the plan area is responsive to rain, with high stream flows directly following high rainfall. Floods and variations in stream flow are stochastic and distributed throughout the year when rain occurs (October–May). Along the north coast, however, where our land is located, the greatest precipitation and flooding occur in late fall and winter (December–March). Within the last decade, there have been many intense storms in the plan area and, as a result, frequent flooding in its rivers.

Floods have the capacity to re-shape river or stream channels and transport large sediment loads. In our conservation approach, MRC assumes that meteorological and geological events—including severe storms, unusually wet years, and earthquakes—are major triggers for erosion and mass wasting in watercourses of the plan area.

Typically, hydrologists describe floods in terms of peak events, such as a 100-year or 50-year flood. This terminology, based on flood frequency analysis, describes the recurrence interval for peak flows. A 50-year flood, for example, has a 2% chance of occurring in any given year, whereas a 20-year flood has a 5% chance of occurring in any given year.[2]

3.2.1.2.2 Records on the Noyo and Navarro rivers

The Noyo and Navarro Rivers have the longest recorded stream flow in coastal Mendocino County; their records date back to 1952.

Using peak flow records from Noyo River, 1952–2000, the flood of record is 1974 (26,600 cfs). This was greater than a 50-year event for Noyo River. In the 1990s, Noyo River had at least 8 storms greater than a 1.5 year return interval:

- 1 around a 30-40 year recurrence (1993).
- 1 >5-year recurrence (1995).
- 6 >1.5-year recurrence.

Using peak flow records from Navarro River, 1952-2000, the flood of record is 1955 (64,500 cfs). This was greater than a 50-year event for Navarro River. In the 1990s, Navarro River had at least 15 storms greater than a 1.5 year return interval:

- 2 >10-year recurrence (1993 and 1995).
- 5 >5-year recurrence (1 in 1993, 3 in 1995, and 1 in 1998).
- 8 >1.5-year recurrence.

Using stream flow data from both the Navarro and Noyo Rivers for the last 50 years, there have been

- 4 events >20-year recurrence (1955, 1965, 1974, and 1993).
- 4 events >10-year recurrence (1970, 1982, 1986, and 1996).

[2] All data in this sub-section is from the United States Geological Survey (USGS). Refer to http://waterwatch.usgs.gov/new/index.php?id=sitemap, accessed 05/06/2011.

3.2.2 Geology and geomorphology of the plan area

3.2.2.1 Geologic features

The plan area lies within the Coast Range, a string of mountains along the Pacific coast of North America from Oregon to southern California. The Coast Range in Mendocino and Sonoma Counties is primarily underlain by folded and sheared marine sandstones and siltstones; schists; and dispersed metamorphic blocks and volcanic rocks of the Franciscan assemblage (Bailey et al. 1964). The Franciscan assemblage and the Great Valley Sequence are from the Mesozoic (248–65 mya) and Tertiary (65–1.8 mya) periods.

The plan area is subject to high rates of mass wasting and erosion due to steep topography, high uplift rates, weak rocks, and very sheared and faulted conditions of underlying bedrock. A system of long faults, trending northwest, has broken this region into narrow slices. In addition, the Mendocino Triple Junction and its northward movement also influence the environmental setting of the plan area.

Beginning about 8 million years ago, tectonic uplift and Pleistocene sea level changes developed a sequence of marine terraces along the Mendocino County coast. Periods of glacial advance and falling sea level, combined with mountain uplift, formed steep coastal bluffs, resulting in topographic steps. During interglacial periods when sea level was rising, broad wave-cut platforms were established. Finally, watercourse incision slowed near the ocean and along major rivers because rising sea levels flooded the incised channels.

3.2.2.2 Sediment inputs

Sediment inputs to stream channels are high in the plan area due to geologic conditions, and, in part, to past land use, such as ground disturbances on steep, unstable slopes and in stream channels; removal of LWD from stream channels; and removal of streamside vegetation. There is always a dynamic between LWD, water, and sediment in stream channels; in the plan area, high sediment loads occur because of increased sediment delivery and reduced LWD levels.

3.2.2.3 Soil types

The plan area consists of 236 different soil types, based on soil properties and slope steepness, according to the Soil Survey of Mendocino County, California, Western Part (USDA 2006). Ratings for soil types cover equipment limitation and hazards from soil compaction, sheet erosion, and rill erosion. Recommendations for equipment limitation include (a) use of cable yarding equipment, instead of wheeled and tracked equipment, on steep slopes (>30%) and (b) road watering in the dry season, specifically on the Zeni and Ornbaun soils. Regulatory and technical guidelines for erosion control are available in the California Forest Practice Rules and in numerous state, federal, and university publications (USDA 2006).

Three major regimes for soil climate, recognized by *Soil Taxonomy* (USDA 1975), exist for forest vegetation in the plan area:

- udic-isomesic.
- ustic-isomesic.
- xeric-mesic.

These regimes, which primarily aid in determining the survivability of tree seedlings, are established by soil temperatures at a depth of 20 in. and by duration and season of soil moisture. They are influenced by cool, moist marine air from the Pacific Ocean (USDA 2006).

Examples of the udic-isomesic regime (i.e., low elevation with strong coastal influence) include the Big River and Cottoneva soil types. The well-drained Big River soils, which have a seasonal high-water table at a depth of more than 5 ft, are some of the most productive forest soils in the world. The somewhat poorly drained Cottoneva soils, which have a seasonal high-water table at a depth of 2 to 3 ft, are unproductive. Redwood in Cottoneva soils is typically stunted while red alder dominates. One of the best indicators of Cottoneva soils is an abundance of nettles in the understory. Predominance of Douglas-fir increases as the soil climate regimes change from high-to-low coastal influence.

In the ustic-isomesic regime, soil and air temperatures are higher and soil moisture is lower than in the udic-isomesic regime because of the reduced marine influence. These characteristics are especially apparent after removal of tree canopy. Plant competition is very high in the ustic-isomesic regime due to the lack of moisture in the soil.

Soils in the xeric-mesic regime are subject to high surface temperatures and little-to-no marine air influence. Plant competition is also very high in this regime, which characteristically lacks redwood trees.

3.2.2.4 Mass wasting

DEFINITION

Erosion is an inclusive term for the detachment and removal of soil and rock by the action of running water, wind, waves, flowing ice, and mass movement.

Mass wasting is the down slope movement of soil or rock under the influence of gravity.

The terminology of our HCP/NCCP that describes mass wasting features (a.k.a. landslides) closely follows the definitions of Cruden and Varnes (1996). Landslide terms are formed from two nouns, the first describing the material that the landslide is composed of and the second describing the type of movement. MRC identifies landslides with the following names:

- Debris slides.
- Debris torrents.[3]
- Debris flows.
- Rock slides.
- Earth flows.

Appendix G (sections G.2.1.1 and G.2.1.2) provides more detail on these mass wasting processes.

3.2.2.4.1 Forest management practices affecting mass wasting

Mass wasting is a naturally occurring process that can be accelerated by anthropogenic disturbances. Forest management practices can alter the natural frequency and magnitude of mass wasting events by

- Changing the resisting and driving forces of slope geometry.
  - Loading the top of a landslide with fill material.
  - Removing the buttressing toe support by grading.
- Altering water pressures of soil and bedrock.
  - Reducing evapotranspiration by removing trees.

[3] This name does not appear in Cruden and Varnes (1996).

    - Discharging road drainage onto a landslide.
- Altering the shear strength of soil and bedrock.
    - Destroying root strength by removing trees.
    - Reducing effective stress with increased pore water pressure.

3.2.2.4.2 Effects of mass wasting on streams

Increases in sediment due to mass wasting can alter fluvial processes in stream channels; this, in turn, can change water quality, stream ecology, or the quality and quantity of amphibian and anadromous fish habitat.

Mass wasting is able to alter stream environments by

- Increasing bed and suspended sediment loads.
- Modifying the grain-size distribution of channel sediment.
- Introducing woody debris.
- Altering channel morphology by aggradation.
- Damming and obstructing a channel.
- Scouring a channel to bedrock.

Stream systems ultimately adjust to major alterations downstream as well as upstream of mass wasting; however, the consequences of mass wasting may last a long time.

3.2.2.4.3 Effects of mass wasting on anadromous salmonid habitat

In the Pacific Northwest, where anadromous fish are present, mass wasting can have both beneficial and adverse effects on anadromous salmonid habitat.

BENEFICIAL effects of mass wasting on anadromous salmonid habitat include

- Formation of new spawning, rearing, and over-wintering habitat due to the addition of coarse gravels in the channel.
- Introduction of woody debris and boulders from landslides that increase cover and improve pool-to-riffle ratios.

ADVERSE effects of mass wasting on anadromous salmonid habitat include

- Filling of pools and scouring of riffles.
- Blockage of fish access.
- Disturbance of side-channel rearing areas.
- Siltation of spawning gravels.
- Modification of food resources for invertebrates.

The magnitude of these effects depends on the frequency, location, and intensity of mass wasting, as well as the capabilities of a particular stream to transport sediment. The likelihood of a landslide within a watershed increases with watershed size; a larger basin encompasses a greater number of landslide sites (such as colluvial filled hollows) and has a greater potential to experience a triggering storm or earthquake (Benda et al. 1998). Beneficial and adverse effects typically occur simultaneously, and the relative relationship between the two will vary, even for individual events. Because of their higher stream power (i.e., their energy to transport sediment and debris), larger streams and rivers adjust to mass wasting disturbances faster than smaller streams.

3.2.3 Historical recap of the adjustment area

3.2.3.1 Land use

If you would understand anything, Aristotle said, observe its beginning and its development. Historical perspective reveals changing attitudes toward the land we call the *adjustment area*, starting with the vegetation management of the indigenous people and moving forward through the logging practices and technology of the last 2 centuries.

HISTORICAL TIMELINE	
INDIGENOUS PEOPLE	Indigenous people developed a system of vegetation management that extended throughout most of the Holocene, a name given to the last 11,000 years of earth history—the time since the last "ice age." Research at JDSF suggests that Native Americans burned forests about every 20 years. Basically, they used fire to expedite travel; increase the availability of plants for food, medicine, and basket making; and keep prairies and meadows open for hunting. In effect, the ecosystem that MRC is trying to recover was a managed system very early in its history. This management by indigenous people affected total biomass as well as watersheds; it allowed, for example, for greater water yield and locally larger floods.[4]
1850-1900	In the mid-1800s, harvesting of old-growth timber began; harvesting progressed slowly until 1900. Harvesting techniques included burning, tree felling, re-burning, and downhill yarding into and through watercourses. Oxen or steam donkeys conveyed the logs to railroads, which transported them to the mills. Splash dams also transported logs downstream to the mills.
1900-1929	With advances in steam technology and demand for wood products created by the 1906 San Francisco earthquake, harvesting of old growth increased and peaked just prior to the onset of the Great Depression in 1929.
1930-1940	During the Great Depression (1929-1940), there was a drop in the demand for wood products. This caused a slowdown of harvesting. Prior to World War II, the best value for harvested lands was grazing. Some of the land was repeatedly burned to allow for grazing. A major wildfire occurred on September 22, 1931. It began at 3 separate locations on Big River and burned approximately 30,000 ac on its path southeast of Jackson Demonstration State Forest, through Comptche and into the Navarro Watershed. As a result of the Comptche Fire, CDF (now CAL FIRE) initiated a period of total fire exclusion.
1941-1945	Many economic historians peg the end of the Great Depression with the U.S. entry into World War II. Mobilization after Pearl Harbor created millions of factory jobs but also pulled over 10 million working-age Americans into the draft. Migrant farm workers from southern and central parts of the nation, some referred to as “Okies,” came to places like Rockport, CA to fill sawmill jobs. However, finding replacement parts for worn-out machinery whether in a sawmill or in the family Ford was even more difficult, if not impossible. The government rationed everyday items from gasoline to tires and sugar to hosiery.

[4] Tom Spittler, Senior Engineering Geologist in the California Geological Survey (CGS), made this observation in a written response to the first draft of the HCP/NCCP (01 October 2003).

HISTORICAL TIMELINE	
1945-1970	After World War II, there was an increase in the demand for wood products, spurred by the demand for suburban homes. For yarding, tractors replaced steam donkeys and oxen; for log transportation, trucks replaced railroads and rivers. This, in turn, created a need for new road construction. For the most part, fire suppression efforts resulted in the exclusion of fire from the area. In the 1950s, the California Department of Fish and Game began requiring landowners to remove large woody debris from watercourses.
1970-1980	The majority of the remaining old growth was harvested into the 1970s. Second growth harvesting began in the 1970s, relying on tractor yarding, with roads and landings close to watercourses. Fire was still excluded from the landscape. The 1970s also saw the implementation of environmental and tax laws regulating timber harvesting, including the Federal Endangered Species Act (1973).
1980 TO PRESENT	Cable yarding systems, especially on steeper slopes, started to become more prevalent in the 1980s. This eventually became the most common method of yarding. With the switch from tractor to cable yarding, timber companies relocated roads from nearby watercourses to ridge tops. On June 20-21, 2008, lightning storms ignited approximately 129 fires in Mendocino County. The Mendocino Lightning Complex burned 54,817 ac; 23,196 of those acres were in the plan area. CAL FIRE declared the fires contained by July 19.

3.2.3.2 Historical location of roads and tractor trails

MRC owns and manages approximately 2300 miles of truck roads with an estimated truck-road density of 6.9 mi./sq. mi.[5] These roads are for transportation of forest products from forest to lumber manufacturing centers. Placement or layout of the MRC road system developed from historic yarding methods. The term *yarding* refers to the temporary collecting of felled trees at a *landing* site for later transport to mills via splash dams, railroads, and trucks. As recounted in the historical timeline above, the means of yarding evolved from bull teams to steam donkeys, from tractors to cables and helicopters. Roads developed wherever logging was carried out, with little planning for road networks. Often roads followed old railroad grades in canyon bottoms adjacent to streams or rivers. This is the historic road configuration that MRC has inherited on our land.

3.2.3.2.1 Impact of cable logging on road configurations

Today, approximately 54% of harvest operations in the plan area are yarded by cable or helicopter. These techniques typically result in less ground disturbance than other yarding practices; they convey logs at or above the ground to the road network. To facilitate such techniques, MRC relocates roads high up on slopes where risk of sediment discharge is relatively low. Many roads have already been relocated. This ongoing shift to harvest methods which result in less ground disturbance has created opportunities for MRC to decommission roads near stream bottoms, where the risk to water quality from sediment discharge is great. Sections 8.3.1.2 and 8.3.3.2 provide details about new road construction and decommissioning which MRC anticipates will occur during the first decade of HCP/NCCP implementation.

[5] This road mileage is an estimate from our GIS data based on aerial photos and GPS road surveys. The 213,244 ac of the plan area convert to approximately 333 mi^2. To calculate truck road density, we divided road mileage by square miles of the MRC plan area: 2300/333 = 6.9.

3.2.3.2.2 Impact of skid trails on sediment delivery

From the 1930s to the mid-1980s, most of the timber in the plan area was yarded by tractor. Prior to the 1970s, these tractor trails included steep slopes (>70%) and watercourse channels. The common practice was to use tractors to skid logs adjacent to or directly in intermittent and ephemeral stream channels. Most tractor or skid trails were constructed with cut and fill methods. This left perched fill material to erode into watercourses. As a result of the California Forest Practice Act in 1973, tractor skidding is prohibited on watercourse channels and steep slopes. However, pre-existing skid trails have left sediment delivery issues.

3.3 Aquatic Habitat

MRC and the previous land-owner, Louisiana Pacific Corporation, both conducted watershed analyses and fishery research. This subsection summarizes information on aquatic conditions developed from these efforts, including

- Aquatic species distribution.
- Stream temperature observations.
- Stream shade rating.
- Stream LWD rating.
- Stream gravel permeability rating.
- Fine sediment rating.
- Fish habitat conditions for spawning, rearing, and over-wintering life-stages.
- Sediment input summaries by planning watersheds.
- Road density by planning watershed.
- Estimates of under-sized culverts.
- Mass wasting types by planning watershed.
- Estimated peak flow changes to forest harvest.

Most of the information summarized here is available in greater detail in the MRC distribution reports for watershed analysis, stream temperature, and aquatic species. Refer to Appendix G, *Watershed Analysis: Background and Methods*, for details on our methods.

3.3.1 General concept of a watershed

DEFINITION	A **watershed** is that part of a landscape that drains to a particular stream, river, or other body of water.

Often a watershed is bounded by hilltops and ridges. The natural depression in the landscape *catches* rain and snow which ultimately *drains* downslope. Watersheds come in all sizes. Some encompass millions of square miles, while others may be only a few hundred acres. Watersheds can cross county, state, and even international boundaries. Homes, farms, towns, cities, forests, and more can make up a watershed. Smaller watersheds are usually part of larger watersheds. Figure 3-1 illustrates this general concept of a watershed.

Figure 3-1 General Illustration of a Watershed

3.3.2 Definition of watershed and watershed analysis

Within our HCP/NCCP, MRC uses very specific definitions for different types of watersheds, as well as for the process and units of watershed analysis.

DEFINITION

A **planning watershed** is a management unit designated by the California Interagency Watershed Mapping Committee (CalWater) based on area and hydrology.[6]

Focus watersheds are the primary locations where MRC will intensively monitor and study the biological response of aquatic organisms to habitat conditions and closely observe watershed conditions.

Watershed analysis is a structured approach[7] for determining current impacts of forest practices on public resources in a watershed, such as water quality and fish habitat, and establishing guidelines for future management.

A **watershed analysis unit (WAU)** is an area of land, typically covering multiple planning watersheds, which a landowner defines for watershed analysis.

3.3.3 Watershed analysis units

Most of the information about current conditions of aquatic habitat in the plan area was developed from watershed analysis. MRC has defined 12 watershed analysis units (WAUs).

[6] CalWater is the official map for watersheds in California that average between 3000 and 10,000 ac. On the Web, information about CalWater is at http://cain.ice.ucdavis.edu/calwater/ (accessed 05/18/2011).

[7] The Washington State Department of Natural Resources originally developed the methodology.

