MRC HCP/NCCP ERRATA SHEET – 2012 PUBLIC DRAFT

1) The Master Agreement for Timberland Operations (Appendix T) will be split into two separate pieces – one in the document will cover prescriptions contained within in HCP/NCCP and one external document to cover agreements utilizing the PTEIR/EIS for environmental analysis.

2) Page 8-20 HCP/NCCP, Measures 8.2.3.1.5-9 and 8.3.1.5-10 should say Class I and Large Class II AMZ rather than small Class II AMZ. The same change should be made in the Appendix W to the list of conservation measures.

3) Some review and changes may be made to the Largest Tree Retention on pages 8-18 and 8-19 for Class I and Large Class IIs. The possible changes include changing large tree conservation measures to ensure that the same type and number of trees are being maintained as disclosed in the HCP/NCCP and analyzed in the EIS/PTEIR with an easier methodology to enforce and apply the measures.

4) Appendix K, K.5.1.9.1 Ongoing operations
Operations initiated prior to Feb 1st
4th bullet should say activity centers are located for all territories within 0.5 mile of the harvest boundary or a 0.5 mile buffer will be place around the most recent activity center.
3rd bullet should say, "Operations were ongoing between January 25 and January 31…"
Also 2nd section should relate to operations continuing past March 11th.

5) Please change table reference from E-4 to E-3 (see below)
E.2.10 Standards for fords

8. Surface the road with rock to at least a 6 in. (15 cm) depth. Armor the bed of the road with rock extending past the width of the dip (Table E-3).

6) Appendix N: Section N.3, change reference from N.1.4 to N.2.4. Section N.4, change references from N.1.3, N.1.4 and N.1.5 to N.2.3, N.2.4 and N.2.5. Section N.5, change reference from 13.5.3.1 to 13.6.3.1. Section N.6.2, change reference from N.2.1 to N.6.1.

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Appendix Z: Coho Recovery Strategies
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[1] There were 8 drafts of the HCP/NCCP from 2002 to the Public Draft in 2011.
[2] Transferred as President of Humboldt Redwood Company (HRC) 2008
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[4] Drafts 4-6 ; MRC layoff 2009
[5] Resigned 2009
[6] Resigned 2004
[7] Resigned 2004
[8] Drafts 4 to 8
[9] Resigned 2003
[10] Drafts 5 to 8
[11] Resigned 2005
[12] Resigned 2004
[13] Resigned 2007
[14] Resigned 2007

MRC Team 2011/2012

Individual commitment to a group effort—that is what makes a team work, a company work, a society work, a civilization work.

Vince Lombardi (1913-1970)

While the number of MRC employees directly working full-time on our HCP/NCCP since 2002 has been 1 and part-time 3-5, it is the work of the entire MRC team that makes the conservation measures we are proposing possible. Those who work in the field have begun implementing many of the proposed measures even before HCP/NCCP commencement and will carry that effort forward for years or decades to come. Those who work in the office provide equally essential support in the areas of administration, finance, information, and logistics. We can reach our goal only as a team. For this reason, we recognize our entire 2011/2012 team at MRC.

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[15] Eric Grant was reported missing on 10/27/2010. Despite the efforts of a CHP helicopter pilot, divers, and other searchers along the coastal waters and bluffs near Albion, CA, he has not been located. This has been a tragic loss for the MRC team.

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The Natural Community Conservation Plan Act (NCCPA) mandates that an independent science panel analyze and review the plan prior to completion. The intent of this process is to ensure that the plan is grounded in scientifically defensible principles and methods. MRC wishes to thank the distinguished group of science advisors who reviewed the first draft of our HCP/NCCP. Subsequent to that review, the advisors conducted a workshop in May 2003 and later prepared a report that was submitted to MRC in August 2003. MRC used this report in revising our HCP/NCCP. The science advisors were

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Agency Assistance

MRC wishes to acknowledge the assistance we have received from various state and federal agencies during the development of our HCP/NCCP. Since our current document grew out of new efforts begun in spring 2002, we have cited the names of agency representatives who consistently worked with us over the long haul. In any event, we know that projects such as this one are a team effort. For every name cited, there are other dedicated individuals who have worked in the background giving advice and consultation. We appreciate all those who lent their time and expertise to this project.

The following staff from the signatory agencies provided technical and policy assistance:

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REGIONAL WATER QUALITY CONTROL BOARD (RWQCB)

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Photo Acknowledgements

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[18] The Brousseau Collection at St. Mary's College of California contains over 12,500 photographs of about 2000 species of California wildflowers, fungi, trees, and other plants taken between 1925 and 1988 by Brother Alfred Brousseau F.S.C. (1908-1988). Online access is through the University of California Berkeley Digital Library Project.
[19] Salmonid illustrations in Chapter 4
[20] Photo from Lichens of North America, Yale University Press, 1998

Reader's Guide

- GOAL OF MRC DOCUMENTATION

  At its best, documentation should be easy to use, read, understand, and reference. This is often difficult to achieve in large documents dealing with complex scientific or technological issues—particularly when many voices need to be blended into one. Our task was further complicated by the fact that the audience for the HCP/NCCP ranges from scientists to corporate executives, from field technicians to the general public. While we have always attempted to make the information in the HCP/NCCP as accessible as possible, we recognize that the inherent requirement of addressing scientific, legal, and governmental issues sometimes leaves no room for *plain talk*.

- INFORMATION DESIGN AND CHUNKING

  One technique for cutting through document complexity is chunking. Chunking is a process of breaking down large units of information into smaller units of information in order to improve learning and comprehension. We have chunked information in the HCP/NCCP through the use of headings, font changes, white space, color, and icons. In addition, we have selected out certain types of information, labeled them, and attached visual cues for the reader. For example, conservation measures always appear in the same type of table, with the same colors, and the same icon. Such consistent patterns increase a reader's predictive ability. When they see these cues, they know what type of information to expect.

- PHOTOGRAPHS AND ILLUSTRATIONS

  While photographs are not essential to a document, we have included them to remind our readers and ourselves that an HCP and NCCP are ultimately about living animals and plants, not just about words and legalities. We have also included illustrations of some concepts and terms. Illustrations are proven tools for increasing understanding. Some of us are primarily verbal learners and others visual learners. In either case, illustration can aid in the interpretation of text and promote memory retention.

- DEFINITIONS AND GLOSSARY

  Within the chapters of the HCP/NCCP, we have included certain definitions that are important to understanding the subject at hand. Professionals from several different fields have contributed to this plan and will be evaluating it—foresters, wildlife biologists, fisheries biologists, ecologists, botanists, hydrologists, and geologists. Every field has its own technical terminology. While we need to address a subject at a professional level, we also need to ensure that others outside a particular field can follow the discussion, preferably without flipping pages to a glossary. In addition to the definitions embedded in the text, however, we do have a glossary in Chapter 16 with other terms that may be unfamiliar to some readers.

- SCIENTIFIC NAMES AND ACRONYMS

  In general descriptions and discussions of wildlife species, we have used common English names. For clarity, we have included scientific names in the plant species accounts (Chapter 6) since many plants have more than one common name and many common names apply to more than one plant. Finally, in government and legal circles, acronyms abound. Chapter 17 has a list of acronyms used in this document and their meanings.

- PERSONAL COMMUNICATIONS

  One of the most important elements of an HCP/NCCP is documentation of the sources of information; this is how the reader can evaluate the "weight "of the evidence. Personal communications present a special challenge. MRC has made every effort to fully document our own references to conversations (face-to-face or telephone), letters, and emails; citations, either run into the text or in a footnote, including the name of the persons originating and receiving the communication, the type of communication, and the date.

Executive Summary

Start by doing what is necessary; then do what is possible; and suddenly you are doing the impossible.
Francis of Assisi (1181-1226)

After preliminary meetings with government agencies and some intermittent drafting forays in 2000-2001, MRC created a dedicated HCP/NCCP project in spring 2002. It is a project that has involved a major financial commitment, as well as the contributions of over 50 individuals, including MRC employees, environmental and botanical consultants, staff from the federal and state agencies, and science advisors. In some cases, the heart of the process was "managing chaos." Faced with complex ecosystems, complex regulations, and complex concerns, our task was always to build on what we knew, learn what we could, and define problems in a way that allowed consensual solutions. In submitting our HCP/NCCP for review and approval, MRC believes that we have exceeded the regulatory demands. Our goal is not simply to protect the endangered species and biodiversity of our forest lands, but to enhance the conditions under which forest life survives and endures.

We have chosen to pursue both an HCP and an NCCP—a first for an industrial timberland. MRC land is a working forest. Forests are more than trees. Forests are also creeks, rivers, soils, fungi, grasses, wildflowers, songbirds, raptors, amphibians, fish, mammals, insects, and microscopic life too myriad to count or imagine. Moreover, forests are not ecological islands. Many species in a forest move back and forth between surrounding landscapes and streams, air and ocean. Any proposed conservation measures must grapple with this dynamic complexity and interaction. Partial solutions would ultimately be unworkable and unsatisfactory, both for MRC and the wildlife agencies. Moreover, we did not want to propose conservation measures under an HCP that might be countermanded, during implementation, by other government regulations. It quickly became clear that we needed to bring everyone to the same table—CDFG, USFWS, NMFS, RWQCB, CAL FIRE, and CGS, as well as other agencies that might want to review specific proposals in the HCP/NCCP related to their own regulatory authority. Then, as the proverb says of those who tackle big tasks with ambition, we "put a ladder against the sky"—and started climbing! Our climb may not have reached the

heavens but it did produce what we believe is new and higher ground for both the HCP and NCCP programs.

In the chapters that follow there are literally thousands of details, too many, in fact, to condense for an executive summary. At best, we will only touch on a few major points, starting with the goal and term of the plan. By protecting, enhancing, and creating habitat for covered species, MRC intends to contribute to their recovery and attain predictability for our management of endangered species and natural communities within our forest lands. MRC seeks an 80-year period for the HCP/NCCP. While 80 years may seem a long time for a project, it is actually the time it will take for most of our timber stands to grow to maturity. Our efforts to restore and re-grow the heavily logged land tracts that MRC purchased in July 1998 have, in a real sense, just begun. This clearly is an investment that requires time, patience, and a mind-set for the future. Many, understandably, have reservations about long-term agreements, especially one that involves a unique natural resource like the coastal redwoods. Things can change over the course of 80 years. Environmental factors can change. Advances and attitudes in science can change. Adaptive management—a critical part of the whole HCP/NCCP process— will allow us scientific scrutiny and flexibility to face these inevitable changes and steer new and better courses of action as required.

Understanding the comprehensiveness of this HCP/NCCP is very important. In total, there are 40 fish, wildlife, or plant species or sub-species directly affected by it. That, in itself, is a huge number and represents more "coverage" or proposed protection than most plans under the HCP and NCCP programs. In the MRC plan, there are 9 covered fish and wildlife species or sub-species—coho salmon, Chinook salmon, steelhead, California and northern red-legged frog, coastal tailed frog, northern spotted owl, marbled murrelet, and Point Arena mountain beaver—and 31 covered rare plants, such as Humboldt milk-vetch and coast fawn lily.

Chapters 4-6 give accounts of each of these covered species, along with the latest research from the scientific literature. The species accounts document for the 80-year plan the starting point of our knowledge. Inevitably, time will show that we and the scientific community did not always know what we thought we knew. While

some are uncomfortable with the inherent fuzziness of adaptive management, we often, as Aristotle observed almost 2400 years ago, have to learn by doing.[21] Chapters 8 through 11 propose specific conservation measures for the covered species based on the current knowledge of MRC management and staff. Interaction with local government agencies, university researchers, consultants, and professionals in our industry have continually informed and adjusted our corporate knowledge throughout this proposal process.

Almost as extensive as the covered species list are the lands covered by our HCP/NCCP; they consist of approximately 213,244 acres. These are not contiguous acres but a virtual archipelago of forests spread out across Mendocino County. MRC hopes, in the future, to close in some of the land gaps, making the possibilities for conservation and forest management even more effective. There are provisions in the plan in the event MRC purchases additional land and explanations in Chapter 1 of how these additions will come under HCP/NCCP coverage.

In addition to individual species, the HCP/NCCP addresses natural communities within MRC land, including North Coast coniferous forest, upland broadleaved forest, closed cone forest, oak woodland, the deciduous riparian community, and the aquatic community. One way that MRC will protect these natural communities is by keeping our working forest intact. The biggest threat to natural communities in California has been urban development. Often government regulations have only managed to save pockets of these ecosystems surrounded by shopping malls and office buildings. MRC, on the other hand, is not proposing to convert any of our natural communities to other land use. Chapters 8 and 9 propose conservation measures specifically for aquatic and terrestrial habitat and for habitat elements, such as old-growth trees, snags, and rocky outcrops. These chapters discuss how MRC will mitigate any habitat loss with restoration of disturbed areas, creation of new habitat, heightened protections for critical areas, like murrelet habitat in Lower Alder Creek, and, in some cases, conservation easements. Prevention of habitat loss is a major issue that our HCP/NCCP tackles as well, with MRC proposals for recruiting LWD to streams; moderating stream temperatures; limiting or excluding

[21] Nicomachean Ethics, Book II

heavy equipment in sensitive areas; reducing sediment delivery from mass wasting; upgrading, and in some cases, decommissioning roads and skid trails.

Accountability is essential to any plan. Simply proposing conservation measures, no matter how innovative or far-reaching, is not enough. There must also be a means of tracking whether the conservation measures produce the desired results. Chapter 13 explains how MRC will monitor the conservation measures we put in place—collecting and analyzing data to ensure that we meet, under review by the regulatory agencies, measurable targets and objectives. Chapter 15 summarizes alternatives to these MRC conservation measures that are considered in environmental impact analysis.

Finally, one of the requirements of an HCP/NCCP is to ensure that there will be adequate funding for the proposed measures. The Implementation Agreement explains what those funding commitments are. In addition, we will prepare annual budgets and reports, covering all HCP/NCCP projects, for review by the wildlife agencies.

It is clear from just this brief overview that MRC has undertaken a huge task in this HCP/NCCP. We have set high standards for ourselves, both in terms of the timber industry and in terms of ecological stewardship. However, we believe this is a task that can be done—and we are eager to begin.

Chapter 1

Purpose and Scope of the Plan

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1 PURPOSE AND SCOPE OF THE PLAN

1.1 Company on a Mission

Mendocino Redwood Company (MRC) began in 1998 based on the conviction that a timber company could set high standards of environmental stewardship and, at the same time, operate a successful business. From the outset, our mission has been to restore MRC forests for long-term ecological and economic vitality. This mission centers around 4 commitments:

1. Improving the inventory of coastal redwoods, Douglas fir, and other conifers on our land so that the volume of conifers at least doubles within the next 50 years.
2. Maintaining and creating sustainable habitat for terrestrial and aquatic species resident in MRC forests.
3. Restoring the species composition of forests and wildlife that were present before commercial timber harvests began.
4. Conducting a successful business that will earn a return on investment while at the same time producing quality products and community pride.

To date, these commitments have provided the basis for MRC planning, including timber harvest plans (THPs), landscape level planning, internal management plans, and Option A, a requirement of the California Forest Practice Rules (CFPR).

1.2 Submission of the Plan

Building on these commitments to forest stewardship, MRC is submitting this document to the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS) as our Habitat Conservation Plan (HCP) under provisions of the Federal Endangered Species Act (ESA); to the California Department of Fish and Game (CDFG) as our Natural Community Conservation Plan (NCCP) under provisions of the Natural Community Conservation Planning Act (NCCPA); and to the California Department of Forestry as our Programmatic Timber Environmental Impact Report (PTEIR) under provisions of the California Forest Practice Rules (CFPR). Chapter 2 provides details on this legislation—ESA, NCCPA, and CFPR —as well as on other federal and state statutes and ordinances that regulate the timber industry in California.

1.3 What Sets Our Plan Apart

Our HCP/NCCP is the most ambitious and comprehensive ever proposed for industrial timberlands. In addition, the plan represents a series of “firsts” for the HCP and NCCP programs:

- First HCP for an industrial timberland that is bundled to an NCCP—both with the explicit goal of improving the quantity and quality of habitat.
- First NCCP for a working forest.
- First NCCP entirely on private lands.
- First NCCP with a private company as the sole applicant.
- First NCCP that does not propose to permanently remove habitat for construction projects.
- First NCCP that does not propose to convert land from a semi-natural state to industrial, agricultural, or residential use.
- First NCCP that does not simply set aside wildlife preserves to achieve its conservation goals.

1.4 Goals for the Plan

Through our HCP/NCCP, MRC intends to

- Protect, enhance, and increase habitat for covered species.
- Mitigate the impact of our land management on covered species.
- Maintain and improve biodiversity on our land.
- Contribute to the recovery of threatened and endangered species through specific biological goals and objectives outlined in Chapters 8-11.
- Attain "regulatory certainty" for our endangered species management.

1.5 Regulatory Purpose of the Plan

An HCP and NCCP are tools to reconcile the demands of conservation with the demands of economic development. Private landowners, such as MRC, must abide by the protections set up by ESA and NCCPA for animals and plants. At the same time, landowners may use their property for economic development compatible with ESA and NCCPA. An HCP and NCCP allow a landowner and the wildlife agencies to collaborate on long-term conservation planning rather than focus on the impacts of isolated short-term incidents or actions.

1.6 Challenges in Merging an HCP and NCCP

HCPs and NCCPs, while both concerned with conservation, take different approaches. HCPs focus on protection for individual listed species. NCCPs focus on protection for entire natural communities. Accomplishing the goal of an NCCP is a particularly daunting task.

Where is the common ground between HCPs and NCCPs? Both planning approaches agree that protecting species entails protecting the habitat that supports the species. HCPs propose habitat conservation measures for covered species, concentrating on habitat for reproduction, feeding, rearing, migration, and shelter. NCCPs, on the other hand, seek to conserve, connect, and manage the best habitat whether currently occupied by a covered species or not. All the species in a natural community are considered important to the ongoing survival of the community—from the plant species and smaller organisms to the poster wildlife species.

Until now, NCCPs have mainly addressed the issue of urbanizing landscapes and industrial development in southern California. Urbanization is the process of transforming natural and agricultural areas into cities. In its relentless progression, urbanization divides the land into small parcels for business and residential use. From a conservation standpoint, the long-term maintenance and enhancement of a working forest that protects natural processes, communities, and habitat is a preferred alternative to the persistent pressures for urbanization of California's private forest and agricultural lands.

One of the challenges facing MRC has been how to successfully merge the requirements of both an HCP and an NCCP. This goes even to the level of document organization. Do you organize topics by species or by natural communities? The organization of our document was dictated, in fact, by corporate history; our document began as an HCP. History aside, we believe we have met the challenge of bringing together the somewhat different perspectives of an HCP and NCCP with comprehensive conservation measures that will protect both covered species and natural communities on our land.

1.7 Protections and Permits

1.7.1 Protection lists and statuses

In order to receive protection under ESA or CESA (California Endangered Species Act), species must be designated as either *endangered* or *threatened*. USFWS, NMFS, and the California Fish and Game Commission (CFGC) may also find that a proposed species warrants listing as a *candidate* for possible addition to the federal and state lists. In addition, these agencies maintain lists of *species of concern*. Sections 2.2.1 and 2.3.1 address the legal aspects of these listings for ESA and CESA respectively. In this introduction to the HCP/NCCP, we have simply provided the definitions that are necessary background to the species lists that appear in section 1.8.

DEFINITION

An **endangered species** is one in danger of extinction throughout all or a significant portion of its range.

A **threatened species** is one likely to become endangered within the foreseeable future throughout all or a significant portion of its range.

Federal candidate species are those for which there is sufficient information to warrant listing even though the agencies have not completed or approved such listing.

State candidate species are those which CDFG has formally *noticed* as being under review or proposed regulation for addition to the lists of threatened or endangered species.

Federal species of concern are those for which insufficient information exists about their status or threats in order to list them under the ESA.

State species of special concern are vertebrate species that show declining population levels and limited ranges or that face continual threats to their persistence.

Under federal law, there was never a *rare* status for plants and animals. However, under state law, prior to CESA, plants and animals could be listed as *rare*. With the passage of CESA, all animals formerly listed under state law as *rare* were reclassified as *threatened* to coincide with federal law; plants listed under state law as *rare* retained this status. Today, under state law, plant species can, of course, change their legal status; from time to time, a *rare* plant, for example, may become *threatened* or *endangered*. Moreover, the protections of ESA and CESA apply to plants under different circumstances. ESA primarily protects federally listed plants on federal lands and on private lands where there is federal involvement, e.g., through permitting or funding. Unlike federally listed wildlife, listed plants are not subject to ESA prohibition against take. CESA protects state listed plants anywhere within California, except when a federal agency is taking action on federal lands.

Calling a plant rare is a really a statement about the extent of its distribution or the abundance of its populations (Fiedler 1995, as cited in Nakamura and Nelson 2001). Human intervention or interference can result in a plant becoming rare. A plant, for example, may become rare as a

result of human collection as well as from habitat loss or degradation. However, a plant may also be *naturally rare*. This may be due to the unique characteristics of the plant itself.

DEFINITION	A **rare plant** is one that, although not presently threatened with extinction, is found in such small numbers throughout its range that it may become endangered if its present environment worsens (California Fish and Game Code § 1901).

1.7.2 Authorization impacting protected species

Private landowners who wish to conduct activities on their land that might incidentally *take* a species listed under ESA or CESA must first obtain a *take permit* (ITP) from USFWS, NMFS, or CDFG.

There are certain differences between the protections that ESA and CESA afford these species.

- Under ESA, the definition of *take* is to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect any species listed as endangered or threatened. ESA does not prohibit *take* of federally listed plant species or federal candidate species.

- Under CESA, the definition of *take* is to hunt, pursue, kill, or capture a listed species, as well as any other actions that may result in adverse impacts from an attempt to *take*. CESA does not include the terms *harass* and *harm.* Moreover, CESA prohibits *take* of state candidate species until CDFG makes a final decision on their listing.

The two federal signatories to this HCP/NCCP—USFWS and NMFS—also have subtle distinctions between the terms *harass* and *harm*.

- USFWS interprets harass to include any “intentional or negligent act or omission” that disrupts normal species behavior and that will likely result in injury to wildlife (50 CFR17.3). NMFS has not defined "harass" by regulation.

- USFWS and NMFS interpret *harm* as significant modification and degradation of wildlife species habitat that impairs essential wildlife species behavior (such as breeding, feeding, or sheltering) and that actually kills or injures wildlife. The regulatory definitions of these terms are at 50 CFR17.3 for USFWS and at 50 CFR 222.102 for NMFS.

Sections 2.2.2 and 2.3.2 provide the legal definitions of *take*, *harass*, and *harm* as well as a more in-depth description of the authorization process under ESA and CESA respectively.

1.7.2.1 Federal permits

Upon approval of an HCP, USFWS may authorize *take* of federally listed terrestrial and resident aquatic wildlife species covered in the plan; NMFS can authorize *take* of anadromous fish species covered in the plan. ESA does not prohibit incidental take of federally listed plants as long as state laws are not violated. However, when USFWS issues a federal permit for a project, such as an HCP, the agency must also ensure that federally listed plants are not jeopardized by the project. Throughout our HCP/NCCP, any reference to authorized take of covered species under the federal permits refers to take of wildlife covered species only; however, the plan also includes

measures to offset loss of federally listed plant species and their habitats. MRC has included plants among covered species (section 1.8.2) because we recognize the benefit in conserving these plant species and we want to ensure they are not jeopardized. In addition, we seek to extend to them any "no surprises" assurances under ESA. Briefly, the *no surprises rule* states that once a government agency and a landowner agree to conservation measures and mitigation both sides must abide by the agreement.

1.7.2.2 State permits

Upon approval of an NCCP, CDFG may authorize *take* of any species covered by the plan, including plant species. Pursuant to an approved NCCP, CDFG may also provide assurances to plan participants commensurate with the participants own assurances to CDFG regarding their proposed conservation measures and implementation strategies.

1.8 Covered Species in the Plan

DEFINITION

Covered species are species on MRC covered lands that are listed as *threatened*, *endangered*, or *species of concern* and for which MRC has proposed conservation measures; the wildlife agencies may permit incidental take of such species.

1.8.1 Fish and wildlife species

The HCP/NCCP covers 9 fish and wildlife[1] species or sub-species in the plan area. CDFG has listed 2 of these species as *endangered*, 1 as *threatened*, and 6 as of *special concern*. On the federal level, 7 of these species have *threatened* or *endangered* status. One species—the coastal tailed frog—is not classified as *threatened* or *endangered* by either ESA or CESA. The coastal tailed frog does, however, occupy habitat frequently used by other species covered in the HCP/NCCP. As a result, MRC can extend habitat protection to the coastal tailed frog as well.

Table 1-1 lists the covered fish and wildlife species in the order in which they are discussed in the species accounts, along with their federal and state status. If there are 3 terms listed under the scientific name as is the case for the northern spotted owl (i.e., *strix occidentalis caurina*), this indicates a sub-species; the northern spotted owl is a sub-species of spotted owl.

1.8.2 Plant species

In addition to fish and wildlife species, the HCP/NCCP covers rare plants. Table 1-2 lists these 31 plants in alphabetical order by scientific name. Along with the legal status of plants listed by ESA and CESA, we include classifications from the CDFG *Natural Diversity Database (NDDB)* and from the CDFG *California Rare Plant Rank (CRPR).* Appendix R, *Plant Rankings*, explains the relationship between CRPR and the CNPS list of the California Native Plant Society (CNPS), a state-wide non-profit organization that publishes and maintains an *Inventory of Rare and Endangered Vascular Plants of California*. Basically, in 2010 CDFG renamed its list to CRPR to distinguish it from the CNPS list. While the CNPS listing process informs the CDFG list, it is not the only information that CDFG considers in its CRPR list. Appendix Q, *Plant Communities by Inventory Block*, also shows the likely location of our covered plants in the plan area and provides

[1] Ordinarily, wildlife refers to "living things and especially mammals, birds, and fishes that are neither human nor domesticated." In government administration and policy, however, a distinction is sometimes made between fish and wildlife. We have adopted this same distinction.

information on their microhabitat (e.g., mesic, serpentine, grassland), their habitat elevations, and bloom periods.

Table 1-1 Fish and Wildlife Species Covered by the HCP/NCCP

Fish and Wildlife Species Covered by the HCP/NCCP			
Common Name	**Scientific Name**	**Fed Status**	**State Status**
coho salmon (Southern Oregon /Northern California ESU)	*Oncorhynchus kisutch*	T	T
coho salmon (Central California Coast ESU)	*Oncorhynchus kisutch*	E	E
Chinook salmon (California Coastal ESU)	*Oncorhynchus tshawytscha*	T	-
steelhead (Northern California Coast ESU)	*Oncorhynchus mykiss*	T	CSC[a]
steelhead (Central California Coast ESU)	*Oncorhynchus mykiss*	T	-
California red-legged frog[b]	*Rana draytonii*	T	CSC
northern red-legged frog	*Rana aurora*	-	CSC
coastal tailed frog	*Ascaphus truei*	-	CSC
northern spotted owl	*Strix occidentalis caurina*	T	CSC
marbled murrelet	*Brachyramphus marmoratus*	T	E, BFS
Point Arena mountain beaver	*Aplodontia rufa nigra*	E	CSC

TABLE NOTES

[a] Only summer steelhead have the CSC designation.

[b] The range of the California red-legged frog was officially changed to include southern Mendocino County (see 70 FR 66906, p. 66914, 11/03/2005 and 71 FR 19244, p. 19290, 04/13/2006). This HCP/NCCP covers both subspecies of red-legged frogs wherever they occur in the plan area.

Codes
- E – endangered species
- T – threatened species
- CSC – California species of concern
- BFS – designated as sensitive by the California Board of Forestry and Fire Protection
- ESU - evolutionally significant unit

Table 1-2 Plant Species Covered by the HCP/NCCP

Plant Species Covered by the HCP/NCCP						
Common Name	**Scientific Name**	**Federal Status**	**State Status**	**NDDB**	**CRPR**	**CRPR Threat Code**
Humboldt milk-vetch	*Astragalus agnicidus*	None	E	G2/S1.1	1B	.1
small groundcone	*Kopsiopsis hookeri*	None	None	G5/S1S2	2	.3
pygmy cypress	*Hesperocyparis pygmaea*	None	None	G2T2/S2.2	1B	.2
swamp harebell	*Campanula californica*	None	None	G3/S3.2	1B	.2
California sedge	*Carex californica*	None	None	G5/S2?	2	.3
bristly sedge	*Carex comosa*	None	None	G5/S2?	2	.1
deceiving sedge	*Carex saliniformis*	None	None	G2/S2.2	1B	.2
green sedge	*Carex viridula* var. *viridula*	None	None	G5T5/S1.3	2	.3
Oregon goldthread	*Coptis laciniata*	None	None	G4G5/S3.2	2	.2
streamside daisy	*Erigeron biolettii*	None	None	G3?/S3?	3	NA
coast fawn lily	*Erythronium revolutum*	None	None	G4/S2.2	2	.2
Roderick's fritillary	*Fritillaria roderickii*	None	E	G1Q/S1.1	1B	.1

Plant Species Covered by the HCP/NCCP						
Common Name	**Scientific Name**	**Federal Status**	**State Status**	**NDDB**	**CRPR**	**CRPR Threat Code**
Pacific gilia	*Gilia capitata* ssp. *pacifica*	None	None	G5T3T4/S2.2?	1B	.2
glandular western flax	*Hesperolinon adenophyllum*	None	None	G2/S2.3	1B	.2
thin-lobed horkelia	*Horkelia tenuiloba*	None	None	G2/S2.2	1B	.2
hair-leaved rush	*Juncus supiniformis*	None	None	G5S2.2?	2	.2
coast lily	*Lilium maritimum*	None	None	G2/S2.1	1B	.1
Baker's meadowfoam	*Limnanthes bakeri*	None	R	G1/S1.1	1B	.1
running-pine	*Lycopodium clavatum*	None	None	G5/S3S4.2	4	.1
Mendocino bush mallow	*Malacothamnus mendocinensis*	None	None	GXQ/SX	1A	NA
seacoast ragwort	*Packera bolanderi* var. *bolanderi*	None	None	G4T4/S1.2	2	.2
Bolander's beach pine	*Pinus contorta* ssp. *Bolanderi*	None	None	G5T3/S3.2	1B	.2
North Coast semaphore grass	*Pleuropogon hooverianus*	None	T	G1/S1.1	1B	.1
white-flowered rein orchid	*Piperia candida*	None	None	G3G4/S3.2	1B	.2
great burnet	*Sanguisorba officinalis*	None	None	G5?/S2.2	2	.2
maple-leaved checkerbloom	*Sidalcea malachroides*	None	None	G3G4/S3S4.2	4	.2
purple-stemmed checkerbloom	*Sidalcea malviflora* ssp. *purpurea*	None	None	G5T2/S2.2	1B	.2
beaked tracyina	*Tracyina rostrata*	None	None	G1G2/S1S2.2	1B	.2
Santa Cruz clover	*Trifolium buckwestiorum*	None	None	G1/S1.1	1B	.1
long-beard lichen	*Usnea longissima*	None	None	G4/S3.1	NA	NA
oval leaved viburnum	*Viburnum ellipticum*	None	None	G5/S2.3	2	.3

TABLE NOTES

Coverage
- All listed plants are covered by a permit from CDFG.

Codes
E – endangered species
T – threatened species
NA – not applicable

Acronyms
NDDB = Natural Diversity Database
CRPR = California Rare Plant Rank

1.9 Selection Process for Covered Species

After considering the wide-range of special-status species in our timber forests, MRC selected the covered species for our HCP/NCCP based on several factors:

- Current status of a species under ESA and CESA.
- Potential for future listing of a species under ESA and CESA.
- Potential for MRC forest management to adversely impact a species.
- Cost to MRC of covering additional species not listed as *endangered* or *threatened*.
- Ability of MRC to effectively conserve and manage the species in order to meet the regulatory standards of the NCCPA and receive regulatory assurances.
- Advantages of conserving and managing covered species on a landscape scale rather than a project scale.

1.9.1 Choosing species for plan coverage

1.9.1.1 Fish and wildlife species

Our reasons for selecting specific fish and wildlife species were as follows:

- MRC covered coho salmon, Chinook salmon, steelhead, and California red-legged frogs because
    a. USFWS, CDFG, or NMFS listed them as *threatened or endangered*.
    b. MRC was confident that we could develop a feasible plan to restore, enhance, and protect the habitat for these species.
- MRC covered northern red-legged frogs and coastal tailed frogs because they would benefit from the protections provided for coho salmon, Chinook salmon, steelhead, and California red-legged frogs.
- MRC covered northern spotted owls, marbled murrelets, and Point Arena mountain beavers because
    a. USFWS or CDFG listed them as *endangered* or *threatened.*
    b. MRC wanted a predictable management plan and regulatory certainty for these species.

1.9.1.2 Plant species

MRC covered plant species based on conservation and distribution criteria.

- Conservation criteria
    1. Listed as *rare*, *threatened*, or *endangered* under CESA or ESA; or
    2. Designated under CNPS as 1B or 2 (CNPS 2001, 2006); or
    3. Ranked by CNDDB as S1, S2, or S3 (CDFG 2006).

- Distribution criteria
    1. One or more occurrences of the plant species are currently known in the plan area; or
    2. Known geographic range of the species includes the plan area or the adjustment area for this HCP/NCCP; and
    3. Suitable habitat is (a) currently in the plan area or (b) expected to occur in the plan area or (c) within the adjustment area.
    4. Rare plant species are either known from or expected in the natural communities, vegetation types, and habitats that are the focus of this HCP/NCCP.

Three of our covered plant species do not meet the conservation criteria outlined above. *Maple leaved-checkerbloom* and *running pine* have been down-listed to CNPS 4 and CNDDB S3S4.2 during the preparation of this HCP/NCCP. *Long-beard lichen* is currently not on any special status list. MRC acknowledges, however, that new occurrences of these 3 species in Mendocino County may be regionally rare and locally significant despite their ranking. Since these plants may occur in areas where MRC will conduct logging operations, we are seeking coverage for them under our HCP/NCCP.

1.9.2 Excluding species from plan coverage

1.9.2.1 Fish and wildlife species

Our reasons for not covering specific fish and wildlife species were as follows:

- MRC did not cover the bald eagle because it rarely occurs in the plan area and, therefore, covered activities are unlikely to impact it.
- MRC did not cover the California freshwater shrimp because its habitat does not exist in or near the plan area.
- MRC did not cover Vaux's swift, purple martin, peregrine falcon, Sonoma tree vole, Pacific fisher, pileated woodpecker, and southern torrent salamander because
    a. USFWS and CDFG have not listed these species as *threatened* or e*ndangered*; and
    b. Additional coverage entailed additional financial burden for MRC in the form of more conservation measures, monitoring, and adaptive management.
- MRC did not cover the foothill yellow-legged frog because our HCP/NCCP will enhance shade and cold water habitat for anadromous salmonids and other amphibians, while foothill yellow-legged frogs prefer water that is warmer and more open.

    NOTE
    Foothill yellow-legged frogs are in decline in many regions of the state but appear to be quite abundant within the plan area. The conditions contributing to the decline of foothill yellow-legged frogs elsewhere in the state (i.e., urbanization, dams, pesticide drift, etc.) are not as prevalent in the plan area.

1.9.2.2 Plant species

MRC did not select plants known only in communities and habitats in the plan area where covered activities are not proposed (i.e., coastal dunes, coastal bluffs, and coastal scrub). We also excluded plants that are not likely to occur in the adjustment area or be impacted by covered activities. Our covered rare plant list includes species known mainly from coastal prairie only if they also occur within forest communities or adjacent to forest communities.

1.10 Species Not Covered in the Plan

Within the plan or assessment areas, there may be species currently listed by ESA and CESA but not covered under our HCP/NCCP, including, for example, the bald eagle, the California freshwater shrimp, and the lotus blue butterfly. Statutory *take* prohibitions will continue to protect such species. MRC will request technical assistance from the appropriate wildlife agencies whenever we propose potential disturbance or habitat modifications that may affect listed species not covered in the plan. For species listed after formal approval of the HCP/NCCP, we will either manage such species on a case-by-case basis with technical assistance from the wildlife agencies or amend the HCP/NCCP to include them. Finally, we will evaluate potential impacts and propose mitigation on a site or THP basis and describe these in the PTHP. Such proposals are subject to standard review and comment by the wildlife agencies.

1.11 Natural Communities in the Plan

DEFINITION

A **natural community** is an integrated group of species—plant, animal, fungal, and microorganism—that inhabits a given area, often identified by its principal, or sometimes unique, vegetation types.[2]

The word *natural* does not imply that an area has been completely untouched by human activity. Nor does it imply that what exists in an area now is what always existed there. Some natural communities have been created by natural disasters. A fire sweeps through a woodland and in its wake grassland comes alive. Like all life, natural communities are constantly changing and moving through natural transitions.

In the case of natural communities, we may protect what remains today or attempt to restore what existed 50 or 100 years ago. MRC, for example, is protecting the remaining old growth redwood stands on our land and restoring the species composition and distribution in our forests as a whole. In this way, we are enhancing the natural community of coastal redwood and Douglas fir.

MRC identified and delineated the natural communities in the plan area using our own inventory data, input from the wildlife agencies, and various natural community schemes from the scientific literature (see Appendix P, *Natural Community Schemes).* Some schemes rely solely on either vegetation or wildlife habitat, while others use a combination of both. Likewise, some schemes reduce classifications to very small scales, so that vernal pools or serpentine soils are considered separate communities. MRC used such schemes in typing our vegetation, but adapted them to the distinct experience and goals of commercial forest management. We consider vernal pools and serpentine soils, for example, as habitat elements that might be found throughout any of the natural communities in our forests.

The MRC inventory system bases its vegetation stratification on aerial photographs and ground-truthing[3] (see Appendix U, *Inventory Strategy*). Typically, we do not map vegetation under 20 ac for our inventory database, unless it is a distinct or unique natural community. At the scale of resolution used in the MRC inventory database and subsequently in our HCP/NCCP, the natural communities in the plan area are

- North Coast coniferous.
  - Redwood forest.
  - Douglas fir forest.
- Broadleaved upland.
  - Hardwood.
  - Mixed hardwood and conifer.
- Closed cone coniferous.
  - Pygmy cypress.
  - Bishop pine.
- Oak woodlands.

[2] Definitions of natural community vary somewhat. CDFG defines a natural community as a distinct, identifiable, and recurring association of plants and animals that are ecologically interrelated (FGC subsection 2702d).

[3] Ground truthing is a term used in cartography, satellite imagery, analysis of aerial photographs, and other remote sensing techniques in which data is gathered at a distance. Ground truth refers to information collected on the ground to aid in the interpretation and analysis of what is being sensed remotely.

  - Oak woodland.
  - Grasslands.
- Salt marsh.
- Deciduous riparian.
  - Red alder.
- Aquatic.
  - Lotic (running water wetlands).
  - Lentic (still water wetlands).

Other natural communities, such as coastal scrub and coastal dune, do occur in the plan area but are not covered by the HCP/NCCP. These communities comprise a very minor portion (less than 50 ac) of the plan area and are unlikely to be impacted by covered activities. The HCP/NCCP does not apply to *take* of listed species in communities not covered by the HCP/NCCP.

1.12 Covered Lands in the Plan

In addition to specifying covered species, MRC must specify which lands are covered by our HCP/NCCP. Throughout our HCP/NCCP, there are references to *plan area*, *adjustment area*, and *assessment area*.

DEFINITION

The **plan area** is MRC land covered by the HCP/NCCP; the terms *plan area* and *covered lands* are synonymous.

The **adjustment area** encompasses the plan area as well as land adjacent to the plan area—primarily commercial timberland—from which MRC may add or delete covered lands.