Watershed analysis units are not the same as planning watersheds since a single WAU typically includes multiple planning watersheds. Table 3-1 lists the WAUs in the plan area, along with their acreage. In the *HCP/NCCP Atlas* (MAP 2*)*, there is also a spatial representation of the WAUs.[8]

Table 3-1 Watershed Analysis Units in the Plan Area

WAU	Acres	Planning Watersheds within WAU
Albion River	15,800	Lower, Upper, and Middle Albion River; South Fork Albion; Big Salmon Creek
Noyo River	20,000	Duffy Gulch, Hayworth Creek, Little North Fork, McMullen Creek, Middle Fork North Fork Noyo River, North Fork Noyo River, Olds Creek, Redwood Creek
Garcia River	11,800	East of Eureka Hill, Inman Creek, Lamour Creek, North Fork Garcia River, North of Gualala Mountain, Rolling Brook, Signal Creek, South Fork Garcia River, Victoria Fork
Hollow Tree Creek	21,100	Upper, Middle, and Lower Hollow Tree Creek; Low Gap Creek; and Jack of Hearts Creek
Navarro River	54,600	Dutch Henry Creek, Floodgate Creek, Flynn Creek, Hendy Woods, Horse Creek, John Smith Creek, Little North Fork Navarro River, Lower South Branch Navarro River, Middle Navarro River, Middle South Branch Navarro River, Mouth of Navarro River, North Fork Indian Creek, North Fork Navarro River, Ray Gulch, Upper Navarro River, Upper South Branch Navarro River
Northern Russian River	5700	Upper Ackerman Creek
Big River	34,000	Chamberlain Creek, East Branch North Fork Big River, James Creek, Laguna Creek, Lower North Fork Big River, Martin Creek, Mettick Creek, Rice Creek, Russell Brook, South Daugherty Creek, Two Log Creek, Upper North Fork Big River
Cottaneva Creek	8000	Cottaneva Creek
Rockport Coastal Streams	10,000	DeHaven Creek, Juan Creek, Hardy Creek, and Howard Creek
Greenwood Creek	9900	Upper and Lower Greenwood Creek
Elk Creek	14,000	Upper and Lower Elk Creek
Alder Creek and Schooner Gulch	13,300	Alder Creek, Mallo Pass Creek, and Schooner Gulch Creek

3.3.4 Resource assessment report

One outcome of a watershed analysis is a resource assessment report which is divided into several sections or modules (see section 7.4.5). In watershed analysis, we perform resource assessments

[8] Where possible, a river's watershed defines the boundaries of a WAU. The boundaries of MRC land do not always fit individual watershed boundaries; in some cases, small parcels of MRC land adjacent to a watershed are included in a WAU. Also, larger planning watersheds or watershed analysis units can subsume small coastal streams that may not have any connection to larger watercourses. Big Salmon Creek, for example, is within the Albion WAU but flows directly into the Pacific Ocean.

of mass wasting; surface and point source erosion (roads and skid trails); hydrology; riparian function; stream channel conditions; fish habitat; amphibian distribution; and sediment inputs.

MRC is currently[9] analyzing watersheds within our land. For our HCP/NCCP, we use watershed analysis to develop

- Baseline information on conditions affecting aquatic habitat in a watershed.
- Initial habitat conservation measures and initial restoration priorities specific to a watershed.
- Summaries of watershed research data for adaptive management of covered aquatic species.
- Hypotheses tested in the focus watershed studies (Chapter 13: M§13.5.1.2-2, M§13.5.3.2-1, M§13.5.4.1-1, M§13.5.4.1-3).

3.3.5 Watershed analysis process

With watershed analyses, MRC synthesizes long-term trends for species and their habitat. We expect to complete the initial watershed analysis of all our land by 2010. During initial data collection, MRC estimates that staff members will walk approximately 40-45 of the 500 miles of Class I and Class II aquatic habitat. Most of this field effort will be in Class I aquatic habitat. In addition, MRC uses aerial photography calibrated by field measurements to examine 100% of each watershed for canopy cover and mass wasting (see Appendix G, *Watershed Analysis: Background and Methods*).

Watershed analysis begins with a resource assessment. Modules for mass wasting, riparian function, and surface and point-source erosion address hill-slope hazards. Module reports describe physical processes and potential triggering mechanisms for each hillslope hazard. Likewise, modules for fish habitat, amphibian distribution, and stream channel condition assess the vulnerability of anadromous salmonid and amphibian habitat to hillslope hazards and water quality impacts.

Watershed analysis then synthesizes results of the resource assessment. The synthesis identifies linkages between hillslope hazards and vulnerable resources. With this synthesis, MRC develops conservation measures for our HCP/NCCP.

3.3.6 Summary of aquatic habitat conditions by major streams and rivers

Based on the goals and objectives in Chapter 8, *Conservation Measures for Aquatic Habitat*, Table 3-8 summarizes the habitat condition of each major river or tributary within the plan area and CalWater planning watersheds. It shows the habitat conditions for temperature, shade, LWD, stream substrate, and channel morphology as well as existing conditions for anadromous salmonid spawning, rearing, and over-wintering. In Table 3-8, we used the percentage of watercourse segments with at least 70% average canopy cover to determine stream shade conditions within each planning watershed. The canopy values are an average for conditions throughout the planning watershed. Stream shade, however, also takes stream temperature into account along with canopy cover. Similarly, information in Table 3-8 for LWD describes the percent of segments with low or moderate wood demand which is only one component in the complete analysis of LWD conditions. Appendix S, *Targets for LWD and Effective Shade*, has a

[9] During the term of the HCP/NCCP, MRC will use watershed analysis somewhat differently. Chapter 13, *Monitoring and Adaptive Management*, describes modifications to the watershed analysis programs for the purpose of assessing the effectiveness of aquatic conservation measures.

complete analysis and ratings for LWD and stream shade. For each of the watercourses in Table 3-8, we also show whether we recently detected one or more of the covered species—coho salmon, steelhead, Chinook salmon, coastal tailed frog, red-legged frog—or whether there is evidence that these species historically existed in the plan area. In effect, Table 3-8 provides a brief look at watershed conditions across many parameters.

3.3.6.1 Interpreting MRC data on streams and rivers

The remainder of this subsection explains how to interpret each field or parameter in Table 3-8. The name of each field is preceded by a table icon, i.e., . The data in several of the fields is a qualitative index developed by MRC for aquatic habitat conditions. These qualitative indices or ratings, as shown in Table 3-2, rank MRC data on habitat conditions in comparison to published information on functional habitats.

Table 3-2 Qualitative Indices

Ratings for Aquatic Habitat	
Rating	Interpretation
OT (on target)	Habitat meets published targets for well-functioning conditions.
M (marginal)	Habitat meets functional, not optimal, conditions.
D (deficient)	Habitat is functioning at a low level and needs improvement.
ND (no data)	There is no data on the condition of the aquatic habitat. MRC has not targeted some areas for data collection because only a small portion of a watershed may lie within the plan area.
TBD (to be determined)	There is currently no data on the condition of the aquatic habitat but MRC will collect data at a later date.

The first 3 indices have specific ranges attached to them that vary by the condition measured, e.g., shade, LWD, or gravel permeability.

MRC collects and analyzes all data for large woody debris, instream sediment, effective shade, and anadromous salmonid habitat at the watercourse segment[10] level. We then group the data in order to rate individual planning watersheds, multiple planning watersheds, and the entire plan area.

Stream Temperature: Max, MWAT, MWMT

Important metrics for summer water temperatures in streams or rivers are maximum stream temperature (Max); maximum weekly average temperature (MWAT); and maximum weekly maximum temperature (MWMT). Table 3-8 shows Max, MWAT, and MWMT for all major rivers and streams in the plan area. These observations typically were made in 2003. If there were no observations in that year, we included observations from 2002 and 2001. When there were 2 observations for a particular stream or river, we presented the

[10] MRC uses the term *segment* in 3 aquatic monitoring programs: watershed analysis, long-term channel monitoring, and focus watershed studies. Typically, each segment length is about 20-30 times the bankfull width or 300-1500 ft. The average planning watershed where MRC owns a majority of the watershed contains roughly 10-20 segments for watershed analysis and one long-term channel monitoring segment.

downstream observation first. Table 3-9 is a summary of aquatic conditions in the plan area by watershed analysis unit. Below is a brief summation of temperature research on covered species. We provide this information as an aid in assessing temperature conditions described in Table 3-8. The ranges are not MRC targets or objectives for covered species.

Welsh et al. (2001) found that coho salmon were not present in any streams which had a MWAT greater than 16.7^{o}C (62.1°F) or a MWMT greater than 18.0^{o}C (64.4°F). Likewise, coho salmon were present in all streams with a MWAT less than 14.5^{o}C (58.1°F) and a MWMT less than 16.3^{o}C (61.3°F). Hines and Ambrose (1998) found that the number of days a site exceeded an MWAT of 17.6^{o}C (63.7°F) was one of the most influential variables predicting presence or absence of coho salmon. Stein et al. (1972) reported that growth rate in juvenile coho salmon slows considerably at 18°C (64.4°F), while Bell (1973) reported that growth of juvenile coho salmon ceases at 20.3°C (68.5°F).

We used temperature ranges from Nielsen et al. (1994) for steelhead because specific MWAT and MWMT thresholds have not been defined or determined. Temperatures for rearing steelhead range from 7.2° to 14.4°C (45°F to 57.9°F). Optimum temperatures for juveniles range from 10° to 12.8°C (50° to 55°F); water temperature becomes lethal for juveniles at 23.8°C (74.8°F) (Bell 1991). The Nielson article noted behavioral changes including decreased foraging and increased aggressive behavior as pool temperature reached approximately 22^{o}C. As pool temperature increased above 22^{o}C, juveniles left the observation pools and moved into stratified pools where temperatures were lower.

According to Marshal et al. (1996), coastal tailed frogs typically live in waters between 5^{o} and 16^{o}C (41^{o} and 61^{o}F). Embryos of coastal tailed frogs have the narrowest temperature tolerance range (5^{o} to 18^{o}C or 41^{o} to 64^{o}F) and the lowest lethal temperature limit among North American frogs (Brown 1975a). Streams with water temperatures above 15^{o}C (59^{o}F) for extended periods are not suitable for reproduction of coastal tailed frogs (Hayes 1996).

Individual species accounts in Chapter 4, *Covered Aquatic Species*, discuss in more detail how stream temperatures can affect various life stages of anadromous salmonids and amphibians. While high water temperatures indicate unsuitable habitat for anadromous salmonids like coho salmon and steelhead or cold water amphibians like coastal tailed frogs, they do not necessarily indicate poor land use. Other factors influence stream temperatures, such as size of the stream or river, shade from riparian vegetation, and local air temperature.

! There are streams and rivers in the plan area that are not at optimal temperature for aquatic species. Conditions upstream can influence water temperatures downstream. Riparian areas beyond MRC property boundaries, for example, may lack canopy closure or have channel widths that make canopy ineffective in cooling stream temperatures. Achieving optimal temperatures for covered species, therefore, is not a target of our HCP/NCCP. Reaching achievable stream temperatures is a target of our HCP/NCCP. MRC, in consultation with the wildlife agencies and RWQCB, will determine through adaptive management what temperatures are "achievable" in specific streams and locations.

Stream Shade

MRC rates the overall quality of shade in rivers and streams on our lands. This rating is based on the percentage of watercourse segments within a planning watershed that are *on-target* for effective shade. We do not consider canopy cover relevant for watercourse segments with an MWAT of 15°C or less because shade does not improve temperatures for covered species below this lower limit.

DEFINITION	**Effective shade** is the amount of potential solar radiation that fails to reach the ground or water surface due to vegetation or topography.

Measuring instream shade

A solar pathfinder, which takes into account aspect, topographical shading, and canopy cover, provides the best estimate of effective shade. Using this device, however, can be cumbersome and time-consuming. In the past, MRC personnel used a spherical densitometer about 75% of the time to determine average canopy cover over a surveyed stream segment. Going forward with HCP/NCCP implementation, we will use a solar pathfinder to determine effective shade. Refer to Appendix S, *Targets for LWD and Effective Shade*, for details on instream shade monitoring.

The density of canopy determines how much light filters down to the ground below. The closer trees are to one another, the more their individual canopies will overlap and the less sunlight will penetrate. The term *effective shade* describes the amount of light or heat—varying seasonally and diurnally based on the angle of the sun—that is attenuated as it passes to the stream or forest floor. It is expressed as a percentage of the energy that would have penetrated in the absence of vegetation or topography. Canopy, on the other hand, refers to vegetation that obscures a vertical view of the sky; sun angle has no effect on canopy measurements. MRC has field estimates of canopy cover from watershed analysis for a substantial portion of our land.

Setting targets for stream shade

In order to set targets for canopy cover, MRC used curves that predict effective shade (or canopy cover) as a function of bankfull width (EPA 1999a; EPA 2000a). Details on these curves are in Appendix G (section G.3.3.3). Generally, smaller streams can achieve higher canopy closure than larger streams. Therefore, MRC set lower canopy cover targets for larger streams. Table 3-3 shows MRC ratings for canopy cover as a function of bankfull width.

Table 3-3 Ratings for Canopy Cover

Rating	Bankfull Width (ft)	Canopy Closure (%)
On Target	< 30	> 90
On Target	30–100	> 70
On Target	100–150	> 40

Currently, MRC also takes stream temperature into account when analyzing effective shade. We collect stream temperature data annually to describe instream temperature conditions in most planning watersheds where MRC owns significant portions. Typically, we install multiple stream temperature probes within each of these planning watersheds, particularly in streams that are anadromous and that have aquatic species present.[11] MRC assumes that downstream temperatures are higher than those recorded at the stream temperature probes in smaller headwater areas (Figure 3-2[12]). Appendix S, *Targets for LWD and Effective Shade*, provides further detail on analyzing effective shade and on the scale of analysis.

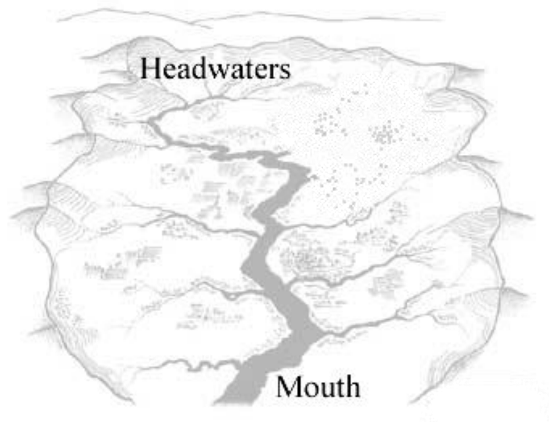


Figure 3-2 Headwaters and Mouth

MRC bases the assessment of instream effective shade for individual watercourse segments on the following factors:

1. Stream temperature

    - If the MWAT for the watercourse segment, averaged over 3 consecutive seasons, is below 15°C, current conditions provide *on-target* effective shade for all watercourses upstream of the temperature monitoring station in that sub-basin.[13]
    - If the MWAT for the watercourse segment is above 15°C, proceed to step 2.
    - If no temperature data is available for that segment, we assume that the segment does not meet the temperature target.

2. Stream canopy cover
   MRC measures instream canopy at discrete points and not continuously throughout surveyed stream segments; we then apply an average canopy value to a segment. Lastly, we determine whether the segment, based on bankfull width, meets the average canopy requirement described in Appendix G (section G.3.3.3) and summarized in Table 3-3.

[11] Refer to http://www.mrc.com/Monitoring-Aquatic.aspx (accessed 11/24/2009) for MRC reports on aquatic monitoring.

[12] This figure is adapted from an illustration of the Naugatuck River Watershed Association (CT). Headwaters are where a stream or river begins, often just a trickle of water in the mountains. Small rivulets of water flow downhill, merging together to become a stream, which mixes with other tributaries and becomes a river that finally opens at its mouth into an ocean, lake, or desert basin.

[13] The term sub-basin refers to drainages within a planning watershed. MRC typically has numerous temperature monitoring stations in planning watersheds where we own a significant portion (i.e., 50% or more). Refer to Chapter 13 under M§13.5.1.1-5 for details.

Assessing planning watersheds for instream shade

MRC bases the assessment of the entire planning watershed for effective shade on the number of stream segments (not weighted by stream length) that are meeting stream temperature or canopy cover requirements. Table 3-4 shows the ratings for effective shade in each planning watershed. The *marginal* and *deficient* categories include an alternative rating for those areas that have a large number of watercourse segments less than 30 ft in bankfull width and canopy within the range of 70% to 89%. Appendix S (section S.3) includes the analysis for current effective shade conditions.

Table 3-4 Ratings for Effective Shade

Rating	Interpretation
On Target	More than 80% of perennial watercourse segments that are within a planning watershed have on-target effective shade.
Marginal	60–80% of perennial watercourse segments that are within a planning watershed have either on-target effective shade or more than 70% canopy.
Deficient	Less than 60% of perennial watercourse segments that are within a planning watershed have either on-target effective shade or less than 70% canopy.

Table 3-8 provides current canopy cover and stream temperature data for monitored streams within each major drainage basin. We have not normalized the percentages of perennial watercourses within a planning watershed for stream length.

Stream LWD

MRC rates watercourse condition based on

1. Demand—a value derived from 3 sources:
    a. LWD recruitment potential from streamside stands.
    b. Sensitivity of the channel to LWD.
    c. Current conditions of observed number of key LWD pieces per 100 m.
2. Percentage of stream segments meeting target number of key LWD pieces.

Table 3-5 shows the ratings for LWD habitat conditions. Appendix S (section S.2) describes the analysis for determining current conditions.

Table 3-5 Ratings for LWD

Rating	Interpretation
On Target	Over 80% of surveyed segments by length have low or moderate LWD demand.
Marginal	50-80% of surveyed segments by length have low or moderate LWD demand OR over 80% of stream segments have at least half of their target number of key LWD pieces.
Deficient	Less than 50% of surveyed segments by length have low or moderate LWD demand and low numbers of functional or key LWD.

MRC assesses the quality of stream gravel by measuring its permeability. Periodically, we also take bulk gravel samples to determine the composition of the gravel, particularly the proportion of fine sediment. We collect permeability and bulk gravel samples in long term channel monitoring segments on our land.

To evaluate the quality of spawning substrate, we used the most recent permeability measurements from a stream bed and the median percent of fine particles observed in bulk gravel samples. These measurements become an index of the quality of a stream for spawning survival (Appendix H, section H.4). Tables 3-6 and 3-7 give the ratings for permeability and fine sediment.

Table 3-6 Ratings for Stream Gravel Permeability

Rating	Stream Gravel Permeability
On Target	>10,000 cm/hr permeability = >55% survival index
Marginal	>2000 cm/hr permeability = >30% survival index
Deficient	<2000 cm/hr permeability = <30% survival index

Table 3-7 Ratings for Sediment

Rating	Sediment
On Target	<7% in size class < 0.85 mm using dry sieve techniques[14]
Marginal	7-14% in size class < 0.85 mm using dry sieve techniques
Deficient	>14% in size class < 0.85 mm using dry sieve techniques

Channel Morphology: Res. Depth (ft), St. Dev. Res. Depth (ft)

Monitoring the longitudinal profile of a stream channel segment and taking a cross-section at particular points along the same segment provide useful observations of a stream channel's response to LWD and coarse sediment. MRC surveys longitudinal profiles on monitoring segments of long term channels within our land. Longitudinal or cross-sectional profiles are plots showing variations in elevation along the length of a river. A longitudinal plot gives elevation changes of riffles and pools within a monitoring reach, while a cross-section provides insight into channel widening and narrowing, or responses of a stream channel to aggradation or degradation. To demonstrate stream channel conditions from our longitudinal profiles, we provide in Table 3-8 the mean residual pool depth and the standard deviation of elevations around that mean. Both of these values help to describe channel complexity and track long-term trends. We used our most recent observations as a baseline condition in current monitoring segments of long-term channels.

[14] MRC used sediment information from the Noyo TMDL (EPA 1999b) to develop a target for fine sediment from dry-sieve techniques; the target is less than 7% of the gravel composition in size class <0.85 mm. In the TMDL for the Garcia River (NCRWQCB 1997), where dry sieving is not specified, the target for gravel composition in size class <0.85 mm is less than 14%.

Anadromous Salmonid Life Stage Condition: Spawning, Rearing, Over-wintering

During watershed analysis, MRC assesses current fish habitat conditions. We rate the quality of fish habitat for spawning, rearing, and over-wintering based on targets derived from literature. Spawning habitat conditions are evaluated on the basis of gravel availability and quality (gravel sizes, subsurface fines, and gravel embeddedness) as well as on preferred spawning areas of anadromous salmonid located at the tail-outs of pools. Summer rearing habitat conditions for anadromous salmonids are evaluated on size, depth, and availability of pools and on complexity and quantity of cover, particularly LWD. Over-wintering habitat is evaluated on size, depth, and availability of pools; the proportion of habitat units with cobble or boulder-dominated substrate; and quantity of cover. Refer to Appendix G, *Watershed Analysis: Background and Methods* section G.3.5 for specific information on how MRC determined scores and ratings.