An **assessment area** is any location inside or outside the adjustment area that MRC evaluates for its habitat, species, sediment load, or other resources, as well as for HCP/NCCP impacts.

1.12.1 Plan area

The initial plan area will include approximately 213,244 ac owned by MRC in Mendocino County.[4] As surveys become more accurate, this acreage adjusts. Moreover, the plan area may increase if MRC buys land in the adjustment area or decrease if MRC sells land in the plan area.

As the map in Figure 1-1 shows, MRC forests are not a solid block of land; they are pockets or islands within a greater landscape. The plan area is located west of Highway 101, from the Humboldt-Mendocino county line to the southernmost extent of the Russian River watershed. Appendix C, *Legal Descriptions of MRC Timberland*, provides up-to-date deed references.

1.12.2 Adjustment area

MRC may add land from the adjustment area that is not already part of the plan area or delete land from the existing plan area. Most of the adjustment area, also shown in Figure 1-1, is zoned

[4] Our HCP/NCCP always refers to gross acres, while the PTEIR refers to net acres. The PTEIR uses the MRC landscape model in its analysis of actual forest cover. To calculate net acres, the landscape model subtracts 3% of the acreage for roads. For example, if the number of gross acres was 1000, the net acres would be 970. Therefore, there will be noticeable discrepancies between statements of acreage in the HCP/NCCP and in the PTEIR.

for timber production. Industrial timberlands comprise the largest portion of the land, including Hawthorne Timber Company, Soper-Wheeler Company, Pioneer Resources, and Gualala Redwoods. Commercial timberland, owned, for example, by The Conservation Fund and the Redwood Forest Foundation, make up another portion. Finally, Jackson Demonstration State Forest (JDSF) and small non-industrial timber owners account for the remainder of the timberland.

Other land uses include state parks, such as Navarro River Redwoods and Big River State Park; rural residential development along public roads, such as Comptche-Ukiah/Orr Springs, Greenwood Ridge, Navarro Ridge, Little River Airport, and Albion Ridge; and agriculture, such as livestock grazing and vineyards.

1.12.2.1 Implications of adding and deleting land

Forest types for commercial timberlands within the adjustment area are primarily coastal redwood and Douglas fir, with pockets of hardwoods. The vast majority of these lands have been managed for timber production over the last 100 years. The flora, fauna, and geology, as well as current and potential habitat conditions for covered species, are similar throughout the adjustment area.

Although the adjustment area is similar to the plan area, there are inherent differences between the two. Therefore, any addition or deletion of lands will require either a major amendment or minor modification to the HCP/NCCP, as explained in section 1.13. MRC will tabulate the acreage for each addition or deletion of land separately, rather than accumulating the total acreage annually. This will allow the wildlife agencies to review each transaction.

While adding land to or deleting land from the adjustment area should not require MRC to develop new or revised conservation measures, the size of the plan area does impact certain conservation objectives and operational timelines. For additions or deletions of land, MRC may need to revise

- Number of northern spotted owl territories designated most productive (section 10.3.1.2.1).
- Timelines and targets for sediment reduction (section 8.3.3.2.1)
- Schedule for monitoring studies in focus watersheds (section 13.4.3).[5]

We have provided cross-references to specific sub-sections in our HCP/NCCP which address revisions of objectives and timelines as a result of addition or deletion of land because understanding those revisions requires the context and definitions within Chapters 8, 10, and 13.

Finally, if MRC adds to the initial plan area any land on which there are species or natural communities not covered by our HCP/NCCP but protected by the wildlife agencies, such species and communities will be subject to take avoidance and other environmental review.

1.12.3 Assessment area

Species and resources outside the adjustment area may impact species and resources inside the adjustment area. MRC may recognize increases in barred owl occupation and activity within the assessment area, for example, and consult with the wildlife agencies on possible implications for the adjustment area. Likewise, changes in the temperature or sediment load of streams in the assessment area may foreshadow problems for covered aquatic species in the adjustment area. As

[5] Refer to sections 3.3.1 and 3.3.2 respectively for the definitions of a watershed and a focus watershed.

a result, MRC and the wildlife agencies will evaluate specific resources within the assessment area for impacts to our HCP/NCCP.

1.13 Major Amendments and Minor Modifications to the Plan

Refer to Appendix A, *Implementing Agreement*, section 9.0 for a complete description of the HCP/NCCP modification and amendment process, covering, e.g., document corrections; procedures for adding and deleting land from the plan area; minor modifications to survey, monitoring, and reporting protocols; and transfer of incidental take permits as part of land transfer.

MRC may make alterations to the HCP/NCCP through either a major amendment or a minor modification. Examples of such alterations are

- Edits to correct errors (typographical, grammatical, and format).
- Modifications of conservation measures to meet goals and objectives.
- Alterations of monitoring protocols due to technical or scientific advances.
- Addition and deletion of land in the plan area.

With respect to changes in the covered land base through land purchases or sales, the size and timeframe of the transaction determines whether the plan requires a major amendment or minor modification. Focusing on such changes, Table 1-3 shows examples of transactions that trigger the amendment and modification process.

Table 1-3 Triggers for HCP/NCCP Amendment and Modification Process

Triggers for HCP/NCCP Amendment and Modification Process	
Major Amendment	**Minor Modification**
Addition of Land	Addition of Land
▪ Additions ≥ 10,000 ac in a calendar-year within the adjustment area. ▪ Total cumulative additions to the plan area ≥ 53,311 ac (i.e., 25% of 213,244 ac) since the issuance of an ITP. ▪ Additions made 60 years after the issuance of an ITP. ▪ Re-addition of land deleted from the plan area in the previous 20 years. ▪ Addition of land outside the adjustment area.	▪ Additions <10,000 ac in a calendar year within the adjustment area.
Deletion of Land	Deletion of Land
▪ Deletions ≥ 10,000 ac in a calendar year. ▪ Total cumulative deletions ≥ 31,986 ac (i.e., 15% of 213,244) since the issuance of an ITP. ▪ Deletions that significantly alter conservation objectives. ▪ Deletion of any portion of LACMA that results in lesser protections for either the deleted or retained areas of LACMA.	▪ Deletions <10,000 ac in a calendar year. ▪ Reallocation of any portion of covered lands to equal or higher protection, e.g., conservation easements or state and national parks.
Changes Exclusive of Land Base	Changes Exclusive of Land Base
▪ Additions or deletions of covered species. ▪ Substantive changes in conservation	▪ Minor changes in monitoring protocols. ▪ Clarifications of conservation strategies.

Triggers for HCP/NCCP Amendment and Modification Process	
Major Amendment	**Minor Modification**
strategies. ▪ Editorial changes in the HCP/NCCP that could have substantive effects on the ground. ▪ Revision of goals and objectives, except as specified in the HCP/NCCP.	▪ Editorial changes in HCP/NCCP wording or grammar. ▪ Minor adjustments, with agency approval, to conservation measures that still meet or exceed their original intent.[6]

1.14 Activities Covered in the Plan

Just as MRC must specify the species and lands covered by our HCP/NCCP, we must also specify any activities covered under the plan, as shown in Table 1-4.

Table 1-4 Covered Activities in the HCP/NCCP

Covered Activities in the HCP/NCCP	
Category	**Activities**
Silviculture	• Commercial harvesting Commercial harvesting is the cutting of trees for sale. In all its various types of harvesting, MRC seeks to retain in the post-harvest stand important structural or biological elements from the pre-harvest stand, such as wildlife trees, old growth trees, and downed logs. The goal is to achieve various ecological, social, and geomorphic objectives with each harvest. The MRC Timber Management Plan (TMP) details how much harvesting is likely to occur under various types of silviculture. While MRC will undoubtedly develop new silvicultural techniques over the course of this plan, our current types of harvest are ▪ Commercial thinning Harvesting trees in a young-growth stand to maintain or increase the average diameter of the residual trees, promote timber growth, and improve forest health. ▪ Selection Harvesting trees singly or in small groups to establish and maintain multi-storied uneven-aged stands dominated with conifers. ▪ Group selection Harvesting groups of trees covering up to 2.5 ac to establish and maintain multi-storied uneven-aged stands dominated with conifers. ▪ Transition Harvesting trees singly or in groups to develop an uneven-aged stand from an even-aged stand or a stand with an irregular or imbalanced proportion of hardwoods-to-conifers. ▪ Variable retention Rotation of stands with excessive hardwood competition or stands where the current conifer stocking consists mainly of trees with little growth potential. ▪ Seed tree and shelterwood removal Harvesting a portion of the seed trees (i.e., trees that can produce seeds for reforestation) after a fully stocked conifer stand has become established. ▪ Rehabilitation Harvesting hardwoods in conifer stands which do not meet minimum stocking standards for conifer dominance. ▪ Alternative prescription Harvesting trees by techniques other than those prescribed above.

[6] Typically, such adjustments are not site-specific, i.e., they are not unique to a single THP.

Covered Activities in the HCP/NCCP	
Category	**Activities**
	▪ Sanitation and salvage Harvesting dying or dead trees to maintain or improve stand health.
	• Vegetation management Vegetation management is the non-commercial alteration of a stand to promote (a) conifer growth, health, or vigor; or (b) rare plants through the removal of invasive plants. ▪ Planting Planting occurs mainly during the months of December through March; seedling and cultivar[7] conifers are planted in recently managed stands in order to establish a new stand or age class in a stand. Work is done by hand; access to work areas is by pickup trucks, in accordance with our winter operation guidelines, and by all-terrain vehicles (ATVs). ▪ Manual brush and tree removal ○ Chainsaw Brush and small trees are cut with chainsaws to reduce competition with residual conifers for light, nutrients, and water. These operations are sometimes referred to as chainsaw release, pre-commercial thinning, or clean and release. ○ Heavy equipment Heavy equipment is used to remove brush or small hardwood trees where there is little or no conifer regeneration. Winter operations and other restrictions prescribe the use of heavy equipment. ▪ Prescribed burning Prescribed burning is the intentional use of fire to prepare a recently harvested area for planting and habitat restoration or to reduce exotic pests. MRC uses burns in accordance with a site-specific plan and in consultation with the California Department of Forestry and Fire Protection (CAL FIRE) and the Air Quality Management District (AQMD). In general, MRC intends that burns will be small in scale and kept away from sensitive habitats. ▪ Slash pile burning Slash pile burning is the planned burning of slash concentrations—usually at landings after timber harvest operations—to reduce fire hazard. This burning is done during the late fall and winter periods in accordance with a permit from the AQMD. Burning takes place outside of fire season as defined by CAL FIRE.
Commercial timber operations	Commercial timber operations entail the removal of trees from stands, such as felling; bucking; limbing; yarding; loading and hauling timber; and maintenance of logging equipment. Specific conservation measures within this plan prescribe the use of heavy equipment. ▪ Felling Felling is the manual use of a chain saw or heavy equipment to sever a standing tree from a stump. Felling occurs away from sensitive habitats, such as snags, old growth, and nest structures, and does not impact the residual stand. ▪ Limbing and bucking Limbing and bucking are the manual use of a chain saw or heavy equipment to sever limbs from a bole and cut the bole into predetermined log lengths. ▪ Yarding Yarding is the use of heavy equipment to move logs from within a stand to a landing where they are loaded onto trucks for transport to saw mills. Currently, the primary yarding methods are ○ Tractor Tractors are used to pull logs to the landing.

[7] A cultivar is a collection of plants that have been selected or bred for particular characteristics, e.g., resistance to disease. Cultivars may be the result of deliberate or accidental breeding or they may be selections from plants growing naturally in the wild.

Covered Activities in the HCP/NCCP	
Category	**Activities**
	○ Cable Cables are used at a log landing to pull logs from the stand to the landing. ○ Helicopter Helicopters are used to lift the logs off the ground and fly them from the stand to the landing. ▪ Loading and hauling Loading and hauling are the use of heavy equipment at a landing to load logs onto semi-trucks for transport. ▪ Maintenance and refueling of heavy equipment Maintenance and refueling of heavy equipment in the plan area must be carried out (a) at least 100 ft from a watercourse, spring, seep, or wet area; (b) 500 ft from current activity centers of northern spotted owl territories; and (c) 0.25 miles from an occupied marbled murrelet site. The only exception is if equipment breaks and cannot be moved. MRC will observe all applicable county, state, and federal laws when using hazardous waste.
Roads and landings	Appendix E, *Road, Landing, and Skid Trail Standards*, specifies use of roads; location and drainage of roads; construction, reconstruction, and maintenance of roads and landings; temporary or permanent road closure; stream-crossings; application of erosion-control measures; and water drafting.
Rock pits and quarries	Within this HCP/NCCP, the terms *rock pit*s and *quarries* are synonymous. By definition, these terms describe operations in areas where more than 1000 yd^3 of rock have been or will be mined. Although final numbers are dependent upon complete road surveys, MRC estimates that we currently have 99 rock pits across the plan area. Appendix B, *HCP/NCCP Atlas* (MAPS 14A-C), provides the locations of these rock pits and indicates whether or not they are on a mainline road. Our rock pits range in size from 0.25 ac to 2.5 ac. Depending on the need for rock in the immediate vicinity, the operation levels at a rock pit vary greatly. MRC consistently uses some rock pits—typically, 2 to 5—every year; however, most are used at least once every 5 or 10 years. In any given year, we might mine less than 100 yd^3 or more than 10,000 yd^3 of rock for erosion control and road surfacing. Our HCP/NCCP does not cover the commercial use of rock pits, i.e., the sale of products from the rock pits. Appendix E, *Road, Landing, and Skid Trail Standards*, details operational standards for rock pits.
Data collection for monitoring	Data collection includes surveys and habitat measurements for covered species. In the process of surveying, MRC conducts various activities, such as banding spotted owls; capturing and handling covered amphibian and fish species; snorkeling; and electro-fishing. Chapter 13, *Monitoring and Adaptive Management*, details the monitoring strategies for our HCP/NCCP.
Habitat improvement and creation	Instream habitat improvement includes structure placement and replacement, channel re-alignment, and bedload reduction, as detailed in Chapter 8, *Conservation Measures for Aquatic Habitat*. Improvement of terrestrial habitat includes control of invasive plants that threaten rare plants; creation and enhancement of amphibian habitat; and creation of habitat for the Point Arena mountain beaver.
Grandfathered THPs	Grandfathered THPs are those approved prior to the issuance of an ITP that are in compliance with the Planning Agreement (see section 2.5.1).

1.15 Activities Not Covered in the Plan

Other activities may occur in the plan area that are not covered by our HCP/NCCP and for which incidental take is not authorized. In some cases, MRC conservation measures describe limitations on such activities; discussing these limitations within the context of the conservation measures does not imply these activities are covered activities. The application of pesticides, for example, is not a covered activity but C§10.2.2.3-15—a conservation measure cited in Chapter 10—places

limitations on its use within 150 ft of occupied red-legged frog habitat.[8] Examples of other activities not covered by the HCP/NCCP include removal of trees that are utility hazards; hunting, fishing, and recreating; grazing; harvest of minor forest products (firewood, greenery, and mushrooms); use of MRC roads by parties other than MRC employees, contractors, permittees, or others under the supervision of MRC; and emergency fire suppression by CAL FIRE or other firefighting agencies.

1.16 Time Period of the Plan

MRC seeks an 80-year period for ITPs issued in response to this plan. While this is the time that MRC judges necessary to meet all goals of our HCP/NCCP, it also corresponds to the amount of time required for a majority of our timber stands to reach maturity, primarily with uneven-aged management.

1.17 Early Termination

Appendix A, *Implementing Agreement*, and Appendix Y, *Termination Mitigation*, detail measures that will take effect if MRC terminates the HCP/NCCP before its full 80-year term or transfers land into or out of the plan area.

1.18 Planning for Uncertainty

Uncertainty is part of life. Chapter 14, *Changed and Unforeseen Circumstances*, identifies some of the uncertainties inherent in planning for species and habitat conservation. While this HCP/NCCP was still in draft, MRC employees, along with thousands of Californians, experienced wildfires on an historical scale.

Unexpectedly, the fires came on the first day of summer. Starting on the evening of June 20, 2008 and continuing until the early hours of June 21, a lightning storm swept across California, sparking more than 2000 wildfires in 17 counties and burning about 1.1 million ac state-wide. In Mendocino County alone there were 129 small fires which, over time, combined into larger fires. On June 26, Governor Arnold Schwarzenegger declared a State of Emergency in Mendocino and Shasta Counties. By July 19, an estimated 54,817 ac had burned in Mendocino County. In addition to Mendocino, the hardest hit counties were Shasta and Trinity with 86,500 ac burned and Butte County with 59,400 ac burned.

Just to bring the Mendocino Lightning Complex fires under containment required 1922 fire personnel, including 917 from CAL FIRE. Apart from CAL FIRE, there were volunteer fire-fighters from out-of-state as well as from other countries, such as Australia and Canada. In addition, MRC hired contract fire-fighters from Oregon along with helicopter support. During the month of July, about 200 National Guard troops, camped at Boonville, were also used for fire mop-up. CAL FIRE costs for fighting the fire exceeded $50 million.

Figure 1-2 illustrates the fires on all MRC land within Mendocino County, not just in the plan area. The green lines show the fire perimeters from June 24-25; the red lines, from July 14-17. The small flame icons, visible on enlarged views of the map, indicate ignition points. The fires reached their ultimate perimeters by July 17, burning about 12% of the MRC land base. Table 1-5 estimates the acreage burned within each inventory block of the plan area, along with the percentage of the inventory block burned.

[8] Herbicides are a category of pesticides. MRC herbicide applications are in compliance with the ruling in Washington Toxics Coalition et al. vs. EPA and the American Crop Protection Association et al.

Table 1-5 Acres Burned in Plan Area

Inventory Block	Estimated Acres of Plan Area Burned	Total Acres in Inventory Block	% of Inventory Block Burned
Albion	148	14,786	1.0%
Big River	8	33,468	0.0%
Garcia	6	14,906	0.0%
Navarro East	2406	30,863	7.8%
Navarro West	1384	23,549	5.9%
Rockport	8839	38,427	23.0%
South Coast	9495	34,281	27.7%
Total	22,286	190,281	11.7%

In 2009, we made an assessment of the fire impacts. For clarity, those assessments are flagged with a distinctive icon in the species accounts (Chapters 4-6).

Having learned how the 2008 wildfires affected vegetation, wildlife species, and habitat on MRC forestlands, we incorporated this knowledge into our management practices. The intent of a long-range plan like the HCP/NCCP is to provide continuity even in the face of unexpected events like the Mendocino Lightning Complex of 2008.

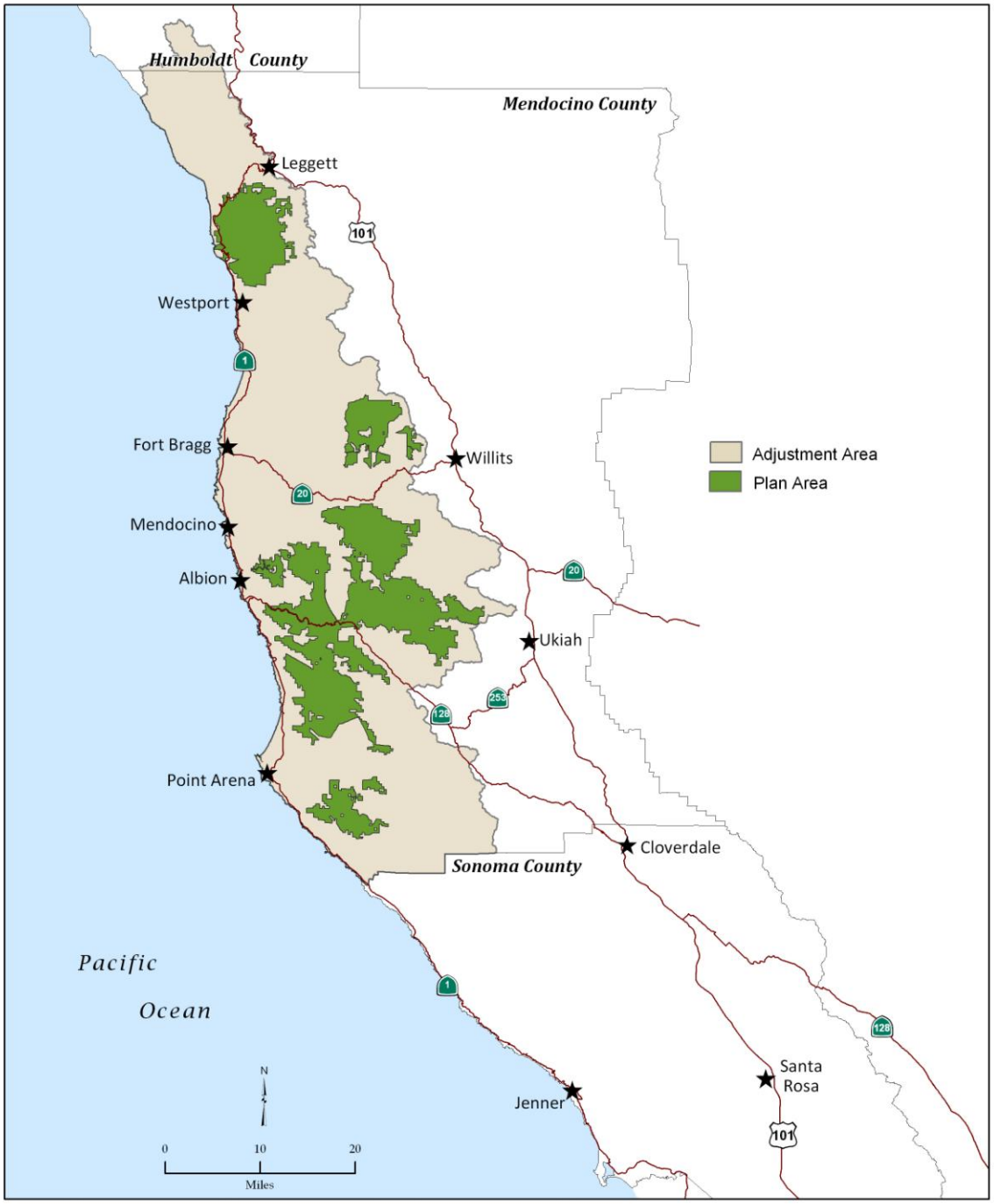
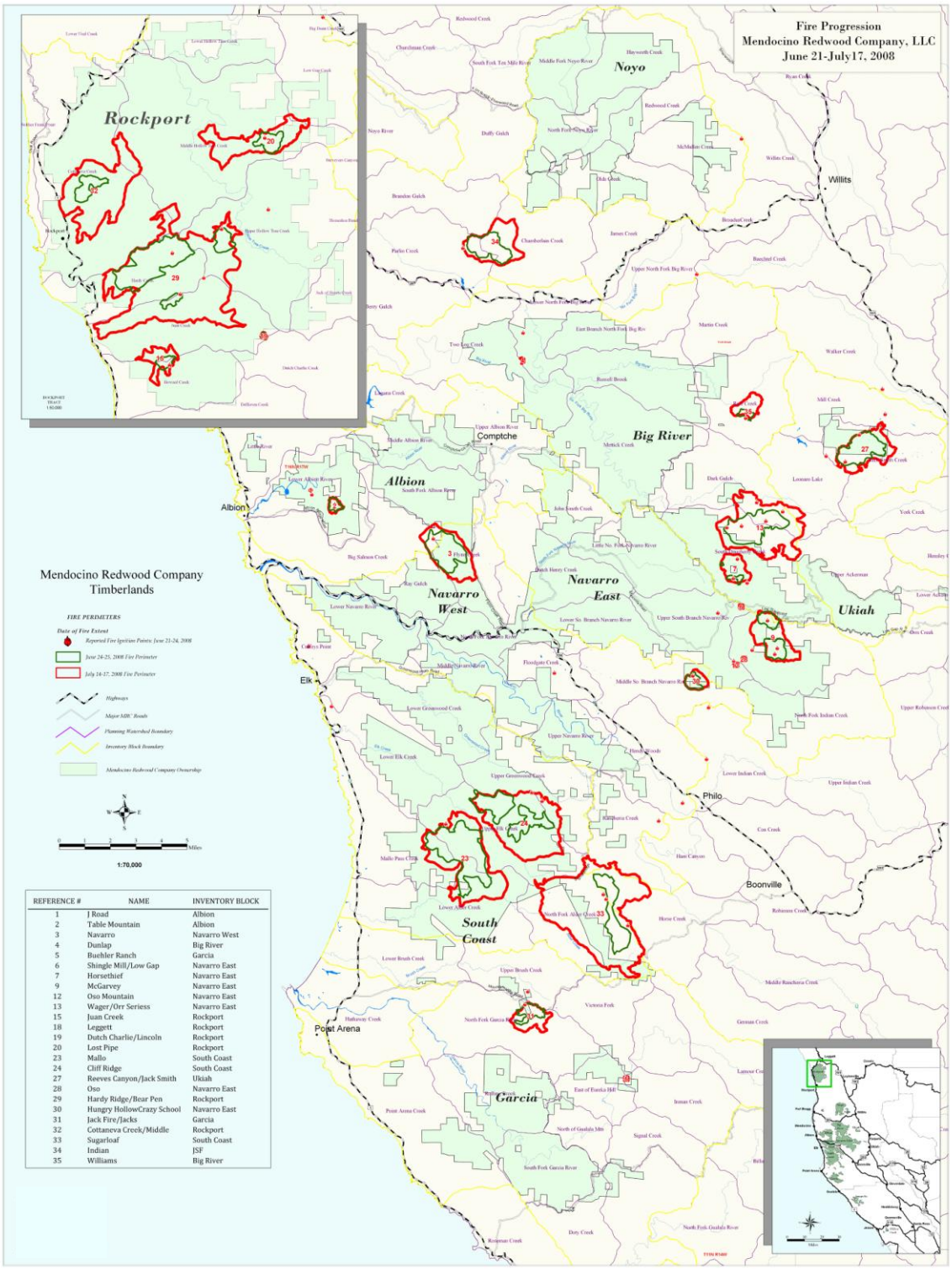


Figure 1-1 Map of HCP/NCCP Plan Area and Adjustment Area



REFERENCE #	NAME	INVENTORY BLOCK
1	J Road	Albion
2	Table Mountain	Albion
3	Navarro	Navarro West
4	Dunlap	Big River
5	Buehler Ranch	Garcia
6	Shingle Mill/Low Gap	Navarro East
7	Horsethief	Navarro East
9	McGarvey	Navarro East
12	Oso Mountain	Navarro East
13	Wager/Orr Seriess	Navarro East
15	Juan Creek	Rockport
18	Leggett	Rockport
19	Dutch Charlie/Lincoln	Rockport
20	Lost Pipe	Rockport
23	Mallo	South Coast
24	Cliff Ridge	South Coast
27	Reeves Canyon/Jack Smith	Ukiah
28	Oso	Navarro East
29	Hardy Ridge/Bear Pen	Rockport
30	Hungry HollowCrazy School	Navarro East
31	Jack Fire/Jacks	Garcia
32	Cottaneva Creek/Middle	Rockport
33	Sugarloaf	South Coast
34	Indian	JSF
35	Williams	Big River

Figure 1-2 Fire Progression and Perimeters

Chapter 2

Regulatory and Management Context

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2 REGULATORY AND MANAGEMENT CONTEXT

2.1 Introduction

Chapter 2 provides an overview of the legal context within which MRC prepared our HCP/NCCP, along with our proposals to meet regulatory requirements. Inevitably, some of this text reads like *legalese*—the descriptions dense and specialized. This, unfortunately, goes with the territory.

2.1.1 Regulation of the California timber industry

The timber industry is heavily regulated in California. MRC timber operations, for example, are subject to numerous federal, state, and local laws, statutes, regulations, and ordinances that protect soils; forests; fish and wildlife habitat; threatened, endangered, and rare species; air quality; water quality; wetlands; and cultural resources. Following are the most important legislative acts or regulations, in the order in which they are discussed in this chapter:

- Federal Endangered Species Act (ESA).
- California Endangered Species Act (CESA).
- Natural Community Conservation Planning Act (NCCPA).
- Z'berg-Nejedly Forest Practice Act (FPA).
- Federal Clean Water Act (CWA).
- California Porter-Cologne Water Control Quality Act.
- Water Quality Control Plan for the North Coast Region (Basin Plan).
- California Coastal Act.
- Federal Coastal Zone Management Act (CZMA).
- Surface Mining and Reclamation Act (SMARA).
- National Environmental Policy Act (NEPA).
- California Environmental Quality Act (CEQA).
- National Historic Preservation Act (NHPA).
- Migratory Bird Treaty Act (MBTA)

2.1.2 Key legislation for HCP/NCCP

A series of diagrams in this subsection graphically introduce the key pieces of legislation discussed in this chapter, along with the documents and permits that flow from them.

- Figure 2-1 shows the legislative acts that are directly related to MRC conservation planning for endangered species and natural communities.

- Figure 2-2 shows the legislative acts that mandate environmental impact analysis of proposed projects, like HCPs and NCCPs.

- Figure 2-3 shows additional legislative acts whose requirements MRC is seeking to meet through our HCP/NCCP.

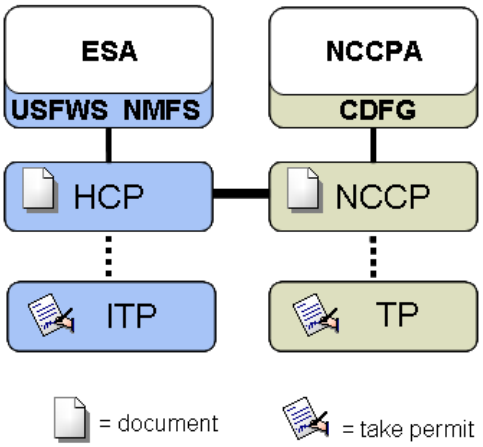

Figure 2-1 ESA and NCCPA

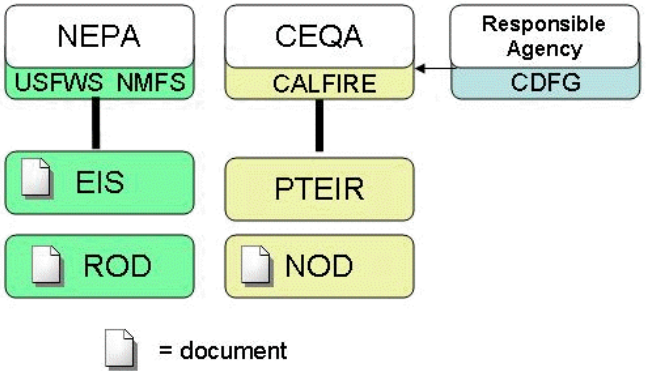

Figure 2-2 NEPA and CEQA

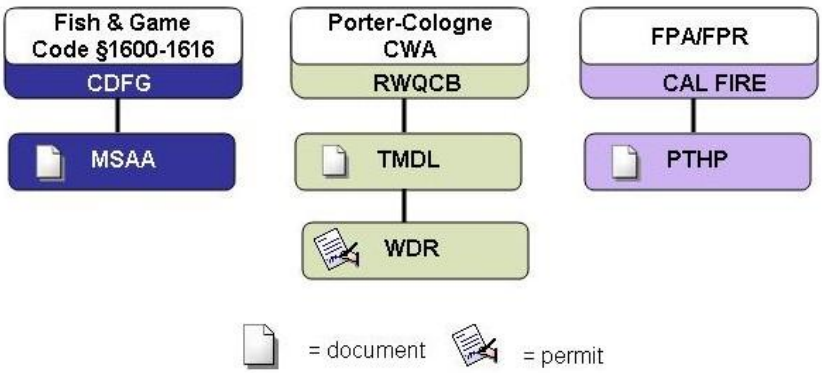

Figure 2-3 Additional Legislation

2.2 Federal Protections

2.2.1 Listings and critical habitat under ESA

Enacted in 1973, the Federal Endangered Species Act (ESA) attempts to conserve ecosystems and provide for protection and recovery of endangered and threatened species. NMFS of the Department of Commerce and USFWS of the Department of Interior are both responsible for administering ESA. NMFS has jurisdiction over marine species, including anadromous fish, listed under ESA, while USFWS has jurisdiction over terrestrial species, including plants and non-anadromous aquatic species, listed under ESA.

In order to receive protection under ESA, a species must be listed as either endangered or threatened by USFWS or NMFS, using the best scientific data available. The agencies also maintain a list of candidate species.

Once a species is listed as endangered or threatened, several regulatory protections become effective. The principal protection is a prohibition on "take" under Section 9(a) (1) (B) of ESA.

DEFINITION

Take under ESA means "to hurt, harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct."

Take can encompass a broad range of activities, including those that cause destruction of species habitat or modification of species habitat that significantly impairs essential behavioral patterns, including breeding, feeding, rearing, or migration.

Under Section 7 of ESA, a federal agency involved with either a public or private project may need to consult with USFWS or NMFS to ensure that its actions do not jeopardize the continued existence of a federally listed species, including plants. This requirement applies whether or not the species is covered by an HCP.

At the time of a species listing, USFWS or NMFS may designate *critical habitat* for the species.

DEFINITION

Critical habitat is an area defined by regulation and intended to include geographic locations which are essential to the recovery and conservation of a species.

USFWS and NMFS do not designate critical habitat unless they can determine that an area actually will contribute to the conservation of a species. Critical habitat designations, when made, affect federal agency decisions and federally permitted activities.

USFWS or NMFS must prepare a recovery plan for species under their jurisdiction, unless the Secretary of the Interior or the Secretary of Commerce, respectively, determines that the plan will not promote the conservation of the species. Recovery plans include management measures recommended for the conservation and survival of a species. They are intended to recover the species to a level of abundance and viability throughout its range, so that listing is no longer necessary. Recovery plans are also meant to encourage cooperative conservation efforts between public and private landowners.

Critical habitat has been designated for a few species covered under our HCP/NCCP, including the marbled murrelet and certain anadromous fish. In preparing our plan, MRC considered these

critical habitat designations. More importantly, MRC intends to manage our timberlands for the health of many key species and natural communities. We are not restricting our conservation efforts only to those species on our lands that are listed by federal and state agencies.

2.2.2 Incidental take permits (ITP)

DEFINITION

Incidental take under federal law is "any taking otherwise prohibited, if such taking is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity."

In 1982 an amendment to ESA allowed private landowners to receive ITPs for the *take* of endangered and threatened species in the course of "otherwise lawful activities." Oftentimes, *take* may not directly kill an individual organism. In some cases, *take* may mean a habitat modification (i.e., harm) or noise and visual disturbance (i.e., harass). ESA may authorize incidental take stemming from actions of state or local governments, corporations, or private individuals, but only if the take will not appreciably reduce the survival and recovery of the species in the wild. ITPs are appropriate whenever there is a chance that an activity could *take* a listed species. ESA does not prohibit take of plants. While Table 1-2 lists the plants covered by our HCP/NCCP, coverage only includes various levels of protection extended to these rare plants. ITPs are not relevant to plants.

USFWS and NMFS approve ITPs only after an applicant has submitted an HCP for listed species that meets strict regulatory criteria, established by these federal wildlife agencies. Applications for ITPs, including an HCP, are voluntary. While ITPs often are issued for individual projects, ESA also encourages project proponents to plan for long-term conservation of species on an ecosystem level. The plan must include conservation measures to meet biological goals and objectives for covered species and their habitat. If approved, an ITP will take effect for covered species at the time a permit is issued. Covered species may include listed and unlisted species; therefore, unlisted species may also be named in an ITP. For unlisted covered species, an ITP will take effect when a species is actually listed. MRC has chosen to include unlisted species in our HCP/NCCP and our application for an ITP. This coincides with MRC efforts to provide conservation and management measures on an ecosystem basis.

To ensure that a listed species is not placed in jeopardy, ESA provides specific guidance on habitat conservation and mitigation measures. Prior to making a decision whether to issue an ITP, USFWS and NMFS must comply with ESA consultation requirements and public review provisions, as well as with the environmental analysis and public review mandated by the National Environmental Policy Act (NEPA).

2.2.3 HCP and NCCP

MRC intends our HCP/NCCP together with the Implementing Agreement to satisfy the legal and scientific requirements for federal HCPs and state NCCPs. These documents will support issuance of an ITP for covered species under ESA Section 10(a)(1)(B) and the issuance of a take authorization for covered species under NCCPA (Fish and Game Code section 2835).

2.2.3.1 ITP under ESA

ESA generally prohibits "take" of species listed as endangered or threatened unless an applicant obtains an ITP from USFWS or NMFS. MRC is applying for an ITP under Section 10(a)(1)(B) of the ESA to authorize the take of federally listed species as a result of MRC covered activities.

To obtain an ITP under Section 10 of the ESA, an applicant must submit an HCP that specifies

> (i) the impact which will likely result from such taking;
> (ii) what steps the applicant will take to minimize and mitigate such impacts, and the funding that will be available to implement such steps;
> (iii) what alternative actions to such taking the applicant considered and the reasons why such alternatives are not being utilized; and
> (iv) such other measures that…[USFWS/NMFS] may require as being necessary or appropriate for purposes of the plan.
>
> ESA, section 10(a)(2)(A)

USFWS and NMFS will issue an ITP if they find with respect to the permit application and the HCP that

> (i) the taking will be incidental;
> (ii) the applicant will, to the maximum extent practicable, minimize and mitigate the impacts of such taking;
> (iii) the applicant will ensure that adequate funding for the plan be provided;
> (iv) the taking will not appreciably reduce the likelihood of the survival and recovery of the species in the wild; and
> (v) the measures, if any, required under subparagraph (A)(iv) will be met; and…[USFWS/ NMFS] has received such other assurances as [they] may require that the plan will be implemented…The permit shall contain such terms and conditions as…[USFWS and NMFS] deems necessary or appropriate to carry out the purposes of this paragraph, including, but not limited to such reporting requirements as [USFWS/NMFS] deems necessary for determining whether such terms and conditions are being complied with.
>
> ESA, section 10(a)(2)(B)

2.3 State of California Protections

2.3.1 Listings under CESA

Enacted in 1970, the California Endangered Species Act (CESA) states that "it is the policy of the state to conserve, protect, restore, and enhance any endangered or any threatened species and its habitat" (California Fish and Game Code, section 2052). CESA generally parallels the main provisions of ESA prohibiting *take* of listed species and is administered by the California Department of Fish and Game (CDFG). CESA prohibits take of species listed as endangered or threatened, as well as candidates for such listing, while also providing several regulatory mechanisms to authorize the incidental take of species.

DEFINITION

Take, under CESA, is to "hunt, pursue, catch, capture, or kill or attempt to hunt, pursue, catch, capture, or kill" (California Fish and Game Code, section 86).

As a guide to state agencies, the California Fish and Game Code states that

> . . . it is the policy of the state that state agencies should not approve projects as proposed which would jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat essential to the continued existence of those species, if there are reasonable and prudent

> alternatives consistent with conserving the species or its habitat which would prevent jeopardy (California Fish and Game Code, section 2053).

2.3.2 Alternative forms of take authorization in CESA

Anyone wishing to conduct activities that might harm endangered, threatened, or candidate species listed by the state may seek a permit for take from CDFG. While CESA does not specifically require preparation of an HCP to apply for an ITP, state law sets out high standards that an applicant must meet before CDFG may issue such a permit.

Under section 2081 of the Fish and Game Code, CDFG may issue a permit for

> . . .take of endangered species, threatened species, and candidate species if all of the following conditions are met: (1) The take is incidental to an otherwise lawful activity. (2) The impacts of the authorized take shall be minimized and fully mitigated . . . . (3) The permit is consistent with any regulations adopted pursuant to Sections 2112 and 2114. (4) The applicant shall ensure adequate funding to implement the measures required by paragraph 2, and for monitoring compliance with, and effectiveness of, those measures. (California Fish and Game Code, section 2081, subd.(b))

Under CESA, measures to minimize and mitigate impacts of *take* must be proportional to the impact of authorized taking of a species. Moreover, all measures must be capable of successful implementation and further the applicant's objectives to the greatest extent possible. Also for state-listed species, CDFG may, under certain circumstances, accept a federal ITP as consistent with CESA and satisfying its requirements.