Table 3-8 Aquatic Habitat Conditions for Major Streams and Rivers: 1998-2008

Aquatic Habitat Conditions for Major Streams and Rivers: 1998-2008																	
Plan Area																	
Streams and Rivers within CalWater Planning Watersheds	Covered Species					Stream Temperature			Stream Shade (% of segments with >70% average canopy)[M]	Stream LWD (% of segments with low or moderate demand)[L]	Stream Substrate		Channel Morphology		Salmonid Life Stage Condition		
	coho	sthd	Chnk	ctf	rf	Max (C°)	MWAT (C°)	MWMT (C°)			Permeability[P] (cm/hr)	Cum. of Fines (by weight) <0.85 mm	Res. Depth (ft)	St. Dev. Res. Depth (ft)	Spawning	Rearing	Over-wintering
SF Eel River																	
Hollow Tree Crk. (lower)	C[1]	C[1]	C[2]			21.8	19.9	21.1	0%	0%	ND	ND	ND	ND	OT	M	M
Hollow Tree Crk. (middle)	C[1]	C[1]	C[2]			20.1	17.9	19.2	75%	0%	249	10-13%	1.18	1.48	M	M	M
Hollow Tree Crk. (upper)	C[1]	C[1]	C[2]			18.4	16.4	17.6	100%	0%	368	5-9%	0.47	0.54	M	M	M
South Fork Crk.	C[1]	C[1]				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Walters Crk.	H[2]	C[1]				ND	ND	ND	ND	ND	ND	ND	ND	ND	M	D	D
Bear Crk.	H[1]	C[1]	C[2]			ND	ND	ND	ND	ND	585	4-6%	ND	ND	M	M	OT
Redwood Crk.	C[1]	C[1]	C[2]			17.1	16.1	16.7	ND	ND	ND	ND	ND	ND	D	M	M
Bond Crk.	C[1]	C[1]				18	16.5	17.4	ND	ND	394	3%	0.27	0.42	OT	M	M
Michaels Crk.	C[1]	C[1]				18.1	16.2	17.5	ND	ND	ND	ND	ND	ND	OT	M	M
Waldron Crk.	C[1]	C[1]				ND	ND	ND	ND	ND	ND	ND	ND	ND	OT	M	M
Bear Wallow Crk.	C[1]	C[1]				17.1	15.5	16.4	ND	ND	46	6-13%	0.39	0.47	ND	ND	ND
Huckleberry Crk.	C[1]	C[1]			C[7]	17.4	16	16.7	ND	ND	ND	ND	ND	ND	M	M	M
Butler Crk.	C[1]	C[1]				ND	ND	ND	ND	ND	ND	ND	ND	ND	OT	M	M
Jack of Hearts Crk.	C[1]	C[1]	H[3]			17.9	16.5	17.5	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cottaneva Creek																	
Cottaneva Crk.	C[1]	C[1]		C[7]		16.2	15.1	15.7	94%	32%	ND	ND	ND	ND	ND	ND	ND
S.F. Cottaneva Crk.	C[1]	C[1]		C[7]		15.6	14.1	15.1	80%	ND	928	8-11%	0.37	0.60	ND	ND	ND
Rockport Crk.	C[1]	C[1]				ND	ND	ND	100%	ND	ND	ND	ND	ND	ND	ND	N

Aquatic Habitat Conditions for Major Streams and Rivers: 1998-2008																	
Plan Area																	
Streams and Rivers within CalWater Planning Watersheds	Covered Species					Stream Temperature			Stream Shade (% of segments with >70% average canopy)[M]	Stream LWD (% of segments with low or moderate demand)[L]	Stream Substrate		Channel Morphology		Salmonid Life Stage Condition		
	coho	sthd	Chnk	ctf	rf	Max (C°)	MWAT (C°)	MWMT (C°)			Permeability[P] (cm/hr)	Cum. of Fines (by weight) <0.85 mm	Res. Depth (ft)	St. Dev. Res. Depth (ft)	Spawning	Rearing	Over-wintering
Slaughterhouse Gulch	C[1]	C[1]		C[7]		ND	ND	ND	100%	ND	ND	ND	ND	ND	ND	ND	ND
Kimball Gulch	H[3]	C[1]		C[7]		14.9	13.6	14.1	100%	ND	ND	ND	ND	ND	ND	ND	ND
Powderhouse Gulch		C[1]		C[7]		ND	ND	ND	100%	ND	ND	ND	ND	ND	ND	ND	ND
M.F. Cottaneva Crk.	C[1]	C[1]		C[7]		ND	ND	ND	100%	ND	ND	ND	ND	ND	ND	ND	ND
N.F. Cottaneva Crk.	C[1]	C[1]		C[7], C[7A]		ND	ND	ND	100%	ND	ND	ND	ND	ND	ND	ND	ND
Hardy Creek																	
Hardy Crk.	H[3]	C[1]		C[7]		16	14.1	15.3	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
N.F. Hardy Crk.		C[1]		C[5]		15.2	13.4	14.6	ND	ND	ND	ND	ND	ND	ND	ND	ND
S.F. Hardy Crk.		C[1]		C[1]		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Juan Creek																	
Juan Crk.	H[3]	C[1]		C[1]	C[7]	15.7	14.2	15.2	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
Little Juan Crk.		C[1]		C[1]		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Howard Creek																	
Howard Crk.	H[3]	C[1]		C[5]		15.6	13.9	15.1	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
Rock Crk.		C[1]		C[1]		15.2	14	14.7	ND	ND	ND	ND	ND	ND	ND	ND	ND
Noyo River																	
Noyo R. (NF Noyo	C[1]	C[1]	C[3]			21	18.8	20.2	100%	0%	5206	3-11%	0.88	1.04	OT	D	D

Aquatic Habitat Conditions for Major Streams and Rivers: 1998-2008

Plan Area

Streams and Rivers within CalWater Planning Watersheds	Covered Species					Stream Temperature			Stream Shade (% of segments with >70% average canopy)[M]	Stream LWD (% of segments with low or moderate demand)[L]	Stream Substrate		Channel Morphology		Salmonid Life Stage Condition		
	coho	sthd	Chnk	ctf	rf	Max (C°)	MWAT (C°)	MWMT (C°)			Permeability[P] (cm/hr)	Cum. of Fines (by weight) <0.85 mm	Res. Depth (ft)	St. Dev. Res. Depth (ft)	Spawning	Rearing	Over-wintering
PWS)																	
Noyo R. (Olds Crk PWS)	C[1]	C[1]				ND	ND	ND	100%	0%	ND	ND	ND	ND	OT	M	M
Noyo R. (McMullen PWS)	C[1]	C[1]				ND	ND	ND	100%	0%	ND	ND	ND	ND	ND	ND	ND
N.F. Noyo R. (NF Noyo PWS)	C[1]	C[1]	C[3]			20.6	18.4	19.7	ND	ND	ND	ND	ND	ND	M	D	D
N.F. Noyo R. (MFNF PWS)	C[1]	C[1]				18.5	16.8	17.9	100%	9%	1521	5-14%	0.42	0.53	M	M	M
Marble Crk.	C[1]	C[1]				17.5	16.1	17	ND	ND	2549	4-13%	0.56	0.64	M	M	D
Gulch No.7	H[3]	C[1]				ND	ND	ND	ND	ND	ND	ND	ND	ND	M	M	D
Hayworth Crk.	C[1]	C[1]	C[3]			20.5/ 20.4	18.6/ 18.4	19.8/ 19.7	60%	51%	2312	2-18%	0.65	0.89	M	M	M
N.F. Hayworth Crk.	C[1]	C[1]				19.9	17.8	19.2	ND	ND	ND	ND	ND	ND	D	M	M
M.F.N.F. Noyo R.	C[1]	C[1]				18.9	17.1	18.2	ND	ND	1721	3-14%	0.34	0.55	M	M	M
Dewarren Crk.		C[1]				ND	ND	ND	ND	ND	ND	ND	ND	ND	D	M	M
Olds Crk.	C[1]	C[1]				18.7	17.4	18.1	ND	ND	ND	ND	ND	ND	OT	D	D
Redwood Crk.	C[1]	C[1]				19.7	18.1	19.2	100%	ND	ND	ND	ND	ND	OT	M	OT
McMullen Crk.	C[1]	C[1]				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Burbeck Crk.		C[1]				19.4	17	18.6	ND	ND	ND	ND	ND	ND	ND	ND	ND
Big River																	
Big River (Two Log PWS)	C[1]	C[1]			C[7]	ND	ND	ND	71%	4%	2174	7-14%	0.4	0.58	M	M	D
Big River (Russell Brook PWS)	C[1]	C[1]				23.6	19.4	22.5	57%	7%	ND	ND	ND	ND	M	M	M
Big River (Rice Crk PWS)	C[1]	C[1]				ND	ND	ND	0%	0%	ND	ND	ND	ND	M	D	D
Russell Brook	C[1]	C[1]				18.3	16.6	17.8	ND	ND	ND	ND	ND	ND	M	M	M

Aquatic Habitat Conditions for Major Streams and Rivers: 1998-2008

Plan Area

Streams and Rivers within CalWater Planning Watersheds	Covered Species					Stream Temperature			Stream Shade (% of segments with >70% average canopy)[M]	Stream LWD (% of segments with low or moderate demand)[L]	Stream Substrate		Channel Morphology		Salmonid Life Stage Condition		
	coho	sthd	Chnk	ctf	rf	Max (C°)	MWAT (C°)	MWMT (C°)			Permeability[P] (cm/hr)	Cum. of Fines (by weight) <0.85 mm	Res. Depth (ft)	St. Dev. Res. Depth (ft)	Spawning	Rearing	Over-wintering
N.F. Big River	C[1]	C[1]	H[3]			20.9	19	20.3	67%	23%	ND	ND	ND	ND	OT	M	M
East Branch N.F. Big River	C[1]	C[1]				19.4/ 20.2	17.4/ 17.7	18.6/ 19.5	100%	11%	1003	9-11%	0.45	0.57	M	M	M
Two Log Crk.	C[1]	C[1]			C[1]	16.4	15.5	15.9	ND	ND	ND	ND	ND	ND	M	M	M
Tramway Gulch	C[1]	C[1]				ND	ND	ND	ND	ND	ND	ND	ND	ND	M	D	D
S.F. Big R.	C[1]	C[1]			C[5]	22.7	20.3	21.9	ND	ND	2292	8-13%	0.95	1.23	OT	M	M
Ramon Crk.	C[1]	C[1]				21.7/ 21.3	18.5/ 18.3	20.7/ 20.4	ND	ND	48	10-16%	0.42	0.56	M	D	D
Mettick Crk.		C[1]				ND	ND	ND	46%	6%	ND	ND	ND	ND	M	D	D
Anderson Gulch		C[1]				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Boardman Gulch		C[1]				ND	ND	ND	ND	ND	ND	ND	ND	ND	M	D	D
Halfway House Gulch		C[1]				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Daugherty Crk.	C[1]	C[1]				22.2/ 21.0	19.1/ 18.3	21.2/ 20.0	86%	9%	610	11-22%	0.79	1.13	M	M	M
Soda Crk.		C[1]				ND	ND	ND	ND	ND	ND	ND	ND	ND	M	M	OT
Gates Crk.	C[1]	C[1]				21.3	18.8	20.5	ND	ND	ND	ND	ND	ND	M	D	M
Snuffins Crk.	C[1]	C[1]				ND	ND	ND	ND	ND	ND	ND	ND	ND	D	M	M
Albion River																	
Albion River (Lower PWS)	C[1]	C[1]	C[1]		C[7A]	ND	ND	ND	100%	0%	5137	1-14%	1.42	1.38	OT	M	M
Albion River (Middle PWS)	C[1]	C[1]			C[6A]	18.7	16.2	17.7	100%	0%	1080	0-20%	0.73	0.77	OT	M	M
Albion River (Upper PWS)	C[1]	C[1]				17.9	16	17.2	100%	0%	ND	ND	ND	ND	ND	ND	ND
Railroad Gulch	C[1]	C[1]		C[7]	C[7]	15.2	14.3	14.9	ND	ND	ND	ND	ND	ND	M	M	M
Pleasant Valley Crk.	C[1]	C[1]				14.9	13.8	14.5	ND	ND	ND	ND	ND	ND	M	M	M
Deadman Gulch	C[1]					14.5	13.6	14.2	ND	ND	ND	ND	ND	ND	ND	ND	N

Aquatic Habitat Conditions for Major Streams and Rivers: 1998-2008

Plan Area

Streams and Rivers within CalWater Planning Watersheds	Covered Species					Stream Temperature			Stream Shade (% of segments with >70% average canopy)[M]	Stream LWD (% of segments with low or moderate demand)[L]	Stream Substrate		Channel Morphology		Salmonid Life Stage Condition		
	coho	sthd	Chnk	ctf	rf	Max (C°)	MWAT (C°)	MWMT (C°)			Permeability[P] (cm/hr)	Cum. of Fines (by weight) <0.85 mm	Res. Depth (ft)	St. Dev. Res. Depth (ft)	Spawning	Rearing	Over-wintering
Slaughterhouse Gulch	C[1]	C[1]			C[7]	14.9	13.7	14.5	ND	ND	ND	ND	ND	ND	ND	ND	ND
Duckpond Gulch	C[1]					21.3	15.6	20.7	ND	ND	ND	ND	ND	ND	M	M	M
S.F. Albion River	C[1]	C[1]	H[3]			17.9/ 15.6	15.5/ 14.6	17.1/ 15.3	100%	0%	71	3-11%	0.73	0.87	M	M	M
Norden Gulch	C[1]	C[1]				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Little N.F. Albion River	C[1]	C[1]				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bull Team Gulch	C[1]	C[1]				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Kaison Gulch		C[1]			C[1]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
E. Railroad Gulch	C[1]	C[1]				ND	ND	ND	ND	ND	ND	ND	ND	ND	OT	M	M
Tom Bell Crk.	C[1]	C[1]			C[1]	ND	ND	ND	ND	ND	ND	ND	ND	ND	M	M	M
N.F. Albion R.	C[1]	C[1]				ND	ND	ND	ND	ND	ND	ND	ND	ND	OT	M	M
Upper Russian River																	
Alder Crk.		C[1]				22.1	20.2	21	ND	ND	ND	ND	ND	ND	M	D	D
Ackerman Crk. (Upper PWS)		C[1]				23.2	18	22.6	0%	0%	3453	8-13%	0.55	0.77	M	M	M
Navarro River																	
Navarro River (Lower PWS)	C[1]	C[1]		C[7A]	C[7]	ND	ND	ND	50%	18%	ND	ND	ND	ND	M	M	M
Navarro River (Middle PWS)	C[1]	C[1]				20.3	19.4	19.9	0%	0%	3651	13-25%	1.67	1.53	M	M	M
Navarro River (Upper PWS)	C[1]	C[1]				ND	ND	ND	67%	30%	ND	ND	ND	ND	M	M	M
Navarro River (Hendy Wood)		C[1]				26.1	22.2	25.5	100%	0%	ND	ND	ND	ND	ND	ND	ND

Aquatic Habitat Conditions for Major Streams and Rivers: 1998-2008

Plan Area

Streams and Rivers within CalWater Planning Watersheds	Covered Species					Stream Temperature			Stream Shade (% of segments with >70% average canopy)[M]	Stream LWD (% of segments with low or moderate demand)[L]	Stream Substrate		Channel Morphology		Salmonid Life Stage Condition		
	coho	sthd	Chnk	ctf	rf	Max (C°)	MWAT (C°)	MWMT (C°)			Permeability[P] (cm/hr)	Cum. of Fines (by weight) <0.85 mm	Res. Depth (ft)	St. Dev. Res. Depth (ft)	Spawning	Rearing	Over-wintering
Marsh Gulch	C[1]	C[1]		C[1]		15.2	14.1	14.9	100%	ND	ND	ND	ND	ND	D	M	M
Murray Gulch	C[1]	C[1]		C[1]	C[1]	15.6	14.5	15.2	100%	ND	ND	ND	ND	ND	M	D	D
Flume Crk.	C[1]	C[1]		C[7]		14.1	13.4	13.8	100%	ND	1396	8-13%	ND	ND	M	M	M
Ray Gulch		C[1]			C[7]	13.7	13.3	13.5	100%	19%	ND	ND	ND	ND	OT	OT	M
Flynn Crk.	C[1]	C[1]				16	14.7	15.8	100%	0%	13,103	3-13%	0.54	0.55	OT	M	M
North Branch N.F. Navarro River (Dutch Henry PWS)	C[1]	C[1]				20.4	18.3	19.9	0%	0%	ND	ND	ND	ND	OT	M	OT
North Branch N.F. Navarro River (Little NF PWS)	C[1]	C[1]				20.9	18.2	20.2	100%	0%	15,149	6695	0.43	0.6	ND	ND	ND
Cooks Crk.	C[1]	C[1]				19	17.3	18.6	0%	ND	ND	ND	ND	ND	OT	M	M
John Smith Crk.	C[1]	C[1]				17.4	17.1	17.2	100%	0%	6516	5-10%	0.76	0.65	M	M	M
Redwood Crk.	C[1]	C[1]				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Little N.F. Navarro River	C[1]	C[1]				19.8	18.4	19.3	ND	0%	5217	7-11%	0.55	0.65	M	M	M
South Branch N.F. Navarro River (Lower)	C[1]	C[1]				20.5	18.5	19.8	80%	0%	5467	4-13%	1.12	1.19	OT	D	M
South Branch N.F. Navarro River (Middle)	C[1]	C[1]				20.5	18.5	19.8	25%	0%	ND	ND	ND	ND	M	M	M
South Branch N.F. Navarro River (Upper)	C[1]	C[1]				ND	ND	ND	40%	ND	ND	ND	ND	ND	M	M	M
Bailey Crk.		C[1]				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bear Crk.	C[1]	C[1]				ND	ND	ND	ND	ND	ND	ND	ND	ND	M	D	D

Aquatic Habitat Conditions for Major Streams and Rivers: 1998-2008

Plan Area

Streams and Rivers within CalWater Planning Watersheds	Covered Species					Stream Temperature			Stream Shade (% of segments with >70% average canopy)[M]	Stream LWD (% of segments with low or moderate demand)[L]	Stream Substrate		Channel Morphology		Salmonid Life Stage Condition		
	coho	sthd	Chnk	ctf	rf	Max (C°)	MWAT (C°)	MWMT (C°)			Permeability[P] (cm/hr)	Cum. of Fines (by weight) <0.85 mm	Res. Depth (ft)	St. Dev. Res. Depth (ft)	Spawning	Rearing	Over-wintering
Bridge Crk.	C[1]	C[1]				ND	ND	ND	0%	ND	ND	ND	ND	ND	OT	M	M
Shingle Mill Crk.		C[1]				ND	ND	ND	100%	ND	ND	ND	ND	ND	M	M	D
McGarvey Crk.		C[1]				ND	ND	ND	0%	ND	ND	ND	ND	ND	M	D	D
Low Gap Crk.	C[1]	C[1]				ND	ND	ND	100%	ND	ND	ND	ND	ND	M	M	M
Hardscratch Crk.	C[1]	C[1]				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Tramway Gulch		C[1]				14.5	13.6	14.1	ND	ND	ND	ND	ND	ND	ND	ND	ND
Perry Gulch		C[1]				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Berry Crk.		C[1]				14.5	13.5	14.1	0%	ND	ND	ND	ND	ND	OT	D	D
Floodgate Crk.		C[1]				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Black Rock Crk.		C[1]				16	14.9	15.8	ND	0%	ND	ND	ND	ND	M	D	M
N.F. Indian Crk.	H[2]	C[1]				25.1/22.5	20.1/19.4	24.0/21.6	0%	NA	ND	ND	ND	ND	OT	M	M
West Branch N.F. Indian Crk.		C[1]				16.8	15	15.8	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cold Springs Crk.		C[1]				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Greenwood Creek																	
Greenwood Crk (Lower PWS)	I	C[1]		C[7A]	C[7A]	20.8/19.2	17.3/16.7	19.9/18.6	75%	14%	ND	ND	0.47	0.59	ND	ND	ND
Greenwood Crk (Upper PWS)	I	C[1]		C[7A]		20.3	17.6	19.6	80%	19%	357	4-6%	0.85	1.19	ND	ND	ND
Corrals Gulch		C[1]				17.2	15.3	16.8	ND	ND	ND	ND	ND	ND	ND	ND	ND
Big Tree Crk.		C[1]		C[7]		16.5	15.5	16.2	ND	ND	ND	ND	ND	ND	ND	ND	ND
Elk Creek																	