Commercial timber operations proposed by MRC may result in take of species listed as threatened or endangered under CESA, or candidates for such listing. However, MRC is not pursuing an ITP under Fish and Game Code section 2080.1 or 2081. Instead, MRC is proceeding under an alternate state statute, as explained in section 2.3.3. If this alternative becomes impractical, however, MRC may elect to pursue an ITP under section 2081 or a consistency determination under section 2080.1.

2.3.3 Natural community conservation plan (NCCP)

2.3.3.1 Description of the scope, objectives, and process

CDFG may authorize take of a species, including unlisted species, under the Natural Community Conservation Planning Act (DFG Code 2800 et seq.). In that case, an applicant must provide for conservation and management of all species covered in an NCCP approved by CDFG. An NCCP identifies and provides for measures necessary to conserve and manage natural biological diversity within a plan area while allowing appropriate development and growth.

The NCCPA provides for conservation beyond that required for mitigation of any proposed activities of the plan. This conservation is a mutual objective of the applicant and CDFG. MRC, for example, may have policies for old growth and hardwood retention that provide for the recovery of covered species in the plan area. Likewise, CDFG may purchase conservation easements from MRC in sensitive habitats, such as pygmy forest or Lower Alder Creek; such easements preclude development and restrict harvest to protect critical conservation areas.

The NCCPA requires independent scientific input regarding conservation goals, principles, strategies, and uncertainties. To comply with this requirement, MRC convened a science panel May 23-24, 2003. Refer to *Appendix V* for a summary of the science panel's recommendations.

Also in May 2003, MRC and CDFG entered into a Planning Agreement under Section 2810 of the NCCPA to lay out the scope, objectives, and process for developing an HCP/NCCP. The Planning Agreement, as amended in 2009,

- Defines the goals and obligations of CDFG and MRC.
- Specifies the benefits of the HCP/NCCP, including conservation of species and natural communities, as well as greater regulatory efficiency and certainty.
- Details geographic boundaries of the conservation planning area.
- Lists the natural communities and the endangered, threatened, candidate, and other species that are the initial focus of the HCP/NCCP.
- Describes the initial proposal for possible covered activities.
- Identifies the preliminary conservation objectives for the planning area, namely,
  - To preserve and enhance riparian habitat and functions.
  - To minimize sediment inputs to watercourses that can harm aquatic species.
  - To retain structural components of terrestrial habitat necessary for the diversity of native species.
  - To conserve existing rare or unique habitats.
- Establishes
  - Processes for independent scientific guidance and public participation.
  - Interim measures for projects under development and a means for CDFG review.
  - Mitigation to achieve preliminary conservation objectives.
- Encourages concurrent planning for wetlands and waters.
- Ensures coordination with USFWS and NMFS.
- Outlines financial and staffing commitments during development of the plan.

MRC prepared this HCP/NCCP to meet legal and scientific requirements for approval by CDFG and to obtain issuance of a permit under Section 2835 of the NCCPA. MRC intends for the permit to apply to covered species named in Table 1-1 and Table 1-2.

2.3.3.2 NCCP checklist

According to the NCCPA, CDFG must determine whether the MRC plan fulfills the requirements of an NCCP. Table 2-1 paraphrases those requirements, provides their relevant sections in the California Fish and Game Code, and indicates where MRC has addressed them within the HCP/NCCP.

Table 2-1 NCCP Checklist

Checklist for NCCP Requirements	
Requirement (California Fish & Game Code Section)	**HCP/NCCP Cross Reference**
▪ The plan was developed in accordance with the process identified in the Planning Agreement (MRC 2009) per section 2810 (2820(a)(1)).	▪ Section 2.3.3.1 *Natural Community Conservation Plan* ▪ Chapter 7 *Planning for Conservation*

Checklist for NCCP Requirements	
Requirement (California Fish & Game Code Section)	**HCP/NCCP Cross Reference**
▪ The plan integrates adaptive management strategies that are periodically evaluated and modified based on information from monitoring programs and other sources; these strategies assist conservation of covered species and ecosystems within the plan area (2820(a)(2)).	▪ Chapter 13 *Monitoring and Adaptive Management*
▪ The plan 1. Protects habitat, natural communities, and species diversity on a landscape or ecosystem basis through the creation and long-term management of habitat reserves or other measures that provide equivalent conservation of covered species appropriate for land, aquatic, and marine habitats within the plan area (2820(a)(3)). 2. Conserves, restores, and manages representative natural and semi-natural landscapes to maintain the ecological integrity of large habitat blocks, ecosystem function, and biological diversity (2820(a)(4)(A)). 3. Establishes one or more reserves or proposes other measures that provide equivalent conservation of covered species within the plan area and linkages between them and adjacent habitat areas outside of the plan area (2820(a)(4)(B)). 4. Protects and maintains habitat areas that are large enough to support sustainable populations of covered species (2820(a)(4)(C)). 5. Sustains the effective movement and interchange of organisms between habitat areas to maintain ecological integrity of habitat within the plan area (2820(a)(4)(E)).	▪ Chapter 8 *Conservation Measures for Aquatic Habitat* ▪ Chapter 9 *Conservation Measures for Terrestrial Habitat* ▪ Chapter 10 *Conservation Measures for Fish and Wildlife* ▪ Chapter 11 *Conservation Measures for Rare Plants*
▪ The plan incorporates a range of environmental gradients (such as slope, elevation, aspect, and coastal or inland characteristics) and high habitat diversity; this provides for shifting distributions of species due to changed circumstances (2820(a)(4)(D)).	▪ Chapter 1 *Purpose and Scope of the Plan* ▪ Chapter 3 *Environment and Habitat*
▪ The plan identifies allowable activities and restrictions within reserve areas compatible with conservation of species, habitats, natural communities, and associated ecological functions (2820(a)(5)).	▪ Section 1.14 "Activities Covered in the Plan" ▪ Chapter 8 *Conservation Measures for Aquatic Habitat* ▪ Chapter 9 *Conservation Measures for Terrestrial Habitat* ▪ Chapter 10 *Conservation Measures for Fish and Wildlife* ▪ Chapter 11 *Conservation Measures for Rare Plants*

Checklist for NCCP Requirements	
Requirement (California Fish & Game Code Section)	**HCP/NCCP Cross Reference**
▪ The plan contains specific conservation measures that meet the biological needs of covered species and that are based on the best available scientific information about the status of covered species and the impacts of permitted activities on those species (2820(a)(6)).	▪ Chapter 4 *Covered Aquatic Species* ▪ Chapter 5 *Covered Terrestrial Species* ▪ Chapter 9 *Conservation Measures for Terrestrial Habitat* ▪ Chapter 10 *Conservation Measures for Fish and Wildlife* ▪ Chapter 11 *Conservation Measures for Rare Plants*
▪ The plan contains a monitoring program (2820(a)(7)).	▪ Chapter 13 *Monitoring and Adaptive Management*
▪ The plan contains an adaptive management program (2820(a)(8)).	▪ Chapter 13 *Monitoring and Adaptive Management*
▪ The plan includes an estimated timeframe and process for implementing reserves or other conservation measures, including obligations of landowners and plan signatories and consequences for failure to acquire lands in a timely manner (2820(a)(9)).	▪ *Implementing Agreement* ▪ Chapter 8 *Conservation Measures for Aquatic Habitat* ▪ Chapter 9 *Conservation Measures for Terrestrial Habitat* ▪ Chapter 10 *Conservation Measures for Fish and Wildlife* ▪ Chapter 11 *Conservation Measures for Rare Plants*
▪ The plan ensures that mitigation and conservation measures are roughly proportional in time and extent to the impact on habitat or covered species authorized under the plan. These provisions identify (a) the conservation measures—including assembly of reserves where appropriate and implementation of monitoring and management activities—that the landowner will maintain or carry out in rough proportion to the impact on habitat or covered species and (b) the measurements that will be used to determine if this occurs (2820(b)(9)).	▪ MRC applies most conservation measures during the THP process. Other conservation measures, such as those for controllable erosion, are not directly tied to the THP process.
▪ The plan ensures adequate funding to carry out the conservation measures identified in the plan (2820(a)(10)).	▪ *Implementing Agreement*

Checklist for NCCP Requirements	
Requirement (California Fish & Game Code Section)	**HCP/NCCP Cross Reference**
▪ The plan defines species coverage, including any conditions of coverage (2820(b)(1)).	▪ Chapter 1 *Purpose and Scope*
▪ The plan establishes long-term protection of habitat reserves or provides equivalent conservation of covered species (2820(b)(2)).	▪ Chapter 8 *Conservation Measures for Aquatic Habitat* ▪ Chapter 9 *Conservation Measures for Terrestrial Habitat* ▪ Chapter 10 *Conservation Measures for Fish and Wildlife* ▪ Chapter 11 *Conservation Measures for Rare Plants*
▪ The plan defines specific terms and conditions, which, if violated, would result in the suspension or revocation of the permit, in whole or in part. CDFG will include a provision requiring notification to the plan participant of a specified period of time to cure any default prior to suspension or revocation of the permit in whole or in part. These terms and conditions will address, but are not limited to, provisions specifying the actions CDFG will take under all of the following circumstances (2820(b)(3)): 1. The plan participant fails to provide adequate funding. 2. The plan participant fails to maintain the rough proportionality between impacts on habitat or covered species and conservation measures. 3. The plan participant adopts, amends, or approves any plan or project without the concurrence of the wildlife agencies that is inconsistent with the objectives and requirements of the approved plan. 4. The level of take exceeds that authorized by the permit.	▪ *Implementing Agreement*
▪ The plan specifies procedures for amendment of the plan and the *Implementing Agreement* (2820(b)(4)).	▪ *Implementing Agreement* ▪ Chapter 1 *Purpose and Scope*
▪ The plan ensures implementation of a monitoring program and adaptive management program (2820(b)(5)).	▪ *Implementing Agreement* ▪ Chapter 13 *Monitoring and Adaptive Management*
▪ The plan provides for oversight of plan implementation to assess mitigation performance, funding, and habitat protection measures (2820(b)(6)).	▪ Chapter 7 *Planning for Conservation* ▪ Chapter 13 *Monitoring and Adaptive Management*

Checklist for NCCP Requirements	
Requirement (California Fish & Game Code Section)	**HCP/NCCP Cross Reference**
▪ The plan provides for periodic reporting to the wildlife agencies and the public for purposes of information and evaluation of plan progress (2820(b)(7)).	▪ Chapter 13 *Monitoring and Adaptive Management*
▪ The plan provides mechanisms to ensure adequate funding to carry out the conservation actions identified in the plan (2820(b)(8)).	▪ *Implementing Agreement* ▪ Chapter 7 *Planning for Conservation*
▪ The plan ensures that mitigation and conservation measures are roughly proportional in time and extent to the impact on habitat or covered species authorized under the plan. Plan provisions will identify the conservation measures, including assembly of reserves where appropriate and implementation of monitoring and management activities, that will be maintained or carried out in rough proportion to the impact on habitat or covered species and the measurements that will be used to determine if this is occurring. (2820(b)(9))	▪ Chapter 7 *Planning for Conservation* ▪ Chapter 8 *Conservation Measures for Aquatic Habitat* ▪ Chapter 9 *Conservation Measures for Terrestrial Habitat* ▪ Chapter 10 *Conservation Measures for Fish and Wildlife* ▪ Chapter 11 *Conservation Measures for Rare Plants*
▪ The plan stipulates that if a participant does not maintain proportionality between *take* and conservation measures specified in the *Implementing Agreement* and does not either (a) cure the default within 45 days or (b) enter into an agreement with CDFG within 45 days to expeditiously cure the default, CDFG will suspend or revoke the permit, in whole or in part (2820(c)).	▪ *Implementing Agreement*
▪ The plan requires that data and reports associated with monitoring programs be available for public review; the landowner must also conduct public workshops on an annual basis to provide information and evaluate progress toward attaining the conservation objectives of the plan (2820(d)).	▪ Chapter 13 *Monitoring and Adaptive Management* ▪ *Implementing Agreement*

2.4 Summary of ESA, CESA, and NCCPA

Table 2-2 provides a summary of the federal and state legislation discussed up to this point, as it specifically relates to our HCP/NCCP.

Table 2-2 Summary of ESA, CESA, and NCCPA

Legislation Acronym	Purview of Legislation	Take Authorization	MRC Seeking Authorization?	Issuing Agency	Requirement for Issuance
ESA	▫ Animals and plants that appear on the federal lists of endangered or threatened species.	Incidental Take Permit (ITP)	Yes.	USFWS NMFS (anadromous species, such as salmon)	HCP
CESA	▫ Animals native to California that appear on the state lists of threatened, endangered, or candidate species. ▫ Plants native to California that appear on the state lists of threatened, endangered, or rare species.	2080.1 or 2081 Permit	No	CDFG	2080.1 requires a federal ITP or incidental take statement, while 2081 requires an application and may include a plan similar to an HCP.
NCCPA	▫ Animals native to California that appear on a state list of threatened, endangered, or candidate species, as well as any other species for which take authorization is desired or that is integral to the design of the NCCP. ▫ Plants native to California that appear on a state list of threatened, endangered, or rare species, as well as any other species for which take authorization is desired or that is integral to the design of the NCCP. ▫ Natural communities or ecosystems.	2835 Permit	Yes	CDFG	NCCP

2.5 Forest Management

2.5.1 Timber harvest plans

The intent of the California Board of Forestry and Fire Protection (BOF) through the administrative arm of the Department of Forestry is to move large forestland owners away from site-specific plans and toward a landscape-level or watershed-level approach to forest management. MRC planning is consistent with such an approach.

The Z'berg-Nejedly Forest Practice Act of 1973 (FPA) governs all timber harvesting on private and state-owned lands in California. The FPA is intended to regulate non-federal timberlands and enhance, restore, and maintain the productivity of timberland wherever feasible. Its goal is to achieve maximum sustained production of high-quality timber while giving consideration to recreation, watersheds, wildlife, range and forage, fisheries, regional economic vitality, employment, and aesthetic enjoyment.

The FPA authorizes and requires the BOF to adopt timber harvesting rules and regulations for all commercial timber harvesting on non-federal lands. Those rules, known as the California Forest Practice Rules (CFPR), are in turn administered and enforced by the California Department of Forestry and Fire Protection (CAL FIRE). Thus, the CFPR implements the legislative requirements and intent of the FPA.

Under FPA and CFPR, landowners must submit Timber Harvest Plans (THP) to CAL FIRE for all commercial timber harvesting on non-federal timberlands.

DEFINITION

A **THP** is a landowner's blueprint for harvesting an individual stand of timber or a group of stands.

THPs are prepared by registered professional foresters (RPFs) who are licensed to write these complex and detailed plans. Among other things, the THP answers

- What trees are proposed for harvest?
- How will they be harvested?
- How will the site be reforested?
- What steps and mitigation measures will be taken to
    - Prevent erosion and other damage to the environment?
    - Maintain water quality?
    - Protect wildlife habitat?
    - Ensure the sustainability of other forest values?

CAL FIRE foresters review THPs for compliance with FPA and CFPR, as well as with other state and federal laws that protect watersheds and wildlife. Before a THP is approved, Forest Practice Rules require an interdisciplinary environmental review by several state agencies, including CAL FIRE, CDFG, Regional Water Quality Control Board (RWQCB), counties, Coastal Commission, Department of Parks and Recreation, and the California Geological Survey (CGS). In addition, CAL FIRE conducts pre-harvest inspections on most plans; review teams from other agencies participate, as their staffing permits, on a subset of plans. At this time, the agencies can ask for additional mitigation if a proposed activity threatens a forest resource or violates any other federal or state law. The Forest Practice Rules also require that a THP be available for public comment for at least 30 days. CAL FIRE considers all comments from the agencies and the public, and prepares written responses before approving or denying a THP.

If a THP meets the intent of the California Forest Practice Act to maintain the productivity of timberlands while protecting other non-timber related resources, it is approved; the timberland owner can then proceed with harvesting operations according to terms of the plan. State forest practice inspectors can and do visit active harvest sites to make certain forest practice rules are followed. If violations are found, penalties can be imposed on a timber operator, an RPF, or a landowner.

Timber harvest plans generally have 3-year durations; CAL FIRE can extend this to 5 years at their discretion. MRC possesses valid THPs for timber operations already in progress in the plan area. MRC also has submitted several proposed THPs to CAL FIRE for specific properties which it intends to harvest. We will continue preparing and submitting THPs for planned timber operations and implementing approved THPs. THPs currently submitted must comply with *take* prohibitions of the state and ESA. Future THPs within the plan area will incorporate any applicable conservation measures, adaptive management, monitoring, or other provisions of this HCP/NCCP. MRC may implement or continue to implement previously approved THPs after the effective date of the Implementing Agreement according to their previously approved terms and applicable state and federal law. However, such THPs may not be covered activities or subject to HCP/NCCP requirements and they will not receive incidental take authorization under federal and state permits. Any THP or THP amendment approved after ITP issuance will comply with the conservation measures in the HCP/NCCP.

2.5.2 Maximum sustained production

The Forest Practice Rules (FPR) require timberland owners to achieve maximum sustained production (MSP) of high quality timber products "while giving consideration to values relating to recreation, watershed, wildlife, range and forage, fisheries, regional economic vitality, employment, and aesthetic enjoyment" (PRC 4513). Timberland owners controlling more than 50,000 ac fulfill the requirement for MSP through a Sustained Yield Plan (SYP), an Option A, or a PTEIR (see 14 CR 1092).

Currently, MRC does have an Option A. Revised in February 2008, our Option A serves as a 100-year harvest schedule for MRC forestland. MRC used this 100-year time frame to calculate the Long Term Sustained Yield according to the Forest Practice Rules. Key issues covered in the report include harvest levels; harvest compared to growth; silviculture; and non-timber forest values. Option A contains current MRC operating policies for protecting terrestrial and aquatic wildlife habitat, public access, and domestic water supply.

However, in conjunction with our HCP/NCCP, MRC will submit a PTEIR to demonstrate MSP. Our Timber Management Plan (TMP), which is an appendix of the PTEIR, relates our management policies to the Forest Practice Rules.

2.5.3 Forest stewardship council (FSC)

The Forest Stewardship Council is an international non-profit organization founded in 1993 to support forest management that is environmentally appropriate, socially beneficial, and economically viable. The association consists of a diverse group of representatives from around the world, including

- Environmental, social, and community groups.
- Professionals in forestry and the timber trade.
- Organizations of indigenous people.
- Organizations for forest product certification.

While not a regulatory agency, FSC is noteworthy because it administers a voluntary, third-party certification program that encourages a marketplace for well-managed forests. FSC authorizes use of a particular logo on products that meet the internationally recognized FSC *Principles and Criteria of Forest Stewardship*. To receive this logo, a company's timber must be tracked from forest to shop. FSC aims to provide an independent, international, and credible labeling scheme on timber and timber products. This label extends to the consumer a guarantee that a product has come from a forest which has been evaluated and certified according to agreed social, economic, and environmental standards.

In the fall of 1998, MRC requested a review by Scientific Certification Systems (SCS), an FSC certifying body. During this review, the strengths and weaknesses of MRC operations were documented. Immediately, MRC began work on the deficiencies cited during the SCS review. We shifted our resource inventory to a stand-based system, using aerial photos to stratify vegetation into classes, and developed an online database to ensure current information. Our forest management placed increased emphasis on ecosystems.

In the summer of 1999, SCS conducted a full evaluation of MRC operations in tandem with a separate FSC-accredited certifier, Smartwood. MRC received FSC certification of our operations in November 2000. Smartwood and SCS re-certified MRC on November 9, 2005. This certification is good for 5 years, during which time MRC will undergo annual audits. MRC has prepared our HCP/NCCP to be compatible with FSC principles.

2.6 Water

While MRC developed this HCP/NCCP in consultation with the wildlife agencies, we anticipate that the measures for covered species will also meet the Water Quality objectives described below.

2.6.1 Clean water act (CWA)

The federal Clean Water Act of 1977 is the principal federal legislation designed to protect the quality of the nation's waters. The purpose of CWA includes "the protection and propagation of fish, shellfish, and wildlife." The Environmental Protection Agency (EPA) is charged with implementing most of CWA, including Section 303, which contains provisions for establishing and meeting water quality standards. CWA provides for establishment of Total Maximum Daily Loads (TMDLs) where water bodies are not meeting established water quality standards.

DEFINITION	A **TMDL** is a quantitative assessment of water quality problems, contributing sources, and load reductions or control actions needed to restore and protect waterbodies.

CWA also permits EPA to delegate many of the permitting, implementation, and enforcement aspects of the law to state governments. In California, the State Water Resources Control Board (SWRCB) and the Regional Water Boards have the authority to implement most CWA programs, although EPA still retains oversight responsibilities.

During review of individual THPs, CAL FIRE considers the requirements of CWA. MRC intends for our HCP/NCCP to comply with CWA regulations, as well as with current state and federal standards for water quality control. Our conservation measures for sediment reduction, aquatic management zones, and terrain stability units specifically pertain to Water Quality requirements.

2.6.2 Total maximum daily load

Section 303(d) of CWA establishes a water quality assessment and planning process through which states, territories, and authorized tribes are required to

- Identify polluted waterbodies in which *beneficial uses* are impaired.
- Set priorities for addressing these polluted waters.
- Write pollutant control plans, called TMDLs, in order to attain state water quality standards.

A TMDL represents a written, quantitative assessment of water quality problems and contributing pollutant sources that

- Identifies one or more numeric targets based on applicable water quality standards.
- Specifies the maximum amount of a pollutant that can be discharged (or the amount of a pollutant that needs to be reduced).
- Allocates pollutant loads among sources in a watershed.
- Provides a basis for taking actions needed to meet numeric target(s) and implement water quality standards.
- Uses data collection and monitoring to (a) review trends at set milestones; (b) determine if management is achieving objectives; and (c) adapt management, if necessary, to meet objectives.

The TMDL process provides a means for determining the causes of waterbody impairment. It allocates responsibility among different sources of pollutant discharge in order to reduce pollutant emissions and achieve water quality standards. The TMDL process also affords the public the opportunity to participate in decisions about these pollutant control plans.

EPA national policy is that all TMDLs must provide reasonable assurances that they can and will be implemented to meet water quality standards. This means that waste load (for point-source) and load (for non-point source) allocations are technically feasible and can be implemented in a reasonable period of time. States are generally responsible for developing TMDLs; EPA reviews and approves them. If EPA does not approve a TMDL, it is responsible for establishing the TMDL for the state. In some cases, EPA may be forced to establish TMDLs under court order or consent decree, when the state has not yet adopted and submitted a required TMDL.

Section 303(d) of CWA requires states to identify waterbodies that do not meet water quality standards and are not supporting beneficial uses. Each state must submit an updated list, called the *List of Impaired Waterbodies* or 303(d) list, to EPA by April of each even numbered year. In addition to identifying waterbodies that are not supporting beneficial uses, the 303(d) list identifies pollutants or stressors causing impairment, and establishes a planned schedule for addressing the impairment.

States are not required to include implementation plans when an initial TMDL is submitted to EPA. Rather, federal regulations require states to incorporate TMDLs in their Water Quality Management Plan (WQMP) along with implementation measures for all aspects of WQMP and TMDL. Where states do not submit implementation plans with the TMDL, the TMDL should include a time schedule for completion of the implementation plan. In practice, TMDLs are usually implemented through existing state regulatory and non-regulatory programs. These programs control pollutant discharges from point sources, such as discharges from wastewater treatment plants, and non-point sources, such as polluted runoff from commercial timberlands or agricultural lands. In California, RWQCB prepares the implementation plans.

2.6.3 Impaired water bodies in the MRC plan area

There are 2 forms of pollution that impair waters on MRC land: sediment and water temperature. Table 2-3 shows the 303(d) status of all significant water bodies within the MRC plan area, along with pollutants that exceed water quality standards.

Table 2-3 Status under CWA of Significant Waterbodies in the HCP/NCCP Plan Area

Status under CWA of Significant Waterbodies in the Plan Area		
Body of Water	**Status of TMDL**	**Implementation[a]**
South Fork Eel (Hollow Tree Creek is a tributary.)	TMDL for sediment and temperature established by US EPA on December 16, 1999.	Implementation plan to be completed by RWQCB.
Noyo	TMDL for sediment established by US EPA on December 16, 2001.	Implementation plan to be completed by RWQCB.
Big River	TMDL for sediment established by US EPA in December 2001. TMDL for sediment to be completed.	Implementation plan to be completed by RWQCB.
Albion	TMDL for sediment established by US EPA in December 2001.	Implementation plan to be completed by RWQCB.
Navarro	TMDL for sediment and temperature established by US EPA in December 2000.	Implementation plan to be completed by RWQCB.
Greenwood Creek	Not on official 303(d) list.	n/a
Garcia	TMDL for sediment approved by US EPA on March 7, 2002.	Implementation plan completed by RWQCB in 2002.
Russian	TMDL for temperature to be completed. TMDL for sediment to be developed (due 2011). SWRCB may propose a requirement for a TMDL for pathogens.	n/a
Alder Creek/ Schooner Creek/ Mallo Pass	Not on official 303(d) list.	n/a
Elk Creek	Not on official 303(d) list.	n/a
Gualala River	TMDL for sediment established by US EPA in December 2001. TMDL for temperature to be completed.	Implementation plan to be completed by RWQCB.
Cottoneva Creek	Not on official 303(d) list.	n/a

Status under CWA of Significant Waterbodies in the Plan Area		
Body of Water	**Status of TMDL**	**Implementation[a]**
Rockport coastal streams (Hardy, Juan, or Howard Creeks)	Not on official 303(d) list.	n/a

TABLE NOTES

[a] Implementation and monitoring are required under the state Porter-Cologne Water Quality Control Act and 40 CFR §130.6 for inclusion in the Basin Plan.

n/a = not applicable

In sum, one significant waterbody, the Garcia River, has a completed TMDL and implementation plan. The remaining waterbodies on the 303(d) list, with the exception of the Russian River, have had sediment TMDLs established by EPA and await implementation by the state. The Russian River TMDL is not due until 2011. The water temperature TMDLs for Garcia, Gualala, and Big Rivers are not yet scheduled for development.

Our HCP/NCCP addresses water-quality concerns by

- Preserving and enhancing aquatic habitat through limited harvest within Aquatic Management Zones (AMZs)[1] and the addition of large woody debris (LWD) to streams.
- Managing for streamside stands with large, dense conifer species.
- Promoting and increasing recruitment of LWD.
- Maintaining ecologically appropriate water temperatures.
- Promoting riparian functions, such as nutrient cycling, coarse organic inputs, flood water roughness, and structure.
- Protecting stream bank stability.
- Minimizing and re-mediating sediment inputs to watercourses that can harm aquatic species.

In addition, our HCP/NCCP contains special adaptive management and monitoring measures especially designed for long-term conservation and enhancement of aquatic habitat. We considered TMDLs in the formation of our adaptive management and monitoring measures. As a result, our plan should meet future objectives or numeric targets for sediment or water temperature. MRC consulted and cooperated with the Regional Board in preparing our HCP/NCCP and will continue to do so during implementation. For the most part, we expect to rely on the measures in the HCP/NCCP to meet water quality requirements and anticipate that the RWQCB will incorporate such measures into their permits. RWQCB, for example, issues permits for waste discharge related to MRC timber harvest and other land management. If the MRC regime for water quality control is successful, we anticipate that the RWQCB may wish to include it in TMDL implementation plans for watersheds within the plan area.

2.6.4 Porter-Cologne water quality control act

The California Porter-Cologne Water Quality Control Act, at Water Code Section 13240 (Porter-Cologne Act), along with the Federal Water Pollution Control Act, as amended by the Clean

[1] AMZs are strips of land alongside Class I, Class II, and Class III watercourses (see Table 8-1 for watercourse definitions) where MRC will manage riparian function.

Water Act, require water quality control plans for waters of the state, as well as public review of those plans. SWRCB establishes statewide policies and plans for the implementation of state and federal control laws for water quality. RWQCB adopts and implements water quality control plans for a region.

The Water Quality Control Plan for North Coast Region, also known as the Basin Plan, identifies beneficial uses of water and describes the problems of water quality and quantity in surface and ground water in the region. The plan area of our HCP/NCCP lies within the North Coastal Basin—1 of 2 large natural drainages there. The North Coastal Basin is made up of 9 hydrologic units:

1. Redwood Creek.
2. Trinidad.
3. Mad River.
4. Eureka Plain.
5. Eel River.
6. Cape Mendocino.
7. Mendocino Coast.
8. Russian River.
9. Bodega.

Table 2-4 shows, within the HCP/NCCP plan area, beneficial uses of water and projected effects, as well as potential impacts relative to current regulations.[2]

Table 2-4 Beneficial Uses of Water and Potential Impacts of HCP/NCCP

Beneficial Uses of Water and Potential Impacts of HCP/NCCP		
Category of Beneficial Use	**Expected HCP/NCCP Effect**	**Potential Impacts from HCP/NCCP**
Cold freshwater habitat (COLD)	+	Conservation measures that target riparian conditions should produce a maximum amount of cold freshwater habitat across the plan area.
Warm freshwater habitat (WARM)	-	Conservation measures should improve cold water habitat and reduce non-natural warm water habitat.
Estuarine habitat (EST)	+	Conservation measures that target sediment control and riparian conditions should positively impact downstream sedimentation and water temperatures of estuarine habitat.
Inland saline water habitat (SAL)	0	This habitat does not occur in the plan area.

[2] The beneficial uses in this table are also in the Basin Plan for waters within MRC land. Chapter 2 of the Basin Plan provides definitions of these beneficial uses. The Basin Plan is available on the North Coast RWQCB at http://www.swrcb.ca.gov/northcoast/water_issues/programs/basin_plan/basin_plan.shtml (accessed 05/04/2011).

Beneficial Uses of Water and Potential Impacts of HCP/NCCP		
Category of Beneficial Use	**Expected HCP/NCCP Effect**	**Potential Impacts from HCP/NCCP**
Marine habitat	+	Conservation measures that target riparian conditions should produce improved freshwater, which flows into marine habitats.
Rare, threatened, or endangered species (RARE)	+	Conservation measures that target rare, threatened, and endangered species and their habitats should positively impact federal and state species covered in this plan.
Migration of aquatic organisms (MIGR)	+	Road design standards that require watercourse crossings to allow migration of all life stages of anadromous fish and that remove or modify current barriers should positively impact aquatic organisms.
Spawning, reproduction, or early development (SPWN)	+	Conservation measures that target sediment control and riparian conditions should positively impact all life stages of covered salmonid species.
Freshwater replenishment (FRSH)	0	Forest management in this plan should not impact freshwater replenishment.
Water quality enhancement (WQE)	+	Conservation measures in this plan should enhance water quality.
Municipal and domestic supply (MUN)	+	Conservation measures that target sediment control should positively impact the quality of domestic water supply in the plan area, including drinking water.
Agricultural supply (AGR)	+	Conservation measures that limit water supply for some agricultural uses should increase the quality of pond habitat for amphibian species.
Industrial service supply (IND)	+	Conservation measures that target sediment control and riparian conditions should positively impact downstream effects of industrial uses of water, such as mining, hydraulic conveyance, and fire protection.
Industrial Service Supply (PRO)	+	Conservation measures that target sediment control and riparian conditions should positively impact industrial uses of water downstream.
Hydropower generation	0	Forest management in this plan should not impact hydropower generation.

Beneficial Uses of Water and Potential Impacts of HCP/NCCP		
Category of Beneficial Use	**Expected HCP/NCCP Effect**	**Potential Impacts from HCP/NCCP**
Groundwater recharge (GWR)	0	Forest management in this plan should not impact groundwater recharge.
Navigation (NAV) Navarro and Russian Rivers	+	Conservation measures that target sediment control should positively impact river navigation by lowering the frequency of dredging to keep navigation corridors open.
Water contact recreation (REC-1)	±	Conservation measures that target sediment control should positively impact water recreation by promoting clean water and deep pools. Conservation measures that increase LWD for habitat development could adversely impact water recreation, such as boating or rafting.
Non-contact water recreation (REC-2)	+	Conservation measures that target sediment control and riparian conditions should positively impact recreational activities that might indirectly involve water contact or that focus on aesthetic enjoyment, such as picnicking or hiking.
Commercial and sport fishing (COMM)	+	Conservation measures for salmonid species and habitat should increase salmonid populations and improve commercial and sport fishing.
Wildlife habitat (WILD)	+	Conservation measures that target sediment control and riparian conditions should improve general wildlife habitat, such as water sources, vegetation for cover, and available prey.
Presence of areas of special biological significance (ASBS)	+	Conservation measures for seeps, springs, wet areas, pygmy forest, and oak woodlands protect areas of biological significance.
Flood peak attenuation and flood storage (FLD)	+	Riparian conservation measures should enhance buffers in riparian areas.
Wetland habitat (WET)	+	Conservation measures target seeps, springs, wetlands, wet areas, and wet meadows.
Native American culture (CUL)	+	Aquatic conservation measures should improve current riparian conditions for anadromous salmonids, which are an integral part of local native culture.

Beneficial Uses of Water and Potential Impacts of HCP/NCCP		
Category of Beneficial Use	**Expected HCP/NCCP Effect**	**Potential Impacts from HCP/NCCP**
Subsistence fishing (FISH)	+	Riparian conservation measures should improve conditions for native fish, increasing the potential for subsistence fishing.
Aquaculture (AQUA)	+	Conservation measures that target sediment control and riparian conditions should improve the potential for cultivation and harvesting of aquatic plants and animals.

TABLE NOTES

+ Positive impact - Negative impact ± Positive and negative impact 0 No discernible impact

The Basin Plan, which is part of the comprehensive California Water Plan and complies with the California Environmental Quality Act (CEQA), sets water quality objectives to protect and enhance the beneficial uses identified in Table 2-4. It also contains an implementation plan with specific measures and prohibitions, action plans, and policies designed to achieve and maintain water quality objectives. The California Water Code—Porter-Cologne and CWA section 303(c)(1)— mandates updates to the Basin Plan every 3 years. This triennial review is itself the process to update the Basin Plan. The RWQCB adopts the Basin Plan; subsequently, SWRCB, the Office of Administrative Law, and the federal EPA approve it.

Regional Boards regulate all pollutant or nuisance discharges that may affect either surface water or groundwater. Any person proposing to discharge waste within a region must file a report of waste discharge with the Regional Board. No discharge may take place until the Regional Board issues a waste discharge requirement (WDR) or a waiver of the waste discharge requirement. The Regional Board uses the Basin Plan as a regulatory tool and standard, principally by relying on objectives, implementation measures, and other prohibitions when assessing particular discharges. Section 13243 of the Porter-Cologne Act authorizes the Regional Board to specify certain conditions or areas where discharge of waste, or certain kinds of waste, will not be permitted. These specifications may be in the Basin Plan or in a WDR. Among others, the Basin Plan for the North Coast Region contains specific measures and prohibitions to protect water quality and beneficial uses from actual and potential nonpoint source discharges, such as logging and herbicide waste from silvicultural applications. An action plan, which is consistent with the State Nonpoint Source Management Plan, promotes implementation of best management practices through voluntary implementation, regulatory-based encouragement, and effluent limitation.

The Basin Plan specifies when the Regional Board will waive or require reports on waste discharge, as follows:

> The Regional Board considers that implementation of the discharge prohibitions relating to logging, construction, or associated activities can provide appropriate protection to waters of the region from these sources of waste and, in the great majority of their activities, will waive the need for reports of waste discharge and waste discharge requirements. However, where investigations (by the staff of the Regional Board) indicate that the beneficial uses of water may be adversely affected by waste discharges, the

> staff shall require the submission of Reports of Waste Discharge.
> (NCRWQCB 1996, 85)

Our HCP/NCCP incorporates, at a minimum, the discharge prohibitions stated in the Basin Plan. Therefore, in carrying out our forestry operations, MRC may not file reports of waste discharge, unless ongoing investigations by the Regional Board indicate that we need to submit a report and receive a WDR.

2.6.5 Streambed alteration agreements

Section 1602 of the California Fish and Game Code generally prohibits anyone from substantially diverting, obstructing, or changing the natural flow, bed, channel, or bank of any river, stream, or lake in California. It also prohibits using any material from streambeds, unless first notifying CDFG. In addition, Section 1602 prohibits actions that might substantially and adversely affect an existing fish or wildlife resource. In such cases, CDFG must make a determination of adverse effect and advise what reasonable measures need to be taken through a lake or streambed alteration agreement (1600 Agreement).

CDFG generally enters into 1600 Agreements for a term not to exceed 5 years. However, under certain conditions, CDFG may issue a 1600 Agreement for a longer term if the measures adequately protect fish and wildlife resources and comply with other statutory requirements. CDFG approval of 1600 Agreements is subject to CEQA review.

In preparing our HCP/NCCP, MRC has notified CDFG of our proposed activities, some of which fall under the regulations of Section 1600. While MRC has not identified the specific dates and locations of these proposed activities, CDFG can develop standard conditions to ensure that the proposed activities do not result in substantial adverse effect on fish and wildlife resources.

MRC has requested a Master Agreement for Timber Operations (MATO) for our proposed activities (see Appendix T). Since our HCP/NCCP will conserve and enhance fish and wildlife habitat in the plan area, MRC proposes that our conservation and management provisions serve as the measures and conditions for the MATO. If compliance with the measures and conditions in the MATO are not feasible for certain covered activities or if the covered activities are not subject to the MATO, MRC will notify CDFG and enter into a separate 1600 Agreement that complies with the conservation measures of the HCP/NCCP.

MRC will incorporate current water drafting agreements as covered activities provided those activities include the additional drafting requirements in Appendix E, *Road, Landing, and Skid Trail Standards* and in Appendix T, *Master Agreement for Timber Operations.*

2.6.6 Coastal zone

2.6.6.1 California coastal act

The California Coastal Act was enacted in 1976 to provide long term protection to California's 1100-mile coast line (Public Resources Code sections 30000 et seq.). The Coastal Act established a partnership between the state and local governments to manage the conservation and development of coastal resources in the coastal zone through a comprehensive planning and regulatory program. The coastal zone was drawn by the California Legislature in 1976 and stretches from 3 miles out at sea to inland points that vary from several hundred yards to 5 miles from shore. The policies in the Coastal Act are implemented through Local Coastal Programs (LCPs).

The coastal zone is divided into 74 coastal jurisdictions, each of which is responsible for establishing 1 or more LCPs within its scope. Each LCP is prepared by local coastal jurisdiction and certified by the Coastal Commission. An LCP contains a land use plan (LUP) that identifies the location, type, and density for any future development within the coastal zone, along with any other conditions or rules applied to such development. An LCP must also contain an implementation plan (i.e., zoning ordinance) to apply the policies of the Coastal Act and the LCP to future development. While each LCP is designed to reflect unique local characteristics of a particular coastal community, issues of statewide concern must also be addressed.

2.6.6.2 Coastal development permits

The Coastal Commission possesses initial permitting authority over most new development in a coastal zone. After an LCP for a local coastal jurisdiction is approved by the Coastal Commission, the permitting authority is transferred to local government. However, the Coastal Commission retains permanent permitting authority over development proposed on the shoreline, including tidelands, submerged lands, and public trust lands.

The Coastal Act provides that new development causing a “change in the density or intensity of use of land…[and] change in the intensity of use of water, or of access thereto” requires a coastal development permit from either the Commission or local government. Certain types of development or activities are exempt from the permit requirement. Timber operations which are in accordance with a THP submitted under provisions of the Z'berg-Nejedly Forest Practice Act (1973) are exempted from the permit process (Public Resources Code, section 30106).