Aquatic Habitat Conditions for Major Streams and Rivers: 1998-2008

Plan Area

Streams and Rivers within CalWater Planning Watersheds	Covered Species					Stream Temperature			Stream Shade (% of segments with >70% average canopy)[M]	Stream LWD (% of segments with low or moderate demand)[L]	Stream Substrate		Channel Morphology		Salmonid Life Stage Condition		
	coho	sthd	Chnk	ctf	rf	Max (C°)	MWAT (C°)	MWMT (C°)			Permeability[P] (cm/hr)	Cum. of Fines (by weight) <0.85 mm	Res. Depth (ft)	St. Dev. Res. Depth (ft)	Spawning	Rearing	Over-wintering
Elk Crk.	C[1]	C[1]		C[1A]	C[1]	17.1/ 16.5	15.6/ 15.0	16.4/ 16.0	TBD	TBD	17,989	1-20%	1.02	1.09	TBD	TBD	TBD
South Fork Elk Crk.	C[1]	C[1]		C[7]	C[7]	13.7	12.7	13.5	TBD	ND	5242	1-20%	0.23	0.38	TBD	TBD	TBD
Three Springs Crk.	H[2]	C[1]		C[7]		16.8	15.1	16.3	TBD	ND	ND	ND	ND	ND	TBD	TBD	TBD
Sulphur Fork Crk.	H[2]	C[1]		C[7]		ND	ND	ND	TBD	ND	ND	ND	ND	ND	TBD	TBD	TBD
Soda Fork Crk.	H[2]	C[1]		C[1]		ND	ND	ND	TBD	ND	ND	ND	ND	ND	TBD	TBD	TBD
Mills Creek																	
Mills Crk.		C[1]			C[1]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Mallo Pass Creek																	
Mallo Pass Crk.	H[2]	C[1]		C[7]	C[7A]	14.5	13.9	14.4	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
Alder Creek																	
Alder Crk. (Lower PWS)		C[1]		C[7]		19.4	16.7	18.7	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
Alder Crk. (NF Alder PWS)		C[1]				20.7	18.3	19.9	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
Owl Crk.				C[7]		12.9	12.5	12.8	TBD	ND	TBD	TBD	TBD	TBD	TBD	TBD	TBD
Tramway Gulch		C[1]		C[7]		ND	ND	ND	TBD	ND	TBD	TBD	TBD	TBD	TBD	TBD	TBD
Nye Crk.		C[1]		C[1]		15.2	13.9	14.5	TBD	ND	TBD	TBD	TBD	TBD	TBD	TBD	TBD
Tin Can Crk.		C[1]		C[1]		15.2	14	14.6	TBD	ND	TBD	TBD	TBD	TBD	TBD	TBD	TBD
John Crk.		C[1]		C[7]		16	14.7	15.4	TBD	ND	TBD	TBD	TBD	TBD	TBD	TBD	TBD

Aquatic Habitat Conditions for Major Streams and Rivers: 1998-2008

Plan Area

Streams and Rivers within CalWater Planning Watersheds	Covered Species					Stream Temperature			Stream Shade (% of segments with >70% average canopy)[M]	Stream LWD (% of segments with low or moderate demand)[L]	Stream Substrate		Channel Morphology		Salmonid Life Stage Condition		
	coho	sthd	Chnk	ctf	rf	Max (C°)	MWAT (C°)	MWMT (C°)			Permeability[P] (cm/hr)	Cum. of Fines (by weight) <0.85 mm	Res. Depth (ft)	St. Dev. Res. Depth (ft)	Spawning	Rearing	Over-wintering
Bee Tree Crk.		C[1]		C[1]		15.4	14.4	15	TBD	ND	TBD	TBD	TBD	TBD	TBD	TBD	TBD
Panther Crk.		C[1]				ND	ND	ND	TBD	ND	TBD	TBD	TBD	TBD	TBD	TBD	TBD
Garcia River																	
Garcia River (Rolling Brk PWS)	C[1]	C[1]	H[3]			21.3	18.4	20.7	75%	0%	ND	M	ND	ND	ND	ND	ND
Garcia River (SF Garcia PWS)	C[1]	C[1]	H[3]		C[7]	16.4	14.9	16.3	73%	19%	4868	3-12%	1.51	1.58	OT	M	M
Lee Crk.		C[1]				12.9	12.8	12.9	TBD	ND	ND	ND	ND	ND	ND	ND	ND
Rolling Brook		C[1]				15.6	14.3	15.4	TBD	ND	1601	2-6%	0.1	0.19	M	M	M
S.F. Garcia R.	C[1]	C[1]				16.4	14.9	16.3	TBD	ND	2262	ND	0.42	0.50	M	M	M
Flemming Crk.	C[1]	C[1]				14.1	13.5	14.1	ND	ND	ND	ND	ND	ND	ND	ND	ND
Inman Crk.	H[3]	C[1]				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Schooner Gulch																	
Schooner Gulch	H[2]	C[1]		C[7]		15.2	13.8	14.9	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
Shingle Mill Gulch						16.8	13.8	16.3	TBD	ND	TBD	TBD	TBD	TBD	TBD	TBD	TBD
Hall Gulch		C[1]				14.5	13.6	14.3	TBD	ND	TBD	TBD	TBD	TBD	TBD	TBD	TBD
China Gulch						15.2	13.6	14.7	TBD	ND	TBD	TBD	TBD	TBD	TBD	TBD	TBD
Owl Crk.		C[1]				ND	ND	ND	ND	ND	ND	ND	ND	ND	M	D	M

TABLE NOTES

Species Codes

coho=coho salmon, sthd=steelhead, Chnk=Chinook salmon, ctf=coastal tailed frog, rf=red legged frog

Aquatic Habitat Conditions for Major Streams and Rivers: 1998-2008

Plan Area

Streams and Rivers within CalWater Planning Watersheds	Covered Species					Stream Temperature			Stream Shade (% of segments with >70% average canopy)[M]	Stream LWD (% of segments with low or moderate demand)[L]	Stream Substrate		Channel Morphology		Salmonid Life Stage Condition		
	coho	sthd	Chnk	ctf	rf	Max (C°)	MWAT (C°)	MWMT (C°)			Permeability[P] (cm/hr)	Cum. of Fines (by weight) <0.85 mm	Res. Depth (ft)	St. Dev. Res. Depth (ft)	Spawning	Rearing	Over-wintering

Detection/Presence Codes

C[1] Species detected during MRC aquatic species distribution surveys between 1994 and 2002 (MRC 2002a).
C[1A] Species detected in a tributary to the watercourse during aquatic species distribution surveys between 1994 and 2002 (MRC 2002a).
C[2] Species detected during MRC/CDFG ground surveys for spawning anadromous salmonids (MRC 2000, unpublished data).
C[3] Record of presence is based on an email to Matt Goldsworthy (MRC) from Sean P. Gallagher (CDFG—Fort Bragg, CA) on 8 December 2006.
C[4] NCWAP (North Coast Watershed Assessment Program). 2002. Gualala Watershed Synthesis Report (Draft), 104pp.
C[5] Species detected during 2001 Herpetological Class II Surveys.
C[6] Species detected incidentally (MRC Incidental Wildlife Sightings Database).
C[6A] Species detected in a tributary to the watercourse (MRC Incidental Wildlife Sightings Database).
C[7] Species detected in stream during baseline amphibian distribution surveys (2003, 2004, 2005, 2006, 2007, and 2008).
C[7A] Species detected in tributary to the stream, or in nearby pond during baseline amphibian distribution surveys (2003, 2004, 2005, 2006, 2007, and 2008).
H[1] Brownell, N. F., William, M. K., and Reber, M. L. 1999. Historical and current presence and absence of coho salmon in the Northern California Portion of the Southern Oregon-Northern California Evolutionary Significant Unit. NOAA/NMFS.
H[2] Record of historic presence is based upon Hassler et al. 1991. Neither the source nor the exact location of these accounts has been confirmed. In some cases, the reference may be to portions of a stream not within MRC property.
H[3] Record of historic presence is based upon Cherr and Griffin 1979. Neither the source nor the exact location of these accounts has been confirmed. In some cases, the reference may be to portions of a stream not within MRC property.
H[4] NMFS (National Marine Fisheries Service). 2000a. California coastal salmon and steelhead current stream habitat distribution table (Draft). Prepared by NMFS, Long Beach, CA.
I Inconclusive based on review of sources.
P Geometric mean; most recent data.
L Rated by planning watershed; not applicable to individual watercourse segments. Each planning watershed will have anywhere from 3 to 30 field-observed segments, depending on how much of the planning watershed MRC owns.
M Rated by planning watershed; not applicable to individual watercourse segments. Each planning watershed will have anywhere from 3 to 30 field-observed segments, depending on how much of the planning watershed MRC owns. Watershed analysis maps for riparian conditions include canopy cover estimates for individual segments from reviews of aerial photographs.

Data Codes

D=Deficient; M = Marginal; OT = On Target; ND = No data will be collected; TBD = To be determined (i.e., data yet to be collected).

Table 3-9 Summary of Aquatic Conditions by Watershed Analysis Unit

Summary of Aquatic Conditions by Watershed Analysis Unit									
Watershed Analysis Unit	**Annual Salmonid Monitoring Basin (ASMB)**	**Coho Presence**	**Stream Temperature**		**Stream Shade**	**Stream LWD**	**Stream Morphology**		
			Average MWAT (C) for All Tributaries Monitored	Standard Deviation of Temperatures within Basin	Average % of Segments with >70% Average Canopy	Average % of Segments with Low or Moderate Demand	Permeability (cm/hr)	Cumulative % of Fines < 0.85 mm (by weight)	Average Residual Depth (ft)
South Fork Eel River	Hollow Tree Creek	annual	16.8	1.3	58%	0%	264	3%	0.6
Rockport Coastal Streams	Cottaneva Creek	annual	14.3	0.8	91%	32%	928	8-11%	0.6
Rockport Coastal Streams	Juan Creek	historical, doubtful	14.2	NA	TBD	TBD	TBD	TBD	TBD
Noyo River	North Fork Noyo River	annual	17.6	0.9	90%	20%	2662	3-11%	0.6
Big River	Big River (above South Fork Big River)	episodic	17.6	1.5	84%	17%	526	7-14%	0.4
Big River	South Fork Big River	annual	18.8	1.4	72%	8%	1451	8-22%	0.9
Albion River	Albion River	annual	14.6	1.0	100%	0%	1080	0-20%	0.7

Summary of Aquatic Conditions by Watershed Analysis Unit									
Watershed Analysis Unit	Annual Salmonid Monitoring Basin (ASMB)	Coho Presence	Stream temperature		Stream Shade	Stream LWD	Stream morphology		
			Average MWAT (C) for All Tributaries Monitored	Standard Deviation of Temperatures within Basin	Average % of Segments with >70% Average Canopy	Average % of Segments with Low or Moderate Demand	Permeability (cm/hr)	Cumulative % of Fines < 0.85 mm (by weight)	Average Residual Depth (ft)
Albion River	South Fork Albion River	annual	15.1	NA	100%	0%	71	3-11%	0.7
Navarro River	North Branch North Fork Navarro River	annual	17.2	1.8	50%	0%	8961	8-25%	0.6
Navarro River	South Branch North Fork Navarro River	episodic	16.7	2.5	26%	0%	5467	4-13%	1.1
Greenwood Creek	Greenwood Creek	none detected	16.4	1.1	78%	17%	357	4-6%	0.7
Elk Creek	Elk Creek	highly episodic	14.4	1.4	TBD	TBD	11,616	1-20%	0.6
Point Arena Streams	Mallo Pass Creek	historical, doubtful	13.9	NA	TBD	TBD	TBD	TBD	TBD
Point Arena Streams	Alder Creek	none detected	14.9	1.9	TBD	TBD	TBD	TBD	TBD
Garcia River	South Fork Garcia River	episodic	14.4	0.8	73%	19%	3565	3-12%	1.0

Summary of Aquatic Conditions by Watershed Analysis Unit									
Watershed Analysis Unit	Annual Salmonid Monitoring Basin (ASMB)	Coho Presence	Stream temperature		Stream Shade	Stream LWD	Stream morphology		
			Average MWAT (C) for All Tributaries Monitored	Standard Deviation of Temperatures within Basin	Average % of Segments with >70% Average Canopy	Average % of Segments with Low or Moderate Demand	Permeability (cm/hr)	Cumulative % of Fines < 0.85 mm (by weight)	Average Residual Depth (ft)

TABLE NOTES

NA = not applicable   TBD = To Be Determined

Table 3-9 is a compilation of information from Table 3-8 in an effort to summarize data by watershed analysis unit. The canopy values shown in Table 3-9 are averages of all canopy values for each planning watershed within a WAU. For example, the South Fork Eel River WAU is the average of Lower, Middle and Upper Hollow Tree Creek, i.e., (0% + 75% + 100%) / 3 = 58%. The same process of averaging applies to LWD values.

3.3.7 Regional summary of aquatic habitat conditions

Table 3-8 examined aquatic habitat conditions from the viewpoint of individual rivers and tributaries in the plan area. In this subsection, we look at aquatic habitat conditions from a regional viewpoint, i.e., across the entire plan area.

Stream and watershed conditions are dynamic with natural disturbances occurring stochastically, both temporally and spatially. We cannot expect that habitat conditions at a regional scale will be *on target* everywhere and at all times. Rather we should expect a range of habitat conditions both spatially and temporally. Therefore, interpreting habitat conditions across their distribution is more useful and accurate. When a regional distribution skews toward *on target* conditions over time with expected deviations following disturbances, this is the best indication of favorable habitat conditions.

3.3.7.1 Stream shade

To determine stream shade, MRC first assesses stream temperature and then canopy cover based on the bankfull width of the stream. Figure 3-3 indicates that stream shade conditions are generally marginal to deficient in the plan area. Appendix S, *Targets for LWD and Effective Shade,* provides further details on the derivation of Figures 3-3 and 3-4.[15]

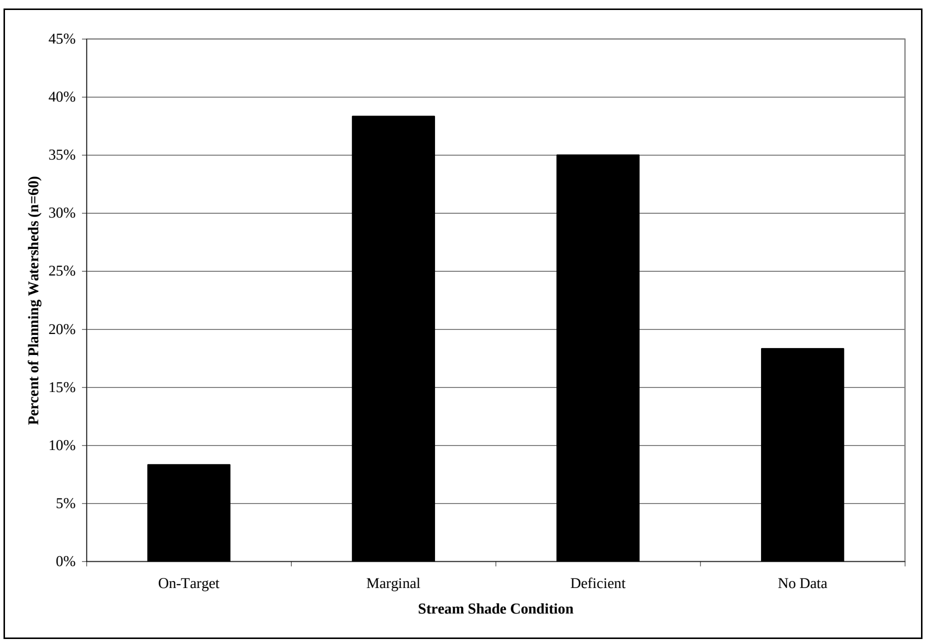


Figure 3-3 Effective Stream Shade in MRC Planning Watersheds as of 2005

[15] Determining the on-target ratings for instream LWD in individual stream segments (Figure 3-4) entailed many steps, one of which was calculating the density of LWD volume by stream length. In our data analysis, there was no similar normalization process for stream shade (Figure 3-3). The histograms in Figures 3-3 and 3-4 summarize data for the entire plan area.

3.3.7.2 Instream LWD conditions

Figure 3-4 demonstrates that instream LWD conditions are not favorable in the plan area. A majority of streams exhibit *marginal* or *deficient* LWD conditions with few streams being *on target*. The distribution for LWD skews toward *deficient* conditions.

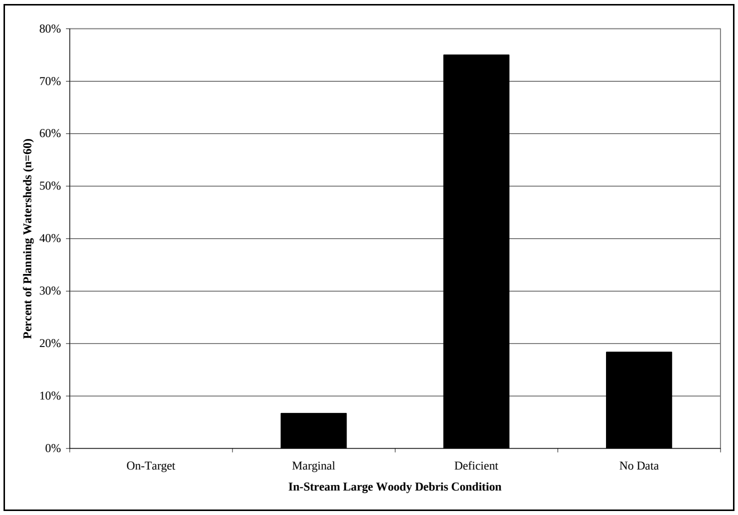


Figure 3-4 LWD Conditions in MRC Planning Watersheds as of 2005

Since 1998, MRC has worked with various agencies and non-profit organizations installing LWD within our planning watersheds. Table 3-10 shows the distribution of these 26 LWD projects by planning watershed for the period 1998-2007.