2.6.6.3 Certification of consistency

The Coastal Commission also is responsible for reviewing all federal activities that affect coastal resources. The federal Coastal Zone Management Act (CZMA) requires each coastal state to prepare a coastal management program (16 U.S.C. sections 1451-1465).

The National Oceanic and Atmospheric Administration (NOAA) must approve all state coastal management programs, including a state’s delineation of the coastal zone. The California Coastal Act and the California Coastal Management Program (CCMP) constitute the state coastal management program for purposes of the federal CZMA and have been approved by NOAA.

CZMA contains a federal consistency requirement, which prompts the Coastal Commission to review applications for federal permits that can reasonably be expected to affect the coastal zone. The Coastal Commission must ensure that the federally-permitted activity affecting any coastal use or resource is conducted in a manner consistent with the CCMP. The state may list in its coastal management program those federal licenses or permit activities that are automatically subject to the state’s review under the federal consistency requirement (15 CFR section 930.53). For all other federal licenses or permit activities that are not listed in the state coastal management program, the Coastal Commission may request a consistency certification, but only after receiving approval from the Director of the federal Office of Ocean and Coastal Resource Management (OCRM).

Consistency certification generally addresses whether a federal action and its associated facilities affect any coastal land or water use or natural resource of the coastal zone, and, if so, whether the activities satisfy the substantive requirements of the CCMP. Even if activities permitted by a federal agency fall outside of the coastal zone, they may be reviewed for consistency with the CCMP if they affect land and water uses or natural resources inside the coastal zone.

To submit a consistency certification, an applicant for a federal license or permit must assert and demonstrate that the proposed activity complies with the CCMP and that the activity will be conducted in a manner consistent with the CCMP. The certification needs to be supported by any necessary data and information, including

- A copy of the federal permit application.
- A detailed description of the proposal and its coastal effects.
- An evaluation of the consistency of the project with enforceable policies of the CCMP.
- Comprehensive data and information sufficient to support the consistency determination.

Federal incidental take permits issued under ESA are currently not on the list of federal licenses or permits subject to certification for consistency with the CCMP. During the preparation of our HCP/NCCP, MRC consulted with staff from the Coastal Commission. We informed them about the scope of our HCP/NCCP and its covered activities. MRC also presented conservation and protection measures from the HCP/NCCP. These measures are intended to comply with the CCMP and the Coastal Commission's policies for protecting coastal resources. In addition, the federal incidental take permit must be consistent with the California Coastal Act and the CCMP, including the Coastal Commission's policies for environmental sensitive habitat areas (ESHAs) and wetlands.

The staff of the Coastal Commission has not indicated that it would seek approval to review the MRC application for a federal incidental take permit for consistency with the CCMP. As a result, there is no need for MRC to submit a consistency certification.

2.6.7 Surface mining and reclamation act (SMARA)

The Surface Mining and Reclamation Act of 1975 (SMARA) requires that a reclamation plan be approved for all sites where (1) there is surface mining of minerals and (2) removal of overburden is in excess of 1000 yd^3 in any one location. In 1996, changes were made to SMARA that provide for an exemption for excavation of grading materials for roadbed construction and maintenance; such excavation must be conducted in connection with timber operations or forest management on land owned by the same person or entity. The exemption is not provided for excavation or grading within 100 ft of a Class I watercourse or 75 ft of a Class II watercourse (i.e., a watercourse buffer), or for excavation of materials that are sold for commercial purposes. The majority of MRC rock pits do not require a SMARA permit since they meet the 1996 exemption; however, MRC secures permits for any rock pits which require them.

The intent of SMARA is (a) to necessitate the reclamation of mined lands; (b) to minimize adverse effects on the environment; and (c) to protect the public health and safety. The 1996 exemption was created for timberland owners because mined materials were not being sold for financial gain; instead they were being used to control surface erosion during road maintenance. The exemption provided timberland owners with an economical source of *road base* to stabilize running surfaces, and *rip-rap*, or loose stone, to stabilize stream banks and cut-slopes. The exemption is not provided for rock pits near watercourses; this encourages timberland owners to move surface mining operations away from rivers and streams.

Additionally, surface mining operations conducted outside the watercourse buffer are exempt from the SMARA permit process only if slope stability and erosion are controlled in accordance with CCR, Title 14, Article 9, Section 3704(f) and Section 3706(d). The person closing the site implements, where necessary, re-vegetation measures and post-closure uses in consultation with CAL FIRE.

2.7 Environmental Review

2.7.1 National environmental policy act (NEPA)

The National Environmental Policy Act of 1969 applies, as amended, to all federal agencies that affect the environment. NEPA establishes environmental policies for the nation; provides an interdisciplinary framework for the agencies to assess environmental impacts; and contains "action-forcing" procedures to ensure that agency decision makers take environmental factors into account.

The Council on Environmental Quality (CEQ), implementing the procedural provisions of NEPA, requires all agencies to analyze the impact of their proposed actions and to include other agencies and the public in the process. The scope of NEPA analysis covers the direct, indirect, and cumulative effects of the proposed action.

As part of the HCP/NCCP process, MRC is assisting NMFS and USFWS to prepare a draft environmental impact statement (EIS). The issuance of ITPs by NMFS and USFWS are major federal actions that trigger the NEPA requirement for environmental analysis and disclosure of potential environmental impacts of proposed actions. The analysis in the EIS will consider the proposed conservation and management measures, including the mitigation and minimization measures, which would be implemented through our HCP/NCCP. The analysis will also consider and compare several alternatives to our HCP/NCCP. NMFS and USFWS will prepare a final EIS following a period of public review and comment on the draft EIS and HCP. In the final EIS, NMFS and USFWS will respond to public comments and incorporate suggested changes where appropriate. NMFS and USFWS are serving as the co-lead agencies under NEPA and will use their independent judgments in determining whether the EIS complies with NEPA regulations.

2.7.2 California environmental quality act (CEQA)

Similar to NEPA, the California Environmental Quality Act (CEQA) requires state agencies with discretionary permitting authority over a proposed project to evaluate the potential environmental effects of the project. If one or more potential significant impacts are identified, the state agencies must prepare a detailed environmental impact report (EIR). If no potential significant impacts are identified or if all of the potential significant impacts can be mitigated to levels less than significant by redesigning the project or incorporating mitigation measures into the project proposal, the state agencies may prepare a negative declaration. Approval of both a TMP and an NCCP, along with issuance of an ITP in association with an NCCP are "projects" within the meaning of CEQA and require environmental review.

To comply with CEQA, MRC has elected to use a Programmatic Timber Environmental Impact Report (PTEIR). A PTEIR is a CEQA environmental impact report that also meets certain requirements identified in the California Forest Practice Rules (see California Public Resources Code, section 1092, et seq.). A PTEIR places additional emphasis on environmental impacts associated with timber harvest so that the PTEIR analysis of such impacts can be incorporated and relied on during preparation of subsequent "programmatic timber harvest plans." Specifically, a PTEIR must assess "impacts and provide mitigation for on-site and off-site impacts resulting from timber operations involved with an ownership, portion of an ownership, or multiple ownerships" (Public Resources Code, section 1092.01(b)).

CAL FIRE approval of a TMP is a discretionary action subject to CEQA; CAL FIRE is, therefore, the CEQA lead agency for the PTEIR. As the CEQA lead agency, CAL FIRE will direct and oversee preparation of the PTEIR and will rely on the PTEIR for purposes of assessing

the potential environmental impacts that may result from implementation of the TMP. CDFG approval of the HCP/NCCP and MATO, as well as issuance of an incidental take permit, are discretionary actions subject to CEQA. Therefore, CDFG will be a CEQA "responsible agency." CDFG will collaborate with CAL FIRE and assist in the preparation of the PTEIR. Moreover, CDFG will rely on the PTEIR to assess potential environmental impacts resulting from MRC activities authorized under the ITP and MATO. The CEQA document, while prepared by CAL FIRE, must be acceptable to CDFG as they make their findings.

MRC is assisting CAL FIRE to prepare the draft PTEIR. The analysis in the PTEIR will consider the timber management regime proposed in our TMP. In addition, the analysis will assess the proposed conservation and management measures implemented through our HCP/NCCP, as well as several alternatives. CAL FIRE will prepare a final PTEIR following a period of public review and comment. The final PTEIR will respond to public comments and incorporate suggested changes where appropriate. As the lead agency under CEQA, CAL FIRE will use its independent judgment in determining whether the PTEIR complies with CEQA, the CEQA Guidelines, and the Forest Practice Rules.

Other state approvals described in this section may also require CEQA review. When appropriate, the state agencies responsible for such approvals will rely on the environmental analysis contained in the PTEIR to fulfill CEQA requirements.

Some state programs qualify as a certified regulatory program (CRP) and are exempt from the requirement of preparing a formal EIR. While not allowing the certified regulatory program to avoid other provisions in CEQA, such as the policy of avoiding significant adverse effects on the environment where feasible, exemption does provide for an alternative process to achieve CEQA goals of environmental protection. The preparation, review, and approval of THPs under the Forest Practices Act and the California Forest Practice Rules (CFPR) have been identified as a CRP. The documentation, analysis, and findings prepared for ordinary THPs in accordance with the CFPR, serve, therefore, as the "functional equivalent" of an EIR under CEQA. However, because MRC is preparing a TMP and has elected to use a PTEIR, upon CAL FIRE approval or "certification" of the PTEIR, MRC will subsequently be allowed to prepare Programmatic Timber Harvest Plans (PTHPs), which rely on and "tier" from the PTEIR.

The RWQB water quality program—including the amendment of basin plans, the adoption and implementation of TMDLs, and the issuance or waiver of WDRs—has also been approved as a CRP.

2.7.3 Joint environmental document

For projects that must comply with NEPA and CEQA, CEQA Guidelines and NEPA regulations strongly urge state and federal agencies to work together to prepare a single document that will satisfy both state and federal laws. The resulting document, of course, will be inadequate if it only satisfies one or the other statute. While there are some differences in legal requirements for both the contents of the federal and state analyses and the procedures to approve or certify them, the lead agencies can, with coordination, accommodate them in a joint document. When a proposed project requires both an EIR and an EIS, the applicant requests the lead agencies to prepare a joint document, in order to prevent delay, duplication, and excess paperwork.

MRC entered into a Memorandum of Understanding (MOU) with NMFS, USFWS, CAL FIRE, and CDFG to prepare a joint PTEIR/EIS for the review and approval of our HCP/NCCP. That MOU provided a process for the preparation of the joint PTEIR/EIS and described the

relationship and responsibilities of the parties, including NMFS, USFWS, CDFG, MRC, and an independent contractor, Stillwater Sciences, retained to prepare the draft PTEIR/EIS. In particular, the MOU clarified that the independent contractor served under direct control of the resource agencies; these agencies exercise their independent judgment under NEPA and CEQA and ensure that the final PTEIR/EIS is prepared in accordance with all applicable laws.

2.8 National Historic Preservation Act

2.8.1 THP activities

Within MRC land, there may be properties included in the National Register of Historic Places or eligible for such inclusion. These properties could be affected by proposed THP activities. To ensure compliance with the National Historic Preservation Act (NHPA), MRC, USFWS, and NMFS will enter into a programmatic agreement with the State Historic Preservation Office, the Tribal Historic Preservation Office, and CAL FIRE. The agreement will identify steps MRC, USFWS, CAL FIRE, CDFG, and NMFS will take to preserve historical resources on MRC land. These steps will be based on the portion of THP review that identifies and protects cultural resources and will be implemented for activities covered by ITPs, including those not ordinarily subject to THP review.

2.8.2 Activities not related to a THP

NHPA addresses covered activities, whether or not they relate to a THP. For ground disturbance that is not proposed in conjunction with a THP (such as expansion of rock pits, site preparation using tractors, and prescribed burning) but that requires compliance with NHPA, MRC will seek the advice of a professional archaeologist and prepare an *Archaeological Report* similar to those included in THPs. As necessary, we will propose protective measures in the report and include any additional measures required by the CEQA lead agency. Next, we will submit the report to the CEQA lead agency for approval. Finally, MRC will adopt and apply all mitigation measures within the report approved by the lead agency.

2.9 Migratory Bird Treaty Act (MBTA)

The Migratory Bird Treaty Act of 1918, as amended (MBTA), implements various treaties and conventions between the U.S. and Canada, Japan, Mexico, and the former Soviet Union for the protection of migratory birds. Under the MBTA, taking, killing, or possessing migratory birds is unlawful, as is taking of any parts, nests, or eggs of such birds (16 U.S. Government Code [USC] 703). *Take* is defined more narrowly under the MBTA than under ESA and includes only the death or injury of individuals of a migratory bird species or their eggs. As such, *take* under the MBTA does not include the concepts of harm and harassment as defined under ESA. The MBTA defines migratory birds broadly; all covered birds in this plan are considered migratory birds under the MBTA.

The USFWS *Habitat Conservation Planning and Incidental Take Permit Process Handbook* (1996) includes Appendix 5 ("FWS Guidance on Addressing Migratory Birds and Eagles"). According to these guidelines, an incidental take permit can function as a Special Purpose Permit under the MBTA (50 CFR 21.27) for the take of all ESA-listed covered species in the amount or number and subject to the terms and conditions specified in an HCP. Any such take will not be in violation of the MBTA (16 USC 703-12). Within the plan area, the northern spotted owl and marbled murrelet are protected by MBTA.

Of these, the marbled murrelet is currently listed under ESA. Accordingly, once issued, the incidental take permit will automatically function as a Special Purpose Permit under the MBTA,

as specified in 50 CFR Sec. 21.27, for a 3-year term subject to renewal by the permittees. Should any other of the covered birds become listed under ESA during the permit term, the ESA permit would also constitute a Special Purpose Permit under the MBTA for that species for a 3-year term as specified in 50 CFR 21.27 subject to renewal by the permittees.

Non-listed covered species as well as other migratory birds not covered by the permit will benefit from seasonal restrictions on construction and other conservation measures described in our plan. Habitat restoration and management under our plan will also be a significant "benefit to the migratory bird resource" as required by the Special Purpose Permit.

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°C (62.1°F) or a MWMT greater than 18.0°C (64.4°F). Likewise, coho salmon were present in all streams with a MWAT less than 14.5°C (58.1°F) and a MWMT less than 16.3°C (61.3°F). Hines and Ambrose (1998) found that the number of days a site exceeded an MWAT of 17.6°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°C. As pool temperature increased above 22°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° and 16°C (41° and 61°F). Embryos of coastal tailed frogs have the narrowest temperature tolerance range (5° to 18°C or 41° to 64°F) and the lowest lethal temperature limit among North American frogs (Brown 1975a). Streams with water temperatures above 15°C (59°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.

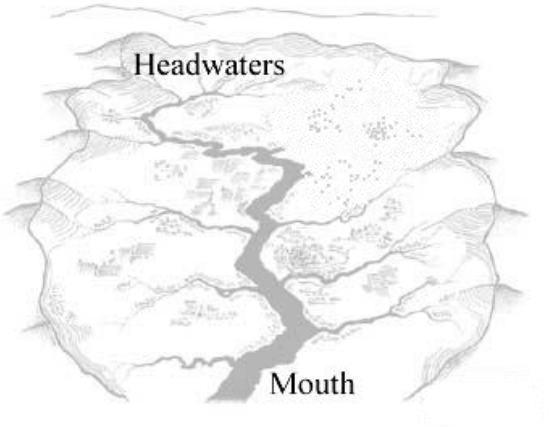


Figure 3-2 Headwaters and Mouth

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	DND
Duckpond Gulch	C[1]					21.3	15.6	20.7	ND	ND	ND	ND	ND	ND	M	M	DM
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	DND
Bull Team Gulch	C[1]	C[1]				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	DND
Kaison Gulch		C[1]			C[1]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	DND
E. Railroad Gulch	C[1]	C[1]				ND	ND	ND	ND	ND	ND	ND	ND	ND	OT	M	DM
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	20.1/1 9.4	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]

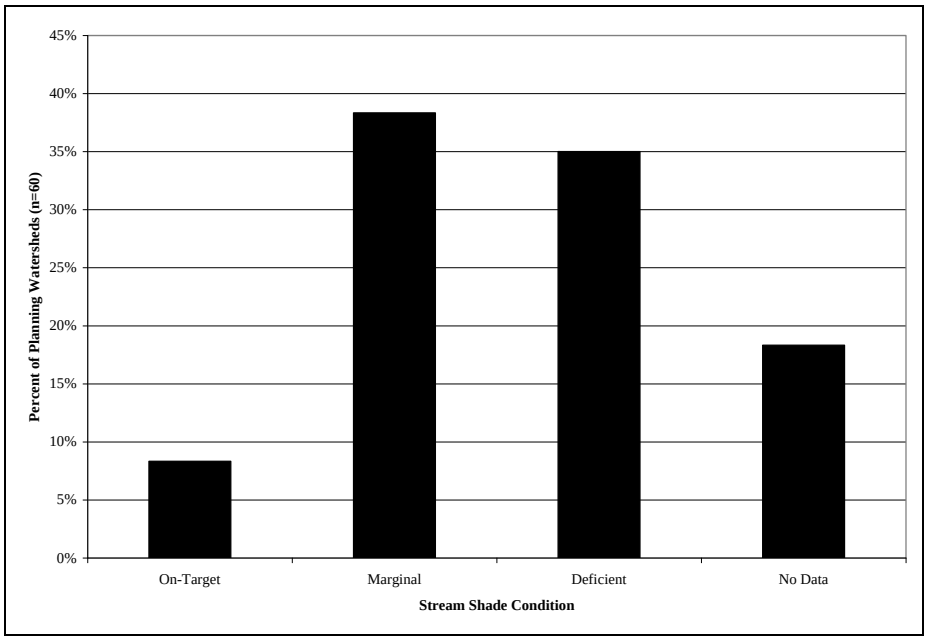


Figure 3-3 Effective Stream Shade in MRC Planning Watersheds as of 2005

[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.

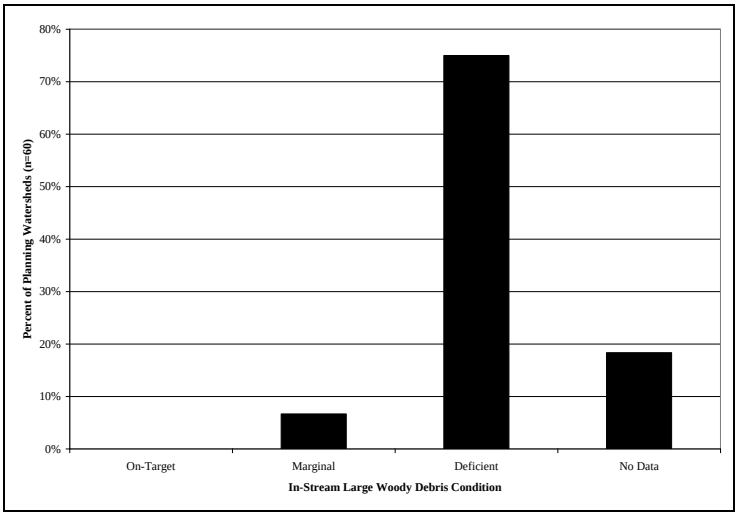


Figure 3-4 LWD Conditions in MRC Planning Watersheds as of 2005

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.

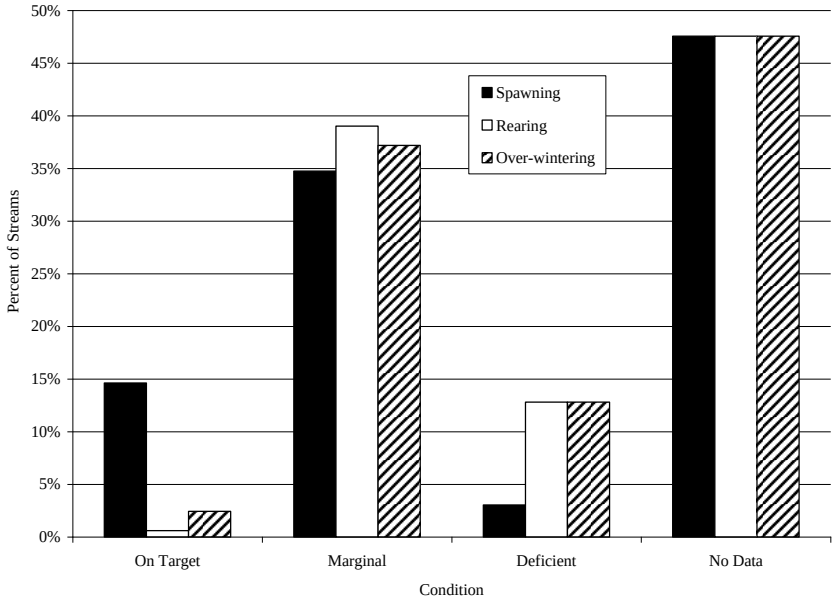


Figure 3-5 Anadromous Salmonid Habitat Condition by Life Stage

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.

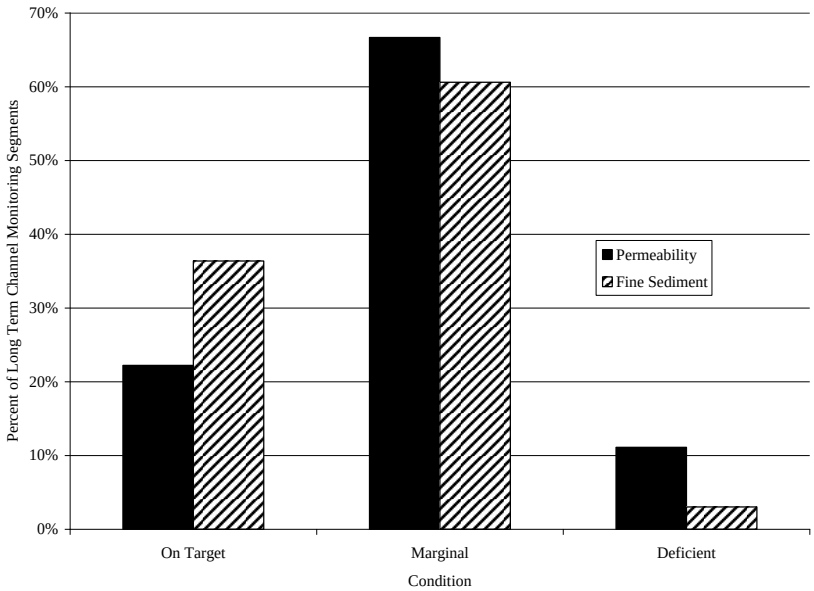


Figure 3-6 Spawning Gravel Quality from Long Term Monitoring Segments

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

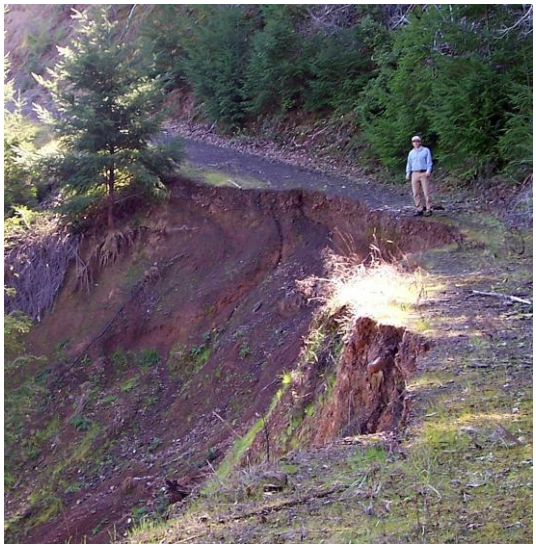
Sediment delivery occurs through either episodic inputs or chronic inputs (Table 3-13). The type of input influences MRC management and monitoring. A majority of sediment inputs within the plan area are episodic. Mass wasting is episodic and represents 57% of the sediment inputs. Surface erosion from 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

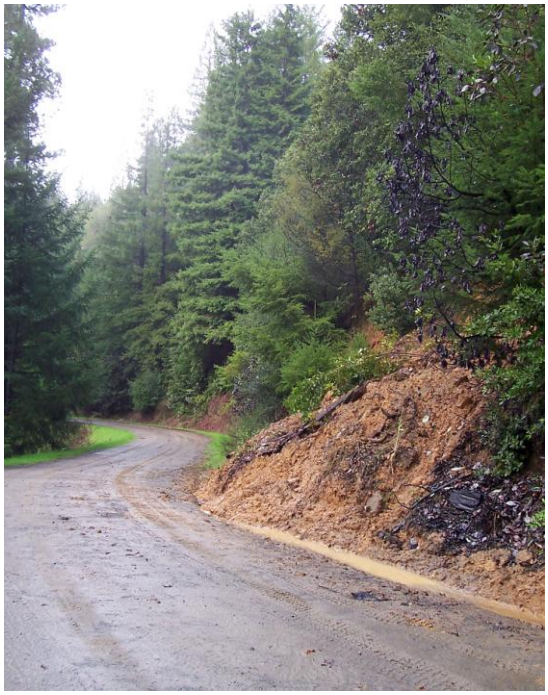
3.3.9.1 Forest roads

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 Strategy*, 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).

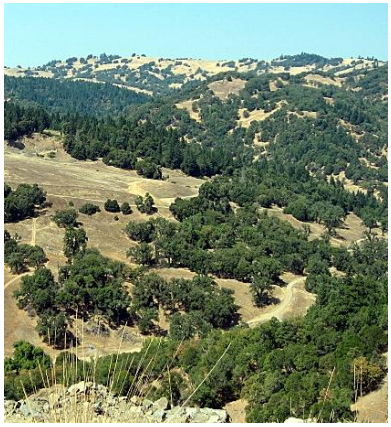
Habitat

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.

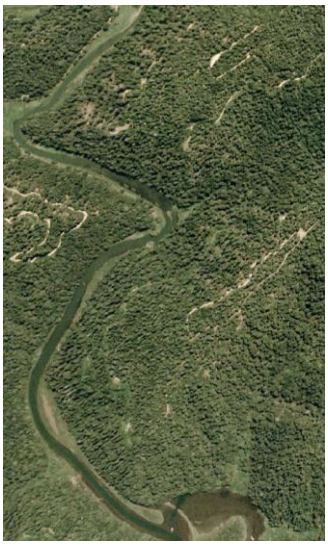
3.4.3.5 Salt marsh

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).

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.



Salt Marsh
Albion Inventory Block

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.

Chapter 4

Covered Aquatic Species

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4 COVERED AQUATIC SPECIES

4.1 Introduction

Chapter 4 includes species accounts for each aquatic species covered by our HCP/NCCP. A species account is a brief description and history of the species from the scientific literature. Species accounts are the starting point for conservation planning—a process that must begin with awareness and understanding. The general topics developed for each species account in this chapter are geographic distribution, local distribution, life history, habitat requirements, ecological interactions, sensitivity to disturbance, and key uncertainties. Key uncertainties address gaps in MRC knowledge, such as the historical or current abundance of a species in the plan area, factors that might limit its recovery, impacts of land management upon species populations, and what exactly "species friendly" silviculture might be. MRC has italicized and flagged (▶) the key uncertainties that become hypotheses in the validation monitoring programs; Chapter 13, *Monitoring and Adaptive Management*, discusses these programs in detail.

4.1.1 Mendocino lighting complex (2008)

MRC assessed the impacts to the habitat and population of covered aquatic species as a result of the lightning fires in 2008 (see section 1.18). Under the individual species accounts, we indicate the apparent damage.

4.2 Coho Salmon

4.2.1 Geographic distribution

Coho salmon (*Oncorhynchus kisutch*) are distributed throughout the northern temperate latitudes in North America and Asia. In North America, they spawn in coastal streams from Monterey Bay, California to Point Hope, Alaska (Kostow 1995). Populations occur in smaller coastal streams as far south as the San Lorenzo River, Santa Cruz County (Moyle et al. 1989).

Illustration by Ron Pittard

Populations of coho salmon in the HCP/NCCP assessment area belong to 2 evolutionarily significant units (ESUs), as currently recognized by NMFS. Populations in river basins from Punta Gorda (Humboldt County) and north to Cape Blanco (Oregon) belong to the Southern Oregon/Northern California Coasts ESU. Populations in river basins from Punta Gorda (Humboldt County) south to and including the San Lorenzo River (Santa Cruz County), belong to the Central California Coast ESU. NMFS listed the Central California Coast ESU as threatened in 1996 and the Southern Oregon/Northern California Coasts ESU as threatened in 1997. In 2005 NMFS upgraded the listing of the Central Coast ESU from threatened to endangered. In 2002, CDFG listed the Southern Oregon/Northern California Coasts ESU as threatened and the Central California Coast ESU as endangered.

4.2.2 Local distribution

Timberlands included in our HCP/NCCP extend over a large area in Mendocino County, from Hollow Tree Creek in the north to the Garcia River in the south. The entire plan area lies within the range of coho salmon and includes the watersheds of numerous small coastal streams and large rivers, such as the Eel River, Big River, Noyo River, Navarro River, Garcia River, and Russian River.

Historically coho salmon were present in many streams and tributaries in the plan area, although populations of coho salmon have decreased in the past few decades. Researchers have recorded fewer coho salmon, especially in streams within the southern watersheds, such as the Gualala River and Russian River (NCWAP 2002, Brown et al. 1994). Coho salmon are currently present in Hollow Tree Creek, Cottoneva Creek, Jack of Hearts Creek, Noyo River, Big River, Albion River, Elk Creek, South Fork Garcia River, and Navarro River (MRC 2002a).

Re-establishment of coho salmon in streams where they were historically present has proved difficult. Weldon "Wendy" Jones, currently retired from CDFG, reported that between 1995 and 1998 CDFG released juvenile coho salmon in Howard Creek in an attempt to re-establish the species in this watershed (Jones 2000, 9). Preliminary data indicates that coho salmon have not yet returned to Howard Creek (MRC 2002a).

4.2.3 Population trends

The most recent information on population trends of coho salmon is quite bleak. Of 13 streams between the Smith River and Scott Creek where surveys were conducted in 2007-2008, there has been a 73% decline in returning coho salmon, compared to the same year-class lineage returns in 2004-2005. No stream had an increase or level returns. One stream, Redwood Creek in Marin County, had a complete failure, with no returns for the first time on record. Scott Creek had only four jack returns, compared to 329 adults in 2004-2005. There is a slight trend of greater declines toward the south, but for the most part, the data shows large reductions in returning adults throughout the California coast. This phenomenon extends beyond California; preliminary and incomplete surveys of 22 streams through January in the Oregon Coast ESU found a mean decline in coho returns of 70% relative to returns in 2004-2005. The survey estimate of 51,000 returning adults to the Oregon Coast ESU in 2007-2008 is the lowest since 1999.

Ocean conditions were poor for salmon growth and survival during spring and summer of both 2005 and 2006. The Wells Ocean Productivity Index (WOPI)[1] accurately predicts zooplankton, juvenile shortbelly rockfish, and common murre production along the California coast. It is, therefore, a valid indicator of ocean productivity. Index values for spring and summer of 2005 and 2006 were low, indicating poor conditions for growth and survival. In fact, only the El Niño years (1982-83, 1992-93, and 1999) had lower WOPI values.

The WOPI assesses conditions on a local scale for California, but has tracked another index, the Northern Oscillation Index (NOI), which describes climate variability in the broader region of the North Pacific Ocean. In 2005 and 2006, the WOPI decoupled from the NOI, suggesting local conditions on the California coast were worse than in the larger North Pacific region. These results indicate that ocean conditions in spring and summer, when juvenile coho and Chinook salmon enter the ocean, were unfavorable to growth and survival. This may explain the poor returns of both coho in 2007 and 2008 and Chinook salmon in 2007.

Coho salmon have undergone substantial population declines and no longer inhabit many of the streams in California where they historically occurred. Brown et al. (1994) estimated that populations of coho salmon in California have decreased to less than 6% of 1940 levels. Populations of coho salmon in the southern part of the range have shown the greatest declines (Hassler et al. 1991, Brown et al. 1994), with few coho salmon occupying coastal streams near or south of San Francisco Bay. In the Central California Coast ESU, where historical populations

[1] WOPI is a composite index of 13 oceanographic variables and indices, weighted heavily by sea level height, sea surface temperature, upwelling index, and surface wind stress.

are estimated to have been between 50,000 and 125,000 naturally spawning fish, current abundance is estimated to be less than 5000, most of which likely originated in hatcheries (Brown and Moyle 1991, Bryant 1994, CDFG 1994).

In the Southern Oregon/Northern California Coasts ESU, where historical abundance of coho salmon is estimated to have ranged from 150,000 to 400,000, abundance is currently estimated to be about 30,000, of which roughly 20,000 originated in hatcheries (Brown and Moyle 1991, Bryant 1994, CDFG 1994, Weitkamp et al. 1995). CDFG conducted annual counts of spawning escapement from 1938 to 1975 at Benbow Dam on the South Fork Eel River; the results fluctuated considerably. The overall trend, however, was a substantial decline in the population of coho salmon during this time period (Taylor 1978). The average annual count during the first 10 years of operation (1938–1947) was 14,327 coho salmon. During the last 10 years of operation (1966–1975), the average annual count was 1846.

NMFS compiled the most recent data showing population trends for coho salmon of Central California Coast and Southern Oregon/Northern California Coasts ESUs (2001). The NMFS review only included streams with consistent data, spanning at least 6 continuous years. Data from the 3 streams in the Central California Coast ESU that fit the time criteria (Caspar Creek, Little River, and Pudding Creek—all in Mendocino County) show that abundance of coho salmon in the 1990s was clearly lower than in the mid-to-late 1980s, with a continual decrease during the 1990s (NMFS 2001). Based on currently available data, NMFS concluded that the Central California Coast ESU is presently in danger of extinction (NMFS 2001).

NMFS observed a general pattern of decline in the California portion of the Southern Oregon/Northern California coho salmon ESU (NMFS 2001). Since there are few datasets going back as far as the 1980s, however, NMFS suggests caution in interpreting the trend data. Data from Hollow Tree Creek, a South Fork Eel River tributary in the plan area, indicates an overall decline in abundance of coho salmon since the late 1980s (NMFS 2001). This contrasts with data recorded at other locations in the South Fork Eel basin, which shows no obvious trend in abundance of coho salmon from 1994–2000 (NMFS 2001). NMFS concluded that the Southern Oregon/Northern California Coasts ESU is presently not at risk of extinction, but is likely to become endangered in the near future.

4.2.3.1 Hatchery production

Most coho salmon produced in California are from hatcheries (Greenley 1985, Baker and Reynolds 1986). Brown et al. (1994) estimated that less than 5000 native coho salmon now spawn in California streams. Those river basins still supporting runs of wild native coho salmon have annual spawning populations of fewer than 100-1300 adults; the higher range of that estimate is from the South Fork Eel River.

The Noyo River Egg Collecting Station, operated by CDFG, is in Jackson Demonstration State Forest on the South Fork Noyo River; this station is the only fish culture facility in California that has focused exclusively on coho salmon (CDF et al. 2000). The number of coho salmon eggs collected between 1973 and 1999 ranged between 4500 and 1,381,755; female coho salmon have had an average of about 2200 eggs (CDF et al. 2000). Eggs collected at the Noyo facility are shipped to Mad River Hatchery for hatching and rearing and then back to the Noyo River for planting. In the 1970s, the Noyo fish culture station supplemented its broodstock of coho salmon, during years of low escapement, with eggs from the Alsea River in Oregon and the Washougal River in Washington; CDFG transfer permits document this. Noyo coho salmon have been transplanted to almost all of the coastal streams of Mendocino County as well as to the Mad River

and Prairie Creek Hatcheries; they are also the origin of the broodstock at Warm Springs Hatchery on the Russian River (Higgins et al. 1992, CDF et al. 2000).

4.2.3.2 Commercial and recreational harvest

Ocean harvest rates, which were likely high in the 1970s, have declined since adoption of harvest limits in the early 1980s. Ocean harvest of wild coho salmon is prohibited. In California, harvest of hatchery coho salmon is prohibited as well. Fisheries outside of California—from Oregon on north—can only target coho salmon from hatcheries when escapement of wild fish will be high.

4.2.4 Life history

4.2.4.1 Overview

Coho salmon are 1 of 5 species of Pacific salmon distributed along the coast of North America, the others being Chinook salmon, sockeye, pink, and chum salmon. Lengths and weights of adult coho salmon range from 45 to 60 cm (18 to 24 in. and 3 to 6 kg (7 to 13 lb.), respectively (Shapovalov and Taft 1954, Godfrey 1965, Scott and Crossman 1973, Meehan and Bjornn 1991). Coho salmon weighing over 12 kg (26.5 lb.), however, have been caught (Meehan and Bjornn 1991). Adult coho salmon are generally smaller than Chinook salmon; moreover, a coho salmon has a white gum line, while a Chinook salmon has a black gum line. Dark spots on the back, dorsal fin, and upper lobe of the tail distinguish coho salmon from chum and sockeye salmon (Hassler 1987). Lack of oval blotches on the lower lobe of the tail distinguishes them from pink salmon (Moyle 1976).

Unlike Chinook salmon and steelhead, coho salmon do not appear to have genetically distinct, temporally segregated runs (Moyle et al. 1989). However, the strong homing abilities of coho salmon make it likely that each coastal stream has a distinctive strain adapted to local environmental conditions (Moyle et al. 1989).

Populations of coho salmon can be divided into 2 types of fish: big-river and short-run. Big-river coho salmon migrate from 97 to 194 km (60 to 120 mi) or more in main river systems to spawn in mainstems or tributaries (Moyle et al. 1989). Short-run coho salmon live in smaller coastal streams and tributaries of the lower reaches of big rivers and rarely migrate more than 97 km (60 mi) miles upstream. While much of the natural production of big-river coho salmon has now been supplanted by hatchery populations in California, short-run coho salmon are more dependent on natural reproduction (Moyle et al. 1989).

4.2.4.2 Adult upstream migration and spawning

Coho salmon spend about 3 to 4 months within spawning gravels as eggs and alevins, up to 15 months rearing in fresh water, and approximately 16 months in the ocean (Sandercock 1991). Over 95% of coho salmon in Washington, Oregon, and California mature and return from the ocean to fresh water in their third year of life (NMFS 1995). These 3-year-old coho salmon adults are considered to be age 1.1, having spent one winter in fresh water and one winter in the ocean. In addition, spawning runs of coho salmon usually include males that return after spending only 6 months at sea; these males are commonly referred to as jacks (age 1.0). Female coho salmon may return at 2 years of age as well (Nielsen et al. 1991).

Following 1 or 2 winters at sea, coho salmon attain sexual maturity in the summer. Adult coho salmon migrate to the vicinity of their natal stream during late summer and fall (Sandercock 1991). They do not enter the stream system all at one time. Instead they arrive throughout the spawning season in a pattern that reflects the occurrence of storms that increase flow in the spawning streams (Shapovalov and Taft 1954). There may be some selective advantage to

spawning later in the season. Coho salmon often dig up or disturb eggs deposited in the gravel by females which arrived earlier and then died after spawning; this is called redd superimposition.

Males generally dominate the early part of a coho salmon run, while females return in greater numbers later during the run (Shapovalov and Taft 1954, Moyle et al. 1989). Typically, the number of females slightly exceeds the number of males among 3-year-old spawners; however, jacks and 3-year-old males combined are more numerous than females (Shapovalov and Taft 1954, Salo and Bayliff 1958, Fraser et al. 1983). Jacks probably have higher ocean survival rates than 3-year-old males because of their shorter exposure to ocean fisheries (Gross 1991). The sex ratio for all of the spawning adult coho salmon deriving from a single brood year is close to 50:50.

Most adult coho salmon migrate upstream during daylight hours (Sandercock 1991, Neave 1943), with peak activity usually occurring at dawn and sunset (Fraser et al. 1983). Coho salmon move through shallow riffles quickly, perhaps to reduce predation risk; they seek deeper, quieter pools in which to rest before migrating further upstream (Sandercock 1991).

Briggs (1953) observed coho salmon moving across riffles where the water depth was only 5 cm (2 in.). Under proper conditions, vertical leaps of more than 1.83 m (6 ft) are possible to surmount instream barriers (Reiser and Peacock 1985). Cruising speeds, which are used for long-distance travel, are up to 1 m/s (3.3 ft/s). Sustained speeds, which may last several minutes and are used to surpass rapids or other barriers, range from 1–3.2 m/s (3.3–10.6 ft/s). Darting speeds, which are brief bursts used in feeding and escape, range from 3.2–6.6 m/s (10.6–21.5 ft/s) (Bell 1986).

Homing of coho salmon and other Pacific salmon to their natal streams is well-documented in the literature. Coded-wire tag (CWT) recoveries of wild adult coho salmon indicate that straying rates may be in the range of 0.1%–2.0% (Sandercock 1991, Labelle 1992). Salmon that are blocked from access to their natal tributary may die before choosing an alternate location to spawn (Ricker and Robertson 1935, Hartman and Raleigh 1964).

Females select a nest site after arriving on the spawning ground, and defend the area against other females. Redd construction behavior is similar to that displayed by other anadromous salmonid species; the female excavates a depression in the gravel by turning on her side and using her body and tail to displace the gravel downstream. Digging activity may last as long as 5 days, during which time the female will dig up to 7 egg pockets in succession, progressing in an upstream direction (Shapovalov and Taft 1954, Tautz 1977, van den Berghe and Gross 1984, Sandercock 1991). Egg pockets range from 50–70 cm (19.5–27.3 in.) in diameter and from 9–24 cm (3.5–9.4 in.) in depth (Tautz 1977, van den Berghe and Gross 1989). The average number of eggs deposited per egg pocket ranges from 300 to 1200, with the most frequent number being 800 to 900 (Sandercock 1991).

Fecundity and egg size generally increase with the size of the female (Allen 1958, Ivankov and Andreyev 1969, Stauffer 1976, Beacham 1982). Fecundity can range from 1000 to 7600 eggs, and is commonly 2500–5000 eggs per female (Beacham 1982, Sandercock 1991). Beacham (1982) found significant regional and annual variability in the fecundity of coho salmon. Beacham and Murray (1993) examined data for 40 coho salmon populations and found only a weak association between fecundity and latitude. Results from their investigations also suggest that female coho salmon that spawn in upper river locations after long migrations were smaller

and less fecund than females spawning in coastal streams. Perhaps the smaller females allocate more energy reserves to migration than to gonadal development.

Standardized fecundities for females of 520 mm (20.8 in.) postorbital-hypural length were found to be lowest in California (2610 eggs/female), Vancouver Island, British Columbia (2470 eggs/female), and Queen Charlotte Island, Alaska. Ocean conditions may also influence fecundity. Johnson (1988) reported reduced fecundity of Oregon coho salmon related to the 1982–1983 El Niño episode that affected ocean conditions in the northeast Pacific. Because female coho salmon exhibit little variation in their period of marine residency, ocean conditions favoring increased growth and higher fecundity (van den Berghe and Gross 1989, Fleming and Gross 1990) may result in greater densities in rearing areas and increased competition among fry (Quinn 1994).

Two separate tactics may be used by male coho salmon in fertilizing the eggs laid by a female, depending on whether the male is a 2-year-old jack or a 3-year-old adult (Gross 1985). Adult, or hooknose males, are adapted for fighting other males to achieve dominance and to fertilize a defended female's eggs. Jacks employ a sneaking tactic, using refuges, such as rocks, LWD, or shallow areas near females that are constructing redds. They rush in to fertilize some of the eggs during the act of spawning between a female and a dominant hooknose male. Because jacks have a shorter marine residence, they do not spawn with coho salmon from their same brood year; this increases genetic variation in the population (Young 1999).

The eggs of a female may often be fertilized by more than 1 male (Gross 1984, Sargent et al. 1987). Gross (1991) estimated that there was an equal probability of jack and hooknose reaching the spawning grounds and successfully breeding. This may be due in part to selective harvesting of hooknose males (Gross 1991). Among coho salmon, larger juveniles or smolts tend to return as jacks (Wallis 1968, Hager and Noble 1976, Gross 1991). Factors that may influence juvenile growth and body size include genetics, egg size, time of hatching, water flow, temperature, quality of feeding territory, stream productivity, predation pressure, and population density (Gross 1991). Young (1999) found that the proportion of jacks in a population was positively correlated with spawner density, which, in turn, relates to environmental conditions.

Fertilization rates under natural conditions appear to be very high, close to the percentages of eggs found fertilized under ideal conditions in hatcheries (Shapovalov and Taft 1954). Hobbs (1937) found that various species of salmonids had average fertility rates of over 99% under natural conditions.

Females continue to guard the spawning redd and prevent superimposition by other females until they are too weak to maintain position in the current (Briggs 1953). Both males and females die soon after spawning. The post-spawning survival time for females averages from 8 to 13 days (Briggs 1953, Willis 1954, Crone and Bond 1976, van den Berghe and Gross 1986). Larger females appear to guard redds for longer periods, perhaps because of their greater energy reserves (van den Berghe and Gross 1986, 1989).

Van den Berghe and Gross (1984) found that larger females among a wild population of coho salmon in Washington dug significantly more egg pockets than smaller females. In addition, larger females dug deeper redds, burying their eggs as much as 2.5 times deeper than small females. Females compete aggressively on the spawning grounds for suitable redd sites. Those that arrive late may dig up eggs laid by previous spawners. Broods of larger females are probably less susceptible to redd superimposition. There are fewer potential competitors that can dig as

deep; as a result, there is likely a selective advantage to large-bodied females (van den Berghe and Gross 1984). Holtby and Healey (1986) concluded, however, that large size was not necessarily an advantage; this explains the range of adult female sizes that they observed in the spawning run. Small females may display a tendency to spawn in sites with lower velocity flows and smaller gravels; these sites may be less susceptible to scour than sites selected by the larger females (Holtby and Healey 1986).

4.2.4.3 Egg incubation, alevin development, and fry emergence

Following deposition in the gravel, coho salmon eggs incubate for 35–50 days at temperatures of approximately 9 to 11°C (48.2 to 51.8°F) (Shapovalov and Taft 1954); incubation time is inversely related to water temperature. After hatching, salmon larvae (alevins) remain in the gravel while undergoing further development and absorption of the yolk sac. Emergence begins 2–3 weeks after hatching and may continue for an additional 2–7 weeks (Shapovalov and Berrian 1940). Many alevins emerge at night (Shapovalov and Taft 1954, Mason 1976a), which presumably decreases vulnerability to predation (Shapovalov and Berrian 1940, Bams 1969, Mason 1976a, Godin 1980).

Estimates for egg-to-emergence survival rates of coho salmon range from approximately 10% (Tagart 1984) to 85% (Shapovalov and Taft 1954). Factors which affect egg survival include fine sediments, temperature, permeability, dissolved oxygen, gravel mobilization during high flow events, low flows, freezing, bird and insect predation, and fungal infections (Sandercock 1991).

4.2.4.4 Juvenile freshwater rearing

Upon emergence from the gravels, coho salmon fry seek low velocity areas along shallow stream margins (Shapovalov and Taft 1954). As they grow, juvenile coho salmon move to deeper habitats, although they continue to prefer low-velocity habitat throughout the rearing period. Juvenile coho salmon establish territories or form hierarchical groups in pools based on optimal foraging positions (Dolloff and Reeves 1990, Fausch 1993). During the winter, when water temperatures are low (< 7°C or 44.6°F), aggressive territorial behavior and feeding is reduced (Shapovalov and Taft 1954). Coho salmon generally rear in freshwater for 1 or 2 years prior to out-migration. In more northern parts of their range, such as Alaska, coho salmon may rear in freshwater for up to 4 years before out-migrating (Sandercock 1991, Drucker 1972).

Fry begin to display territorial behavior within a week after emergence (Mason 1966). Fry that emerge early tend to have an ecological advantage over those emerging later. They control better feeding territories, grow at higher rates, and have lower emigration rates (Mason and Chapman 1965).

Juveniles form territories and hierarchies in areas with water current. When food is repeatedly delivered from specific locations, larger individuals generally occupy the best feeding stations (Sandercock 1991, Fausch 1984). In higher velocities, where invertebrates drift in the same direction, coho salmon exhibit the strongest defense of territory. In lower velocity areas, such as off-channel habitats, coho salmon are less territorial, aggregating loosely and scrambling for food (Mundie 1969, Fausch and White 1986, Puckett and Dill 1985, Nielsen 1992). In pools, hierarchies may form into groups, with larger individuals stationed in upstream segments of the pool and smaller individuals in downstream sections (Mundie 1969, as cited in Sandercock 1991).

Individuals unable to defend territories are known as floaters (Puckett and Dill 1985). They occupy space between and around the territories of the dominant fish in glides or pools. Fry that are unable to defend territories may also emigrate downstream to the ocean (Hartman et al. 1982)

or to other areas within the stream system (Shapolalov and Taft 1954). Coho salmon that maintain dominant positions in hierarchies show the highest summer growth rates. Subdominant members of hierarchies grow slower, and floaters grow the slowest of all (Nielsen 1992, Fausch 1984). Allen (1969) estimated the territory size of juvenile coho salmon at 0.34 m^2 (3 ft^2) for fry 49 mm (1.93 in.) in length; 0.79 m^2 (8 ft^2) for juveniles at 4 months of age; and 3.5–5.5 m^2 (39–61 ft^2) for yearling size fish of about 110 mm (4.33 in.) length.

Populations of coho salmon are generally believed to be limited by density-dependent mechanisms operating within the freshwater environment (Allen 1969, Chapman 1962, 1966, McFadden 1969, Marshall and Britton 1990, Meehan and Bjornn 1991). "Habitat conditions are a key factor regulating the production of salmonid smolts. Streams have finite carrying capacities for salmonids, producing similar numbers of young annually if spawning and rearing habitat is not degraded and stocks overfished" (Allen 1969 and McFadden 1969, as cited in House and Boehne 1985, p. 283).

This density dependence has been demonstrated for coho salmon in Pacific Northwest streams (Wickett 1951, Salo and Bayliff 1958, Hunter 1959, Chapman 1965). The availability of suitable rearing habitat is the limiting factor that usually governs the number of juvenile coho salmon produced from a stream system (Larkin 1988, Chapman 1962, 1966).

4.2.4.5 Smolt out-migration and estuarine rearing

Following winter peak flows, juvenile coho salmon emerge from winter hiding areas. In preparation for downstream migration, they feed heavily and grow in size. Outmigration of coho salmon smolt generally occurs in the spring, approximately 1 year after they emerge from gravels at an age termed 1+. Occasionally, coho salmon outmigrate a year later at age 2+. A smaller portion of the out-migration is made up of age 0+ fish migrating downstream as fry, but these fish likely have low probability of surviving to adulthood (Otto 1971, Crone and Bond 1976, Hartman et al. 1982). The proportion of out-migrants that are age 1+ or older generally increases further north in the range of coho salmon. From 40% to 58% of out-migrants in some British Columbia and Alaska rivers are age 2+ or older (Andersen and Narver 1975, Armstrong 1970, both as cited in Sandercock 1991; Mehann and Siniff 1962, Drucker 1972).

Coho salmon appear to have a more protracted out-migration period than other salmon species. Holtby et al. (1989) found that out of 17 years of trapping smolts in Carnation Creek, British Columbia, there was only 1 year in which 50% of the smolts emigrated in less than 14 days. During their study, the period during which 50% of smolts emigrated usually lasted at least 21 days. Unlike other salmon species that migrate as fry or that reach smolt stage at only a few months of age, coho salmon enter smolt stage while migrating downstream. Larger yearlings may be less vulnerable to predation and, therefore, may not need to employ synchronous migration as a predator-swamping tactic. The out-migration of coho salmon generally has been observed at night (Shapovalov and Taft 1954) as with other anadromous salmonids (Mace 1983). This is likely a predator avoidance tactic as piscivorous fish, birds, and mammals generally rely on sight to capture prey.

In general, juvenile coho salmon must reach a fork length of about 100 mm (3.94 in.) for successful smoltification (Drucker 1972, Crone and Bond 1976). Conte et al. (1966) found that maximum salinity tolerance in coho salmon corresponded to a 90 mm (3.55 in.) threshold size. Shapovalov and Taft (1954) found the average size of out-migrating smolts in the range of 103 to 116 mm (4.06 to 4.57 in.) in Waddell Creek, California.

Photoperiod,[2] temperature, water flow, and perhaps lunar or tidal phase are among the environmental factors that may influence smoltification and downstream movement (Parry 1960; Hoar 1965; Wagner 1974; Clarke et al. 1978, 1981; Wedemeyer et al. 1980; Clarke and Shelbourn 1981). McMahon and Holtby (1992) found that the number of coho salmon smolts out-migrating in Carnation Creek, British Columbia increased during temperature declines, but was not strongly influenced by stream discharge or lunar phase. Local factors that signal favorable conditions for rearing downstream within estuaries may influence out-migration of coho salmon smolts. Holtby et al. (1989) found that variability in stream temperatures during spring accounted for 60% of the variability in the median date of coho salmon emigration in Carnation Creek, British Columbia. They hypothesized that this timing/temperature relationship and the timing of adult spawning were adaptations for synchronizing out-migration with windows of opportunity or advantageous conditions in the ocean or estuarine rearing environment. Low flows or high temperatures can accelerate smoltification and advance the timing of out-migration (Shapovalov and Taft 1954, Wedemeyer et al. 1980).

During smoltification, coho salmon may defend their territories less vigorously and migrate downstream in small schools; this is presumably an adaptation for life in the sea (Hoar 1951, Shapovalov and Taft 1954, McMahon and Holtby 1992). In Carnation Creek, McMahon and Holtby (1992) found 95% of smolts aggregated in groups of 5 or more fish. During the smolt out-migration, aggregation size increased and was significantly greater in the estuary than in stream sections. Large smolt aggregations of coho salmon have been observed beneath docks in Oregon estuaries (McAllister 1988) and in low water areas of a Washington estuary with log pilings (Moser et al. 1991). McMahon and Holtby (1992) believed that schooling and cover-seeking behavior of smolts was a continuation of winter parr behavior. When water temperatures in the spring increased above 7°C (44.6°F), they did not observe the return to territorial behavior which was typical in juvenile coho salmon the previous summer.

After reaching the estuary, coho salmon may remain for a few months of residency prior to entering the ocean environment. McMahon and Holtby (1992) found that coho salmon smolts remained in the Carnation Creek estuary for about 2 months (April and May). They noted a similar period of residency for coho salmon in an Oregon estuary (Myers and Horton 1982). Even a short period of estuary rearing may result in enhanced ocean survival, since growth appears to be very rapid in this habitat. Rapid growth during estuary rearing may reduce the vulnerability of coho salmon to predators near shore; predators are a major source of ocean mortality for coho salmon (Holtby et al. 1990).

4.2.4.6 Ocean phase

Coho salmon occur in the ocean along the Pacific coast from Chamula Bay, Mexico (Miller and Lea 1972), to Point Hope, Alaska, through the Aleutians, and from the Anadyr River, USSR, south to Hokkaido, Japan (Scott and Crossman 1973). The genetic characteristics of individual stocks of coho salmon, along with environmental factors, probably determine the timing and pattern of seaward dispersal (Heard 1991). Seasonal movements of salmon at sea are complex and, so far, not linked with any major oceanographic feature (Burgner 1991). However, coho salmon make oriented, rapid, and precise migration to their natal stream (Cury 1994). Salmon migrating to their natal stream may travel at speeds approaching the maximum for sustainable swimming (Burgner 1991).

[2] The photoperiod is the duration of an organism's daily exposure to light, considered for its impact on growth and development.

4.2.5 Habitat requirements

4.2.5.1 Adult upstream migration and spawning

Bell (1986) reported that water temperatures ranging from 7.2 to 15.6°C (45 to 60°F) were suitable for adult migration. However, other researchers report that temperatures over 12.7°C (55°F) may result in a marked increase in disease infection rates of adult coho salmon (Fryer and Pilcher 1974, Holt et al. 1975, Groberg et al. 1978). Wedemeyer stated that water temperatures below 13°C (55.4°F) minimize pre-spawning mortalities of adult coho salmon (as cited in McMahon 1983). Temperatures of 25.5°C (77.9°F) or more are lethal to adult migrants (Bell 1973). Dissolved oxygen levels below about 6.5 mg/l (6.5 ppm) may reduce swimming performance of adult coho salmon or cause avoidance reactions during upstream migration (Davis 1975, Davis et al. 1963). Stream velocities of about 3.05–3.96 m/s (10.0–12.9 ft/s) can retard migration (Reiser and Bjornn 1979). Thompson reports that upstream migration of coho salmon requires a stream velocity less than 2.44 m/s (8.0 ft/s) and water depth of at least 18 cm (7 in.) (1972, as cited in Bjornn and Reiser 1991).

Redds are typically in the transitional area at the downstream end (or tail) of pools as they feed into riffles where the water changes from a smooth to a turbulent flow (Hazzard 1932, Hobbs 1937, Smith 1941, Briggs 1953, Stuart 1953). Flow tends to intrude into gravels in these sites, resulting in good intragravel flow and a smaller proportion of fine sediment (Platts et al. 1979). Spawning sites are usually in areas where there are beds of loose, silt free, coarse gravel and nearby cover for adults (Moyle et al. 1989).

Substrates selected for spawning reflect a balance between the flow and depth of the spawning location, as well as the size of the fish and the availability of suitable habitat. As flow, depth, and fish size increase, salmon are able to displace larger particle sizes of substrate. These substrate sizes range from a D_{50}[3] of 5.4 mm [0.22 in.] to a D_{50} of 35 mm [1.38 in.] (Koski 1966 and Chambers et al.1954, as cited in Kondolf and Wolman 1993).

The hydraulic characteristics of redds aid in keeping the majority of the eggs in the gravel during spawning and prevent their loss due to water current. Shapovalov and Taft (1954) estimated that 97% of the eggs spawned lodge in the pit and are properly buried. Burner (1951) reported that the average area of a coho salmon redd was 2.84 m^2 (30.6 ft^2). Similarly, Crone and Bond (1976) note the average area of gravel disturbed by a spawning coho salmon was 2.6 m^2 (28.9 ft^2). Burner (1951) found that the area required by a spawning pair of coho salmon was 11.7 m^2 (126 ft^2). According to Sandercock (1991), redds were generally separated by an area about 3 times their size.

Bell (1986) states that suitable spawning temperatures for adult coho salmon range from 4.4° to 9.4°C (39.9 to 48.9°F). Researchers have observed adult coho salmon in Oregon spawning at temperatures ranging from 2.5 to 12.0°C (36.5 to 53.6°F) (Burner 1951). Briggs (1953) reported coho salmon spawning in California at temperatures of 5.6 to 13.3°C (42.1 to 55.9°F).

4.2.5.2 Egg incubation, alevin development, and fry emergence

Water temperature affects not only the incubation timing, but also the survival of eggs. Suitable water temperatures for incubation of coho salmon eggs are 4 to 13.3°C (39.2 to 55.9°F), with a slightly narrower range of 6 to 10°C (43 to 50°F) considered optimal (Davidson and Hutchinson

[3] D_{50} is median particle diameter. It represents the median grain size at which 50% of the sample is coarser and 50% is finer.

1938, Bell 1973, Reiser and Bjornn 1979). Eggs will develop normally at lower temperatures if initial development has progressed to where the eggs are tolerant of cold (Reiser and Bjornn 1979). Beacham and Murray (1990), compiling data from Velsen (1987) and additional sources, noted that coho salmon are apparently adapted to low water temperatures during incubation; coho have the highest survival rates of all 5 Pacific salmon species at incubation temperatures of 1.5°C (34.7°F). Coho salmon are poorly adapted to survive high incubation temperatures. Data compiled by Beacham and Murray (1990) indicated that constant incubation temperatures of 13.5°C (56.3°F) resulted in 50 % embryo mortality. In addition, although egg size was more important in determining salmon alevin weight, incubation temperature was more important in determining alevin length. Coho salmon alevin and fry are proportionately larger when incubated at temperatures of 4°C (39.2°F) than at 8 or 12°C (46.4 or 53.6°F).

Survival to emergence of anadromous salmonid eggs and alevins is closely related to the permeability of spawning gravels and the availability of dissolved oxygen (Cloern 1976, Mason 1976a). Permeability of gravels, in combination with flow (i.e., hydraulic head) and dissolved oxygen concentration, determine the delivery of dissolved oxygen to the eggs and alevins and thus their survival. Permeability of spawning gravels (their relative resistance to flow through the gravels) may be affected by gravel characteristics such as porosity, size, shape, depth, and arrangement of gravel particles, and, perhaps most importantly, amount of fine sediments (Vaux 1962, McNeil and Ahnell 1964, Cooper 1965, Peters 1965, Moring 1975). Fine sediments (also referred to as fines), such as silt, clay, and sand, reduce gravel permeability by filling in the interstices of the gravel particles. This reduces the amount of dissolved oxygen reaching incubating eggs and developing alevins (Wickett 1954; Coble 1961; McNeil 1962a, 1966; Ringler and Hall 1975; Woods 1980). In the Clearwater River, Washington, Tagart (1976) found that dissolved oxygen in 9 redds was inversely related to the percentage of fines under 0.85 mm (0.034 in.) in diameter.

Eggs and alevins require sufficient amounts of dissolved oxygen for good survival and normal development. Dissolved oxygen requirements appear to be highest in the period during and after hatching of the eggs (Alderdice and Brett 1957, Fast et al. 1982). Phillips and Campbell (1961) observed a positive correlation between intragravel dissolved oxygen within redds and survival of coho salmon embryos. They determined that dissolved oxygen levels must average 8 mg/l (8 ppm) for embryos and alevins to survive. Survival of coho salmon eggs and alevins drops significantly at dissolved oxygen levels at or below 6.5 mg/l (6.5 ppm). Levels below 3 mg/l (3 ppm) cause high rates of mortality (Coble 1961, Shumway et al. 1964, Davis 1975).

Reductions in levels of dissolved oxygen can result in delayed hatching and emergence, smaller size of emerging fry, and increasing incidence of developmental abnormalities (Alderdice et al. 1958, Coble 1961, Silver et al. 1963, Shumway et al. 1964, Mason 1976a). Several studies have shown that Pacific salmon embryos subjected to chronically low concentrations of dissolved oxygen hatch later and result in smaller fry than embryos incubated at higher concentrations of dissolved oxygen (Silver et al. 1963, Shumway et al. 1964, Chapman 1988). Reiser and Bjornn (1979) recommend that dissolved oxygen levels be maintained at or near saturation and that temporary reductions fall no lower than 5 mg/l (ppm) for successful incubation.

Fines are often measured as a percentage of the spawning gravel that is smaller in diameter than some designated size. The proportion of fines that have the potential to result in detrimental effects may vary within and among streams. This is to a large extent because permeability is a function of the full range of sediment particles represented, not just the fines (Moring 1975). Moring (1975) suggested that directly measuring permeability with a standpipe may be more

useful for evaluating the quality of spawning gravel than methods that determine proportion of fines. Permeability is a more direct measure of reduced interstitial flow.

Reiser and Bjornn (1979) provided general habitat guidelines for anadromous salmonid incubation. They recommended that fines ≤6.4 mm (0.26 in.) in diameter account for less than 25% of the volume of the spawning gravel. In unlogged Oregon watersheds, the amount of fine sediments less than 3.3 mm (0.13 in.) in diameter that occurred naturally in gravels used by spawning coho salmon varied from 27% to 55% (Koski 1966, Moring and Lantz 1974). An inverse relationship between the proportion of fines less than 3.3 mm (0.13 in.) in diameter in spawning gravels and the subsequent survival-to-emergence of coho salmon fry has been well-documented (Koski 1966, Hall and Lantz 1969, Cloern 1976). Tagart (1984) documented lower survival-to-emergence of coho salmon at higher concentrations of sand (particle size <0.85 mm or 0.034 in.) and fine sediment. Survival was positively correlated with gravel sizes between 3.35 and 26.9 mm (0.13–1.08 in.) in diameter. Survival-to-emergence of fry was high in laboratory and natural stream investigations where less than 5% of fines were below 3.3 mm (0.13 in.) in diameter (Koski 1966, Hall and Lantz 1969, Cloern 1976). In all of these studies, survival-to-emergence dropped sharply when fines exceeded 15% of spawning gravel.

When female salmon build redds, they generally reduce the amount of fines within the gravels (Burner 1951, Kondolf et al. 1993, Kondolf 2000). Fine sediments, particularly sands transported as bedload, can intrude into the gravels of the completed redd and reduce permeability. Fine sediment may also form a seal or cap in the upper layers of the redd gravel (Einstein 1968), impeding or obstructing the emergence of alevins. This process is known as entombment. Koski (1966) hypothesized that mortality within redds was largely due to the inability of fry to emerge from gravel. Phillips et al. (1975) studied emergence of swim-up[4] coho salmon fry placed in various gravel-sand mixtures. Mean rate of survival-to-emergence was 96% in control groups without sand, but decreased precipitously when the amount of fines was above 20%. Additional studies show that mortality may result from entombment, as well as low levels of dissolved oxygen (White 1942, Cooper 1965, Phillips and Campbell 1961, Phillips et al. 1975, Hausle and Coble 1976, Turnpenny and Williams 1980). Selective mortality of larger fry may occur in substrates with higher amounts of sand or smaller gravels. This is because smaller fry can move through the smaller interstitial spaces present in these substrates (Koski 1975).

In many locations, particularly in coastal California, floods are additional, often significant, sources of mortality. Gravel movement can cause displacement of eggs during incubation. It can also cause mortality by physically injuring embryos in the extremely sensitive stages following fertilization (Gangmark and Bakkala 1960). Several researchers have concluded that movement of spawning gravel can be very detrimental to coho survival during incubation (Neave and Wickett 1953, Wickett 1958, Skud 1958, McNeil 1962b). Management activities, such as the removal of obstructions which reduce flow velocity in streams, may result in more frequent movement of spawning gravels and, thus, increased egg mortality.

4.2.5.3 Juvenile freshwater rearing

Within a few days after emergence, coho salmon fry generally disperse upstream and downstream to find suitable rearing habitat. Fry tend to aggregate in backwaters, side channels, stream margins, and other low velocity areas of the stream, especially areas with low light intensity and overhead cover (Nickelson et al. 1992, Ruggles 1966). Water velocity may be the most important factor in habitat selection of coho salmon fry (Fausch 1993). Researchers have observed coho

[4] This is the life stage that begins when the alevin has absorbed its yolk sac and begins to swim upward to emerge from the gravels where eggs were deposited.

salmon fry in water velocities ranging from 0 to 39 cm/s (0 to 1.3 ft/s) and water depths ranging from 0 to 73 cm (0 to 2.4 ft). As fry increase in size, the depth and velocity of the water they inhabit also increases; at the same time, their distance from cover decreases (Dollof and Reeves 1990).

Riffles play an important role in the productivity of streams populated by coho salmon because they are a primary source of aquatic invertebrates. Ruggles (1966) proposes a pool-to-riffle ratio of 1:1 as optimum for providing food and cover for rearing coho salmon. Human disturbances that result in loss of LWD or increased sediment input also tend to increase the amount of riffles in streams, while decreasing the pool area.

The availability of high quality habitat in summer is critical to maximize the growth of coho salmon; it may be the main determinant of their freshwater survival and fitness in some streams (Fausch 1993). Overwinter survival of salmonids increases with larger size (Hartman et al. 1987, Hartman and Scrivener 1990). Smolt size correlates with survival of anadromous salmonids in the ocean (Peterman 1982, Bilton et al. 1982, Ward et al. 1989).

Hassler (1987) indicated that juvenile coho salmon prefer temperatures of 10 to 15°C (50 to 59°F) while Brett (1952) cited a narrower preferred range of 12 to 14°C (53.6 to 57.2°F). Brungs and Jones (1977) reported growth of juvenile coho salmon at temperatures from 5 to 17°C (41 to 62.6°F). Stein et al. (1972) observed high growth rates at temperatures from 9 to 13°C (48.2 to 55.4°F). Growth may increase with higher temperatures as long as food supplies are not limiting. Laboratory streams have demonstrated, however, that temperature increases of only 4°C (7.2°F) decrease productivity for coho salmon where food is limiting (Hughes and Davis 1986).

High water temperatures that are below those considered to be lethal may also result in negative impacts to rearing coho salmon (e.g., low growth rates). Stein et al. (1972) reported that growth rate in juvenile coho salmon slows considerably at 18°C (64.4°F); Bell (1973) stated that growth of juvenile coho salmon ceases at 20.3°C (68.5°F). According to Griffiths and Alderdice (1972), decreases in swimming speed may occur at temperatures over 20°C (68°F). During smolting, juvenile coho salmon are very sensitive to increases in temperature. Wedemeyer et al. (1980) reported that smoltification and the onset of desmoltification may accelerate at temperatures over 10°C (50°F) and recommended that water temperatures during the smolt period remain below 12°C (53.6°F). This is to prevent shortened duration of smoltification, onset of desmoltification, and increased incidence of infection and disease.

Recent field studies to determine appropriate stream temperature regimes for coho salmon have focused on presence or absence of the species. Hines and Ambrose (1998) found that the number of days a site exceeded an MWAT of 17.6°C (63.7°F) was one of the most influential variables predicting presence or absence of coho salmon. This indicates that stream temperature thresholds should incorporate a time-of-exposure limit within a significant range of temperatures rather than a single MWAT limit. The authors also caution that persistence of fish under certain conditions does not necessarily imply health or success. Welsh et al. (2001) conducted a similar study in the Mattole River watershed. They found that coho salmon were not present in any streams which had a MWAT greater than 16.7°C (62.1°F) or a MWMT greater than 18.0°C (64.4°F). Likewise, coho salmon were present in all streams with a MWAT lower than 14.5°C (58.1°F) and a MWMT less than 16.3°C (61.3°F).

4.2.5.4 Winter rearing habitat

In the winter, as water temperatures decline and flows increase, coho salmon reduce their feeding; their growth is negligible (Shapovalov and Taft 1954). During the coldest months, the most important habitat element for juvenile coho salmon are deep pools with substantial cover in the form of LWD (Hartman 1965; Bustard and Narver 1975a, 1975b; Tschaplinski and Hartman 1983; Murphy et al. 1984; Bisson et al. 1985; Everest et al. 1986; Glova 1986; Heifetz et al. 1986; Swales et al. 1986; Hartman and Brown 1987; Cederholm et al. 1988; McMahon and Hartman 1989; Shirvell 1990; Nickelson et al. 1992).

Although juvenile coho salmon use pools in all seasons, they show a preference for certain pool types in the winter that provide cover and the best refuge from high-water velocities. Instream cover and areas of slow water are essential for protection against predators and displacement by high flows (Bustard and Narver 1975a, Mason 1976a, Hartman et al. 1982). Deep (> 45 cm or 18 in.), slow (< 15 cm/s or 0.5 ft/s) areas within or near (< 1 m or 3.3 ft) instream cover of roots, logs, and flooded brush appear to constitute preferred habitat (Hartman 1965, Bustard and Narver 1975a), especially during freshets (Tschaplinski and Hartman 1983, Swales et al. 1986, McMahon and Hartman 1989).

Mid-channel pools or glides without LWD that provide habitat for large numbers of coho salmon fry in the summer may become largely unsuitable in the winter due to increased flows (Grette 1985, Sullivan 1986). Over-wintering coho salmon are typically absent from riffles, glides, rubble, and pools or other stream habitats lacking cover (Heifetz et al. 1986, Bustard and Narver 1975a, Tschaplinski and Hartman 1983, Ruggles 1966). Juvenile coho salmon may migrate into secondary channels on floodplains or terraces (Cederholm and Scarlett 1982, Peterson and Reid 1984) or may travel long distances to over-winter in tributaries of the spawning stream to escape high or fluctuating flows in the main channel (Peterson 1982a, 1982b; Cederholm and Scarlett 1982).

Coho salmon prefer large, deep pools during both summer and winter, although they may use pools as shallow as 0.3 m (1 ft) (Nickelson et al. 1992). There are positive correlations between a standing crop of juvenile coho salmon and pool volume (Nickelson and Reisenbichler 1977, Nickelson et al. 1979). Studies by Nickelson in Oregon indicate that pools the size of 10–80 m^3 (333–2667 ft^3) or 50–250 m^2 (556–2826 ft^2), which have sufficient riparian canopy for shading, are optimum for production of juvenile coho salmon (as cited in McMahon 1983). As juvenile salmonids age and grow, they tend to swim to the deepest available pools (Dolloff 1983, Dolloff and Reeves 1990). The availability of suitable pool habitat in a stream may limit the number of juvenile coho salmon during summer or winter, depending upon local conditions.

Because juvenile coho salmon show narrower preferences for pool habitat types in the winter than in the summer, habitat limitations may be more common in the winter. Lack of suitable winter habitat may result in poor survival and many studies indicate that availability of winter habitat may be the ultimate factor limiting coho salmon in rearing areas (Chapman 1966, Mason 1976a, Chapman and Knudsen 1980, McMahon 1983, Nickelson et al. 1992). Tschaplinski and Hartman (1983) documented substantial decreases in numbers of juvenile coho salmon during fall and winter, particularly in response to seasonal freshets. They found that habitats such as deep pools, logjams, and undercut banks with woody debris lost fewer fish during high flow events and maintained higher juvenile populations over the winter. Rodgers (1986, as cited by House et al. 1991) found only 9% of the juvenile coho salmon that were present during the summer remained as smolts in Knowles Creek, a stream that lacked good over-wintering habitat. Mason (1976b) provides additional evidence that winter habitat may limit the number of coho salmon; in an

experiment, supplemental feeding increased the biomass of summer low-flow juveniles nearly seven-fold, with no observed increase in smolt yield the following spring.

4.2.5.5 Large woody debris (LWD)

LWD is a crucial habitat requirement for juvenile coho salmon during all life-stages of their freshwater residency. Juvenile coho salmon select habitat primarily on the basis of water velocity (Shirvell 1990), preferring low velocity habitats throughout the juvenile rearing period. In coastal streams, low velocity habitat conditions are primarily produced by LWD. Depth and light intensity also influence habitat selection of juvenile coho salmon, but to a lesser degree than velocity (Shirvell 1990). Juvenile coho salmon appear to prefer the cover afforded by woody debris to that provided by rocks and rocky substrate, while juvenile steelhead show the opposite affinity (Bustard and Narver 1975a, Bugert 1985). Therefore, the presence or absence of LWD in streams may have an overwhelming influence on the suitability of these streams for rearing coho salmon. McMahon and Reeves (1989) postulate that LWD could be considered a keystone habitat feature for salmonids because of its overwhelming influence on channel morphology (e.g., pool formation, bank condition), sediment and organic matter retention, water velocities, and cover availability.

Numerous studies have investigated the relationship between the habitat of juvenile coho salmon and LWD. Low velocity stream habitats preferred by juvenile coho salmon include pools, beaver ponds, and off-channel habitats, such as side channels, backwaters, and tributaries on floodplains and terraces (Everest et al. 1986, Glova 1986, Taylor 1988, Bugert and Bjornn 1991). Smaller coast range streams tend to have more confined channels and less availability of off-channel habitats; in these streams, pools constitute the primary rearing habitat for coho salmon. LWD creates pool habitat, provides refuge from high velocities during high flows, and provides shade and overhead cover that offers protection against predation (Bisson et al. 1987; Andrus et al. 1988; Bilby and Ward 1989; Robinson and Beschta 1990a, 1990b; Sedell and Beschta 1991). In coastal streams throughout the range of coho salmon, LWD is the primary factor governing stream habitat diversity (Swanson et al. 1976, Lisle 1981, Bryant 1982, Beschta and Platts 1986). Several field studies have related density of juvenile salmonids to pools or hydraulic conditions associated with LWD (Bisson et al. 1988, Dolloff and Reeves 1990, Bugert et al. 1991, Taylor 1991). Underwater observations by Shirvell (1990) found that 99% of all coho salmon fry observed were occupying positions downstream of natural or artificial rootwads during artificially-created drought, normal streamflows, and flood streamflows.

Juvenile coho salmon have a greater chance of survival in undisturbed streams. Many studies have documented reductions in rearing habitat as a result of the removal of LWD (Tschaplinski and Hartman 1983, Bisson and Sedell 1984, Koski et al. 1984, House and Boehne 1987). The number of over-wintering coho salmon is low in stream reaches where debris abundance has been reduced or removed due to stream clearing, streamside logging (Tschaplinski and Hartman 1983, Murphy et al. 1986), or other disturbances (Martin et al. 1986). Tschaplinski and Hartman (1983) and McMahon and Holtby (1992) found that the estimated capacity of streams for coho salmon smolts was reduced in clear-cut areas; debris volume and smolt abundance were significantly lower than in reaches bordered by a forested buffer strip.

Nickelson et al. (1992) found that pool habitat that had been enhanced by the addition of woody debris supported significantly higher densities of coho salmon than pools without woody debris. The addition of woody debris to artificially dammed pools increased the density of juvenile coho salmon inhabiting the pools to levels found in naturally dammed pools. Larger juvenile coho salmon appear to benefit most from availability of deeper pools and cover. A study in a British

Columbia stream found that the standing crop of coho salmon at age 1+ was significantly greater in pools with complex cover and was positively correlated to pool volume in a given section of stream (Fausch and Northcote 1992). Presence or absence of woody debris may also affect mating strategies of coho salmon. Gross (1991) noted that streams with less LWD may favor hooknose males over jacks while increases in either LWD (which serves as hiding cover) or shallow water (that is less accessible to large males) may favor jacks and their mating strategy.

Since low water velocities are more common throughout the stream channel in summer, associations of juvenile coho salmon with LWD may not be as apparent as in winter. Some studies have indicated that cover, such as that provided by LWD or riparian vegetation, is not as important in influencing juvenile distribution during the summer (Bustard and Narver 1975a, Grette 1985, Murphy et al. 1986, Taylor 1988, Nielsen 1992, Fausch 1993), while other studies show that coho salmon prefer areas of reduced light intensity in summer (Bugert and Bjornn 1991). The type and intensity of predator threats may influence dependence on cover during the summer (Bugert et al. 1991).

In late summer or fall when stream temperatures are highest and flows are lowest, juvenile coho salmon move into deeper pools and feeding rates decrease (Shapovalov and Taft 1954). Low summer flows result in reduced rearing areas, increased vulnerability to predators, increased stranding, and increased water temperatures; availability of pool habitat mitigates these effects and may be particularly important for coho salmon in streams where these influences are strongest (Smoker 1955, Nickelson et al. 1979, Peterson and Quinn 1994). Burns (1971) found that the highest mortality of juvenile coho salmon in summer occurred during periods of lowest flow. Neave (1948, 1949) and Smoker (1953) demonstrated correlations between low summer flow and low catch of adult coho salmon 2 years later. Deep pools may be important for moderating late summer temperature extremes. LWD may be especially important to juvenile coho salmon in areas with marked low-flow periods in summer, since it creates deep pools and shade.

McMahon and Holtby (1992) found that coho salmon smolts tended to be associated with LWD in Carnation Creek study reaches. Over 80% of smolts (1260 observations) were within 1 m (3.3 ft) of LWD, and 95% were within 2 m (6.6 ft) of LWD. The LWD jam sites were characterized by deep (> 1 m or 3.3 ft), slow-moving (< 15 cm/s or 0.5 ft/s) water, overhead shade, and structurally complex cover afforded by rootwads, undercut banks, and submerged logs. Most smolts were associated with LWD volumes > 14 m^3 (494 ft^3). Smolts were noticeably scarce in areas with deep pools or bank cover that lacked LWD. The authors theorized that cover and velocity refuges provided by woody debris were important for avoiding predation and preventing displacement into the ocean prior to completion of smoltification.