Table 3-10 LWD Projects in the Plan Area: 1998-2007

Planning Watershed	# of LWD Projects
Cottaneva Creek	1
Daugherty Creek (Big River)	5
East Branch North Fork (Big River)	1
Flynn Creek (Navarro)	1
Hayworth Creek (Noyo)	1
Hollow Tree Creek (SF Eel River)	6
Little North Fork Navarro	3
Mettick Creek (Big River)	1
Middle Albion River	1
Russell Brook (Big River)	1
South Branch North Fork Navarro	1
South Fork Albion	3
Upper Ackerman Creek (Russian River)	1
TOTAL	26

3.3.7.3 Anadromous salmonid habitat conditions

Figure 3-5 demonstrates that habitat conditions for anadromous salmonid vary by life stage. This bar graph only depicts current conditions in MRC streams. As MRC implements the goals and objectives of our HCP/NCCP, conditions for anadromous salmonids will improve. MRC evaluates habitat conditions (pool depths, quality of spawning gravels, etc.) collectively for all species of anadromous salmonids, not separately for each species. Spawning habitat has a distribution slightly skewed toward *on target* conditions; however, a majority of the observations indicate *marginal* conditions. Rearing and over-wintering habitat conditions skew slightly toward *deficient* conditions with few *on target* streams; a majority of observations indicate *marginal* conditions. The general trend for all life stages demonstrates a need for improvement, particularly in rearing and over-wintering habitat conditions.

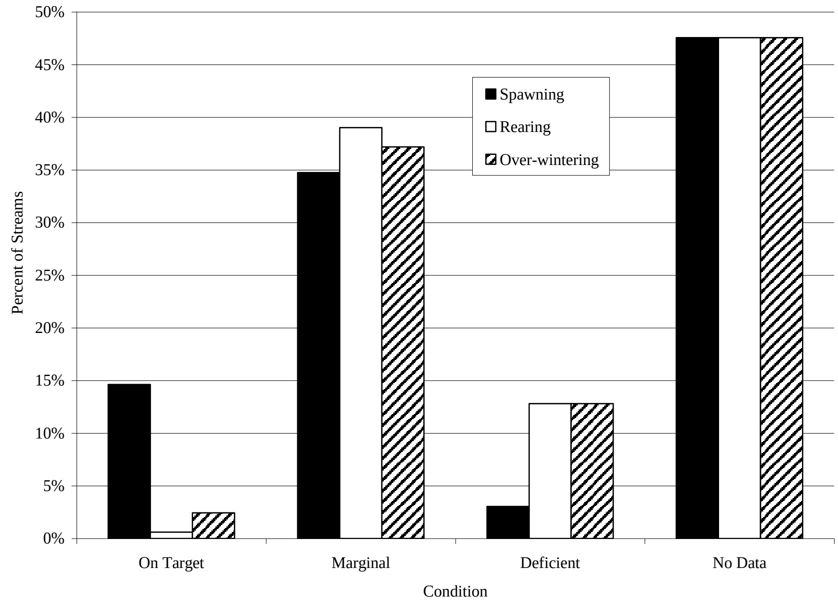


Figure 3-5 Anadromous Salmonid Habitat Condition by Life Stage

3.3.7.4 Spawning habitat conditions

Figure 3-6 supports earlier results for spawning habitat conditions shown in Figure 3-5. The distribution for quality of spawning habitat, indicated by permeability, skews toward *on target* conditions; however, a majority of observations indicate *marginal* conditions with a few *deficient* conditions. The distribution for quality of spawning habitat, indicated by percent fines <0.85 mm, has more *on target* and fewer *deficient* observations than those for permeability.

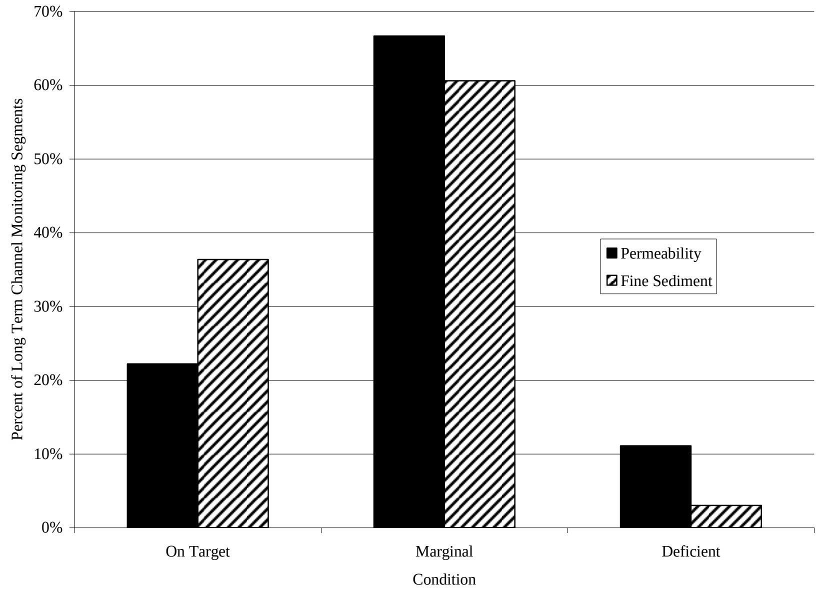


Figure 3-6 Spawning Gravel Quality from Long Term Monitoring Segments

3.3.8 Summary of sediment input by planning watershed

In our watershed analysis, MRC evaluates estimates of sediment inputs from hillslope mass wasting; mass wasting associated with roads; road surface and point source erosion; and skid trail erosion. Table 3-11 summarizes estimates of sediment input by CalWater planning watershed. Appendix G (section G.3) details our methods. Chapter 8 (section 8.3.3) proposes conservation measures relevant to sediment input (C§8.3.3.1.2-1 to C§8.3.3.1.2-24; C§8.3.3.1.3-1 to C§8.3.3.1.3-11; C§8.3.3.1.4-1 to C§8.3.3.1.4-3; C§8.3.3.1.5-1 to C§8.3.3.1.5-6; C§8.3.3.1.6-1 to C§8.3.3.1.6-5; C§8.3.3.1.7-1 to C§8.3.3.1.7-3; C§8.3.3.1.8-1 to C§8.3.3.1.8-9). Chapter 13 (M§13.5.4.1-2 and M§13.5.4.1-2) describes how MRC will monitor for stream sediment.

The information in Table 3-11 should be interpreted carefully. MRC estimated sediment input in varying levels of effort. Some watershed analysis units had more field observations or a greater number of aerial photographs than others; this influences the accuracy and confidence of the results. MRC suggests the following guidelines for interpreting estimates of sediment delivery in Table 3-11:

- Compare planning watersheds within their respective watershed analysis units; interpretations are the same within each watershed analysis unit.
- Exercise caution in comparing across planning watersheds; compare only the magnitude of sediment delivery in one watershed relative to other watersheds.
- Remember that high sediment delivery may result from small areas in a planning watershed; the occurrence of a few landslides or road problems in a small area can create a high sediment delivery rate as, for example, in the planning watersheds of North Fork Indian Creek and Lower Hollow Tree Creek.

3.3.8.1 Interpreting MRC data on sediment inputs

Following is a list of field names in Table 3-11 and an explanation of their data. The name of each field is preceded by a table icon, i.e., .

Total Sediment Inputs

This is the total estimate of sediment delivery from mass wasting as well as surface and point source erosion for each CalWater planning watershed. To assist in interpretation, we have provided the total sediment inputs as rate by mass ($tons/mi^2/yr$) and volume ($yd^3/mi^2/yr$).

Non-Road Mass Wasting Sediment Inputs

This is an estimate of sediment inputs from shallow-seated landslides not associated with a road, skid trail, or landing. The estimate is based on interpretation of field observations and sequences of aerial photographs (typically 3 or 4) spanning the past 30-40 years (or longer when available). The data represents a percent of the total sediment input for each CalWater planning watershed.

Road Mass Wasting Sediment Inputs

This is an estimate of sediment inputs from shallow-seated landslides associated with a road or landing. The estimate is based on interpretation of field observations and sequences of aerial photographs (typically 3 or 4) spanning the past 30-40 years (or longer when available). The data represents a percent of the total sediment input for each CalWater planning watershed.

Road Surface and Point Source Sediment Inputs

This is a total estimate of surface erosion based on both a model and field observations of point source erosion. The surface erosion model predicts sheetwash erosion from road surface, fill, and cut-slopes. The field observations were of culvert wash-outs and gully erosion. The data represents a percent of the total sediment input for each CalWater planning watershed.

Skid Trail Sediment Inputs

This is an estimate of sediment inputs of surface and point source erosion from skid trails. The estimate is based on interpretation of sequences of aerial photographs (typically 3 or 4) spanning the past 30-40 years (or longer when available). Skid trail estimates were developed from densities of skid trail watercourse crossings. The data represents a percent of the total sediment input for each CalWater planning watershed.

Road Density

This is a calculation of miles of MRC roads within a CalWater planning watershed divided by the number of square miles in the portion of the plan area within the CalWater planning watershed.

Table 3-11 Sediment Inputs (1963-2003) and Current Road Density by Planning Watershed

Sediment Inputs (1963-2003) and Current Road Density by Planning Watershed									
CalWater Planning Watershed	**Watershed Analysis Unit**	**PWS (mi^2)**	**MRC Land (mi^2)**	**Total Sediment Inputs ($yd^3/mi^2/yr$)**	**Non-Road Mass Wasting Sediment Input (%)**	**Road Mass Wasting Sediment Input (%)**	**Road Surface and Point Source Sediment Input (%)**	**Skid Trail Sediment Inputs (%)**	**Road Density (mi/mi^2)**
Big Salmon Creek	Albion River	13.4	0.3	ND	ND	ND	ND	ND	9.3
Lower Albion River	Albion River	12.6	7.1	320	64%	21%	10%	5%	6.3
Middle Albion River	Albion River	7.6	5.9	360	38%	32%	21%	9%	6.1
South Fork Albion River	Albion River	9.1	7.3	550	21%	51%	18%	10%	7.8
Upper Albion River	Albion River	13.6	2.8	90	18%	46%	18%	18%	7.4
Lower Alder Creek	Alder Creek/Schooner	16.7	9.3	TBD	TBD	TBD	TBD	TBD	TBD
Mallo Pass Creek	Alder Creek/Schooner	13.7	3.9	TBD	TBD	TBD	TBD	TBD	TBD
North Fork Alder Creek	Alder Creek/Schooner	13.3	3.4	TBD	TBD	TBD	TBD	TBD	TBD
East Branch North Fork Big River	Big River	8.1	4.0	720	15%	11%	43%	32%	ND
Laguna Creek	Big River	5.1	0.11	ND	ND	ND	ND	ND	ND
Lower North Fork Big River	Big River	7.7	3.4	670	28%	24%	31%	17%	ND
Martin Creek	Big River	9.3	0.06	ND	ND	ND	ND	ND	ND
Mettick Creek	Big River	18.3	16.1	810	18%	30%	19%	32%	ND
Rice Creek	Big River	12.6	1.4	570	37%	11%	49%	3%	ND
Russell Brook	Big River	11.0	9.3	700	10%	22%	48%	20%	ND
South Daugherty Creek	Big River	16.7	11.3	760	15%	27%	39%	18%	ND
Two Log Creek	Big River	17.9	6.7	1080	20%	23%	21%	36%	ND
Cottaneva Creek	Cottaneva Creek	16.5	12.5	1109	13%	12%	70%	5%	8.5
Lower Elk Creek	Elk Creek	12.8	7.6	TBD	TBD	TBD	TBD	TBD	TBD
Upper Elk Creek	Elk Creek	15.5	14.4	TBD	TBD	TBD	TBD	TBD	TBD
East of Eureka Hill	Garcia River	5.4	1.6	1110	72%	0%	5%	22%	4.5
Inman Creek	Garcia River	8.6	0.15	860	12%	49%	12%	28%	7.1
Lamour Creek	Garcia River	10.2	0.08	ND	ND	ND	ND	ND	ND
North Fork Garcia River	Garcia River	16.2	0.62	180	ND	ND	35%	65%	15.5
Rolling Brook	Garcia River	12.5	7.2	870	47%	6%	20%	27%	6.9
Signal Creek	Garcia River	6.2	0.14	ND	ND	ND	ND	ND	3.3
South Fork Garcia River	Garcia River	8.7	8.0	1090	35%	16%	26%	22%	6.6
Victoria Fork	Garcia River	7.7	0.28	ND	ND	ND	ND	ND	4.4
Lower Greenwood Creek	Greenwood Creek	13.8	9.4	1042	11%	20%	63%	5%	7.3
Upper Greenwood Creek	Greenwood Creek	11.9	5.7	1024	7%	22%	65%	6%	6.3
Dutch Charlie Creek	Hollow Tree	9.0	0.15	ND	ND	ND	ND	ND	ND
Jack of Hearts Creek	Hollow Tree	5.2	1.1	450	0%	0%	93%	7%	7.7
Low Gap Creek	Hollow Tree	6.9	1.2	650	23%	6%	64%	7%	4.8
Lower Hollow Tree Creek	Hollow Tree	11.7	3.7	3020	27%	59%	12%	3%	10.3
Middle Hollow Tree Creek	Hollow Tree	16.9	15.4	930	45%	12%	31%	12%	5.2

Sediment Inputs (1963-2003) and Current Road Density by Planning Watershed

CalWater Planning Watershed	Watershed Analysis Unit	PWS (mi^2)	MRC Land (mi^2)	Total Sediment Inputs ($yd^3/mi^2/yr$)	Non-Road Mass Wasting Sediment Input (%)	Road Mass Wasting Sediment Input (%)	Road Surface and Point Source Sediment Input (%)	Skid Trail Sediment Inputs (%)	Road Density (mi/mi^2)
Upper Hollow Tree Creek	Hollow Tree	14.0	10.4	710	25%	7%	47%	22%	4.1
Dutch Henry Creek	Navarro River	11.4	7.2	1370	11%	68%	18%	3%	7.8
Floodgate Creek	Navarro River	6.0	1.1	400	16%	69%	13%	2%	7
Flynn Creek	Navarro River	7.6	4.5	260	35%	28%	31%	6%	5.2
Hendy Woods	Navarro River	12.1	1.6	680	0%	0%	98%	2%	8.8
John Smith Creek	Navarro River	5.7	3.2	800	4%	10%	78%	8%	7.8
Little North Fork Navarro River	Navarro River	11.1	10.1	1140	3%	41%	51%	5%	7.6
Lower Navarro River	Navarro River	12.1	7.2	540	31%	33%	32%	4%	7.7
Lower South Branch Navarro River	Navarro River	7.0	6.2	680	24%	55%	15%	6%	7.2
Middle Navarro River	Navarro River	9.0	7.3	1200	45%	33%	17%	5%	7.7
Middle South Branch Navarro	Navarro River	10.1	9.6	1400	11%	51%	29%	9%	7
Mill Creek	Navarro River	12.1	0.65	670	8%	59%	21%	12%	7.3
North Fork Indian Creek	Navarro River	13.9	3.3	2800	7%	86%	7%	0%	4.9
North Fork Navarro River	Navarro River	8.9	6.0	540	18%	25%	46%	11%	6.3
Ray Gulch	Navarro River	6.1	4.8	1210	4%	5%	88%	3%	7.4
Upper Navarro River	Navarro River	5.9	4.6	1810	44%	11%	42%	3%	8.2
Upper South Branch Navarro River	Navarro River	12.3	7.5	780	11%	53%	23%	13%	6.7
Hayworth Creek	Noyo River	11.1	7.5	530	50%	3%	14%	33%	6.2
McMullen Creek	Noyo River	11.0	3.1	380	53%	20%	11%	16%	6.8
Middle Fork Noyo River	Noyo River	7.1	6.5	340	37%	2%	32%	29%	7.5
North Fork Noyo River	Noyo River	10.2	7.7	280	28%	8%	31%	33%	8.1
Olds Creek	Noyo River	10.9	3.6	290	32%	27%	36%	5%	7.4
Redwood Creek	Noyo River	5.3	1.7	160	21%	14%	43%	22%	7.7
DeHaven Creek	Rockport Coastal Streams	8.1	0.05	TBD	TBD	TBD	TBD	TBD	TBD
Hardy Creek	Rockport Coastal Streams	5.7	4.7	TBD	TBD	TBD	TBD	TBD	TBD
Howard Creek	Rockport Coastal Streams	5.5	3.7	TBD	TBD	TBD	TBD	TBD	TBD
Juan Creek	Rockport Coastal Streams	7.7	7.3	TBD	TBD	TBD	TBD	TBD	TBD
Upper Ackerman	Upper Russian	13.6	5.5	580	8%	21%	68%	3%	8.0

TABLE NOTES

ND = No Data (i.e., no survey planned)   TBD = To Be Determined

3.3.9 Summary of sediment input by source of erosion

From watershed analyses completed to date, MRC estimates 73% of the total sediment inputs over the last 3-4 decades of the 20th century are associated with roads and skid trails. Table 3-12 shows a breakdown of sediment input by source of erosion. It also shows, in the far right column of the table, that these values can vary considerably among planning watersheds.

Table 3-12 Percent of Sediment Inputs by Source of Erosion

Plan Area 1960-2000		
Source of Erosion	**% of Total Sediment Inputs**	**Range of % Within Planning Watersheds**
Road associated surface and point source erosion	32	5-98
Road associated mass wasting	30	0-86
Skid trail surface and point source erosion	11	0-65
Non-road or hillslope mass wasting	27	0-73

Sediment delivery occurs through either episodic inputs or chronic inputs (Table 3-13). The type of input influences MRC management and monitoring. A majority of sediment inputs within the plan area are episodic. Mass wasting is episodic and represents 57% of the sediment inputs. Surface erosion from roads and skid trails along with point source erosion account for the remaining 43%. Most road and surface erosion is chronic, while most point source erosion is episodic.

Table 3-13 Sediment Inputs

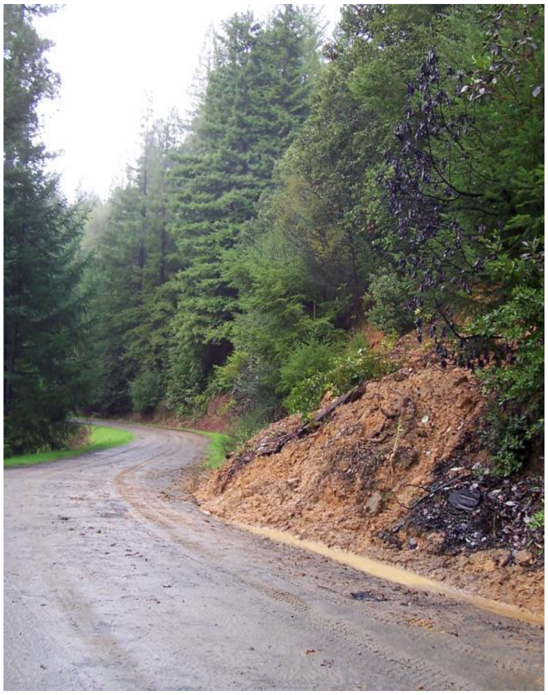
Sediment Delivery				
Type of Input	**Occurrence**	**Hydrologic Event**	**Particle Size of Sediment**	**Examples**
episodic	infrequently	large storms	all particle sizes, from fine sediment to large boulders	• mass wasting • culvert wash-outs
chronic	continuously	precipitation	small particles, from fine sediment to course sediment	• surface erosion • gullies • extensive rills

3.3.9.1 Forest roads

This information on sediment input directs our attention to past effects of forest roads. Although mass wasting from skid trails and hillslopes creates sediment inputs, forest roads create even more. This suggests that the key to controlling significant sediment inputs is appropriate design, placement, and management of forest roads. Skid trail erosion, although prevalent, is not as large a proportion of the sediment inputs as either road-associated erosion or mass wasting. Consequently, while erosion from skid trails needs to be controlled, the higher priority for MRC is sediment inputs from roads.