4.2.5.6 Ocean phase

There are conflicting opinions on whether density-dependent mechanisms are operating at sea for coho salmon. Emlen et al. (1990) found some evidence that coho salmon smolts interact in the near-shore area in a way that generates density feedback on survival. They reported these data mainly to caution against discounting density-dependent mortality at sea. If density-dependent mortality controls the number of coho salmon at sea, hatchery programs to enhance fishery production may be largely ineffective. McGie (1984) had concluded that density-dependent mortality was important in years of low upwelling, but that it was absent in years of high upwelling, when ocean conditions are more favorable for salmon.

Pearcy and Fisher (1988) report that variation in ocean mortality of coho salmon primarily occurs during the first few weeks of ocean residence. Near-shore conditions during late spring and early summer along the coasts of Washington, Oregon, and California may dramatically affect year-class strength (Scarnecchia 1981). Coho salmon along the California and Oregon coasts may be more sensitive to ocean conditions as these areas do not have the extensive bays, straits, and estuaries found in Washington and Alaska. These features may buffer oceanographic effects (Bottom et al. 1986).

Natural changes in climatic conditions may affect populations of coho salmon. For example, a decline in the populations of coho salmon has been associated with ocean warming trends in the northeast Pacific during the period of 1976–1983 (Nickelson 1986; Lawson 1993; Brown et al. 1994). Generally favorable conditions prevailed during the period from about 1945–1975, but upwelling along the Oregon coast has declined in the past 20 years, and marine survival of coho salmon has declined at a similar rate (Bottom et al. 1986, Pearcy et al. 1992, Lawson 1993). The evidence for the positive effects of upwelling is not always strong, however, and the mechanisms that may create benefits to survival of coho salmon from coastal upwelling are not clear (Scarnecchia 1981; Holtby et al. 1990; reviewed by Pearcy et al. 1992). Upwelling along the Pacific coast may be driven by 40–60 year cycles in wind patterns (Ware and Thomson 1991).

Ocean warming along the British Columbia and California coasts has been reported for the last 50 years (Freeland 1990, Roemmich 1992). During periods of climate change, such as warming trends, El Niño events may become particularly intense (Quinn et al. 1986). El Niño events are associated with unusually warm temperatures at the ocean surface and changes in coastal currents and upwelling (NMFS 1995). These ocean conditions result in reductions in primary and secondary productivity and changes in the distributions of predator and prey species; this, in turn, results in reduced growth, survival, and fecundity of coho salmon (Johnson 1988, NMFS 1995). The 1982–83 El Niño had widespread effects on the northeast Pacific and was associated with an estimated 58% reduction in adult survival and a 24–27% reduction in fecundity in populations that rear off the Oregon coast and southward (Johnson 1988). If climate warming continues as predicted, there may be a progressive deterioration of marine habitat for salmonids that could forestall or curtail the recovery of more favorable ocean conditions (Lawson 1993).

4.2.6 Ecological interactions

4.2.6.1 Food web interactions

While in freshwater, juvenile coho salmon feed primarily on aquatic and terrestrial invertebrate drift (Sandercock 1991). Coho salmon depend largely on visual cues for locating food, and rarely feed on non-moving items or benthos. Ideal feeding positions are located in low-velocity areas where energy expenditure is low, adjacent to high velocity water where food delivery rates are high (Mundie 1969). Nielsen (1992) found that dominant individuals, which maintained the optimal feeding positions, fed almost exclusively on aquatic invertebrate drift (chironomids mostly), and that subdominant fish tended to feed on terrestrial invertebrates that dropped into the stream. In most systems coho salmon feed primarily on chironomids, stoneflies, and occasionally crustaceans (Sandercock 1991). Gribanov (1948, as cited in Sandercock 1991) and Mason (1974, as cited in Sandercock 1991) both found that adult insects were the principal life-stage consumed, and secondarily insect larvae. Riffle habitat is the source of much of the aquatic invertebrate production of a stream. Ruggles (1966) proposed a pool-to-riffle ratio of 1:1 as the optimum for providing food and cover for rearing coho salmon. The terrestrial invertebrate component of juvenile coho salmon diet has been correlated with the amount of riparian vegetation adjacent to the streams (Chapman 1965). High flows in winter often present feeding opportunities for juvenile coho salmon. Minakawa and Kraft (1999) found that following these high flows, greater

than 70% of the diet of juvenile coho salmon was composed of springtails; in the periods between high flows, their diet was composed almost exclusively of benthic invertebrates. Yearling coho salmon become piscivorous and often consume other anadromous salmonid fry when available.

4.2.6.2 Diet

During the coho salmon's first few months at sea, they are opportunistic feeders, consuming a wide variety of zooplankton and fish prey (Brodeur 1992). In most northwest Pacific coastal estuaries and bays, coho salmon and Chinook salmon consume mainly invertebrate prey (McCabe et al. 1983; MacDonald et al. 1987, as cited by Brodeur 1991). The most commonly consumed invertebrate prey are euphasiids (krill); in Beacham's (1986) sample of 1364 non-empty stomachs, 54% of total stomach contents were made up of invertebrate prey and 51% of total contents were comprised of euphasiids. In early summer (May–July), while still relatively small, coho salmon tend to feed on small planktonic larvae. Later in the summer they become more piscivorous and the diversity in their diets decreases, consisting mainly of juvenile marine fishes (Brodeur 1992). As coho salmon grow, they may switch from smaller fish, such as sand lance, to larger herring and juvenile rockfish (Beacham 1986); fish prey, in general, constitutes a larger portion of their diet (Brodeur 1991). Prey consumed by coho salmon are generally less than one-fifth their length, but can be up to one-half of the salmon's length (Brodeur 1991).

At sea coho salmon and Chinook salmon are more piscivorous than other Pacific salmon (Beacham 1986). Some differences in diet between coho salmon and Chinook salmon may be attributable to the differences in depths inhabited by the 2 species. Beacham (1986) reported that coho salmon were most abundant at depths of less than 18 m (59 ft), while Chinook salmon were most abundant at depths greater than 18 m.

Changes in the marine food web may result in declines in coho salmon marine survival. Pacific sardine and hake populations, both of which are used as food by coho salmon, have collapsed during the last century and have not recovered in the most recent period of more favorable ocean conditions (Ware and Thomson 1991). Reductions in ocean food supply and intensive hatchery plantings may lead to density-dependent ocean mortality (Brodeur and Pearcy 1990).

4.2.6.3 Predators

Predation is a major component of the mortality suffered by juvenile coho salmon (Sandercock 1991). Predators encountered during the freshwater rearing stage include juvenile steelhead, cutthroat trout, herons, mergansers, otter, and mink. Even where predation is not a major factor affecting coho salmon populations, it may retard recovery when populations are severely depressed (CDFG 1994). Introduced piscivorous fish in some streams may prey on migrating smolts (Kostow 1995). The loss of habitat complexity in streams may make juvenile coho salmon more vulnerable to avian predation by such species as kingfishers, mergansers, and herons. Lonzarich and Quinn (1994) found that predation losses may be up to 50% higher in the simplest habitat type available, indicating the importance of adequate cover and depth in pools. Salmon comprise only a minor part of the diets of harbor seal and sea lions in the Klamath River estuary (Bowlby 1981).

MRC has land in sub-basin tributaries to the South Fork Eel River (Hollow Tree, Mill, and Jack of Hearts Creeks), where Sacramento pikeminnow prey on juvenile salmonids (Nakamoto and Harvey 2002, unpubl. data). Sacramento pikeminnow were first discovered in the South Fork Eel River in 1979. In 1995, over half of the pikeminnow larger than 250 mm (9.8 in.) sampled in the upper South Fork Eel River in August had juvenile salmonids in their stomachs (Nakamoto and Harvey 2002, unpubl. data). Pikeminnow larger than about 100 mm (3.9 in. are potentially

piscivorous; the proportion of fish in their diet generally increases as their length increases. Pikeminnow predation on salmonids appeared to increase after the Potter Valley Project (Lake Pillsbury Reservoir) caused habitat alterations and raised stream temperatures; subsequently, pools filled with sediment from logging (Harvey et al. 2002). However, the pikeminnow's random selection of prey combined with the fact that juvenile coho salmon occur at relatively low densities in the Eel River may prevent adverse effects on the coho salmon population.

During summer, Pikeminnow have occasionally been found in the lower reaches of South Fork Eel River tributaries, such as Hollow Tree Creek, depending on water flow and temperatures (Harvey et al. 2002). Their distribution apparently increases during low-flow years, when water temperatures are warmer, and decreases in high-flow years, when water temperatures are cooler (Harvey et al. 2002). Land management that increases water temperature could further expand their distribution in the South Fork Eel River and its tributaries (Harvey et al. 2002). In addition to pikeminnow predation on coho salmon, the daily interactions between the 2 co-existing species may direct juvenile salmonids to less suitable habitat in the stream and, therefore, decrease their survival rate (Brown and Moyle 1991).

Whether or not Sacramento pikeminnow are present in tributaries, all coho salmon produced in tributaries to the South Fork Eel River must outmigrate through areas with large numbers of pikeminnow during the spring. Pikeminnows in the South Fork Eel River forage on migrating juvenile salmon in the spring (Moyle 2002). However, most of the pikeminnow consumption of salmonids reportedly occur in mid- to late-summer when flows are lower, clearer, and warmer, and the natural ability of salmon to avoid predation may be reduced (Namamoto and Harvey 2002, unpubl. data; Moyle 2002).

Once smolts reach the estuary and the ocean waters near the shore, they may encounter several new predators, including fish, such as spiny dogfish, lamprey, and sharks; piscivorous birds, such as gulls and loons; and marine mammals, such as harbor seals, sea lions, and orcas. Salmon, however, appear to constitute only a small proportion of the diet of most marine mammals (Bowlby 1981, Sandercock 1991).

4.2.7 Sensitivity to anthropogenic disturbances

As a result of their anadromous life history and a full year rearing in freshwater, coho salmon populations are subject to impacts from a variety of sources, including climatic shifts, ocean and freshwater fishing pressure, and natural or man-made habitat changes. Land management has the potential to dramatically affect the suitability of coastal streams for the production of coho salmon. During the freshwater portions of their life cycle, salmon may act as a keystone food resource for terrestrial vertebrate predators and scavengers, and thus they form a critical link between the aquatic and terrestrial ecosystems (Houston 1983, Cederholm et al. 1981, Willson and Halupka 1995). Declines in anadromous fish species, such as coho salmon, may therefore result in cascading effects throughout the trophic system.

Declines in the population of coho salmon in California and Oregon have led to increased regulatory pressure on many activities that potentially affect habitat of coho salmon. On July 25, 1995, NMFS issued a proposed rule to list 3 ESUs of coho salmon as threatened under the ESA (NMFS 1995). The 3 ESUs include the Oregon coast, southern Oregon/northern California, and central California coast populations (NMFS 1995). The present state of these populations is believed to be the result of human-induced conditions (commercial fishing, habitat degradation, and introduction of hatchery fish) exacerbating recent adverse environmental factors, such as drought and poor ocean conditions (NMFS 1995). Degradation of freshwater spawning and

rearing habitat is likely the most important factor causing long-term declines of coho salmon productivity and recent declines in escapement (Pearcy et al. 1992).

Loss of stream habitat is acknowledged as one of the causes of declines of anadromous salmonids in general in the Pacific Northwest and of coho salmon in particular (Nehlsen et al. 1991; Reeves and Sedell 1992; The Wilderness Society 1993). Most of the habitat loss has been the result of watershed disturbances associated with logging, livestock grazing, urbanization, agriculture, mining, and other human activities (Brown et al. 1994, NMFS 1995). These activities typically result in the loss of complex stream habitat that is characteristic of coho salmon streams (Sandercock 1991), particularly a reduction in the amount of LWD and an increase in fine sediment input to the watershed. Other possible factors in the decline of coho salmon are genetic breakdown of native stocks, dam construction, introduced diseases, over-fishing, floods and drought, and climatic change (Brown et al. 1994). In sub-sections 4.2.7.1 through 4.2.7.6, we review several of these causes, which may relate to declines in coho salmon population in the plan area.

4.2.7.1 Changes in hydrologic regimes

Increased peak flows due to logging, grazing, or hydroelectric operations can reduce survival of eggs and alevins through displacement, if gravels are disturbed; juveniles in rearing areas may also be displaced if suitable refuges from high-velocity flows are lacking (Nicholas 1988). Reduced instream flows, due to diversions or reservoir storage, may delay or halt adult and juvenile migrations, limit availability of rearing habitat, and reduce spawning habitat, if minimum water depths are not met (Everest et al. 1985). Droughts may compound oceanic effects by drying up streams, restricting access to some areas, and degrading spawning and rearing conditions (Brown et al. 1994). Lack of sufficient rainfall, resulting in low flows during migration periods, may impede up-stream migration and result in greater vulnerability of the coho salmon to predation (CDFG 1994). Large floods can have deleterious effects as well, scouring stream channels of spawning gravels and woody debris and, thereby, decreasing spawning success and rearing habitat. In recent years, the effects of catastrophic drought and flood have been compounded by stream degradation due to human action.

4.2.7.2 Changes in sediment dynamics

Timber harvesting and road building can increase levels of sediment delivery to channels, which may increase water turbidity, fill pools, and reduce rearing habitat of juvenile coho salmon. Increased water turbidity may have lethal or sub-lethal effects on salmonids. These effects include physiological stress, such as gill trauma and decreased osmoregulatory ability, and behavioral changes, such as delayed migration, decreased feeding rates, and altered prey selection (Bash et al. 2001). Embeddedness of substrates with fine sediments may reduce production (Crouse et al. 1981), primarily by reducing egg-to-emergence survival and aquatic invertebrate production. The sedimentation of coastal estuaries, due to increased upstream erosion, has been documented in rivers of the northern California coast; this reduces good rearing habitat for coho salmon before they migrate to sea (Puckett 1977, Hofstra 1983, Smith 1987). Aggradation of streams from erosion may result in less stable spawning gravels and mortality of eggs and embryos due to gravel movement during freshets (Nawa et al. 1990). Gravel instability may also affect colonization of the streamside area by riparian vegetation. Extremely aggraded streams may have reduced or absent surface flows in the summer (CDFG 1994). Large accumulations of sediment may block juvenile and adult migrations where tributaries join main rivers (Payne and Associates 1989). Intrusion of fine sediments from logging activities into areas, such as pool tails, can cause profound effects on the permeability of spawning gravel and reduce spawning success (McNeil and Ahnell 1964, Peters 1965, Moring 1975). Gravel mining can reduce the

supply of spawning gravels and alter habitat used by rearing coho salmon. Coarse sediment in headwater streams may have particularly persistent and drastic impacts on available habitat.

4.2.7.3 Changes in LWD dynamics

Reduction of LWD in stream channels has been one of the most important long-term effects of forest management on salmonids in North America (Hicks et al. 1991a). Removal of LWD or curtailment of LWD recruitment generally leads to loss of those habitat features most important to rearing juvenile coho salmon and a subsequent decline in anadromous salmonid abundance (Bryant 1980, Toews and Moore 1982, Lestelle and Cederholm 1984, Dolloff 1986, Elliott 1986, Fausch and Northcote 1992). Stream channels tend to become simpler and less stable after the removal of LWD; the habitat complexity that provides substrate diversity, refuges from current velocity, and cover for spawning, feeding, and resting salmonids is also lost (McMahon and Reeves 1989). Several studies have shown that removal of LWD results in wider and shallower channels with little pool volume available at low flows (Bilby 1984, Bisson and Sedell 1984, Heifetz et al. 1986). Cutting of streamside forests and removal of LWD has been observed to decrease frequency and area of pool habitat and increase riffle area (Bryant 1980, Everest and Meehan 1981, Bisson and Sedell 1984). In clearcuts, Bisson and Sedell (1984) observed that the frequency of both pools and riffles appeared to decline, suggesting that the stream profile of gradual steps had changed to a steeper gradient.

Management activities, such as splash damming, stream-cleaning, and timber harvesting, have resulted in the loss of LWD in streams and reduced recruitment from valley slopes (McMahon and Reeves 1989). Sedell and Luchessa (1982) document the extensive removal of LWD and debris jams from streams in the past 150 years. In a basin in which over 50% of the forest had been logged in the past 20 years, House and Boehne (1986) found that the reduction of large conifers in the riparian zone resulted in only 0.4 pieces per 100 m (328 ft) of LWD large enough to influence channel morphology, compared to 18 pieces of LWD per 100 m (328 ft) large enough to influence the channel in a relatively undisturbed section of a small stream in Oregon.

Forests provide LWD to streams that increase aquatic diversity by creating pools and protected backwaters. LWD also provides nutrients and substrate for biological functions, retains sediment, and dissipates energy of the flowing water, which reduces erosion (Maser et al. 1988). Woody debris with a diameter larger than 20 in. is more common in mature and old-growth forests than in young-growth stands where the trees are small (Maser et al. 1988). Forest type and successional stage, disturbance history, and channel size all influence the amount of wood in streams. Streams flowing through young-growth forests and recently harvested areas contain lower numbers of LWD than is found in mature forests (Maser et al. 1988, Meehan et al.1984). The largest trees in old growth or mature forests in the Pacific Northwest, including northern California, are usually conifer species. In some streamside areas where harvest has occurred, hardwood species, such as alder and tanoak, may quickly colonize the cleared areas. Until the conifers eventually out-compete the hardwoods, the only wood available to streams is from the smaller hardwoods.

In general, at any given location in a stream, the larger less mobile, and more rot-resistant conifers will persist longer in streams than the smaller, mobile, and more rot-prone hardwood species. Although instream hardwood logs may function similarly to instream conifer logs, their contributions to aquatic diversity will likely be of smaller magnitude and shorter duration than conifer logs derived from old-growth or mature forest. If recovery of the riparian conifer forest takes an extended period of time before contribution of LWD resumes, there may be a net loss of instream LWD. LWD from smaller hardwood and legacy conifers may decompose, degrade, or

be transported out of the stream before input of LWD resumes; this may result in entire drainage systems devoid of large wood. If this occurs, aquatic habitat can degrade, and populations and diversity of aquatic species may decline.

4.2.7.4 Changes in stream temperatures and water quality

Logging practices that result in increased stream temperatures, such as removing shade over streams, threaten survival and reproduction by coho salmon. Removal of riparian canopy cover exposes more of the stream channel to direct solar radiation. Increased fine sediment inputs can also cause increased stream temperatures by replacing the reflective gravel substrate with darker sediment that could store more solar radiation (Hagans et al. 1986). In addition, sedimentation can reduce intragravel flow, thereby exposing more of the water column to solar radiation (Hagans et al. 1986). Higher temperatures during the incubation period can cause coho salmon to emerge earlier and be displaced by winter freshets (Scrivener and Anderson 1984). High summer water temperatures reduce growth and may cause mortality of juveniles. In addition to its effects on stream temperatures, removal of the riparian canopy also results in reduced input of terrestrial invertebrates and litterfall to the stream, further reducing the allochthonous input that is an important component of stream production. Grazing may also cause degradation of coho salmon habitat through increased upslope and bank erosion and loss of riparian vegetation. Reduction in riparian canopy can also change predation pressures from aerial predators, such as kingfishers.

4.2.7.5 Commercial and recreational harvest

Over-fishing is often mentioned as a major factor contributing to the decline of coho salmon, but its effects are poorly known because catch of wild and hatchery fish are rarely separated (Steward and Bjornn 1990). On the ocean, commercial and sport fishing harvest salmon stocks in a non-discriminatory way. Harvest levels that may be sustainable for hatchery stocks are often too high to be sustained by depressed wild stocks. If conditions within freshwater spawning and rearing areas are poor, salmon cannot rebound quickly from over-fishing; ocean harvest may become an impediment to recovery of populations (CDFG 1994). Coho salmon in areas where females have a strict 3-year life span are particularly vulnerable; these populations lack the resilience to withstand excessive harvest over successive years that might be present in a population of wide-ranging ages. Over-harvest in a single year can decimate the entire population of a stream, if it has only one strong-year class remaining (Brown et al. 1994). Although commercial and recreational fisheries have been severely restricted or closed along much of the west coast for the past few years, these measures have not resulted in increased returns of coho salmon (NMFS 1995). This may be due to continuing habitat degradation and decreasing productivity in streams (Pearcy et al. 1992).

Intensive commercial fishing that preferentially captures the larger and older male coho salmon may enhance jack mating success on the spawning grounds. This would subsequently increase the frequency of jacks in the population, since jack maturity appears to be heritable (Iwamoto et al. 1983, Gross 1991). Reductions of populations may also increase the frequency of coho salmon returning as jacks (Gross 1991), since growth rates could increase at the lower densities found in depressed populations (Bilby and Bisson 1992).

4.2.7.6 Hatcheries

The genetic integrity of native stocks of coho salmon has been affected by the introduction of large numbers of hatchery fish and transplants of different stocks. Nehlsen et al. (1991) suggest that native stocks of coho salmon have high probability of introgression with hatchery stocks. Bartley et al. (1992) noted that transplants of different stocks within California and planting of Oregon and Washington stocks may have effects, such as disruption of locally adapted gene

complexes, swamping and homogenization of native gene pools, and transmittal of non-adaptive traits[5] from hatchery stocks to native stocks. Differences in the genetic structure of native and hatchery stocks can potentially lead to lower survival of subsequent hybrid generations compared with pure wild fish (Steward and Bjornn 1990; Hindar et al. 1991). Studies have shown lower survival of juvenile coho salmon that were offspring of hatchery strays or hybrids of hatchery and wild coho salmon (Smith et al. 1985, Chilcote et al. 1986). Hatcheries have not proven successful in the restoration of native stocks of coho salmon (Withler 1982, Solazzi et al. 1983, Nickelson 1986).

Stocking of juvenile coho salmon may reduce survival of native stocks through increased competition for limited space or food in rearing streams (Nickelson 1986). In streams, survival of juvenile coho salmon from hatcheries can be lower than that of wild coho salmon (Nickelson 1986). Competition for spawning sites can occur when the wild spawners are swamped by larger numbers of hatchery-reared fish. The accelerated growth of fry in hatcheries may result in increased incidence of juvenile coho salmon that return as jacks (Gross 1991). The interaction of hatchery and native stocks also increases disease potential, since native stocks may be exposed to disease organisms originating from hatcheries. For example, some hatchery stocks of coho salmon are known to harbor Bacterial Kidney Disease (BKD), a chronic and slow developing infection that can have adverse effects on coho salmon smolts (CDFG 1994, NMFS 1995).

4.2.8 Impacts of MLC (2008)

At least 17 CalWater planning watersheds, known to have coho salmon present, experienced some impact from the fires. The fires burned over roughly 15,600 ac of the plan area which were in watersheds with coho salmon. Monitoring efforts in our ASMBs (Annual Salmonid Monitoring Basins) will track cohorts of coho salmon in burned and unburned watersheds.

4.2.9 Key uncertainties

The current and historical abundance of coho salmon in most coastal streams and rivers of Mendocino County is largely unknown. Limited information is available describing historical distribution. The continuation of population estimates will be crucial in providing data to allow more robust estimates of abundance.

Although hypotheses exist, MRC needs more information on factors that may limit the recovery and maintenance of coho salmon populations in the region. Freshwater habitat quality and quantity is likely a limiting factor. Most of the research on habitat relationships of coho salmon has been outside the plan area. Specifics of these relationships may not be the same within the plan area.

MRC management has identified the following key uncertainties, with cross references to validation monitoring programs in parentheses:

- What is the current and historical distribution of coho salmon in coastal streams and rivers of Mendocino County?
- *Will the abundance of juvenile coho increase as habitat conditions improve over time* (M§13.6.1.2-1)*?*
- How will the Mendocino Fires of 2008 affect cohorts of coho salmon and their habitats?
- What is the contribution of each limiting factor to coho salmon populations?

[5] Non-adaptive traits do not promote and may even reduce an organism's fitness to survive or reproduce in an environment.

4.3 Chinook Salmon

4.3.1 Geographic distribution

Illustration by Ron Pittard

Chinook salmon (*Oncorhynchus tshawytscha*) are distributed in the Pacific Ocean throughout the northern temperate latitudes in North America and northeast Asia. In North America, they spawn in rivers from Kotzebue Sound, Alaska south to the San Joaquin River in California's Central Valley (Healey 1991). In California, all major rivers of the Central Valley and coastal areas north of San Francisco Bay support Chinook salmon runs (Allen and Hassler 1986). They are most abundant in large rivers, and although they occur in many smaller coastal river systems, they are often absent from streams used by coho salmon (Meehan and Bjornn 1991).

Four runs of Chinook salmon occur in California—fall, late fall, winter, and spring (Allen and Hassler 1986, Leet et al. 1992, Mills et al. 1997). Fall-run populations (or "fall Chinook salmon") occur throughout the species' range and are currently the most abundant and widespread salmon runs in California (Mills et al. 1997). Winter-run populations are limited to the Sacramento River basin and were listed as endangered under the federal Endangered Species Act in 1994. Two apparently distinct stocks of spring-run Chinook (or "spring Chinook salmon") occur in California: a Sacramento-San Joaquin population and a Klamath-Trinity population (Moyle et al. 1995). Although other spring Chinook salmon populations may have existed in smaller coastal streams between these 2 basins, such as the Eel River, they have since been extirpated and there is no evidence of recent spawning in these streams (Moyle et al. 1995).

Chinook salmon populations found in the plan area belong to the California Coastal ESU. This ESU, which encompasses all naturally spawning coastal Chinook salmon from Redwood Creek (Humboldt County) through the Russian River (Sonoma County), was formerly included as part of the Southern Oregon and California Coastal ESU. Chinook salmon in the California Coastal ESU were listed as threatened in September 1999 (NMFS 1999).

4.3.2 Local distribution

The timberlands addressed in our HCP/NCCP cover a large area in Mendocino County, extending from Hollow Tree Creek to the Garcia River. Historically, Chinook salmon were present in many of the major rivers within the plan area including the Eel River (Myers et al. 1998), Big River, Albion River (Cherr and Griffin 1979) and Garcia River (Cher and Griffin 1979). Currently, the occurrence and distribution of fall Chinook salmon in the coastal streams and rivers of Mendocino County is largely unknown. Sampling occurs mainly during the summer months. Adult Chinook salmon enter coastal streams in fall. Their progeny typically swim out to the ocean the following spring and early summer. Spring Chinook salmon are not present within the plan area (Moyle et al. 1995).

Spawning ground surveys, out-migrant trapping, and estuary surveys do sample for Chinook salmon, however, such sampling has not been extensive in the region. Prior to 2002, Hollow Tree Creek was the only watershed within MRC forests known to have a spawning population of Chinook salmon. In 2001-2003 and in 2005-2006, CDFG biologists with the Coastal Watershed Planning and Assessment Program observed adult Chinook salmon in our Noyo River tract.[6] In 2002, MRC biologists also observed juvenile Chinook salmon in the Albion River (MRC 2002a).

[6] Email to Matt Goldsworthy (MRC) from Sean P. Gallagher (CDFG—Fort Bragg, CA) on 8 December 2006.

4.3.3 Population trends

Recent population trends of Chinook salmon appear quite bleak. The Pacific Fisheries Management Council (PFMC) reported on 29 January 2008 unexpectedly low Chinook salmon returns to California in 2007, particularly to the Central Valley. Adult returns to the Sacramento River, the largest of Central Valley Chinook salmon runs, failed to meet resource management goals (122,000-180,000 spawners) for the first time in 15 years.

Ocean conditions were poor for salmon growth and survival during spring and summer of both 2005 and 2006. The Wells Ocean Productivity Index (WOPI), a composite index of 13 oceanographic variables and indices, weighted heavily by sea level height, sea surface temperature, upwelling index, and surface wind stress, has been used to accurately predict zooplankton, juvenile shortbelly rockfish, and common murre production along the California coast. It is, therefore, a valid indicator of ocean productivity. Index values for spring and summer of 2005 and 2006 were low, indicating poor conditions for growth and survival. In fact, only the El Niño years (1982-83, 1992-93, and 1999) had lower WOPI values.

The WOPI assesses conditions on a local scale for California, but has tracked another index, the Northern Oscillation Index (NOI), which is based on the strength of the North Pacific high pressure cell and describes a broader region of the North Pacific Ocean. In 2005 and 2006, the WOPI decoupled from the NOI, suggesting local conditions on the California coast were worse than for the larger North Pacific region. These results indicate that ocean conditions in spring and summer, when juvenile coho and Chinook salmon enter the ocean, were unfavorable to growth and survival. This may explain the poor returns for coho in 2007 and 2008 and for Chinook salmon in 2007.

Fall Chinook salmon are currently the most abundant and widespread of salmon stocks in California (Mills et al. 1997). However, the abundance of fall Chinook salmon has fluctuated widely over recent decades, with some populations often reaching critically low levels. NMFS reported that trends in abundance of Chinook salmon in the California Coastal ESU were highly variable, with the strongest declines generally occurring in populations that are the furthest south (NMFS 1999).

Data on population trends of Chinook salmon in rivers and streams within the plan area is very limited; most recent data only spans short time periods. In a study of anadromous salmonid resources of Mendocino County, Maahs and Gilleard (1994) and Nielsen et al. (1991) sampled 34 coastal streams and rivers to estimate abundance of Chinook salmon, coho salmon, and steelhead. They found Chinook salmon in Caspar Creek, Ten Mile River, Noyo River, and Hollow Tree Creek. The Ten Mile River population originated from introductions of Chinook salmon in the early 1980s, which resulted in a self-sustaining population.

The MRC trapping program in Hollow Creek provided data on downstream migration of Chinook salmon. Data from the 2000 and 2001 seasons shows extreme variability. MRC biologists captured 2128 juvenile Chinook salmon in spring 2000, but only 46 in 2001 (MRC 2002b). Short-term monitoring of Chinook salmon abundance in Hollow Tree Creek indicates a considerable decline since the late 1980s (NMFS 1999).

For most populations for which sufficient data exists, NMFS reported a general decline in abundance; in addition, almost all coastal populations south of the Klamath River were extremely depressed (NMFS 1998). In the Klamath River basin, fall Chinook salmon escapement has been

estimated annually since 1978; populations have ranged from 113,000 spawning adults in 1986 to approximately 12,000 in 1992 (Mills et al. 1997).

There remains a high degree of uncertainty regarding the status of populations in this ESU. In a NOAA Technical Memorandum (2008), Brian C. Spence et al. concluded the following:

> In summary, the lack of data from which to assess viability of extant populations in the northern part of the ESU, the apparent lack of extant populations, with the exception of the Russian River, in the southern half of the ESU, the loss of important life history diversity (i.e., spring-run populations), and the substantial gaps in the distribution of Chinook salmon throughout the ESU strongly indicate that this ESU fails to meet low-risk criteria and is therefore at elevated risk of extinction.

4.3.3.1 Hatchery production

Hatchery production of Chinook salmon in California is concentrated in the Central Valley and Upper Klamath-Trinity Rivers ESUs. According to NMFS (1998), the Rogue, Chetco, Redwood Creek, and Eel River basins have received considerable hatchery releases, derived primarily from local sources. There is also a rearing facility for anadromous salmonid operated by the Commercial Salmon Trollers Association on Hollow Tree Creek. On Hollow Tree Creek, 10% of the 4-year-old fish returning in 1991–1992 were hatchery-reared fish that were released in 1987 as fingerlings (Maahs and Gilleard 1994). In addition, the Ten Mile River population may derive from introductions of Chinook salmon in the early 1980s, which have resulted in naturalized Chinook salmon production. However, confirmation of this would likely require genetic work. In the Russian River basin, the Warm Springs Hatchery on Dry Creek (a tributary of the Russian River) rears fall Chinook salmon for release in the Russian River. This facility rears eggs collected at the Warm Springs and Coyote dams. Juveniles are released at both the hatchery and at Coyote Dam. In 1992, Louisiana-Pacific Corporation reared juvenile Chinook salmon in ponds in the upper Russian River watershed near Ukiah.

In the Eel River basin, CDFG is conducting an on-going recovery program for Chinook salmon stock on the main-stem Eel River at the Van Arsdale Fisheries Station. The purpose of this program is to increase the population of fall Chinook salmon to a point where they are self-sustaining. This program is conducted simultaneously with a regime for improved stream flow from the Potter Valley Hydroelectric Project. While the program is aimed at improving Chinook salmon populations in the main-stem Eel River, fish may stray into other tributaries of the Eel River watershed, including Hollow Tree Creek which is within the HCP/NCCP plan area.

4.3.3.2 Commercial and recreational harvest

No known data exists on commercial or recreational harvest of Chinook salmon originating from streams in the plan area. Since 1978, in larger North Coast California river systems, such as the Klamath, sport harvest has varied from 1310 to 22,200 Chinook salmon; it has averaged about 10% of the total number of adult salmon returning to the river (PWA 1994). Sport harvest in rivers within the plan area, however, appears to be virtually nonexistent.

4.3.4 Life history

4.3.4.1 Overview

Chinook salmon are the largest of the Pacific salmon species, reaching weights of up to 99 lb. (45 kg), although most adults weigh from 10 to 40 lb. (4.5 to 18 kg) (Healey 1991, Meehan and Bjornn 1991, Kostow 1995). Chinook salmon have genetically distinct runs differentiated by the timing of spawning migration, the stage of sexual maturity when entering fresh water, the timing of juvenile or smolt out-migration, and other characteristics (Moyle et al. 1989). Fall (or "ocean-type") Chinook salmon migrate to sea during their first year of life—typically within 3 months

after their emergence from spawning gravel. They spend most of their ocean life in coastal waters, and return to their natal river in the fall, a few days or weeks before spawning (Moyle et al. 1989, Healey 1991).

4.3.4.2 Adult upstream migration and spawning

Adult Chinook salmon migrate upstream from the ocean to spawn in their natal streams, although a small percentage may stray into other streams, especially during high water years (Moyle et al. 1989). Throughout their range, adult fall Chinook salmon generally enter estuaries from July to September, remaining in these areas until they become nearly sexually mature; they move upstream as flows increase in the fall. In California, most adult fall-run Chinook salmon enter streams from August through November, with peak arrival usually occurring in October and November (Leet et al. 1992). In the Klamath River basin, upstream migration peaks somewhat earlier, occurring in August and September (Healey 1991). Spawning occurs in river mainstems and tributaries from early October through December.

Adult Chinook salmon appear to be less capable of negotiating fish ladders, culverts, and waterfalls during upstream migration than coho salmon or steelhead (Nicholas and Hankin 1989). This is due in part to their slower swimming speeds and inferior jumping ability compared to steelhead (Reiser and Peacock 1985; Bell 1986, as cited in Bjornn and Reiser 1991). Cruising speeds, which are used primarily for long-distance travel, range from 0 to 1 m/s (0 to 3.3 ft/s) (Bjornn and Reiser 1991). Sustained speeds, which can be maintained for several minutes, range from 1 to 3.3 m/s (3.3 to 10.8 ft/s) (Bjornn and Reiser 1991). Darting speeds, which can only be sustained for a few seconds, range from 3.3 to 6.8 m/s (10.8 to 22.3 ft/s) (Bjornn and Reiser 1991). The maximum jumping height for Chinook salmon is approximately 2.4 m (7.9 ft) (Bjornn and Reiser 1991).

Upon arrival at the spawning grounds, adult females dig shallow depressions or pits in suitably-sized gravels, deposit eggs in the bottom during the act of spawning, and cover them with additional gravel. Over a period of 1 to several days, the females gradually enlarge redds by digging additional pits in an upstream direction (Healey 1991). Redds are typically 10–17 m^2 (108–183 ft^2) in size, although they can range from 0.5 to 45 m^2 (5.4–484 ft^2) (Healey 1991).

Before, during, and after spawning, female Chinook salmon defend the redd area from other potential spawners (Burner 1951). Briggs (1953) observed that the defended area could extend up to 6 m (20 ft) in all directions from the redd. Redds may be defended by the female for up to a month (Hobbs 1937). Males do not defend redds but may exhibit aggressive behavior toward other males while defending spawning females (Shapovalov and Taft 1954). Both male and female adults die within 2 weeks after spawning (Kostow 1995); females defend their redds until they die or become too weak to maintain position over the redd. Adults do not feed while in freshwater, relying instead on fat reserves for maintenance and gonadal maturation.

4.3.4.3 Egg incubation, alevin development, and fry emergence

Egg incubation generally lasts between 40–90 days at water temperatures of 6–12ºC (42.8ºF to 53.6ºF) (Vernier 1969, Bams 1970, Heming 1982, all as cited in Bjornn and Reiser 1991). At temperatures of 2.7ºC (37ºF), it can take up to 159 days for 50% of the eggs to hatch (Alderdice and Velsen 1978, as cited by Healey 1991). The alevins remain in the gravel for 2-3 weeks after hatching; they absorb most of their yolk sac before emerging into the water column.

4.3.4.4 Juvenile freshwater rearing

Following emergence, fry occupy low velocity, shallow areas near stream margins, including backwater eddies and areas associated with bank cover or LWD, where they aggregate in small schools (Lister and Genoe 1970, Everest and Chapman 1972, McCain 1992). The length of time spent rearing in freshwater varies greatly. Juvenile fall Chinook salmon usually migrate to the ocean at 3 to 6 months of age, having reached a size of 2.8–3.5 in. (70–90 mm) (Meehan and Bjornn 1991). In Hollow Tree Creek, downstream migrants of fall Chinook salmon had an average fork length of 1.8–2.0 in. (46–50 mm), when approximately 100 mi (161 km) upstream of the Pacific Ocean (MRC 2002b). Juvenile Chinook salmon feed and grow as they move downstream in spring and summer (Nicholas and Hankin 1989).

Nicholas and Hankin (1989) suggest that the duration of freshwater rearing is tied to water temperatures, with juveniles rearing longer in rivers with cooler water temperatures. Photoperiod or lunar cycles may be important cues for smolt out-migration, although the relative importance of various cues remains unclear (Bjornn 1971, Healey 1991).

Smolt out-migration and estuarine rearing

Chinook salmon may disperse downstream as fry soon after emergence, early in their first summer as fingerlings, in the fall as flows increase, or as yearlings (Healey 1991). Fall fry and fingerlings usually outmigrate from the spawning areas between January and March. Out-migration of larger smolts generally occurs from April through June, with smolts entering the ocean between April and July (Leet et al. 1992). Although fry typically drift or disperse downstream following emergence (Healey 1991), movement upstream or into cooler tributaries has also been observed (Lindsay et al. 1986, Taylor and Larkin 1986). Downstream migrants, especially those migrating at younger ages, typically spend up to several months rearing in estuaries, feeding, and growing before entering the ocean.

Agonistic behavior may decrease in these saline environments; juveniles in estuaries have been observed in aggregations of up to several hundred fish (Reimers 1968). Extended rearing in estuaries results in relatively large juveniles, i.e., 10–16 cm (4–6 in.), entering the ocean in late summer to early fall; this may increase ocean survival (Nicholas and Hankin 1989).

4.3.4.5 Ocean phase

The distribution and migration routes of adult Chinook salmon vary among stocks. In general, most fish migrate north along the Pacific Coast after entering the ocean, but some stocks migrate to the south (Wahle and Vreeland 1978, Meehan and Bjornn 1991). Once in the ocean, Chinook salmon apparently continue to travel in schools (Reimers 1968). Distances traveled from spawning streams to the ocean varies among stocks. Ocean-type Chinook salmon, which includes most fall-runs, migrate to sea as sub-yearlings and tend to remain in nearby coastal waters throughout their ocean lives (Healey 1991). Healey (1991) postulated that ocean-type Chinook salmon are only in the species' southern range (south of latitude 56°N); there they are the most abundant form of Chinook salmon. From the Klamath River, fall Chinook salmon are narrowly distributed in the ocean, ranging between Point Arena (CA) and Cape Blanco (OR) (Leet et al. 1992).

The number of years fish spend at sea also varies by stock. Some stocks are made up of large Chinook salmon that stay in the ocean for 4 to 7 years; other stocks consist largely of 2-year-old fish that have spent only 1 year at sea (Meehan and Bjornn 1991). Ocean conditions are likely an important cause of density-independent mortality and inter-annual fluctuations in escapement sizes.

4.3.5 Habitat requirements

4.3.5.1 Adult upstream migration and spawning

Adult Chinook salmon require water deeper than 24 cm (0.8 ft) and water velocities less than 2.4 m/s (8 ft/s) for successful upstream migration (Thompson 1972, as cited in Bjornn and Reiser 1991). Most Chinook salmon spawn in the mainstem of large rivers and lower reaches of tributaries, although spawning has been observed over a broad range of stream sizes, from small tributaries 2–3 m (6.6–9.8 ft) in width (Vronskiy 1972) to large mainstem rivers (Healey 1991). Chinook salmon prefer low-gradient (<3%) reaches for spawning and rearing, but will occasionally use higher-gradient areas (Kostow 1995). Water temperatures for spawning adult Chinook salmon are reportedly best when <16ºC (60ºF), and potentially lethal when >23ºC (73ºF) (Moyle et al. 1995). Spawning site or redd locations are dictated by streambed topography and hydraulic conditions (Burner 1951). Redds are typically located near pool tailouts (i.e., heads of riffles) where concentrations of dissolved oxygen between the layers of gravel are high. Chinook salmon are capable of spawning within a wide range of water depths and velocities, provided that flow between gravel layers is adequate (Healey 1991). Chinook salmon redds are generally reported at depths of 10 to 200 cm (3.9 to 78 in.) and in water velocities of 15 to 100 cm/s (0.5 to 3.3 ft/s), although criteria may vary between races and stream basins. Because of their larger size, for example, fall Chinook salmon are able to spawn in deeper water with higher velocities than are spring Chinook salmon (Healey 1991).

Composition of substrate particle size has significant influence on intragravel flow dynamics (Platts et al. 1979). Chinook salmon may have evolved to select redd sites with specific particle size that will ensure adequate delivery of dissolved oxygen to their incubating eggs and developing alevins. In addition, salmon are limited by the size of substrate that they can physically move during the redd-building process. Selected substrates likely reflect a balance between water depth and velocity, substrate composition and angularity, and fish size. As depth, velocity, and fish size increase, Chinook salmon are able to displace larger substrate particles. Substrates preferred by Chinook salmon consist of sediment sizes ranging from 13–102 mm (0.5–4 in.) in diameter, with less than 25% of fines below 2 mm in diameter (Platts et al. 1979; Bell 1986, Bjornn and Reiser 1991).

4.3.5.2 Egg incubation, alevin development, and fry emergence

Proper embryo development and emergence require suitable water temperatures, dissolved oxygen delivery, and substrate characteristics. Review of the literature suggests that 5.8–14.2 ºC (42.5–57.5 ºF) is the optimum temperature range for incubating Chinook salmon (Donaldson 1955, Combs and Burrows 1957, Combs 1965, Eddy 1972, Bell 1973, Healey 1979, Reiser and Bjornn 1979, Garling and Masterson 1985). Sub-lethal stress or mortality of incubating eggs from elevated temperatures begins at about 14.4 ºC (58 ºF) for constant exposures (Combs and Burrows 1957, Combs 1965, Healey 1979).

The deposition of fine sediment in the spawning substrate has a major impact on the delivery of dissolved oxygen to the egg pocket and, consequently, on embryo survival-to-emergence. Several studies have correlated reduced dissolved oxygen levels with mortality, impaired or abnormal development, delayed hatching and emergence, and reduced fry size at emergence in anadromous salmonids (Wickett 1954, Alderdice et al. 1958, Coble 1961, Silver et al. 1963, McNeil 1964, Cooper 1965, Shumway et al. 1964, Koski 1981). Silver et al. (1963) found that low concentrations of dissolved oxygen relate to mortality and reduced size in Chinook salmon and steelhead embryos. Data suggests that growth may be restricted at oxygen levels below saturation (Silver et al. 1963). Fine sediments in the gravel interstices can also physically impair

the fry's ability to emerge through the gravel layer, trapping (or entombing) them within the gravel (Phillips et al. 1975, Hausle and Coble 1976).

4.3.5.3 Juvenile freshwater rearing

Juvenile Chinook salmon tend to use mainstem reaches and estuaries as rearing habitat more extensively than juvenile coho salmon, steelhead, and sea-run coastal cutthroat trout do. Following emergence, fry occupy low-velocity, shallow areas near stream margins, including backwater eddies and areas associated with bank cover, such as LWD (Lister and Genoe 1970, Everest and Chapman 1972, McCain 1992). As fry grow, they move into deeper and faster water further from banks (Hillman et al. 1987, Everest and Chapman 1972, Lister and Genoe 1970). Everest and Chapman (1972) observed at least small numbers of Chinook salmon fry in virtually all habitats sampled in early summer. Because Chinook salmon fry tend to be larger than coho salmon fry upon emergence, they may tend to use areas with higher water velocities than coho salmon (Murphy et al. 1989, Healey 1991). Most researchers have not addressed fry habitat requirements separately from juvenile summer habitat requirements, but there seems to be consensus that Chinook salmon fry prefer quiet, shallow water with cover.

Substantial variability in the depth and velocity preferences of juvenile Chinook salmon has been reported. Juvenile Chinook salmon were in virtually all sampled depths and velocities (Hillman et al. 1987, Murphy et al. 1989). Lister and Genoe (1970) found that juvenile Chinook salmon preferred slow water adjacent to faster water, i.e., 40 cm/s (1.3 ft/s). Everest and Chapman (1972) found emergent Chinook salmon fry using depths less than 60 cm (24 in.) and water velocities less than 15 cm/s (0.5 ft/s).

Juvenile Chinook salmon appear to prefer pools that have cover provided by banks, overhanging vegetation, large substrates, or LWD. As cover increases, so do juvenile densities in pools (Steward and Bjornn, unpubl. data, as cited in Bjornn and Reiser 1991). Water temperature may also influence juvenile habitat use.

Temperatures have a significant effect on juvenile Chinook salmon growth rates. On maximum daily rations, growth rate increases with temperature to a certain point and then declines with further increases. Reduced rations can also result in reduced growth rates. Therefore, declines in juvenile growth rates of anadromous salmonids are a function of both temperature and food availability. Laboratory studies indicate that, with unlimited food supply, growth rates of juvenile Chinook salmon are highest at rearing temperatures of 18.3º to 21.1ºC (65º to 70ºF) (Clarke and Shelbourn 1985, Banks et al. 1971, Brett et al. 1982, Rich 1987). Growth rates decrease at higher temperatures; temperatures above 23.3º C (74º F) are potentially lethal (Hanson 1990).

4.3.6 Ecological interactions

4.3.6.1 Interspecific interactions and competition

A number of studies have attempted to discern the influence of interspecific interactions between juvenile Chinook salmon and other salmonids on habitat preference and migration patterns. Differences in timing of emergence and subsequent growth rates may result in spatial or temporal habitat segregation; this may reduce interspecific competition between species in some areas. For example, in the Big Qualicum River, British Columbia, fall Chinook salmon and coho salmon both occupy stream margin (or lateral) habitats with cover during their first 3 months. Competition for rearing space is reduced by differences in emergence timing and growth rates (Lister and Genoe 1970). Lister and Genoe (1970) observed that juvenile Chinook salmon, perhaps because of their larger size, used higher water velocities in summer than juvenile coho salmon, and moved away from stream margins toward mid-channel areas earlier than coho

salmon. Although coho salmon and Chinook salmon exhibit some degree of habitat segregation on the microhabitat scale, they often inhabit similar regions of streams (Shirvell 1994, Lister and Genoe 1970).

Coho salmon have often been observed to be behaviorally dominant over juvenile Chinook salmon, and thus they may influence habitat use of Chinook salmon. Taylor (1991) found that in streams containing both coho salmon and Chinook salmon, Chinook salmon were more likely to use higher velocity, shallow riffles, while coho salmon formed hierarchies in low-velocity, deep pools. In study streams where coho salmon were absent, Chinook salmon were more likely to inhabit pools, although Chinook salmon appeared to be most abundant in riffles, whether or not coho salmon were present. Coho prefer pools and Chinook salmon prefer riffles. Taylor (1991) suggested that species-specific differences in habitat preferences may be reinforced or exacerbated by the behavioral dominance of coho salmon.

In an experimental stream trough, Stein et al. (1972) found that juvenile coho salmon dominated optimal feeding areas, such as the upstream ends of riffles. In the same study, the presence of juvenile coho salmon reduced growth rates of juvenile Chinook salmon and their access to optimal feeding positions. Stein et al. (1972) suggested that because fall Chinook salmon only rear for a short period in fresh water, the species may only require relatively small territories during this period, moving downstream before late summer flows reduce the amount of habitat available. Stein et al. (1972) concludes that Chinook salmon appear to be better adapted to rearing in mainstem and estuary areas, suggesting a greater tolerance for higher temperatures; coho salmon appear better adapted to rearing in cooler, small tributaries for more extended periods.

Everest and Chapman (1972) observed that timing differences in the spawning and emergence of Chinook salmon and steelhead resulted in size differences and reduced potential for interspecific competition. They found that Chinook salmon and steelhead rearing in sympatry were segregated according to depth, velocity, and substrate characteristics (Everest and Chapman 1972). At age 0+ Chinook salmon typically occupied areas intermediate in depth, velocity, and distance from the stream margin. By comparison, age 0+ steelhead occupied areas shallower, slower, and nearer the bank, while age 1+ steelhead occupied areas deeper, faster, and further from the bank. At age 1+ Chinook salmon occupied similar microhabitats as age 1+ steelhead. Because most Chinook salmon outmigrated earlier in the year, however, competition was reduced through temporal niche segregation (Everest and Chapman 1972). In the Rogue River of Oregon, Reedy (1995) found that juvenile fall Chinook salmon occupied areas closer to the water surface and with lower velocity than age 1+ steelhead, which typically used faster, deeper water. Segregated use of habitat according to depth, velocity, and substrate characteristics has been found to limit competition between rearing Chinook salmon and steelhead in other rivers (Everest and Chapman 1972).

4.3.6.2 Food web interactions

Juvenile Chinook salmon feed on invertebrate drift while rearing in fresh water (Healey 1991). Becker (1973) reported that in the Hanford Reach of the Columbia River, over 95% of their diet consisted of insects, especially adult chironomids. In estuaries, juvenile Chinook salmon may feed on algae, amphipods, fish (e.g., northern anchovy, Pacific herring), and terrestrial insects (e.g., adult Diptera, ants) (Nicholas and Hankin 1989). In the ocean, Chinook salmon feed primarily on small fish such as herring, but also consume amphipods, crab megalopa, squid, and a variety of other organisms (Healey 1980). Adults generally do not feed during their freshwater

spawning migration, relying instead on fat reserves for body maintenance and gonadal maturation.

4.3.6.3 Predators

Predators that feed on eggs, alevins, and juvenile Chinook salmon in rearing habitats include sculpin, trout and other piscivorous fish, as well as river otters, mink, American dippers, mergansers, belted kingfishers, and great blue herons (Healey 1991, Reedy 1995). In addition to these predators, juvenile Chinook salmon migrating downstream are also exposed to predation by birds (e.g., herons, egrets, gulls, and terns), marine mammals, and both native and introduced piscivorous fish. In many systems, juvenile Chinook salmon spend up to several months in estuaries, feeding and growing before entering the ocean (Healey 1991).

4.3.7 Sensitivity to anthropogenic disturbances

During their freshwater residence, Chinook salmon tend to primarily occur in mainstem rivers and larger tributaries. Due to their greater accessibility, these were some of the first areas where human disturbances such as logging, agriculture, and settlement took place. Early valley-bottom logging and the use of splash dams for log transport largely occurred in the mainstems of coastal rivers; this was "particularly devastating" to Chinook salmon habitat (Lichatowich 1989, p. 96). Because Chinook salmon habitat was degraded relatively early on as compared to upper tributary habitats used by coho salmon and steelhead, historical population abundance is particularly difficult to estimate for this species.

Conditions in coastal river habitat used by Chinook salmon appear to have improved since the 1960s, however, and systems have recovered somewhat from certain types of prior damage (Nicholas and Hankin 1989). Mainstem and estuary habitats may actually be recovering from degradation that occurred earlier this century. Smaller streams used by other anadromous salmonids for spawning and rearing have been more recently altered by land-use activities, such as clearcutting and road construction, and remain in degraded condition (Nicholas and Hankin 1989). Because most coastal Chinook salmon are fall-run types, most juveniles leave the rivers during their first summer; watershed disturbances that might increase mortality during winter freshets would not be as important as they are for juvenile coho salmon, steelhead, and cutthroat trout.

4.3.7.1 Changes in hydrologic regimes

Changes in natural flow regimes may impact populations of Chinook salmon through changes in stimuli used for timing of upstream and downstream migrations, dewatering of redds, displacement of fry or juveniles, or scouring of spawning gravels. Flow fluctuations accelerate the rate of downstream migration among Chinook salmon juveniles in laboratory experiments (McPhee and Brusven 1976, as cited in Hunter 1992). Increased peak flows due to logging, grazing, or hydroelectric operations can reduce survival of eggs and alevins through displacement if gravels are mobilized; juveniles may also be displaced if suitable velocity refuges are lacking in rearing areas (Nicholas 1988). Reduced instream flows due to diversions or reservoir storage may delay or halt adult and juvenile migrations, limit availability of rearing habitat, and reduce spawning habitat if minimum water depths are not met (Everest et al. 1985).

4.3.7.2 Changes in sediment dynamics

Timber harvesting and associated road building can cause increased levels of sediment delivery to stream channels, which may cause increased water turbidity, filling of pools, and reduction of rearing habitat for juvenile Chinook salmon. Increased water turbidity may have lethal or sub-lethal effects on salmonids. These effects include physiological stress such as gill trauma and

decreased osmoregulatory ability, and behavioral changes such as delayed migration, decreased feeding rates, and altered prey selection (Bash et el. 2001). Sedimentation and embeddedness of substrates may reduce food availability for salmonids (Crouse et al. 1981), primarily by reducing production of aquatic invertebrate food resources. The sedimentation of coastal estuaries due to increased erosion within the watershed, which has been documented in various coastal northern California rivers, reduces the good rearing habitat available to salmon before they enter the ocean (Puckett 1977, Hofstra 1983, Smith 1987). Increases in fine sediment inputs, that may result from timber harvesting, can substantially reduce spawning gravel permeability and egg-to-emergence survival (McNeil and Ahnell 1964, Peters 1965).

Increased supply of fine sediments to streams can reduce the suitability of spawning and rearing habitats by filling interstitial spaces between sediment particles, reducing intragravel flow and the delivery of dissolved oxygen to incubating eggs and developing alevins (Chapman 1988). Bjornn et al. (1977) found that survival-to-emergence of Chinook salmon declined when percentage of fine sediments (<6.5 mm (0.25 in.)) in spawning substrate was greater than 20–30%.

Sedimentation during the incubation and over-wintering periods may also cause direct mortality by entombing eggs, alevins, fry, and juveniles. Chinook salmon eggs may be more sensitive to reductions in dissolved oxygen than other salmonids, given their large size and small surface-to-volume ratio (Healey 1991). The filling of pools by sediment can reduce the amount of rearing habitat available to juvenile Chinook salmon. Bjornn et al. (1977) found that adding sand and reducing pool volume by 50% reduced abundance of juvenile Chinook salmon by over 66%. Sedimentation may also fill interstitial spaces used as velocity refuge by juvenile salmon during high flow events (Hillman et al. 1987).

4.3.7.3 Changes in LWD dynamics

Reduction of LWD in stream channels has been one of the most pronounced long-term effects of forest management on salmonids in North America (Hicks et al. 1991a); it causes decreased frequency, depth, and complexity of pool habitat used by rearing juvenile salmonids. Removal of LWD from streams throughout coastal Mendocino County, under the direction of CDFG, has taken place since the 1950s (CDFG 1997a, unpubl. data); this has resulted in a general loss of habitat complexity in streams in the plan area. Pool habitat is an important geomorphic feature of channels where Chinook salmon rear; however, such habitat is probably more important to coho salmon (see section 4.2.4). Reduced levels of LWD may limit formation of backwater pools and complex lateral habitat used by emergent Chinook salmon fry (McCain 1992).

4.3.7.4 Changes in stream temperatures and water quality

Logging and grazing practices that reduce riparian vegetation and stream channel shading may increase stream temperature; this, in turn, may reduce survival of adult and juvenile Chinook salmon. In the John Day River (Oregon), high summer water temperatures in mainstem areas appear to reduce usable habitat for juvenile rearing (Lindsay et al. 1986). However, because fall Chinook salmon emigrate to the ocean before the hottest summer months, the effects of elevated water temperatures on juvenile Chinook salmon are generally minimal compared to other salmonids, such as coho salmon and steelhead, that rear in streams during summertime.

Use of fertilizers and pesticides on logging and agricultural areas can reduce water quality and food resources for salmonids (Nicholas 1988).

4.3.7.5 Commercial and recreational harvest

Chinook salmon may be exposed to ocean harvest for several years. Ocean harvest rates of Chinook salmon in Mendocino County are unknown and are difficult to estimate. Restrictions on ocean Chinook salmon harvest in northern California and southern Oregon are likely to have lowered the harvest rate of south-migrating Chinook salmon to levels comparable to north-migrating fish (Nicholas and Hankin 1989). In 1994, the Pacific Fishery Management Council banned commercial salmon harvest off the Washington coast and restricted commercial and sport fishing off the California and Oregon coasts.

4.3.7.6 Hatcheries

Interbreeding between wild and hatchery fish on natural spawning grounds may be a threat to the genetic integrity of wild stocks of Chinook salmon, whether or not the hatchery stock is of native origin. Moyle et al. (1989) point out that hatcheries select for different traits than the natural environment. This is referred to as "domestication selection" because fish are reared under conditions of reduced predation, simplified habitat, artificial feeding, extremely high rearing densities, etc. Hatcheries may also be subject to disease outbreaks, water contamination, and other problems. Hatchery-produced juveniles residing in rivers for an extended period may compete with wild juvenile salmonids for rearing space and food resources. Timing the release of hatchery smolts to avoid competition with juveniles can minimize these effects (Nicholas 1988).

4.3.8 Impacts of MLC (2008)

At least 5 CalWater planning watersheds, known to have Chinook salmon present, experienced some impact from the fires. The fires burned over 2348 ac of the plan area which were in watersheds with Chinook salmon.

4.3.9 Key uncertainties

The current and historical abundance of Chinook salmon in most coastal streams and rivers of Mendocino County is largely unknown. Limited information is available describing historical distribution. The continuation of population estimates will be crucial in providing data to allow more robust estimates of abundance.

Although hypotheses exist, more information is needed on the factors that may limit the recovery and maintenance of Chinook salmon populations in the region. Freshwater habitat quality and quantity is likely a limiting factor. Most of the details about habitat relationships of Chinook salmon are based upon research outside of the plan area. The specifics of these relationships may not be identical within the plan area.

MRC management has identified the following key uncertainties:

- What is the current and historical distribution of Chinook salmon in coastal streams and rivers of Mendocino County?
- What is the contribution of each limiting factor to Chinook salmon populations?

4.4 Steelhead

4.4.1 Geographic distribution

Illustration by Ron Pittard

Steelhead (*Oncorhynchus mykiss*) are distributed throughout the northern Pacific Ocean. Historically they spawned in streams along the west coast of North America from Alaska to northern Baja California. The species is currently known to spawn only as far south as Malibu Creek in southern California (Barnhart 1991, NMFS 1996a). Two major genetic groups occur along the west coast of North America: a coastal and an inland group (Schreck et al. 1986, Reisenbichler et al. 1992, NMFS 1996a). Populations in California are believed to belong only to the coastal group (NMFS 1996a, NMFS 2000b).

4.4.2 Local distribution

The steelhead populations found in the assessment area belong to 2 contiguous ESUs (NMFS 1996a). Populations in river basins from Redwood Creek (Humboldt County) south to and including the Gualala River (Mendocino County) belong to the Northern California ESU. Populations in river basins from the Russian River (Mendocino County) south to and including Aptos Creek (Santa Cruz County) belong to the Central California Coast ESU. On August 18, 1997, NMFS listed populations belonging to the Central California Coast ESU as threatened under the federal Endangered Species Act (NMFS 1997). The listing does not include hatchery populations from the Warm Springs Hatchery on Dry Creek, a tributary to the Russian River. On June 7, 2000, NMFS listed the Northern California steelhead ESU, which includes naturally reproducing populations, as well as several natural-origin hatchery stocks (NMFS 2000b).

The plan area extends over a large area in Mendocino County, from Hollow Tree Creek south to the Garcia River. Within this area are watersheds of numerous small coastal streams and large rivers. Major rivers within the plan area include the Eel, Big, Noyo, Navarro, Garcia, and Russian rivers. Winter-run steelhead or "winter steelhead" occur throughout the plan area.

The former landowner (Louisiana Pacific) conducted fish distribution surveys throughout their coastal Sonoma and Mendocino county lands from 1994 through 1996. MRC is currently repeating this effort. NMFS (2000a) has also compiled data on steelhead occurrence for streams in Mendocino and Sonoma counties. Distribution surveys document the consistent presence of steelhead in nearly every stream in the assessment area that is accessible to this species (NMFS 2000a, MRC 2002c). Steelhead are also present within the Albion and Navarro river estuaries. Portions of these estuaries are within the plan area.

4.4.3 Population trends

Recent status reviews (Good et al 2005) indicate that both the Northern California and Central California Coast DPS of steelhead are “likely to become endangered.” Nearly 25% of the members of the Biological Review Team who conducted the status review urged that the Central California Coast DPS was “in danger of extinction.” The most significant causes for concern for both DPS are the abundance and productivity of steelhead. Although the status review identified a lack of data as a concern, the data available suggests continued declines.

NMFS (1996b) has concluded that populations of naturally reproducing steelhead have been experiencing a long-term decline in abundance throughout their range. Populations in the southern portion of the range have experienced the most severe declines, particularly in streams

from California's Central Valley and southward, where many stocks have been extirpated (NMFS 1996a). Although northern California steelhead populations have also shown downward trends in abundance, these stocks are generally considered to be larger in size and more stable than southern California stocks (Mills et al. 1997). During this century, 23 naturally reproducing populations of steelhead are believed to have been extirpated in the western United States. Many more are thought to be in decline in Washington, Oregon, Idaho, and California. Nehlsen et al. (1991) identified 43 steelhead populations as being of moderate or high risk of extinction. No winter steelhead populations located in the assessment area were identified as at risk.

Based on analyses of dam and weir counts, stream surveys, and angler catches, NMFS (1997) concluded that, of the 160 west coast steelhead stocks for which adequate data were available, 118 (74%) exhibited declining trends in abundance, while the remaining 42 (26%) exhibited increasing trends. In 2000, NMFS again reviewed the most recently available status and trend data and concluded that steelhead in the Northern California ESU were likely to become endangered in the foreseeable future (NMFS 2000b).

No consistent effort has been made to monitor steelhead populations in California (Mills et al. 1997, Cramer et al. 1995). Population data, therefore, are sparse; methods used and quality of data are inconsistent. Available data include dam and weir counts, hatchery returns, angler data, snorkel surveys, and juvenile rearing surveys. Information on long-term trends in abundance is available for only 3 steelhead populations in the state: (1) Sacramento River above Red Bluff Diversion Dam; (2) Eel River above Cape Horn Dam; and (3) Middle Fork Eel River (Cramer et al. 1995). Additional data on returning adult steelhead exist from counts at Benbow Dam on the South Fork Eel River between 1938 and 1975 (Taylor 1978). Populations in the Sacramento River are outside the plan area and, therefore, outside our discussions.

Counts on the Eel River document steelhead declines beginning in the 1950s (Cramer et al. 1995). At Cape Horn Dam on the upper Eel River, adult steelhead escapement since 1967 (i.e., following the construction of the dam) has ranged from 2200 to less than 100 fish (Mills et al. 1997). The lowest count (approximately 50 fish) occurred in 1993. Counts on the Middle Fork Eel River began in 1966 and significant declines were detected beginning in 1987 (Cramer et al. 1995). Although exhibiting declines, the stock is relatively stable in comparison to other populations. This may be the result of several factors: the fairly remote nature of the watershed; the river not being stocked with hatchery fish; and restrictions on angling harvest. On the South Fork Eel River, steelhead numbers showed a generally declining trend during the period of record. During the first 10 years that steelhead were counted (1938–1947), an average of 18,264 steelhead per year passed Benbow Dam. Between 1966 and 1975, the final 10 years of steelhead counting at Benbow Dam, the average had declined to 3195 fish per year (Taylor 1978).

Steelhead populations in the Central California Coast ESU are believed to have exhibited more substantial declines than those in other ESUs. Definitive abundance trends in the area covered by our HCP/NCCP are difficult to discern, due to the paucity of data on steelhead populations in this ESU. In the 1960s, the California Department of Fish and Game (CDFG 1965, as cited in NMFS 1997) counted 50,000 steelhead in the Russian River. NMFS recently estimated that only 7000 steelhead exist in this drainage (NMFS 1997). Similarly, adult steelhead returning to the Warm Springs Hatchery have been monitored since 1981; they have declined steadily, corroborating information which suggests that naturally reproducing steelhead stocks in this basin are also undergoing declines (Cramer et al. 1995).

4.4.4 Life history

4.4.4.1 Overview

Steelhead is the term used to distinguish anadromous populations of rainbow trout from resident populations. Much life history variability exists among steelhead populations. Populations may be broadly categorized, however, into 2 reproductive groups, most commonly referred to as either winter-run or summer-run, depending on the time at which adults enter rivers at the beginning of their spawning migration. Summer-run steelhead occur within the Northern California steelhead ESU, but are not believed to range further south than the Middle Fork Eel River (NMFS 2000b). Because the assessment area extends only as far north as the South Fork Eel River drainage, only winter-run steelhead are believed to occur in the plan area. The following discussions of life history and habitat requirements, therefore, refer only to winter-run steelhead.

4.4.4.2 Adult upstream migration and spawning

Steelhead return to spawn in their natal stream, usually in their fourth or fifth year of life, with males typically returning to freshwater earlier than females (Shapovalov and Taft 1954, Behnke 1992). A small percentage of steelhead may stray into streams other than those in which they were born. Although the majority of steelhead populations are either primarily winter-run or summer-run, adults may enter spawning streams in almost any month of the year and spawning may occur at any time from January to June (Behnke 1992, NMFS 1996a). Winter-run steelhead populations generally enter spawning streams from fall through spring as sexually mature adults and spawn a few months later in late winter or spring (Roelofs 1985, Meehan and Bjornn 1991, Behnke 1992).

Adult steelhead migrate upstream on both the rising and falling limbs of high flows, but do not appear to move during flood peaks. Some authors have suggested that increased water temperatures trigger movement, but some steelhead ascend into freshwater without any apparent environmental cues (Barnhart 1991). Peak upstream movement appears to occur in the morning and evening, although steelhead have been observed to move at all hours (Barnhart 1991). Steelhead are among the strongest swimmers of freshwater fishes. Cruising speeds, which are used for long-distance travel, are up to 1.5 m/s (5 ft/s); sustained speeds, which may last several minutes and are used to surpass rapids or other barriers, range from 1.5 to 4.6 m/s (5 to 15 ft/s), and darting speeds, which are brief bursts used in feeding and escape, range from 4.3 to 8.2 m/s (14 to 27 ft/s) (Bell 1973, as cited in Everest et al. 1985; Roelofs 1987). Steelhead have been observed making vertical leaps of up to 5.2 m (17 ft) over falls (Roelofs 1987).

During spawning, female steelhead create a depression in streambed gravels by vigorously pumping their body and tail horizontally near the streambed. Steelhead redds are approximately 10–30 cm (4–12 in.) deep, 38 cm (15 in.) in diameter, and oval in shape (Needham and Taft 1934, Shapovalov and Taft 1954). Males do not assist with redd construction, but may fight with other males to defend spawning females (Shapovalov and Taft 1954). Males fertilize the eggs as the females deposit them in the redd. Afterwards the females move to the upstream end of the nest and stir up additional gravel, covering the egg pockets (Orcutt et al. 1968). Females then move 2 to 3 ft upstream and dig another pit, enlarging the redd. Females may dig 6 to 7 egg pockets, moving progressively upstream; spawning may continue for several days to over a week (Needham and Taft 1934). A female approximately 85 cm (33 in.) in length may lay 5000 to 10,000 eggs; fecundity is related to age and length of the adult female and varies between populations (Meehan and Bjornn 1991). In cases where spawning habitat is limited, late-arriving spawners may superimpose their redds atop existing nests (Orcutt et al. 1968).

Although most steelhead die after spawning, adults are capable of returning to the ocean and migrating back upstream to spawn in subsequent years, unlike most other Pacific salmon. Runs may include from 10 to 30% repeat spawners, the majority of which are females (Ward and Slaney 1988, Meehan and Bjornn 1991, Behnke 1992). Repeat spawning is more common in smaller coastal streams than in large drainages requiring a lengthy migration (Meehan and Bjornn 1991). Hatchery steelhead are typically less likely than wild fish to survive to spawn a second time (Leider et al. 1986).

Whereas females spawn only once before returning to the sea, males may spend 2 or more months in spawning areas and may mate with multiple females, incurring higher mortality and reducing their chances of repeat spawning (Shapovalov and Taft 1954). Steelhead may migrate downstream to the ocean immediately following spawning or may spend several weeks holding in pools before migrating (Shapovalov and Taft 1954).

4.4.4.3 Egg incubation, alevin development, and fry emergence

Hatching of eggs follows a 20–100 day incubation period, the length of which depends on water temperature (Shapovalov and Taft 1954, Barnhart 1991). Newly-hatched steelhead alevins remain in the gravel for an additional 14–35 days while being nourished by their yolk sac (Barnhart 1991). Fry emerge from the substrate just before total yolk absorption under optimal conditions; later-emerging fry that have already absorbed their yolk supply are likely to be weaker (Barnhart 1991). Upon emergence, fry inhale air at the stream surface to fill their air bladder, absorb the remains of their yolk, and start to feed actively, often in schools (Barnhart 1991, NMFS 1996c). Survival from egg to emergent fry is typically less than 50% (Meehan and Bjornn 1991), but may be quite variable depending upon local conditions.

4.4.4.4 Juvenile freshwater rearing

Juvenile steelhead (parr) rear in freshwater before migrating to the ocean as smolts. The duration of time parr spend in freshwater appears to be related to growth rate, with larger, faster-growing members of coho from the same brood year smolting earlier (Peven et al. 1994). Steelhead in warmer areas, where feeding and growth are possible throughout the winter, may require a shorter period in freshwater before smolting, while steelhead in colder, more northern, and inland streams may require 3 or 4 years before smolting (Roelofs 1985).

Juveniles typically remain in their natal streams for at least their first summer, dispersing from fry schools and establishing feeding territories (Barnhart 1991). Peak feeding and freshwater growth rates occur in late spring and early summer. In the Smith River of Oregon, Reedy (1995) suggested that rising stream temperatures and reduced food availability occurring in late summer may lead to a decline in steelhead feeding activity and growth rates.

Juveniles either overwinter in their natal streams if adequate cover exists or disperse as pre-smolts to other streams to find more suitable winter habitat (Bjornn 1971, Dambacher 1991). As stream temperatures fall below approximately 7°C (44.6°F) in the late fall to early winter, steelhead enter a period of winter inactivity spent hiding in the substrate or closely associated with instream cover, during which time growth ceases (Everest and Chapman 1972). Age 0+ steelhead (less than 1 year of age) appear to remain active later into the fall than 1+ steelhead (Everest et al. 1986). Winter hiding behavior of juveniles reduces their metabolism and food requirements and reduces their exposure to predation and high flows (Bustard and Narver 1975a), although substantial mortality appears to occur in winter, nonetheless. Winter mortalities ranging from 60 to 86% for 0+ steelhead and from 18 to 60% for 1+ steelhead were reported in Fish Creek in the Clackamas River basin, Oregon (Everest et al. 1988, as cited in Dambacher 1991).

Juveniles appear to compete for food and rearing habitat with other steelhead. Age 0+ and 1+ steelhead exhibit territorial behavior (Everest and Chapman 1972), although this behavior may dissipate in winter as fish reduce feeding activity and congregate in suitable cover habitat (Meehan and Bjornn 1991). Reedy (1995) found that steelhead in the tails of pools did not exhibit territorialism or form dominance hierarchies. Steelhead may overwinter in mainstem reaches, particularly if coarse substrates in which to seek cover from high flows are available (Reedy 1995), or they may return to tributaries for the winter (Everest 1973, as cited in Dambacher 1991).

At the end of the freshwater rearing period, steelhead migrate downstream to the ocean as smolts, typically at a length of 15 to 20 cm (5.9 to 7.8 in.) (Meehan and Bjornn 1991). A length of 14 cm (5.5 in.) is typically cited as the minimum size for smolting (Wagner et al. 1963, Peven et al. 1994). Evidence suggests that photoperiod is the most important environmental variable stimulating the physiological transformation from parr to smolt (Wagner 1974). During smoltification, the spots and parr marks characteristic of juvenile coloration are replaced by a silver and blue-green iridescent body color (Barnhart 1991) and physiological transformations occur that allow them to survive in salt water.

Less is known regarding the use of estuaries by steelhead than for other anadromous salmonid species; however, the available evidence shows that steelhead in many systems use estuaries as rearing habitat. Smith (1990) concluded that even tiny lagoons unsuitable for summer rearing can contribute to the maintenance of steelhead populations by providing feeding areas during smolt migration in winter or spring.

Estuarine rearing may be more important to steelhead populations in the southern half of the species' range. This is due to greater variability in ocean conditions and paucity of high quality near-shore habitats in this portion of their range (NMFS 1996a). Estuaries may also be more important to populations spawning in smaller coastal tributaries due to the more limited availability of rearing habitat in the headwaters of smaller stream systems (McEwan and Jackson 1996). Most marine mortality of steelhead occurs soon after they enter the ocean and predation is believed to be the primary cause of this mortality (Pearcy 1992, as cited in McEwan and Jackson 1996). Because predation mortality and fish size are likely to be inversely related (Pearcy 1992, as cited in McEwan and Jackson 1996), the growth that takes place in estuaries may be very important for increasing the odds of marine survival (Pearcy 1992, as cited in McEwan and Jackson 1996; Simenstad et al. 1982, as cited in NMFS 1996a; Shapovalov and Taft 1954).

Steelhead have variable life histories and may migrate downstream to estuaries as age 0+ juveniles or may rear in streams up to 4 years before migrating to the estuary and ocean (Shapovalov and Taft 1954). Steelhead, migrating downstream as juveniles, may rear for 1–6 months in the estuary before entering the ocean (Barnhart 1991). Shapovalov and Taft (1954) conducted exhaustive life history studies of steelhead and coho salmon in Waddell Creek (Santa Cruz County, CA) and found that coho salmon went to sea almost immediately after migrating downstream, but that some of the steelhead remained for a whole season in Waddell Creek lagoon or the lower portions of the stream before moving out to sea. Some steelhead individuals remained in the lagoon rather than moving out to sea and migrated back upstream and underwent a second downstream migration the following year. In Scott Creek lagoon (Santa Cruz County), Marston (1992, as cited in McEwan and Jackson 1996) found that half of the steelhead rearing in the lagoon in June and July of 1992 were less than 90 mm (3.5 in.) and appeared to be pre-smolts. Coots (1973, as cited in McEwan and Jackson 1996) found that 34% of juvenile steelhead in San Gregorio Creek lagoon captured in summer were juveniles less than 100 mm (3.9 in.) in length.

From these studies and others, it has been shown estuaries provide valuable rearing habitat to juvenile and yearling steelhead and not merely a corridor for smolts migrating to the ocean.

In the Columbia River estuary, McCabe et al. (1983) found that steelhead were one of the 3 most common salmonids present, along with Chinook salmon and coho salmon. In this study, yearling steelhead were an important part of the sampling catch in May in the pelagic areas of the upper Columbia River estuary. Overall, steelhead were captured almost exclusively in the pelagic areas of the upper and lower estuary.

4.4.4.5 Ocean phase

The majority of steelhead spend 1 to 3 years in the ocean, with smaller smolts tending to remain in salt water for a longer period than larger smolts (Chapman 1958, Behnke 1992). Steelhead grow rapidly in the ocean compared to in freshwater rearing habitats, with growth rates potentially exceeding 2.5 cm (1 in.) per month (Shapovalov and Taft 1954, Barnhart 1991). Steelhead in the ocean for 2 years typically weigh 3.2 to 4.5 kg (7 to 10 lb.) upon return to fresh water (Roelofs 1985). Unlike other salmonids, steelhead do not appear to form schools in the ocean. Steelhead in the southern part of the species' range appear to migrate close to the continental shelf, while more northern populations of steelhead may migrate throughout the northern Pacific Ocean (Barnhart 1991).

4.4.5 Habitat requirements

4.4.5.1 Adult upstream migration and spawning

During their upstream migration, adult steelhead require deep pools for resting and holding (Puckett 1975, Roelofs 1983, as cited in Moyle et al. 1989). Deep pool habitat (> 1.5 m or 4.88 ft) is preferred by summer steelhead during the summer holding period. Steelhead need water with a minimum depth of 18 cm (0.59 ft) and maximum velocity of 240 cm/s (8 ft/s) for successful upstream migration (Thompson 1972, as cited in Everest et al. 1985). Relatively cool water temperatures, between 10° to 15°C (50° to 59°F) are preferred by adults, although they may survive temperatures as high as 27°C (80.6°F) for short periods (Moyle et al. 1989).

Areas of the stream with water depths from about 18 to 137 cm (7 to 53 in.) and velocities from 0.6 to 1.15 m/s (2 to 4 ft/s) are typically preferred for spawning by adult steelhead (Moyle et al. 1989, Barnhart 1991). Pool tailouts or heads of riffles with well-oxygenated gravels are often selected as redd locations (Shapovalov and Taft 1954). The average area encompassed by a redd is 4.4–5.4 m^2 (47–58 ft2) (Orcutt et al. 1968, Hunter 1973, both as cited in Bjornn and Reiser 1991). Gravels ranging in size from 0.64 to 13 cm (0.25 to 5 in.) in diameter are suitable for redd construction (Barnhart 1991). Steelhead pairs have been observed spawning within 1.2 m (4 ft) of each other (Orcutt et al. 1968). Bell (1986) indicates that preferred temperatures for steelhead spawning range from 3.9° to 9.4°C (39° to 48.9°F). Steelhead may spawn in intermittent streams, but juveniles soon move to perennial streams after hatching (Moyle et al. 1989). In the Rogue River drainage, summer steelhead are more likely to spawn in intermittent streams, while winter steelhead typically spawn in permanent streams (Roelofs 1985).

4.4.5.2 Egg incubation, alevin development, and fry emergence

Incubating eggs require dissolved oxygen concentrations, with optimal concentrations at or near saturation. Low dissolved oxygen increases the length of the incubation period and causes emergent fry to be smaller and weaker. Dissolved oxygen levels remaining below 2 mg/l (2 ppm) result in egg mortality (Barnhart 1991). Information available in the literature indicates that preferred incubation temperatures range from 9° to 11°C (48° to 52°F) (McEwan and Jackson 1996, FERC 1993).