Road slide (left) and road failure (right) in the plan area

Hairpin turn on seasonal road



Bank cut and ditch opened to allow water drainage

The high amount of sediment inputs from roads and skid trails indicates that a greater proportion of sediment, in the watersheds studied, occurs as a result of human activities. The effect of increased sediment on habitat quality of anadromous salmonids is evident in decreased pool depths and frequency, increased turbidity, and increased fine sediment in stream gravels.

Roads within AMZ are of particular concern due to their proximity to watercourses. Table 3-14 classifies the number of miles of MRC roads within Class I, Large Class II, and Small Class II AMZs as of 2009. Approximately 20% of our current road network within AMZs contains road segments that are no longer in use (i.e., decommissioned and historic roads). See Appendix E (section E.2.1) for details on road classifications

Table 3-14 Road Classes within AMZ

Plan Area 2009		
Stream Class	**Road Type**	**Total Miles (Rounded)**
Class I	Decommissioned*	42.9
	Historic*	8.3
	Permanent	36.9
	Seasonal	114.9
	Temporary	36.4
	Total	239.4
Large Class II	Decommissioned*	11.6
	Historic*	1.9
	Permanent	6.8
	Seasonal	33.9
	Temporary	21.0
	Total	75.2
Small Class II	Decommissioned*	8.3
	Historic*	0.8
	Permanent	2.9
	Seasonal	27.9
	Temporary	13.9
	Total	53.89
Class I and Class II Total		368.49

TABLE NOTE
*Not in use

3.3.10 Undersized culverts

DEFINITION

A culvert is a pipe-like construction commonly made of stone, concrete, metal, or PVC that drains a flow of water under a road, railroad, or other obstruction.

Proper sizing of culverts is important in controlling road erosion. Culverts that do not have the capacity to pass debris, water, and sediment during high flow can plug. Plugged culverts can potentially create road prism failures and large sediment inputs. MRC currently designs all new culverts to pass a 100-year flood; however, some of our existing culverts do not meet this standard.

Ackerman Creek Culvert

Culvert Replacement on Masonite Road 4.1 Mile

Failing drop inlet culvert replaced by beveled inlet culvert

In 2 of the watershed analysis units—Navarro River and Cottaneva Creek—MRC determined if culvert size was adequate from a regression equation for the North Coast region (Waananen and Crippen 1977). We estimated the area contributing drainage to each culvert from topography data in our Geographic Information System (GIS). Next, we used this drainage area in the regression equation to predict 50- and 100-year peak flows. A nomograph shows the appropriate culvert size for 50- and 100-year peak flows. By comparing the predicted size to the actual size of existing culverts, we can determine if the culverts are large enough.

Because it was often difficult for us to tell from a map what area of a watershed actually drained to a culvert, one should interpret our analysis of culvert size carefully. On the ground, features can vary from topographic maps. Our analysis was only meant to be a "first cut" at determining proper culvert size. We need to visit ground sites to see if we used an appropriate estimate of drainage area; only this can tell us whether a culvert is, in fact, undersized. Table 3-15 shows the results from the culvert sizing analysis.

An analysis of culvert size for the watersheds of Navarro River and Cottaneva Creek suggests that 46-94% of culverts will not pass a 50-year flood; 49-97% of culverts will not pass a 100-year flood. Although we did not analyze the entire MRC road network for culvert size, these 2 watersheds—Navarro River and Cottaneva Creek—represent a substantial portion of our land base. Watershed analyses for each watershed analysis unit (WAU) will, in total, cover culvert sizing for the remainder of the plan area.

Table 3-15 Culverts at Watercourse Crossings

Navarro River (2001) and Cottaneva Creek (2004) Watershed Surveys						
	Number of Culverts					
Watershed	At Watercourse Crossings	Analyzed for Adequate Size	Potentially Do Not Pass 50-Year Flood	% Potentially Do Not Pass 50-Year Flood	Potentially Do Not Pass 100-Year Flood	% Potentially Do Not Pass 100-Year Flood
Navarro River[16]	783	276	260	94%	267	97%
Cottaneva Creek	155	155	71	46%	76	49%

TABLE NOTE
MRC collected the data for the Navarro River watershed in 2001 and the Cottaneva Creek watershed in 2004 and has not completed a re-survey as of 2010.

3.3.11 Regional conclusions for aquatic habitat conditions

Increased sediment inputs—primarily from roads and low supplies of LWD—are apparent in the habitat of anadromous salmonids in the plan area. Spawning habitat requires sufficient spawning gravels with low levels of fine sediment. Rearing habitat requires cold water with deep and frequent pools. Over-wintering habitat requires deep pools or structure (such as LWD) for aquatic organisms to escape high water flows. From our regional distribution of habitat conditions, MRC concludes that reducing sediment inputs and increasing LWD are the main ways to improve aquatic habitat conditions; this approach will also improve, to a lesser extent, stream temperature and spawning habitat.

Chapter 8 proposes conservation measures for LWD (section 8.2.3.6: C§8.2.3.6-1 to C§8.2.3.6-20) and sediment inputs (section 8.3.3: C§8.3.3.1.2-1 to C§8.3.3.1.2-24; C§8.3.3.1.3-1 to C§8.3.3.1.3-11; C§8.3.3.1.4-1 to C§8.3.3.1.4-3; C§8.3.3.1.5-1 to C§8.3.3.1.5-6; C§8.3.3.1.6-1 to C§8.3.3.1.6-5; C§8.3.3.1.7-1 to C§8.3.3.1.7-3; C§8.3.3.1.8-1 to C§8.3.3.1.8-9). Chapter 13 outlines monitoring programs for LWD (M§13.5.1.1-3), stream sediment (M§13.5.1.2-1 and M§13.5.1.2-2), and shade conditions (M§13.5.1.1-4).

3.3.12 Predicting changes in peak flow

Peak flow is the highest instantaneous discharge of a hydrologic event. Research on watersheds have shown increases in peak flows due to forest harvest (i.e., Ziemer 1981a, Wright et al. 1990, Rice et al. 1979, Jones and Grant 1996, Beschta et al. 2000, Thomas and Megahan 1998, Harr 1981, Lewis et al. 2001). Most findings show the greatest increase in peak flows in the fall, when soil water storage is depleted. The magnitude of increased peak flow decreases as fall and winter progress. Lowest evapotranspiration levels occur during the winter; intervals between storms are relatively short. Therefore, the largest peak flows (> 10-year return interval) have not been shown to increase (Ziemer 1981a, Wright et al. 1990, Ziemer 1998, Beschta et al. 2000). Changes in peak flow have been documented for a 7-year return interval at Caspar Creek (Ziemer 1998, Lewis et al. 2001). The relative size of peak flow diminishes as magnitude of a hydrologic event increases. This is significant because peak flows relevant to road design, channel formation, and sediment transport are larger events that typically occur later in the rainy season.

[16] This includes watercourse culverts on the Masonite Road that drain to the Navarro River.

3.3.12.1 Impact of forest harvest on peak flow

Change in size of peak flows due to forest harvest has long been a source of misunderstanding and public concern. The misunderstanding comes from a belief that removal of vegetation will increase the amount of water available for stream flow and, as a result, flooding will increase as well. The first premise is correct, namely that annual water yield increases following forest harvest (Harr et al. 1979, Keppeler and Ziemer 1990, Rothacher 1970, Lewis et al. 2001). This, in turn, can result in an increased frequency of over-bank flows and possibly a lower discharge required to achieve such flows. However, an increase in water yield does not necessarily equate to an increase in flooding. Likewise, when forest harvest increases peak flow, it does not necessarily increase flooding. Floods are hydrologic events in which water overflows the banks of a stream or river; these events occur infrequently, not necessarily every winter. Peak flows, on the other hand, are the instantaneous highest-flow amount for any given storm. In the Coast Range of Mendocino County, 5–10 storms per year, along with subsequent peak flows, is typical (Ziemer 1998).

3.3.12.2 Impact of increased peak flow on aquatic organisms

The risk of flooding from increased peak flows due to forest harvest is not high; however, there are still risks for aquatic organisms and their habitat. With increased peak flows comes increased stream power. Stream flow has a greater chance of scouring stream gravel or transporting sediment and LWD. This could result in increased scour of anadromous salmonid redds and removal of spawning gravel. It could also cause increased turbidity from bank and streambed erosion or loss of pool habitat in deposition areas of a watershed.

The earliest peak flows of the rainy season, in the fall, are typically not the largest stream flows of the year. Still, they are associated with the greatest increase in peak flows. The increase in small peak flows in the fall is often greater than 100%; some small peak flows increase as much as 300-400% (Lewis et al. 2001, Jones and Grant 1996). Increased peak flows in early fall may displace young-of-the-year anadromous salmonids or amphibians downstream.
In most cases, the percentage of canopy will be much higher because of MRC uneven-aged management. Given that the amount of canopy removed will decrease over time, we do not anticipate substantial scour or channel modification. De Vries (2000) found that small changes in peak flow from logging, like those predicted here, would have minimal effect on the survival of anadromous salmonids. Also, conservation measures in our HCP/NCCP will increase LWD recruitment to stream channels. We do not expect small increases in peak flow to provide enough additional stream power to create increased transport of LWD. Increases in LWD and subsequent improvement in over-wintering habitat should minimize downstream displacement of young-of-the-year anadromous salmonids. Displacement of amphibians covered in our HCP/NCCP is unlikely. By fall, most amphibians will be in their adult form and, therefore, able to leave a stream to evade high stream flow events. Finally, channel roughness, increased by LWD, will slow water velocities and prevent barriers to upstream migration of anadromous salmonids.

MRC addresses the issue of concentrated run-off from roads or other compacted surfaces that create gullies or localized channel and bank erosion in interspersed sections of Appendix E, e.g., E.2.4 #6e (“Standards for Road Prism”), E.2.15 #8 (“Standards for Bridges”), E.5.1 #12 (“Standards for road, skid trail, and landing decommission”).

3.3.12.3 Snow and peak flow

Current research indicates that there are increased peak flows due to forest canopy removal in rain-on-snow dominated areas. Opening canopy, for example, can alter accumulations of snow (Harr 1981). When a warm rain rapidly melts these accumulations, an increase in peak flow can occur. The plan area in northern California does not receive any significant snow accumulations that could contribute to rain-on-snow events.

3.3.12.4 Logging roads and peak flow

At the watershed scale, observations that peak flow increases as a result of logging roads or other compacted surfaces (skid trails, landings, cable-yarding corridors, or fire-lines) are inconclusive. Road construction to accommodate logging has been associated with a significant increase in peak flows in some hydrologic studies (Harr et al. 1979, Jones and Grant 1996), while not in others (Ziemer 1981a, Wright et al. 1990, Duncan 1986, Lewis et al. 2000).

Drainage from roads or other compacted surfaces can alter stream flow at localized sites, creating increased channel and bank erosion, as well as gully formation (Wemple et al. 1996, Weaver and Hagans 1994). Additional stream flow results in a faster delivery of water to channels or hill-slopes. This, in turn, increases stream-channel scour and bank erosion. Erosion is more pronounced in smaller streams, because the proportion of run-off from a road or other compacted surface can be very large compared to a channel's normal flow-volume.

When the amount of road drainage exceeds a soil's capacity to infiltrate it, gullies form. Gullies can result in substantial sediment yield. On steep slopes (> 40%), gullies will more likely form below culverts that drain long stretches of road (Wemple et al. 1996). However, in some geology types (e.g., Franciscan mélange), gullies from increased road run-off can form even on gentle slopes.

3.3.12.5 Prediction of peak flow increase from forest harvest

Redwood Canopy
Photo by James Irwin (1996)

Research at Caspar Creek (Lewis et al. 2001), located adjacent to land within the plan area in coastal Mendocino County, has shown that the magnitude of change to peak flow is related to (1) amount of canopy removed[17] from forest harvest; (2) antecedent wetness of the watershed; and (3) size of the event. Using the Caspar Creek data, we can predict changes in peak flow (Lewis et al. 2001). Table 3-16 summarizes peak flow predictions that MRC modeled in 2002; the predictions are for a 2-year peak flow event in the plan area under current canopy conditions. Appendix I, *Peak Flow Predictions*, explains the equation that MRC used in this model. We selected a 2-year event, because this is typically greater than a bankfull discharge yet small enough to be sensitive to forest harvest. Basically, the results in Table 3-16 disclose a minimal effect on the plan area from the modeled peak flow increases. For interpretations of peak flow effects in CalWater planning watersheds see section 8.4.3.2.

[17] MRC only measures canopy for trees taller than 30 ft. Research at Caspar Creek suggests a return to pre-harvest flow conditions after approximately 10 years (Keppler et. al. 2003). Although growth and stand conditions vary across MRC forests, we believe that 30 ft is a reasonable and conservative estimate for 10 years of tree growth. By estimating canopy only on trees 30 ft or taller, MRC reduces the impact of vegetation removal on hydrologic change.

Table 3-16 Peak Flow Predictions for CalWater Planning Watersheds in the Plan Area

Antecedent Wetness	Index Value (w)	Conditions Modeled in 2002		
		Minimum Peak Flow Increase (%)	Maximum Peak Flow Increase (%)	Median Peak Flow Increase (%)
Dry	50	17.2	41.0	**26.0**
Average Wetness	304	5.9	14.5	**8.7**
Wettest	600	1.9	4.5	**2.8**

3.3.13 Fire impacts on aquatic habitat

Fire is a natural disturbance that occurs in most terrestrial ecosystems. It is also a tool that humans use to manage a wide range of natural ecosystems worldwide. As such, fire can produce a spectrum of effects on soils, water, riparian biota, and wetlands (Neary et al 2008). Low intensity fires can contribute to small increases in sediment loads to aquatic ecosystems due to exposed soils. High intensity fires can significantly alter the sediment and hydrological characteristics of a watershed. Causes of these changes are (1) loss of root structure in the soil; (2) elimination of downed wood that meters runoff; and (3) hydrophobic soil conditions that increase overland flow in upstream areas. Other impacts from high intensity fires include (1) increased air and stream temperatures from the loss of canopy; (2) alterations to stream chemistry from ash; and (3) changes to aquatic biodiversity.

There have been 2 large fires in Mendocino County in recent history. In September 1931, the Comptche fire burned approximately 30,000 ac. In June 2008, the Mendocino Lightning Complex burned approximately 55,000 ac, including 23,196 ac in the plan area.

In 2010, MRC worked on protocols for monitoring short-term impacts due to the 2008 fires. These plans include (1) assessing fire-burned areas for changes to stream channel morphology; (2) modeling changes in sediment runoff on the landscape; and (3) examining impacts to aquatic invertebrates.

3.4 Terrestrial Habitat

In the subsections that follow, we discuss terrestrial habitat under the topics of vegetation distribution, natural communities, and habitat elements. Vegetation distribution is a general term for the dominant vegetation type at the landscape level. Natural communities are smaller-scale categories (i.e., stand level), typically based upon dominant vegetation type.

3.4.1 Vegetation distribution in the plan area

The plan area consists of both forested and non-forested areas. Areas dominated by tree canopy are considered forested. Non-forested areas include brush and grassland. Table 3-17 shows the estimated distribution of these areas as of 2010.

The distribution of vegetation in the plan area varies by inventory block. Some coastal inventory blocks, such as Albion and Navarro West, tend to have few conifer-hardwood stands, while others, such as Rockport, have more. There is little difference in vegetation between the northern and southern segments of the plan area. Because there is a gradient in temperature from west to east, however, there is an increase in Douglas-fir in the eastern segments. Appendix U, *Inventory Strateg*y, explains how MRC collects stand data.

Table 3-17 Distribution of Forested and Non-Forested Areas

Plan Area (2010)		
	Percent	Acres
Forested Areas	98%	209,158
☑ conifer (redwood/Douglas fir)	64%	136,572
☑ conifer-hardwood	32%	68,372
☑ hardwood	2%	4214
Non-forested Areas	2%	4086
Estimated Total Acres in Plan Area		213,244

3.4.2 AMZ distribution within the plan area

Aquatic management zones (or AMZs) are areas of special interest within watersheds. They act as buffers between upslope timber harvest practices and instream habitat needs. AMZs provide canopy cover over streams. By moderating temperature rises from adjacent canopy openings and by storing sediment inputs from road drainage, AMZs ameliorate the effects of near-stream harvest. AMZs prevent streambank erosion, improve floodplain deposition of sediment by slowing down flows over the bank, and increase nutrient cycling to aquatic habitat.

Table 3-18 shows the average canopy closure for AMZ stands as of 2009. Table 3-19 shows the number of acres of hardwood/conifer, mixed hardwood, and tanoak within AMZs of the plan area as of 2009.

Table 3-18 Average Canopy Closure for AMZ Stands by Planning Watershed

Average Canopy Closure for AMZ Stands by Planning Watershed	
Plan Area (2009)	
Planning Watershed	**Average % of Canopy Cover Across AMZ**
Cottaneva Creek	82
Dutch Henry Creek	75
East Branch North Fork Big River	74
Hayworth Creek	92
Hendy Woods	85
John Smith Creek	77
Little North Fork Navarro River	77
Lower Greenwood Creek	70
Lower Hollow Tree Creek	79
Lower Navarro River	78
Lower North Fork Big River	76
Lower South Branch Navarro River	59
Martin Creek	81
McMullen Creek	72
Mettick Creek	91
Middle Albion River	81
Middle Navarro River	68

Average Canopy Closure for AMZ Stands by Planning Watershed	
Plan Area (2009)	
Planning Watershed	**Average % of Canopy Cover Across AMZ**
Middle South Branch Navarro River	72
North Fork Navarro River	93
Olds Creek	79
South Daugherty Creek	71
Upper Ackerman	81
Upper Albion River	96
Upper Hollow Tree Creek	77
Upper South Branch Navarro River	47

TABLE NOTES

* Forested acres include Class I, Large Class II, and Small Class II watercourses.

**MRC first obtains average canopy values for each planning watershed and then multiplies AMZ acres in a planning watershed by its corresponding canopy cover. The sum of the calculated (weighted) acres is then divided by the total AMZ acres in the major river or stream (covering one or more planning watersheds) to obtain the weighted average for that major river or stream.

Table 3-19 Acres of Hardwood and Conifer-Hardwood Stands by Major Drainage

Plan Area (2009)			
Major Drainage	***Total Gross Acres in AMZ**	****Gross Acres with Hardwood in AMZ**	**% of AMZ Stands with Hardwood**
Albion River	1408	48	3%
Big River	3408	655	19%
Garcia River	1339	433	32%
Navarro River	4742	887	19%
Hollow Tree (SF Eel) Creek	2061	732	36%
Noyo River	1756	290	17%
Cottaneva, Howard, Juan, & Hardy Creeks	1408	411	29%
Alder, Elk, Greenwood, & Mallo Pass Creeks	3509	1027	29%
Russian River	756	317	42%
Total	21,293	5007	

TABLE NOTES

* All forested Class I and Large Class II AMZ acres

**Includes stand types: CH (conifer/hardwood), MH (mixed hardwood), TO (tanoak), GX (oak woodland). The codes CH, MH, TO, and GX are naming conventions from the MRC inventory database.

3.4.3 Natural communities

Some ecologists regard natural communities as actually synonymous with habitat (Noss et al. 1997). Clearly in its HCP guise, this document addresses the issue of habitat for covered species, like coho salmon and northern spotted owls. Moreover, many of the conservation measures focus on components of habitat that are necessary for biodiversity in MRC forests, such as wildlife trees. Because natural communities encompass both plant and animal species, discussions relevant to natural communities are threaded throughout our HCP/NCCP under its many aspects of species and their habitat, water quality, species interaction, landscape planning, rare plants, and more. In this sub-section, we will define each of these natural communities and discuss their regional distribution, distribution within the plan area, ecological factors, and habitat features.

Table 3-20 relates the natural communities specifically addressed in our HCP/NCCP to the vegetation types discussed in the remainder of this chapter and later in the conservation measures. The habitat elements, also discussed later, occur in all the natural communities. Riparian forests are included in acreage of other natural communities, such as coastal redwood and Douglas-fir forest. As a result, distribution percentages in Table 3-20 add up to more than 100%.

In the scientific literature, there are often different names to describe the same natural community. MRC used our timber inventory, which delineates our land into stands of similar vegetation, to identify natural communities across the plan area. We tied this inventory, when feasible, to the Vegetation Classification and Mapping Program (VegCAMP) of CDFG.[18] VegCAMP, in turn, is based on the vegetation classification system developed for the Manual of California Vegetation (Sawyer and Keeler-Wolf 1995). In order to be consistent with MRC inventory and standard industry nomenclature, MRC uses community names that occasionally differ from other naming conventions, including VegCAMP. Refer to Appendix P, *Natural Community Schemes*, for a crosswalk between MRC names for natural communities and other names used by various authors.

Table 3-20 MRC Natural Communities

Natural Communities in the Plan Area (2010)			
General Community Type	**Specific Natural Communities**	**Related VegCAMP Code**	**Acres and % Distribution within the Plan Area**
• North Coast Coniferous	• Redwood forest	• 86.100.00	134,468 ac or 63%
	• Douglas fir forest	• 82.200.00	2146 ac or 1%

18 "The Vegetation Classification and Mapping Program (VegCAMP) is a synthesis of the Natural Communities program within the California Natural Diversity Database and the Significant Natural Areas Program. This enables a more focused effort on developing and maintaining maps and the classification of all vegetation and habitats in the state to support conservation and management decisions at the local, regional and state levels." Refer to http://www.dfg.ca.gov/biogeodata/vegcamp/ (accessed 11/24/2009).

Natural Communities in the Plan Area (2010)			
General Community Type	**Specific Natural Communities**	**Related VegCAMP Code**	**Acres and % Distribution within the Plan Area**
• Broadleaved Upland	• Hardwood	• 73.200.00 • 73.100.00	4005 ac or 1.9%
	• Mixed hardwood and conifer	• 82.500.00	68,372 ac 32%
• Closed-cone Coniferous	• Pygmy cypress	• 81.400.00	135 ac or 0.06%
	• Bishop pine	• 87.070.00	319 ac or 0.1%
• Oak woodlands	• Oak woodland	• 71.010.00 • 71.020.00 • 71.050.00	1084 ac or 0.5%
	• Grasslands	• 41.000.00	1669 ac or 0.8%
• Salt marsh	• Lentic • Lotic	• 52.112.00 • 41.200.00	67 ac
• Deciduous Riparian[19]	• Red alder Riparian	• 61.410.00	56 ac or 0.03%
• Aquatic	• Lentic • Lotic	• 52.000.00 • 45.000.00	n/a > 2061 mi.

3.4.3.1 North coast coniferous

There are 2 communities of north coast coniferous forests: coastal redwood and Douglas fir. In some instances, we will make a distinction between these 2 communities based on a significant effect or impact.

Description

Coastal redwood makes up at least 75% of stands[20] that MRC designates as redwood stands. Douglas-fir makes up at least 75% of stands that MRC designates as Douglas-fir stands. Typically redwood and Douglas fir co-exist in the same stand. In these mixed stands, redwood

[19] Deciduous riparian forest is distinct from surrounding communities; however, coniferous forest near water bodies is not distinct from surrounding communities and is subsumed into those adjacent communities.

[20] References here and in the remainder of this chapter to percentages of species that make up a stand are not based on research; they are rules, defined by MRC, that drive our inventory database.

stocking generally exceeds Douglas fir. In order to classify our stands according to VegCAMP, we have included these mixed stands in the VegCAMP classification for redwood. In Douglas-fir stands, redwood has never been a significant part of the species mix. These stands consist of all age-classes and varying percentages of canopy closure. Pure Douglas-fir stands are rare in the plan area as are pure redwood stands. Generally, redwoods dominate conifer stands close to the coast and Douglas firs dominate on the eastern edge of our land. Other species commonly found in conifer stands may include tanoak, madrone, grand fir, Bishop pine, golden chinquapin, western hemlock, red alder, bigleaf maple, California bay laurel, and nutmeg. Understory species often found in these stands include blue blossom, coyote brush, manzanita, and California huckleberry (Mayer and Laudenslayer 1988). Sugar pine and Ponderosa pine are rarely found in north coast conifer stands in the plan area. When these uncommon conifers occur singly or in small patches within a stand unit, MRC treats them as part of the north coast coniferous community. Where they occur on our land, we plan to promote indigenous conifer species, such as sugar pine. On the other hand, we will remove non-native conifer cross-species, such as Knobcone-Monterey, which were cultivated by previous landowners.

In the past, landowners converted large areas of north coast coniferous forest into grasslands and repeatedly burned these areas to support livestock. MRC is slowly converting these grasslands back to coniferous forest. Because these areas once were coniferous forest and can be again, MRC has included grasslands within the north coast coniferous community.

Regional distribution

Mixed redwood and Douglas-fir stands are found along the California coast from the northern extent of California, south to San Luis Obispo County (Barbour and Major 1988). This type of conifer forest, which is not likely to occur above 1000 ft in elevation (FNAEC 1993), is the most common forest type throughout coastal Mendocino County.

MRC distribution

Mixed redwood and Douglas-fir stands, cover 134,468 ac (54,417 ha) or 63% of the plan area. Occurring in all the MRC inventory blocks, this is the most common vegetation type in the plan area, ranging from young, regenerating forests to mature forests. Douglas-fir stands cover 2146 ac (868 ha) or 1% of the plan area.

Ecological factors

Coastal redwood and Douglas fir are generally associated with each other in MRC forests. The composition of conifer stands is related to environmental conditions. Coastal redwood, as its name implies, is found within 2-10 mi (4-16 km) of the coast, in areas of consistent fog, with high summer humidity, cool temperatures, and well-developed soils (Shuford and Timossi 1989). Douglas fir, on the other hand, can occur on drier sites with poorer soils (Mayer and Laudenslayer 1988). Both species live for long periods of time; stand-replacing fires generally favor development of forests dominated by Douglas fir (Sawyer et al. 2000b). Without forest management, our land would retain a high proportion of hardwoods, such as tanoak.

Landowners have reduced old-growth coastal redwood and Douglas-fir to a small fraction of their pre-management range. As of 2010, MRC protects approximately 101 ac (41 ha) of un-harvested old growth considered Type I[21] and 520 ac (210 ha) of Type II old growth. MRC classifies these stands on the ground using FSC and internal criteria. In the past, MRC misclassified some stands as Type II old growth; these stands will be re-classified. Though Type I acreage will remain

[21] Refer to 9.4.1.2 for definitions of Type-I and Type-II stands.

generally consistent, Type II acreage will change throughout the term of our HCP/NCCP. MRC will "ground truth" these stands and refine our techniques for locating and classifying Type II acreage. MRC does not anticipate an actual decline in quantity or quality of Type II acreage within the term of our HCP/NCCP. While MRC has few acres of old growth or mature forest, our use of uneven-aged silviculture and our conservation measures for streams, snags, wildlife trees, spotted owls, and marbled murrelet will, in the future, recruit additional wildlife trees, downed wood, and old growth or functional old growth trees.

Habitat

Coastal redwood and Douglas-fir forest provide habitat for all the animal species covered in our HCP/NCCP. In the upland and riparian portion of this natural community are northern spotted owls, marbled murrelets, Point Arena mountain beavers, and a handful of rare plants, such as Humboldt milk-vetch. The riparian portion of the forest also provides habitat for coho salmon, Chinook salmon, steelhead, coastal tailed frogs, red-legged frogs, southern torrent salamanders, and various rare plants.

Old-growth stands in a forest are especially important to species such as the marbled murrelet and the Pacific fisher. Many bat species are associated with old-growth as well; they use basal hollows as roost sites (Zielinski and Gellman 1999).

3.4.3.2 Broadleaved upland

Description

In the plan area, broadleaved upland forest consists of 2 vegetation types: mixed hardwood-conifer and hardwood. MRC has labeled upland broadleaved forest as hardwoods in our inventory database.

No specific species dominates the vegetation type of mixed hardwood-conifer; conifers comprise less than 75% of a stand. This vegetation type consists of all age-classes and all percentages of canopy closure. Conifers are primarily coastal redwood and Douglas fir while hardwoods are mainly tanoak and madrone.

As a vegetation type, hardwood is a mix of hardwood species; hardwoods make up at least 75% of a hardwood stand. Pure hardwood stands are rare in the plan area, but they do exist. This natural community consists of all age-classes and all percentages of canopy closure. It can vary widely in species composition. In some areas, it may be pure tanoak, while in other areas it may include madrone, California black oak, live oak, California bay laurel, golden chinquapin, red alder, bigleaf maple, Oregon white oak, and eucalyptus (a non-indigenous species).

Regional distribution

Although mixed hardwood-conifer occurs throughout California, the extent of coastal redwood and Douglas-fir forests is limited to northern California. In northern California, this vegetation type is found primarily in Mendocino, Humboldt, and Trinity counties, with some mixed hardwood-conifer occurring in Sonoma County. Mixed hardwood-conifer is interspersed with conifer stands throughout Mendocino County.

Hardwood extends throughout California, mostly west of the Sierra range crest. In northern California, hardwood occurs in most of Mendocino County and in the northern portion of Sonoma County.

MRC distribution

Mixed conifer-hardwood covers 68,372 ac (27,669 ha) or 32% of the plan area. This community occurs throughout covered lands, ranging from young, regenerating forest to mature forest with some characteristics of old growth. Many areas are dominated by tanoak and have limited conifers. Since coastal redwood and Douglas fir take many years to out-compete tanoak, a large proportion of the plan area has more tanoak than we believe would occur in a natural forest. Hardwoods probably made up less than 50% of most conifer stands created by natural process. Because of past management practices, the amount of mixed hardwood-conifer forest in the plan area is higher than would occur naturally. Our HCP/NCCP will seek to restore these forests to conifer rather than hardwood dominance. This will in turn increase the amount of coastal redwood and Douglas-fir forest, while reducing the amount of mixed hardwood-conifer forest.

Because hardwood-dominated stands are a natural early seral condition of redwood/Douglas-fir forests, MRC will retain for the life of the HCP/NCCP small representative samples as aggregated retention in select variable retention and rehabilitation harvests (section 9.3.3.1: C§9.3.3.1-1 to C§9.3.3.1-2; section 9.3.3.2: C§9.3.3.2-1 to C§9.3.3.2-12) as well as hardwood representative sample areas (section 9.3.3.3: C§9.3.3.3-1 to C§9.3.3.3-3)

Hardwood stands with little or no conifer occupancy occur on 4005 ac (1620 ha) or 1.9% of the plan area. This community contains (1) stands that were once conifer, but because of past management have precluded any significant conifer regeneration and (2) stands that have always had little or no conifer potential. Hardwood stands without conifer potential comprise at least 289 acres of the plan area; another 347 acres may be hardwood stands but MRC has not determined this for a fact.

Ecological factors

The presence of mixed conifer-hardwood in the plan area is generally determined by harvest history, slope, aspect, and soil type. These stands are often created by succession—the gradual supplanting of one community of plants by another—and occur after a major disturbance, such as fire or timber harvest. Following harvest, some areas may become dense forest containing primarily tanoak, while others may contain mixed vegetation. These stands can be created by a moderate timber harvest that allows Douglas fir, coastal redwood, and tanoak to regenerate simultaneously. In highly productive soils, these stands usually quickly progress toward conifer-dominated stands. A late successional conifer-hardwood community would likely have an overstory of coastal redwood or Douglas fir and an understory of hardwoods.

Natural hardwood stands are generally found on poorly developed, rocky soil where coastal redwood and Douglas fir cannot out-compete them. Hardwood-dominated stands can also develop when an area is heavily harvested. In this case, hardwoods, specifically tanoak, are able to out-compete both coastal redwood and Douglas fir.

Hardwoods are a primary host for many fungal taxa that are very important to the functioning of the forest community, including conifer productivity.

Habitat

Mixed hardwood-conifer stands have elements of both hardwood and conifer stands. Because these stands are so variable, they provide habitat for a variety of wildlife. Some mast production (i.e., nuts on the forest floor) occurs in these areas offering high quality food for several species of birds and mammals.

Natural hardwood stands, particularly true oaks and pure madrone stands, are very important to wildlife, like birds and some species of mammals. In high mast years, oaks produce large quantities of acorns and madrones produce high volumes of berries.

In upland and riparian portions of this natural community, there are northern spotted owls and rare plants, such as the Humboldt milk-vetch. Watercourses and wetlands provide habitat for all the covered aquatic species and some rare plants as well.

3.4.3.3 Closed-cone coniferous

Description

Pygmy Forest, Mendocino, CA (1976)
Photograph by Dr. Sharon Johnson, UC (Berkeley)

MRC has separated closed-cone forest into Bishop pine forest (319 ac) and pygmy forest (135 ac). In our HCP/NCCP, the difference between pygmy and other closed-cone forest is the prevalence of Bolander's pine and pygmy cypress and the lack of Bishop pine and redwood. Monterey pine is not native to the plan area; as a result, MRC does not note its presence or absence when distinguishing characteristics of closed cone forests. Holland (1986) refers to the types as northern Bishop pine forest and Mendocino pygmy cypress forest. Closed-cone forest is located on thin acidic soils where many trees and shrubs, having adapted to suboptimal growing conditions, are limited in stature. Even the oldest trees reach only limited heights. Several species are characteristic of closed-cone forests in the plan area, including pygmy cypress, Bolander's pine, pygmy manzanita, Bishop pine, and California sedge (Sholars 1997, CNDDB 2002, CNPS 2002). Other plants occur in or near closed-cone forests, including coast trefoil and Bolander's sweet pea, both of which are suspected food plants of lotus blue butterfly larvae.

Regional distribution

Pygmy forest grows only in a narrow discontinuous strip along the Mendocino County coast (Barbour and Major 1988). Pygmy forest is a type of closed-cone forest mainly occurring between Fort Bragg and Albion, approximately 1-2 mi. (1.6 -3.2 km) inland. There are other areas of pygmy forest south of Point Arena and in Sonoma County. Pygmy forest in Monterey County has different characteristics than pygmy forest in Mendocino and Sonoma counties (Holland and Keil 1995).

MRC distribution

Closed-cone forest covers 131 ac (53 ha) or 0.2% of the plan area within Albion, South Coast, and Garcia inventory blocks.

The Mendocino Lightning Complex (2008) burned 17 ac of closed-cone (Bishop pine) forest; it is uncertain how these acres will re-vegetate in the future.

Ecological factors

Pygmy forest is a rare and unique ecosystem in California (Sholars 1984). The majority of pygmy forest in the world is found in Mendocino County. This ecosystem is the result of hundreds of thousands of years of interaction between soil and vegetation (Sholars 1984). Soils in pygmy forest are derived from materials deposited on 5 marine terraces from 115,000 to 1.2 million years ago (Aitken and Libby 1994). Leaching of soil on the terraces has led to nutrient-poor, acidic soils. Underneath the soil surface of pygmy forest, a shallow hardpan makes it difficult for trees with deep roots to survive (Aitken and Libby 1994).

Some pygmy forests also support sphagnum bogs, which form in seeps and depressions within the forest (Sholars 1984). There are few sources of nutrient input for sphagnum bogs, although some nutrients can come from upslope vegetation and soil (Sholars 1997). These soils are easily disturbed and eroded by road and trail building (Sholars 1997).

Along with soil conditions, fire is an important element of pygmy forest. Common tree species in pygmy forest (pygmy cypress, Bishop pine, and Bolander's pine) need high temperatures for cones to open and release seeds. Fires in pygmy forest can stimulate the release of seeds and create bare mineral soil that allows for successful seed germination (Holland and Keil 1995). Also, most shrub species in pygmy forest will re-sprout from stumps after fires (Sholars 1997). If fires occur before trees are able to produce enough cones and seeds to regenerate a stand, they can contribute to the decline of pygmy forest as well (Holland and Keil 1995). When this occurs, chaparral vegetation may replace pygmy forest (Holland and Keil 1995). Fire exclusion can also cause fuel buildup leading to catastrophic fires (Holland and Keil 1995).

Habitat

Pygmy forests are in decline as a result of coastal development. The decline is compounded by the effects of septic leach fields that have increased nutrient load and escalated growth of the trees (Sholars 1984). As a result, the Mendocino County General Plan declares that pygmy forest is an environmentally sensitive habitat area (Sholars 1997).

Pygmy forest provides habitat for rare plants and animals that feed on them, such as the Lotis blue butterfly. The last local sighting of the Lotis blue butterfly was in 1983 in a sphagnum bog located in and near pygmy forest in Mendocino County (Arnold et al. 1994). Pygmy forest drains into coastal redwood and Douglas-fir forest. This riparian feature of pygmy forest provides habitat for some aquatic species covered by our HCP/NCCP.

3.4.3.4 Oak woodlands

Description

Oak woodland in the plan area

Oak woodlands occur where precipitation falls mostly in the winter, followed by warm-to-hot dry summers (Mayer and Laudenslayer 1988). They are not limited by soil type or parent material (Mayer and Laudenslayer 1988), but generally occur on moderate-to-well drained soils that are also moderately deep. In oak woodland stands, the overstory usually consists of hardwoods with scattered conifers. On mesic sites, trees form a dense, closed canopy; on dry sites, trees are more widely spaced. Typical oaks of this natural community include Oregon white oak, California black oak, and canyon live oak. Understory plants in oak woodlands can include blackberry and creeping snowberry. In drier areas, shrubs may include greenleaf manzanita and gooseberry.

Within the context of our HCP/NCCP, MRC considers grassland in or adjacent to oak woodlands as part of the oak woodland community. Grasslands generally occur on flat-to-rolling terrain (Mayer and Laudenslayer 1988). Their climate is characterized by cool, wet winters and hot, dry summers, with annual precipitation ranging from 6-38 in. (15 to 97 cm) per year (Mayer and Laudenslayer 1988). While providing habitat for many rare species of plants and animals, grasslands are threatened by development, grazing, and invasive species. Dominant native grasses in this area of northern California are purple needlegrass and Idaho fescue. Unfortunately, non-indigenous species, such as wild oats, soft chess, ripgut brome, and red brome, now outnumber native grasses. Natural grassland is distinct from grassland that was once forested and then converted for grazing. Typically, MRC will not convert natural grassland into forest.

Regional distribution

Oak woodlands occur in coastal foothills and valleys from Trinity County south. They reach their southern limit in Baja California. The northwest portion of California's oak woodlands occurs between mixed evergreen forests of the coast and grasslands of the Central Valley (Jimerson and Carothers 2002). They can occur at elevations from just above sea level to 5000 ft (1525 m) in interior regions. In Mendocino and Sonoma counties, oak woodlands concentrate at the eastern portions of the counties, further from the coast.

Grasslands occur throughout the Central Valley of California, in the coastal mountains of Mendocino County and in other locations in southern California (Mayer and Laudenslayer 1988). Rather than native species, exotic species dominate most grassland.

MRC distribution

Oak woodland covers 1084 ac (438 ha) or 0.5% of the plan area, mainly in Ukiah and Garcia inventory blocks.

Grassland covers 1669 ac (675 ha) or 0.8% of the plan area, mainly in its eastern portion, although small grass areas are scattered throughout the plan area. There are large grasslands in the inventory blocks of Big River, South Coast, Navarro East, and Navarro West.

Ecological factors

Oak woodlands can occur on a variety of sites; they are mostly found where summers are hot and dry and winters are wet. They contain the greatest plant and animal diversity in any California habitat type, with over 330 species of birds, mammals, reptiles, and amphibians occurring there at some point in their life (CalPIF 2002, Jimerson and Carothers 2002). Oak woodlands provide large quantities of acorns and high quality food, as well as important habitat, such as shelter and nest cavities (CalPIF 2002). Despite their importance to wildlife, today only two-thirds of California's original oak woodlands remain (CalPIF 2002). Unfortunately, even protected oak woodlands are facing threats that may cause a serious decline in habitat. California has passed the Oak Woodland Conservation Act (2001) to protect and conserve these important vegetation types.

Regionally, several factors have decreased oak woodlands. One of the most important threats is the conversion of oak woodlands to development or vineyards (CalPIF 2002). This threat is compounded by sudden oak death (SOD), a pathogen that began attacking oaks in 1985. In addition, oak woodlands are not regenerating naturally due to several causes, including fire suppression, overgrazing, and invasion of non-indigenous plants (CalPIF 2002).

Natural grasslands in the plan area usually occur in forest openings or glades—the typical grassland of the northern California coast. Grasslands are often on ridges and south-facing slopes (Mayer and Laudenslayer 1988). Natural openings can occur in areas where soil is alkaline and high in clay; this prevents trees or forests from establishing. Some grassland currently in the plan area may be the result of burns used to convert forestland to range or farm areas (Sawyer et al. 2000b).

In pre-settlement California, small populations of tule elk, pronghorn, and deer commonly grazed native grasslands. These species may have promoted growth in grasslands. As settlers arrived in California, herds of grazing cattle, sheep, and horses displaced native elk, pronghorn, and deer. Livestock impacted native grassland by trampling plants, compacting soil, and over-browsing seedlings of native plants (Holland and Keil 1995). Settlers also brought and planted non-native Mediterranean plants. Lacking natural predators, these alien plant species were able to out-compete native plants for water, nutrients, and space (Holland and Keil 1995). Heavy grazing and invasion of non-native plant species have had negative impacts on many Mendocino County native grasslands.

Non-native grassland species are likely to invade areas of disturbed soil. Although soil disturbance can be a result of grazing, it can also occur with timber operations, such as road construction, operation of heavy equipment, and temporary placement of log decks.

Habitat

Oak woodlands and grasslands are important natural communities that are declining in Mendocino County. They each provide wildlife habitat. Vaux's swifts, for example, forage over grassland habitat. Other vertebrates in grasslands include garter snake, savannah sparrow, Botta's pocket gopher, and brush rabbit (Mayer and Laudenslayer 1988). Oak woodlands and grasslands also sustain rare plants. Rare native plants, like Blasdale's bent grass, may occur in grasslands, as well as non-native species, such as soft chess and velvet grass. Early in the 20th century, many oak woodlands and grasslands were converted to farmland and cattle pastures.

3.4.3.5 Salt marsh

Description

Salt marsh occurs along the margins of bays, lagoons, and estuaries. These areas include any substrates that are periodically or permanently flooded as well as open water portions of somewhat enclosed coastal waters. Soil salinity in salt marshes varies from nearly the same as seawater, to greater than seawater, to nearly brackish water. "The various physiological stresses exerted in the estuarine environment, especially those related to changing salinities, result in natural communities that are low in species richness but high in density (Mayer and Laudenslayer 1988, 134).

Salt Marsh
Albion Inventory Block

Regional distribution

Salt marshes are found along the entire California coast. The largest areas of salt marsh are in the San Francisco Bay area where the salt marsh harvest mouse also occurs.

MRC distribution

Salt marsh covers 67 ac (27 ha) or about .0315% of the plan area, and is only found in the Albion inventory block.

Ecological factors

Salt marshes occur in areas that are constantly or occasionally flooded with salt water. Over time, the salt marshes will grow into a high marsh as plant remains and sediments deposit. These marshes may be affected by diking, ditching, dredging, filling, mining, diversion, impoundment, and trampling (Mayer and Laudenslayer 1988). Since the salt marsh on covered lands is close to the ocean and not in an area of urban pressure, these factors are not likely to impact this natural community.

Habitat

While salt marshes are declining throughout their range, they still provide a variety of habitats for birds, mammals, amphibians, and reptiles. Bird species that use these areas include herons, egrets, ducks, and hawks. Raccoons, mink, river otters, harbor seals, shrews, bats, and mice are some of the mammal species found there (Mayer and Laudenslayer 1988). Amphibians and reptiles such as the red-legged frog may also occur in this habitat.

3.4.3.6 Deciduous riparian

Description

Deciduous riparian forest is dominated by deciduous tree species along watercourses or sources of water. In the plan area, such forest is typically found low in the watershed and within the flood plain of larger watercourses. Red alder and willow are the dominant species in these locations.

Regional distribution

Deciduous riparian forests occur throughout California. Red alder and willow are along the north coast, growing in size and abundance as one moves further north.

MRC distribution

Deciduous riparian forest covers approximately 56 ac (34 ha) or 0.03% of the plan area generally near Class-I watercourses. The largest portions of this community in the plan area occur in the lower reaches of Juan and Hardy Creeks in our Rockport tract. There are smaller patches, rather than true stands, throughout the plan area (e.g., near lower Albion River).

The Mendocino Lightning Complex (2008) burned about 21 ac of deciduous riparian habitat.

Ecological factors

Deciduous riparian forest provides water, cover, potential dispersal corridors, nesting, and feeding habitat, as well as other needs of wildlife. In addition to sheltering amphibians, such as the Pacific giant salamander and red-legged frog, riparian forest contains rare plants covered by our HCP/NCCP. The aquatic species in riparian forest—generally freshwater communities—include anadromous salmonids and amphibians also covered by our HCP/NCCP.

Habitat

Deciduous riparian forest provides habitat for birds, mammals, amphibians, and reptiles. Since harvesting regulation is more restrictive in riparian areas, these forests tend to retain dense, large trees required by many covered species.

3.4.3.7 Aquatic

Description

Aquatic communities occur in water. Watercourses (streams and rivers), wetlands (marshes, swamps, sphagnum bogs, and fens), and ponds are all features of an aquatic community. Slow-flowing waters, like marshes and swamps, and fast-flowing waters, like streams, are lotic (moving water) systems. Non-flowing waters, like lakes and ponds, are lentic (still water) systems.

Regional distribution

Watercourses, wetlands, and ponds occur throughout California, including the coastal redwood region. Unique, slow-flowing lotic systems, such as sphagnum bogs and fens, are within rare pygmy forests of the region.

MRC distribution

Within the plan area, most aquatic communities are lotic systems. MRC estimates that there are 455 mi. (732 km) of Class I watercourses; 157 mi. (252 km) of large Class II watercourses; 339 mi. (545 km) of small Class II watercourses; and at least 1110 mi. (1786 km) of Class III watercourses. Sphagnum bogs and fens occur in the pygmy forest of the plan area. There are both man-made and natural ponds (lentic bodies) in the plan area. Most man-made ponds are small in size (less than 1/8 ac) and are either relics of past management or constructed more recently for water drafting. The most significant pond in the plan area is Ray Gulch (Lower Navarro). Connected to a Class I watercourse, this pond is approximately 10 ac. Other large ponds are in Railroad Gulch (Lower Albion) and Greenwood Creek.

Ecological Factors and Habitat

Earlier in this chapter, section 3.3 detailed the ecological factors and habitat of the aquatic community.

3.4.4 Habitat elements

Habitat elements are smaller components of habitat (Mayer and Laudenslayer 1988) that may or may not occur within a stand. Often, they are important contributors to the habitat of rare or sensitive species.

Assigning features as either elements or communities can depend on the scale of the feature and the management application. For instance, a watercourse has unique biological features relevant to landscape planning and impact assessment. If the watercourse is small, however, MRC might exclude it during landscape planning. Likewise, we might want to assess its biological features as a community in some instances and as an element in others, depending on whether we are focusing on the watercourse itself or on the biota of the stand through which the watercourse flows. In our HCP/NCCP, we discuss 6 habitat elements that are specifically related to our covered species: (1) old-growth trees; (2) wildlife trees; (3) downed wood; (4) rocky outcrops; (5) hardwoods within conifer stands; and (6) wetlands, watercourses, seeps, and springs.

3.4.4.1 Old growth trees

Individual old-growth trees provide beneficial habitat for many forest-dwelling species in the plan area (Mazurek and Zielinski 2004). MRC has little information on the actual number of individual old-growth trees within our forests. Old-growth trees often have basal hollows used by Pacific fisher and maternity colonies of bats. Moreover, tree roosting bats use the furrows in the bark of old-growth trees as day time roosts. Many other species use the canopy of old-growth trees as roosting areas.

3.4.4.2 Wildlife trees

Wildlife trees provide important features for our covered species. MRC currently has little data on our wildlife trees. We do have information on hard snags, a category of wildlife tree. The plan area has on average 0.43 hard snags per acre with a dbh ≥16 in. Snags are important for cavity-dependent species, such as purple martins. They also produce downed wood for the forest floor. Other types of wildlife trees may include single old-growth trees, trees with large cavities, and large hardwoods.

3.4.4.3 Downed wood

Downed wood is an important structural feature for many taxa, including species of invertebrates, fungi, mammals, and birds. The plan area has on average 7.3 logs per acre that are ≥ 6 ft long and ≥16 in. dbh. The average number of downed logs in the plan area varies greatly among planning watersheds and even more so among individual forest stands.

3.4.4.4 Rocky outcrops

Rocky outcrops occur throughout natural communities as isolated patches of bare or nearly bare rock. MRC has 63 ac (20 ha) of rocky outcrops in the 3 watersheds within the plan area. Rocky outcrops are important for many plant and animal species, including peregrine falcon. In addition, rocky outcrops provide denning, resting, or roosting habitat for other animals, such as bats, woodrats, bobcats, mountain lions, grey foxes, ringtails, coyotes, raccoons, fishers, and skunks.

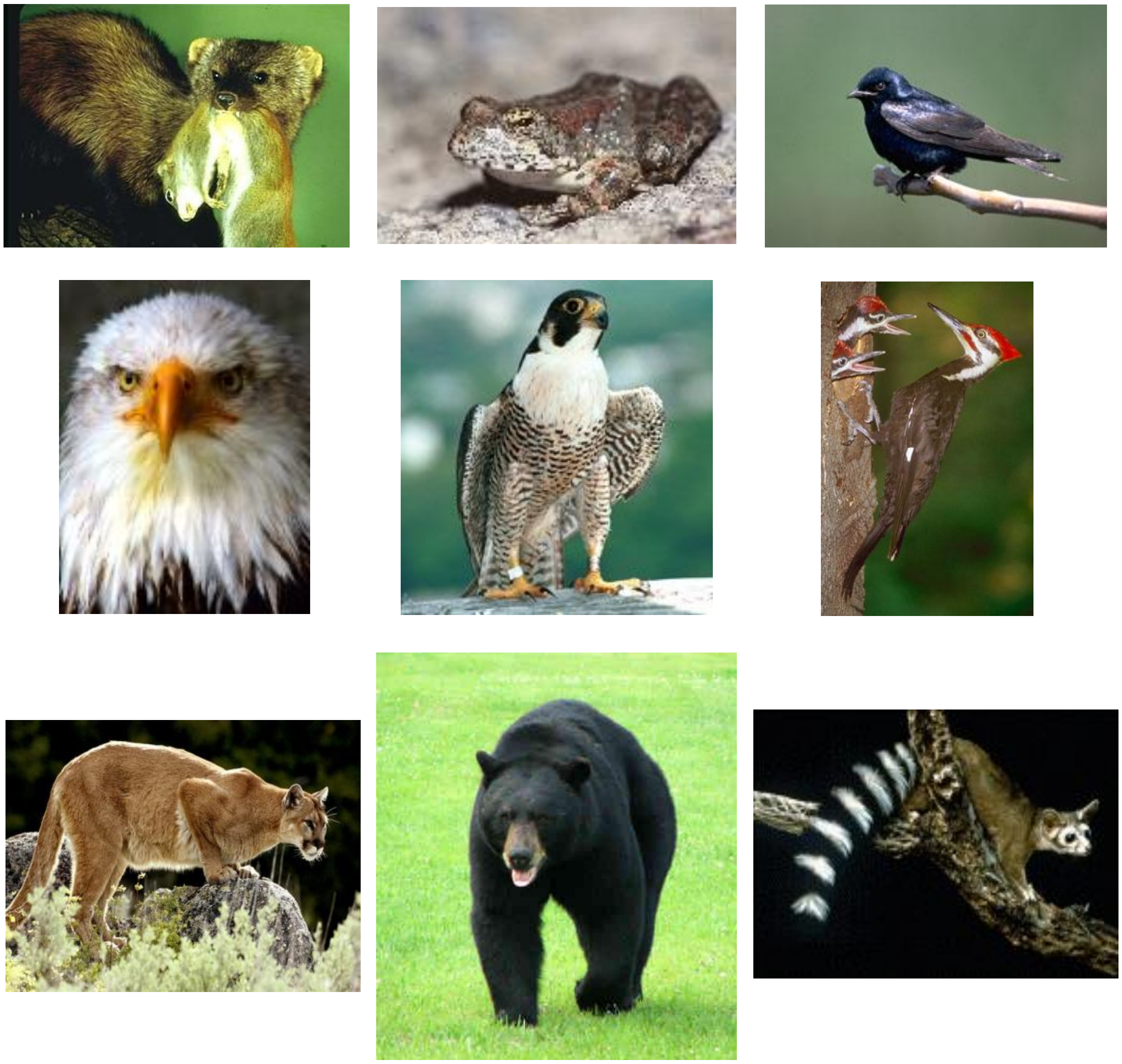
3.4.4.5 Hardwoods within conifer stands

Hardwoods within conifer stands are important to the ecology of a conifer forest and its many wildlife species. They provide biological diversity, den sites for mammals, and nest sites for birds such as spotted owls and pileated woodpeckers. In fact, hardwoods are a native understory component of mixed forests of redwood and Douglas-fir.

3.4.4.6 Wetlands, watercourses, seeps, and springs

Freshwater rivers and creeks, as well as emergent wetlands, account for some of the most productive wildlife habitat in California. Likewise, seeps and springs often have year-round aquatic vegetation; they provide foraging and hydrating sites for covered species, such as the red-legged frog.

Other Potential Species in a Redwood Forest



Top left (Pacific fisher); middle (yellow-legged frog); top right (purple martin)
Center left (bald eagle); middle (pileated woodpecker); right (peregrine falcon)
Bottom left (mountain lion); middle (ringtail); right (black bear)
Photos top row: Bruce Hayward, Bill Leonard, Rob Curtis
Photos center row: Klaus Wiese, Richard Tkachuck, Joe Kosack
Photos bottom row: Jim Dutcher, unidentified photographer, Arizona DFG

3.4.5 CWHR habitat classification system

The California Wildlife Habitat Relationship (CWHR) system is a database that includes (1) a wildlife species list; (2) notes on species in California; (3) distribution maps for species; and (4) habitat classification descriptions (Mayer and Laudenslayer 1988). With CWHR, a landowner can determine which species of wildlife will likely exist in a given area. MRC does not use the classifications of CWHR to describe wildlife habitat on our land or to assess wildlife response to forest management. CWHR uses quadratic mean diameter (qmd) to determine the size class of a stand. In evaluating patchy, uneven-aged stands, an MRC forester or wildlife biologist could assign 2 stands with very different habitat conditions to the same CWHR classification based solely on their qmd. MRC believes that our own internal system provides a more accurate picture of habitat conditions on our land.

CWHR uses similar elements and wildlife habitat assessments to predict occurrences of species common to California. The CWHR was developed with a regional approach in mind. MRC habitat elements and assessments derive (a) from our own site-specific knowledge of our land; (b) from our studies of nest sites and occupied habitat; and (c) from the knowledge of landowners adjacent to the plan area. Consequently, we believe that our structure classes and models are the best predictors of potential habitat for covered terrestrial species in the plan area.

To accommodate our silvicultural practices, MRC has created habitat classes based on the structural classes in our inventory database and landscape plan. These structural classes take into consideration species composition, dominance of trees, and density of trees in different diameter classes. MRC delineates 24 distinct structural classes to categorize stand types in our uneven-aged forest. Using these structural classes, MRC has designated spotted owl habitat based on the judgment and experience of our biologists, guided always by the scientific literature (see section 5.2.5). Like CWHR, our structure classes should prove to be useful tools in predicting the occurrence of other wildlife when suitable habitat designations are made for these species.

3.4.6 Habitat quality for wildlife

MRC has incorporated measures into forest management that limit direct disturbance to wildlife and protect important habitat features. Past management practices, such as harvesting the land without regenerating the forest, may have severely limited current habitat for species like the marbled murrelet. Such practices shifted the forest from coastal redwood and Douglas fir to tanoak dominance in many areas. Although young tanoak may be excellent foraging habitat for northern spotted owls, they are less likely to provide owl nesting habitat. Marbled murrelets may have suffered the most from past harvesting practices. To our knowledge, they only occupy 1 planning watershed in the plan area, probably because other areas lack suitable habitat. Unfortunately, old growth that is critical to murrelets for nesting exists mainly as single trees or small patches in the plan area; plus, such old growth is mostly found inland rather than near the coast where murrelets are more likely to nest. Still, other high-profile species, such as the northern spotted owl, are currently widely distributed across these same lands.

The plan area will change over the next 80 years from its current conditions. Presently, large portions of covered lands have younger stands with a large component of tanoaks. Over the course of our HCP/NCCP, MRC forests will grow into mature stands with fewer tanoaks and more coastal redwoods and Douglas firs. This change in the landscape will provide better habitat for northern spotted owls and marbled murrelets, as well as a variety of other species.

3.4.7 Habitat sensitivity to land use

By definition, forests are habitats most affected by timber harvests. Timber harvest can result in loss of important habitat features in the short term, such as snags and downed logs. In the long term, unrestricted timber harvest can eliminate recruitment of these features; change tree species composition; eliminate or truncate seral stages; and decrease the number of naturally occurring native hardwoods.

The most important effect of timber harvest is a decrease in habitat structures that cannot be replaced, such as large trees, basal hollows in residual trees, upturned root wads, and deeply furrowed bark. Other structures not easily replaced are tree cavities, snags, and downed wood across a range of decay classes. Timber harvest can, and often does, result in a change in the species composition of vegetation, e.g., increasing the size distribution of the remaining trees. Likewise, it can lead to loss of important native hardwoods, such as live oaks and madrone. These hardwoods are especially important in producing high quality food for forest fauna.

Unrestricted timber harvest can affect rare and unique habitats, including oak woodlands, grasslands, pygmy forest, and rocky outcrops. Building roads in the forest, for example, increases disturbance, providing an opportunity for invasion of exotic plants, unauthorized trash dumping, and trespassing.

Clearly, all wildlife habitats are subject to alteration by land use, especially timber harvests. Over the next 80 years, MRC forests will continue to grow and be harvested. However, MRC forest management will also continue to protect and develop habitat for covered species.