4.4.5.3 Juvenile freshwater rearing

After emergence from spawning gravels in spring or early summer, steelhead fry move to shallow-water, low-velocity habitats, such as stream margins and low-gradient riffles, and will forage in open areas lacking instream cover (Hartman 1965, Everest et al. 1986, Fontaine 1988). As fry increase in size in late summer and fall, they increasingly use areas with cover and show a preference for higher-velocity, deeper mid-channel waters near the thalweg (Hartman 1965, Everest and Chapman 1972, Fontaine 1988). In general, age 0+ steelhead occur in a wide range of hydraulic conditions (Bisson et al. 1988), appearing to prefer water less than 50 cm (19.5 in.) deep with velocities below 0.3 m/s (0.98 ft/s) (Everest and Chapman 1972). Age 0+ steelhead have been found to be relatively abundant in backwater pools and often live in the downstream ends of pools in late summer (Bisson et al. 1988, Fontaine 1988).

Older age classes of juvenile steelhead (age 1+ and older) occupy a wide range of hydraulic conditions. They prefer deeper water during the summer and have been observed to use deep pools near the thalweg with ample cover as well as higher-velocity rapid and cascade habitats (Bisson et al. 1982, Bisson et al. 1988). Age 1+ fish typically feed in pools, especially scour and plunge pools, resting and finding escape cover in the interstices of boulders and boulder-log clusters (Fontaine 1988, Bisson et al. 1988). During summer, steelhead parr appear to prefer habitats with rocky substrates, overhead cover, and low light intensities (Hartman 1965, Facchin and Slaney 1977, Ward and Slaney 1979, Fausch 1993). Age 1+ steelhead appear to avoid secondary channel and dammed pools, glides, and low-gradient riffles with mean depths less than 20 cm (7.8 in.) (Fontaine 1988, Bisson et al. 1988, Dambacher 1991). In the Steamboat Creek basin, a tributary to the North Umpqua River in Oregon, Dambacher (1991) found that age 1+ and older juvenile steelhead were most abundant in areas with large boulder substrates compared to other substrate categories.

As steelhead grow larger, they tend to prefer microhabitats with deeper, higher velocity water as locations for focal points. They attempt to find areas with an optimal balance of food supply versus energy expenditure, such as velocity refuge positions associated with boulders or other large rough elements close to swift current with high macroinvertebrate drift rates (Everest and Chapman 1972, Bisson et al. 1988, Fausch 1993). Reedy (1995) indicates that 1+ steelhead especially prefer high-velocity pool heads. Here there are abundant food resources as well as pool tails, which provide optimal feeding conditions in summer due to lower energy expenditure requirements than the more turbulent pool heads. Fast, deep water, in addition to optimizing feeding versus energy expenditure, provides greater protection from avian and terrestrial predators (Everest and Chapman 1972).

Age 1+ steelhead appear to prefer rearing habitats with velocities ranging from 10–30 cm/s (0.3–1.0 ft/s) and depths ranging from 50–75 cm (19.5–29.3 in.) (Everest and Chapman 1972, Hanson 1977, as cited in Bjornn and Reiser 1991). During the juvenile rearing period, steelhead are often observed using habitats with swifter water velocities and shallower depths than coho salmon (Sullivan 1986, Bisson et al. 1988), a species they are often sympatric with. In comparison with juvenile coho salmon, steelhead have a fusiform body shape that is better adapted to holding and feeding in swifter currents (Bisson et al. 1988). Where the 2 species coexist, this generally results in spatial segregation of rearing habitat that becomes most apparent during the summer months. While juvenile coho salmon are strongly associated with low-velocity habitats, such as pools, throughout the rearing period (Shirvell 1990), steelhead will use riffles (age 0+) and higher velocity pool habitats (age 1+), such as scour and plunge pools in the summer (Sullivan 1986, Bisson et al. 1982). In streams within the plan area, coho salmon are sympatric with steelhead in some locations, but patterns of overlapping habitat use are not known.

Preferred rearing temperatures for steelhead range from 7.2° to 14.4°C (45°F to 57.9°F), with optimum temperatures for juveniles occurring from 10° to 12.8°C (50° to 55°F) and lethal temperatures occurring at 23.8°C (74.8°F) (Bell 1991). Preferred migration temperatures are <57°F (<13°C).

4.4.5.4 Lagoon habitat

Lagoon and estuarine habitat are quite important for steelhead and other salmonids. Estuaries serve as important nursery habitat, as they are high in habitat diversity, produce large quantities of low trophic level food, and offer a relatively sheltered environment from predators. Within these dynamic and highly productive environments, juvenile coho salmon and steelhead trout feed and grow while undergoing physiological and behavioral changes associated with smolt transformation. As the juvenile salmonids rear in lagoons and estuaries, additional growth increases their survival rate upon entry into the ocean, especially during years with poor ocean conditions (Cannata 1998).

Smith (1990) found that fish populations utilizing lagoons consisted of freshwater, estuarine, and saltwater species. The number of species increased with lagoon size. Analysis of scales from 27 adult steelhead collected on Pescadero Creek from 1985-1989 showed that 16 fish (i.e., 59.3%) reared in a lagoon their entire lives before entering the ocean. At least 70% of the steelhead sampled reared in the lagoon during some phase of their life. One fish attained 40% of its length while rearing in the lagoon.

Bond (2008) found that during the annual spring emigration in Scott Creek (California), the largest smolts, >150 mm fork length (FL), moved directly to sea, while some smaller smolts remained in the estuary until sandbar formation created a closed freshwater lagoon. High growth rates in the estuary throughout the summer resulted in a near doubling of fork length from the time of estuary entry. The mean FL of spring migrants was 102.2 mm while the mean FL of fall lagoon residents was 195.9 mm. Analysis of the scale morphology of returning adult steelhead indicated that there is strong size-dependent mortality at sea, with estuary reared steelhead showing a large survival advantage.

4.4.5.5 Winter rearing habitat

Steelhead over-winter in pools, especially deep, low-velocity pools with large rocky substrate or woody debris for cover; they also use backwater and dammed pools (Hartman 1965, Swales et al. 1986, Raleigh et al. 1984, Fontaine 1988). Juveniles are known to use the interstices between substrate particles as overwintering cover. Bustard and Narver (1975a) typically found age 0+ steelhead using 10–25 cm (3.9–9.7 in.) diameter cobble substrates in shallow, low-velocity areas near the stream margin. Everest et al. (1986) observed age 1+ steelhead using logs, rootwads, and interstices between assemblages of large boulders (>100 cm or 39 in. diameter) surrounded by small boulders to cobble size (50–100 cm or 19.7–39 in. diameter) materials as winter cover. Age 1+ fish typically stay within the area of the streambed that remains inundated at summer low flows, while age 0+ fish frequently overwinter beyond the summer low flow perimeter along the stream margins (Everest et al. 1986).

In winter, 1+ steelhead prefer water deeper than 45 cm (17.5 in.), while age 0+ steelhead often occupy water less than 15 cm (5.8 in.) deep and are rarely found at depths over about 60 cm (23.4 in.) (Bustard and Narver 1975a). Below 7°C (44.6°F), juvenile steelhead prefer water velocities <15 cm/s (0.5 ft/s) (Bustard and Narver 1975a). Spatial segregation of stream habitat by juvenile coho salmon and steelhead is less pronounced in winter than in summer, although older juvenile steelhead may prefer deeper pools than coho salmon (Bustard and Narver 1975a).

In many coastal California streams, including those in the plan area, the quality of overwintering habitats in tributaries used by steelhead has likely declined due to reductions in in-channel LWD and associated loss of pool habitats and habitat complexity.

4.4.5.6 Ocean phase

Little is known about steelhead use of ocean habitat, although changes in ocean conditions may be important for explaining trends among California coastal steelhead populations (Kostow 1995). Evidence suggests that increased ocean temperatures associated with El Niño events may increase ocean survival as much as 2-fold (Ward and Slaney 1988). The magnitude of upwelling determines the amount of nutrients brought to the ocean surface and relates to wind patterns; it influences ocean productivity and has a significant effect on steelhead growth and survival (Barnhart 1991). Steelhead appear to prefer ocean temperatures of 9°–11.5°C (48.2°–52.7°F) and typically swim in the upper 9–12 m (30–40 ft) of the ocean's surface (Barnhart 1991).

4.4.6 Ecological interactions

4.4.6.1 Food web interactions

Emergent fry initially feed on zooplankton and other microorganisms (Barnhart 1991). Juveniles feed on a wide range of items, primarily those associated with the stream bottom such as aquatic insects, amphipods, aquatic worms, fish eggs, and occasionally smaller fish (Wydoski and Whitney 1979). Juveniles may also feed on spiders, mollusks, and fish, including smaller steelhead (Roelofs 1985). Age 0+ steelhead prefer benthic invertebrates (Johnson and Ringler 1980); larger steelhead, having larger mouths, can consume a broader range of foods (Fausch 1991). In the ocean, steelhead feed on juvenile greenling, squids, amphipods, and other organisms (Barnhart 1991).

Adult summer steelhead do not usually feed in fresh water and can endure long periods without food, during which time their stomachs shrink (Shapovalov and Taft 1954, Roelofs 1987). Summer steelhead, which spend longer periods in fresh water before spawning, may be more likely to feed in freshwater than adult winter steelhead. Food items taken by adults include caddisflies, mayflies, stoneflies, salmon eggs and, infrequently, other fish (Barnhart 1991).

4.4.6.2 Predators

Major predators of adult steelhead include humans, marine mammals, and large pelagic fish. Eggs may be eaten by macroinvertebrates, crayfish, and other fish. Juvenile steelhead may be preyed upon by garter snakes, piscivorous fish, such as older salmonids (including steelhead), freshwater sculpins, introduced piscivorous fish (e.g., smallmouth bass, striped bass), mammals (e.g., river otter, mink), and piscivorous birds (e.g., mergansers, kingfishers, herons, ospreys, loons). Juvenile steelhead have been observed feeding on emergent fry (Shapovalov and Taft 1954).

MRC has land in sub-basin tributaries to the South Fork Eel River (Hollow Tree, Mill, and Jack of Hearts creeks), where Sacramento pikeminnow prey on juvenile steelhead (Nakamoto and Harvey 2002, unpubl. data). Sacramento pikeminnow were first discovered in the South Fork Eel River in 1979. In 1995, over half of the pikeminnow larger than 250 mm sampled in the upper South Fork Eel River in August had juvenile salmonids in their stomachs (Nakamoto and Harvey 2002, unpubl. data). Pikeminnow, larger than about 100 mm, are potentially piscivorous; the proportion of fish in their diet generally increases with length. Habitat alterations and increases in stream temperature from the Potter Valley Project, Lake Pillsbury Reservoir, and pool filling from logging-related sediment appear to increase pikeminnow predation on salmonids (Harvey et al. 2002). However, the non-selective prey selection strategy of pikeminnow, and the fact that

juvenile steelhead occur at relatively low densities in the Eel River, may prevent them from having strong effects on the steelhead population. In addition, because they outmigrate at a relatively large size, steelhead may be less susceptible during migration than other anadromous species.

Pikeminnow sometimes occur in the lower reaches of some South Fork Eel River tributaries, such as Hollow Tree Creek, during summers, depending on flow and water temperatures (Harvey et al. 2002). Their distribution appears to expand during low-flow years when water temperatures in these streams are warmer, and decrease in years with higher flows (Harvey et al. 2002). Land management activities that result in water temperature increases could result in further range expansion in the South Fork Eel River and its tributaries (Harvey et al. 2002). In addition to causing direct mortality through predation on juvenile steelhead, interspecific interactions between the 2 species may force juvenile steelhead to use less optimal habitat in streams where they coexist (Brown and Moyle 1991). Laboratory experiments conducted by Reese and Harvey (2002) indicated that juvenile steelhead growth decreased at temperatures over 20-23ºC (68–73ºF) in the presence of pikeminnow, likely as a result of competition for food and optimal habitat.

Whether or not Sacramento pikeminnow are present in tributaries, all steelhead produced in tributaries to the South Fork Eel must outmigrate through areas with large numbers of pikeminnow during the spring. Pikeminnows in the Eel River forage on migrating juvenile salmon in the spring (Moyle 2002). However, most of the pikeminnow consumption of salmonids reportedly occurred in mid- to late-summer when flows were lower, clearer, and warmer, and the natural ability of salmon to avoid predation was reduced (Nakamamoto and Harvey 2002, unpubl. data; Moyle 2002).

4.4.7 Sensitivity to anthropogenic disturbances

Because of their anadromous life history and changes in habitat requirements at different life stages, steelhead are vulnerable to a wide range of watershed disturbances, including dams, timber harvest, road construction, recreational use, and other human-related disturbances. The relative importance of anthropogenic and natural disturbances as well as ocean conditions for controlling steelhead populations is uncertain. Coastal steelhead habitats, which historically consisted of old-growth temperate moist conifer forests with streams having high structural complexity, have been significantly altered (Kostow 1995). Production of steelhead in coastal northern California appears to be significantly lower than historically, due at least in part to habitat degradation (NMFS 1996b).

4.4.7.1 Physical barriers to migration and movement

There are no major dams or diversions in the plan area that are known to act as barriers to steelhead migration or movement. However, improperly designed or constructed road crossings and culverts may act as barriers to upstream-migrating steelhead and reduce the amount of habitat available for spawning and rearing.

4.4.7.2 Changes in hydrologic regimes

Changes in natural flow regimes may impact steelhead populations through changes in stimuli used for timing of upstream and downstream migrations; dewatering of redds; displacement of fry or juveniles; scouring of spawning gravels; and changes in the quality and quantity of habitat for different life stages. The effects of increased magnitude and altered timing of peak flows due to logging, grazing, or urbanization may include reduced survival of eggs and alevins through displacement if gravels are mobilized. Juveniles may also be displaced if suitable velocity

refuges are lacking in rearing areas (Nicholas 1988). Droughts may compound oceanic effects by drying up streams, restricting access to some areas, and degrading spawning and rearing conditions (Brown et al. 1994). Lack of sufficient rainfall, resulting in low flows during migration periods, may impede upstream migration and result in greater vulnerability to predation (CDFG 1994). Large floods can have deleterious effects as well, scouring stream channels of spawning gravels and woody debris and thereby decreasing spawning success and rearing habitat. The effects of catastrophic drought and flood events have been compounded in recent years by human-induced stream degradation.

4.4.7.3 Changes in sediment dynamics

Sedimentation of streams resulting from increased erosion may reduce spawning success of steelhead and the carrying capacity of juvenile rearing areas. Sedimentation due to land use activities is a primary cause of habitat degradation for steelhead populations on the west coast (NMFS 1996a). Coarse sediment in headwater streams may have particularly persistent and drastic impacts on available habitat. Increased input of fine sediment resulting from natural or anthropogenic disturbance may be the principle cause of egg and alevin mortality in some areas (Shapovalov and Taft 1954). Filling of interstitial spaces with fine sediments reduces intragravel flow through redds, thereby diminishing concentrations of dissolved oxygen and the removal rate of metabolic wastes (Everest et al. 1985). Alevins that develop in oxygen-deficient gravels are smaller at emergence, placing them at a competitive disadvantage (Doudoroff and Warren 1965, as cited in Everest et al. 1985). Sedimentation also reduces the amount of interstitial habitat available for use as a refuge by juvenile salmonids during high-flow events or low temperatures (Hillman et al. 1987). Bjornn et al. (1977) observed reduced juvenile steelhead abundance in Idaho streams characterized by a high degree of substrate embeddedness. Sedimentation of interstices may also reduce aquatic invertebrate production and, therefore, reduce production of juvenile anadromous salmonids (Suttle et al. 2004). Filling of pools with fine sediments can reduce carrying capacity of rearing habitats for juvenile salmonids (Bjornn et al. 1977). Accumulation of fine organic material in gravel, which may occur following logging or other land use disturbances, can also reduce the amount of dissolved oxygen available to incubating eggs, since the decay of this material consumes oxygen (Barnhart 1991).

Aggradation of streams from erosion may result in less stable spawning gravels and mortality of eggs and embryos due to gravel mobilization during freshets (Nawa et al. 1990). Gravel instability may also affect colonization of the streamside area by riparian vegetation. Extremely aggraded streams may have reduced or absent surface flows in the summer (CDFG 1994). Large accumulations of sediment may block juvenile and adult migrations where tributaries join main rivers (Payne and Associates 1989). Gravel mining can reduce the supply of spawning gravels and alter habitat used by rearing steelhead.

Erosion may result in increased water turbidity. Increased water turbidity may have lethal or sub-lethal effects on salmonids. These effects include physiological stress, such as gill trauma and decreased osmoregulatory ability, and behavioral changes, such as delayed migration, decreased feeding rates, and altered prey selection (Bash et al. 2001). The sedimentation of coastal estuaries due to increased upstream erosion, which has been documented in north coastal California rivers, reduces the area of this very high quality rearing habitat available to salmonids before going to sea (Puckett 1977, Hofstra 1983, Smith 1987).

4.4.7.4 Changes in LWD dynamics

Reduction of LWD in stream channels has been one of the most important long-term effects of forest management on salmonids in North America (Hicks et al. 1991a). Stream channels tend to

become simpler and less stable after the removal of LWD. The habitat complexity that provides substrate diversity, refuges from current velocity, and cover used by spawning, feeding, and resting salmonids is also lost (McMahon and Reeves 1989). Reduced LWD may also limit formation of backwater pools and the complex stream margin habitat used by emergent fry (McCain 1992). Reductions in the amount of LWD in stream channels due to either past removal (stream cleaning) efforts or harvest of streamside trees may reduce (a) the carrying capacity of these streams for juvenile anadromous salmonids, especially of the older age classes which may prefer deeper habitats, and (b) the occurrence of deep pools used by adults during migration and holding (NMFS 1996a). Murphy et al. (1985, 1986) found that higher juvenile steelhead densities occurred in reaches with buffer strips adjacent to clearcuts than in reaches without buffer strips where LWD had been removed. Reduced LWD may also result in decreased retention of (a) spawning gravels, (b) fine and coarse particulate organic matter, and (c) carcasses of anadromous salmonids. All of these are important for nutrient cycling and maintenance of macroinvertebrate communities.

In assessment area streams, past removal of in-channel LWD (Holman and Evans 1964, CDFG 1997, unpubl. data) and logging in forest stands adjacent to streams have reduced the occurrence and recruitment of LWD in many areas used by steelhead. Reductions in the frequency of deeper pools required by older age classes of juvenile steelhead due to LWD removal may result in early migration to mainstem habitats, particularly of age 1+ juveniles. Removal of LWD may also be affecting sediment transport processes by increasing stream power and reducing the amount of alluvial material stored in tributaries. This, in turn, reduces the availability of substrate for spawning and overwintering in these tributaries.

4.4.7.5 Changes in stream temperatures and water quality

Factors that result in increased stream temperatures, such as large-scale clearcutting, removal of riparian vegetation, and changes in natural flow regimes, may reduce steelhead populations both directly through increased mortality and indirectly through such factors as changes in growth rates or timing of emergence and downstream migration. Logging practices that result in increased stream temperatures, such as removing shade over streams, threaten survival and reproduction by steelhead. Removal of riparian canopy cover exposes more of the stream channel to direct solar radiation. Increased fine sediment inputs can also cause increased stream temperatures by replacing the reflective gravel substrate with darker sediment that could store more solar radiation (Hagans et al. 1986). In addition, sedimentation can reduce intragravel flow, thereby exposing more of the water column to solar radiation (Hagans et al. 1986). High summer water temperatures reduce growth and may cause mortality of juveniles. In addition to its effects on stream temperatures, removal of the riparian canopy also results in reduced input of terrestrial invertebrates and litterfall to the stream, thereby reducing the allochthonous input that is an important component of stream production. Grazing may also cause degradation of steelhead habitat through increased upslope and bank erosion as well as loss of riparian vegetation.

4.4.7.6 Commercial and recreational harvest

Although sport, tribal, and commercial harvest of steelhead has not occurred on the same scale as other species of Pacific salmon, harvest may be a factor in the decline of some steelhead populations (NMFS 1996b). Estimated sport catch of steelhead in California in the early 1960s was 120,000 adult fish (CDFG 1965, as cited in NMFS 1996b). In the late 1970s and early 1980s, the recreational steelhead harvest rates (percent of population harvested) were estimated to range from 12.5–28% in the Trinity River (CDFG, unpubl. data, as cited in NMFS 1996b) and 5.9–20.2% in the South Fork Trinity River (Mills and Wilson 1991, Wilson and Mills 1992, Wilson and Collins 1992, all as cited in NMFS 1996b). In 1991, CDFG (1991) estimates there

were 99,700 steelhead anglers in California, and steelhead catch in 1993 was in the vicinity of 40,000 fish (NMFS 1996b). However, recreational harvest of wild (non-hatchery) steelhead is currently prohibited in streams draining the assessment area.

Although there is generally little or no commercial or recreational harvest of steelhead in the ocean, some evidence suggests that driftnet fishing may play a role in the decline of Pacific Coast steelhead populations (Light et al. 1988, as cited in NMFS 1996b). In California, gillnet scars have been observed on adult steelhead returning to the Smith River (Higgins et al. 1992) and several streams in Santa Cruz County (NMFS 1996b). Steelhead may also be caught incidentally by large-scale commercial driftnet operations targeting salmon or squid, as well as by illegal high seas driftnet fishing.

4.4.7.7 Hatcheries

Interactions between hatchery and wild steelhead stocks may have contributed to population declines of Pacific Coast steelhead (NMFS 1996b). Wild stocks of steelhead may be adversely impacted by hatchery supplementation through increased competition during the juvenile rearing period and genetic changes resulting from interbreeding between wild steelhead and hatchery steelhead not native to the basin (Moyle et al. 1989). Widespread use of hatchery fish has been cited as contributing to declines in wild steelhead stocks on the Oregon coast (Nehlsen et al. 1991). Differences in the genetic structure of native and hatchery stocks can potentially lead to lower survival of subsequent hybrid generations compared with pure wild fish (Steward and Bjornn 1990, Hindar et al. 1991). The interaction of hatchery and native stocks also increases disease potential, since native stocks may be exposed to disease organisms originating from hatcheries that they would not be exposed to under normal conditions.

Poaching and other impacts on adult holding habitat

Summer steelhead adults are vulnerable to human disturbance during their holding period. Holding steelhead are vulnerable to poaching, because they typically congregate in large numbers in a relatively small number of suitable pools. Steelhead fishing has been restricted in many areas in response to population declines, but the species remains vulnerable to poaching. Adult summer steelhead are especially vulnerable to poaching during summer low flows. Roelofs (1983, as cited by Moyle et al. 1989) has indicated that steelhead populations showing signs of severe declines tend to be in areas that are more accessible to people, while stable populations tend to be found in the most inaccessible streams. Poachers may capture adult steelhead by snagging, spearing, netting, trapping, shooting, or blasting (Roelofs 1987). In both mainstem and tributary streams, increased human disturbance associated with recreational activities, such as boating, swimming, or fishing may affect adult holding habitat. Moyle et al. (1989) indicate that these types of activities may stress adult fish and result in increased mortality in streams heavily used for recreation. These impacts would not affect winter steelhead, which do not require extended use of holding areas prior to spawning.

4.4.7.8 Estuary impacts

Estuary conditions may have an important influence on anadromous fish survival, since anadromous fish must pass through these areas during upstream and downstream migration and since estuarine rearing prior to ocean entry is a life history strategy used by many juvenile anadromous fish to increase marine survival (Giger 1972, Healey 1991, McMahon and Holtby 1992). Degradation of estuary habitats due to diking and filling, increased temperatures, introduction of piscivorous fish, sedimentation due to upstream impacts, and other human activities may have contributed to anadromous fish declines in coastal northern California.

4.4.8 Impacts of MLC (2008)

There were 28 CalWater planning watersheds, known to have steelhead present, which experienced some impact from the 2008 fires. Nearly all the acres burnt over by the fires were in watersheds with steelhead. Monitoring efforts in our ASMBs (Annual Salmonid Monitoring Basins) will track steelhead in burned and unburned watersheds.

4.4.9 Key uncertainties

The current and historical abundance of steelhead in most coastal streams and rivers of Mendocino County is largely unknown. Limited information is available describing historical distribution. The continuation of population estimates will be crucial in providing data to allow more robust estimates of abundance.

Although hypotheses exist, more information is needed on the factors that may limit the recovery and maintenance of steelhead populations in the region. Freshwater habitat quality and quantity is likely a limiting factor. Most of the details about habitat relationships of steelhead are based upon research outside of the plan area. The specifics of these relationships may not be identical within the plan area.

MRC management has identified the following key uncertainties, with cross references to validation monitoring programs in parentheses:

- What is the current and historical distribution of steelhead in coastal streams and rivers of Mendocino County?
- *Will the abundance of juvenile steehead increase as habitat conditions improve over time* (M§13.6.1.2-1)*?*
- What is the contribution of each limiting factor to steelhead populations?

4.5 Northern Red-legged Frog and California Red-legged Frog

4.5.1 Dual focus

There are 2 subspecies of red-legged frog in the plan area. The California red-legged frog (*Rana draytonii)*, listed by USFWS, occurs in the southern portions, while the northern red-legged frog (*Rana aurora*), unlisted, occupies the northern portions. An overlap between species occurs near the Elk Creek Watershed. Our HCP/NCCP provides consistent conservation measures for each.

Photo by Dr. Mark Jennings

4.5.2 Systematics and taxonomy

The taxonomic relationship of the 2 subspecies of red-legged frog is unclear. Confusion in identification occurs where the distributions of the 2 subspecies overlap in northern California (Green 1985, Hayes and Krempels 1986). Significant differences in behavior and morphology of the 2 subspecies suggests that they may be separate species in secondary contact following previous isolation (Hayes and Krempels 1986). Recent investigations by Dr. H. Bradley Shaffer suggest that the species may soon be split into 2 full species: the northern red-legged frog and the California red-legged frog.

The 2 subspecies are difficult to distinguish even in the hand, although California red-legged frogs tend to have more numerous dorsal spots with light centers, rougher skin, shorter limbs, and smaller eyes than northern red-legged frogs (Stebbins 1985).

4.5.3 Geographic distribution

Red-legged frogs occur west of the Cascade Range and Sierra Nevada from British Columbia, Canada south to northern Baja California, Mexico (Stebbins 1985). Northern red-legged frogs occur from Sullivan Bay, British Columbia south to northern Humboldt County, California (Stebbins 1985). Populations of red-legged frogs along the west coast of California from southern Humboldt County south to Point Reyes, Marin County exhibit some characteristics that are intermediate between northern and California red-legged frogs (Hayes and Miyamoto 1984, USFWS 1994a), but appear more closely affiliated with the northern subspecies (Jennings and Hayes 1994).

USFWS considers the California red-legged frog as *threatened* wherever they are found to occur. The historical range of the California red-legged frog included Pacific Slope drainages from Point Reyes in Marin County, California inland to the vicinity of Redding in Shasta County and south to Baja California, Mexico. Currently, they are found primarily in small coastal drainages between Point Reyes south to Santa Barbara County.

The known range of elevations for northern red-legged frogs and intermediate populations extends from near sea level to 1160 m (3800 ft) (Dunlap 1955, as cited in Jennings and Hayes 1994). In California, northern red-legged frogs and intermediate populations occur from near sea level to about 300 m (Jennings and Hayes 1994).

4.5.4 Local distribution

Northern red-legged frogs were detected adjacent to MRC land in the Jackson Demonstration State Forest (JDSF) during baseline wildlife surveys (Kitchen 1992), and one record for JDSF was listed in the California Natural Diversity Database (CDFG 1996a). MRC biologists and foresters have collected information on amphibian presence in the plan area from (1) electrofishing and snorkeling surveys for fish (MRC 2002a); (2) diurnal amphibian surveys on Class II streams conducted in summer 2001 (MRC 2002d); (3) incidental observations during forestry and wildlife surveys (MRC 2002c) and (4) baseline distribution surveys.

MRC has conducted surveys to identify the baseline distribution of red-legged frog breeding sites since 2002. To date, we have detected occupied breeding sites in the following basins: Doyle Creek, Albion River, Railroad Gulch (tributary to Albion River), Ray Gulch (tributary to Navarro River), Greenwood Creek, South Fork Elk Creek, and Mallo Pass Creek. We also observed adult red-legged frogs in Hollow Tree Creek, Juan Creek, Big River, and Navarro River, although we do not have confirmed evidence of reproduction.

MRC has not detected any life stages of red-legged frogs during surveys in Cottaneva Creek, North Fork Noyo River, Russell Brook Creek, East Branch North Fork Big River, Mettick Creek, Ackerman Creek, South Branch North Fork Navarro, North Fork Navarro, Little North Fork Navarro, John Smith Creek, Rolling Brook, and the South Fork Garcia River planning watersheds.

In 2003 Dr. H Bradley Shaffer conducted genetic analyses on larval red-legged frogs from breeding ponds in Doyle Creek, Albion River, Greenwood Creek, and Mallo Pass. Larval frogs from ponds in Doyle Creek and Albion River were determined to be 100% northern red-legged frogs. Larval frogs from ponds in Greenwood Creek and Mallo Pass Creek were determined to be hybrid frogs. These hybrid frogs possessed mitochondrial and nuclear DNA of both northern red-legged frogs and California red-legged frogs. The results of Dr. Shaffer's work conclude that red-

legged frogs residing south of Point Arena may possess 100% California red-legged frog genes (Shaffer et al. 2004).

Red-legged Frog Egg Mass
Photo by Jen Cary

4.5.5 Population trends

- Northern red-legged frog

Although northern red-legged frogs are declining in British Columbia, Oregon, and Washington, there have not been systematic surveys in northern California.

- California red-legged frog

Populations of red-legged frogs in California have declined drastically statewide (Fisher and Shaffer 1996, Hayes and Jennings 1986, Moyle 1973). They are believed to have disappeared from 75% of their historical range (Jennings et al. 1993). The species was extirpated from the Central Valley by 1960 and is currently extremely rare in the foothills of the Sierra Nevada (Jennings et al. 1993). Declines in the species' abundance began in the mid-1800s when they were hunted for food by humans. Over half of the reduction in their range, however, has likely taken place in the past 25 years (Jennings et al. 1993, as cited in Davidson 1993). Habitat loss and alteration are probably the primary causes of decline. Small coastal drainages between Point Reyes National Seashore in Marin County and the town of Carpenteria in Santa Barbara County are some of the only remaining areas with significant numbers of California red-legged frogs (Davidson 1993). Recent investigations into the current population status of this species by Davidson et al. (2001) led him to suggest that declines show the strongest association with upwind agricultural land use. Consequently, wind-borne agricultural pesticides are an important factor in declines. For the examined species, patterns of decline were marginally consistent with ultraviolet radiation and inconsistent with hypotheses on climate change.

4.5.6 Life history

4.5.6.1 Reproduction

- Northern red-legged frog

Male northern red-legged frogs assemble at breeding sites as early as mid-December in warm winters and vocalize beneath the water's surface (Nussbaum et al. 1983). Males have been observed at breeding sites up to a month before females, in water temperatures as low as 2°C (35.6°F). Oviposition occurs early in the year, during a relatively restricted time period from January to March, in ponds and in intermittent and permanent streams with slow or still water. The timing of egg-laying may be related to water temperature. A study conducted in Willamette Valley, Oregon found that egg-laying did not occur until temperatures were above 7.5°C (45°F), although lower minimum temperatures for egg-laying have been documented in populations located further north (Nussbaum et al. 1983). Spawning occurs only at night (Licht 1971). Eggs are typically deposited as a grapefruit-sized mass consisting of 200 to 1100 eggs, which is attached to emergent vegetation, such as cattails and bulrushes in ponds or other still water habitats (USFWS 1997a). Egg masses of northern red-legged frogs are deposited at least 46 cm (18 in. below the water surface and at least 61 to 92 cm (2 to 3 ft) from the water's edge; some egg masses may break free and float to the surface after a few days (Licht 1971). Once egg-laying is complete, adults leave breeding sites and disperse into moist areas with dense, thick vegetation, where they may be found throughout late spring and summer (Jennings and Hayes 1994).

- California red-legged frog

California red-legged frogs breed from late November to early April (Jennings and Hayes 1989, as cited in Davidson 1993). Unlike northern red-legged frogs, California red-legged frogs vocalize in the air rather than underwater. Their egg masses are laid attached to emergent vegetation in a vertical orientation in contact with the water surface rather than submerged (Hayes and Miyamoto 1984, Hayes and Krempels 1986).

4.5.6.2 Growth and development

Northern red-legged frog eggs are relatively large, averaging about 3.03 mm (0.12 in.) in diameter (Licht 1971). Depending on water temperatures, hatching can occur after less than a week (at 20°C) or take more than 8 weeks (at 4.5°C). Hatching typically occurs in 4-5 weeks at temperatures between 8° to 12°C (47° and 53°F) (Nussbaum et al. 1983). Storm (1960) and Licht (1971), on the other hand, specify 6-9°C (43-48°F) for the hatching temperatures (as cited in Jennings and Hayes 1994). Metamorphosis occurs approximately 11 to 14 weeks after hatching (Licht 1974, Brown 1975b; both as cited in Jennings and Hayes 1994), but may take more than a year (Cochram and Goin 1970, as cited in USFWS 1980). Jennings and Hayes (1994) comment that there is a lack of information on variation in the length of larval development.
Male northern red-legged frogs reach sexual maturity in the breeding season following metamorphosis, but most probably do not reproduce until their second breeding season. Females apparently do not attain sexual maturity until the second breeding season after metamorphosis, and most probably do not breed until their third breeding season (Licht 1971).

California red-legged frogs generally take from 6-14 days to hatch and larvae metamorphose between July and September, 3.5 to 7 months after egg laying (Jennings et al. 1993, as cited in Davidson 1993). Males likely reach sexual maturity at 3 years of age and females after 4 years of age (Jennings and Hayes 1985, as cited in Davidson 1993). Most mortality of red-legged frogs is believed to occur in the larval stage (USFWS 1996a).

California red-legged frog tadpoles have been documented overwintering at 11 sites in 4 central coastal California counties (Fellers et al. 2001). Tadpoles in this study were located in spring-fed pools and ponds with cooler temperatures than typical for the red-legged frog. Fellers et al. (2001) suggested that overwintering is not likely to be common in larval red-legged frogs, but should be considered when monitoring for this species.

4.5.6.3 Movements and dispersal

Haggard (2000) found that the average distance that northern red-legged frogs moved from their breeding sites was 149 m. Recent movement studies indicate that the percentage of California red-legged frogs moving away from breeding habitat varies: 66% of females and 25% of males dispersed in one study (Fellers and Kleeman 2007) and less than half in another (Tartarian 2008). Bulger et al. (2003) found that 90% of non-dispersing California red-legged frogs stayed within 60 m of their aquatic sites, with a maximum distance of up to 130 m recorded after summer rain. Fellers and Kleeman (2007) found that the median distance California red-legged frogs dispersed was 150 m, generally moving to the nearest available non-breeding habitat. Dispersing frogs can move great distances; at least 1 record indicates a straight-line map distance of 2.8 km in a single season (Bulger et al. 2003).

Dispersal capabilities of this species are thought to be substantial. Northern red-legged frogs have been found at distances up to 900 m (2953 ft) away from the nearest source of water (Hayes et al. 2001). A radio-tagged female was recorded moving a distance of 2.4 km (1.49 mi) and 3 males from 1.1 to 1.3 km (0.68 mi to 0.81 mi) away from original capture points (Hayes et al.

2001). There is no data available on home range size of northern red-legged frogs, and the species is not known to be territorial.

California red-legged frogs have been found to move distances of up to 1.6 km (1 mi) up or down a stream drainage and may be found up to 1.6 mi (1 mi) from aquatic sites on rainy nights (USFWS 1997a). They will often move away from the water after the first winter rains, causing sites where they were easily observed in the summer to appear devoid of the species (USFWS 1997a).

4.5.7 Habitat requirements

4.5.7.1 General habitat types used

Northern red-legged frogs use a variety of habitat types, from aquatic sites for breeding to riparian and mesic upland forests during the post-breeding season and upland habitats for overwintering at low elevations (Gomez and Anthony 1996, Nussbaum et al. 1983, Licht 1969). In the southern Washington Cascade Range, Aubry and Hall (1991) found adult northern red-legged frogs to be more abundant in mature forest stands, but not significantly so. Gomez and Anthony (1996) found northern red-legged frogs in Oregon to be most abundant in deciduous forest types and reported no captures in mature coniferous forests.

Deep pools are important for several aspects of red-legged frog life history. Licht (1969) reported that northern red-legged frogs usually call underwater from a depth of at least 92 cm (3 ft). The behavioral response to predators by both subspecies of red-legged frogs includes fleeing directly into water and into the deepest portion of the channel or pool (Gregory 1979, as cited in Davidson 1993). Hayes and Jennings (1988) found California red-legged frogs in Central Valley drainages almost exclusively (99%) at sites with some water at least 70 cm (27.5 in.) deep.

4.5.7.2 Reproductive habitat

Red-legged frogs breed in coastal lagoons, permanent or temporary pools, marshes, ponds or backwater portions of permanent or intermittent streams, and artificial impoundments, such as stock ponds and irrigation ponds (Stebbins 1985, Jennings and Hayes 1994, USFWS 1997a). Ponds with emergent vegetation, undercut banks, semi-submerged rootwads, or dense cover from woody riparian vegetation may offer cover from predation and higher quality breeding habitat (USFWS 1997b). The absence of emergent and riparian vegetation, however, does not rule out the possibility that a site can be used for breeding (USFWS 1997a). When breeding occurs in temporary ponds or intermittent streams, water is usually available for a period of at least 4–6 months. Eggs are deposited on strong stems of emergent or aquatic vegetation (Nussbaum et al. 1983), particularly cattails and bulrushes, but also on the stems of sedges, willows, spiraea, and pondweed (USFWS 1980, USFWS 1997a). Eggs have also been found in ponds without vegetation (USFWS 1980).

Limited information exists on movement patterns and site fidelity of red-legged frogs. One study showed that males had a tendency to return to the same breeding site (Calef 1973) and that individuals may show fidelity to particular breeding sites from year to year. Pechman et al. (2001) observed frogs and toads returning to former breeding sites even after the ponds had been drained and filled with soil. Whether adult frogs return to the same terrestrial foraging area following breeding is unknown.

4.5.7.3 Larval habitat

Larval red-legged frogs use both mud and vegetation for cover (Calef 1973, as cited in USFWS 1980). Wiens (1970) characterized optimal habitat as including emergent willow, stems, grasses,

cattails, submerged weed stems, and filamentous algae. Older larvae may be less closely associated with vegetation (Calef 1973, as cited in USFWS 1980).

4.5.7.4 Post-metamorphic and foraging habitat

During the non-breeding season, red-legged frogs may be found far from water, especially in moist or humid habitats (Nussbaum et al. 1983). Northern red-legged frogs forage primarily on land (Licht 1986). California red-legged frogs are frequently encountered in upland settings, including open grasslands with seeps and springs (USFWS 1997a). Young California red-legged frogs may occur in low-velocity, shallow riffles in streams or along the margins of ponds (USFWS 1997a).

In western Oregon, northern red-legged frogs were captured more frequently in riparian than in upslope habitats (Gomez and Anthony 1996). Post-metamorphic individuals have been found to inhabit dense patches of grass and shrubs, such as willow thickets and sedges with a moist substrate (Stebbins 1951, Storm 1960, Twedt 1993; all as cited in Jennings and Hayes 1994). In northwestern California, Twedt (1993) often observed red-legged frogs in dense undergrowth of ferns and sedges along streamside flats in redwood forests. A dense understory may provide both cover from predation as well as create a more humid microclimate. Downed wood may be important as cover in upland areas (Dunlap 1955, Porter 1961; both as cited in USFWS 1980). Aubry and Hall (1991) reported that abundance of northern red-legged frogs in the southern Washington Cascades was significantly associated with downed wood. Under drier conditions, red-legged frogs may remain closer to riparian areas near streams or ponds (Nussbaum et al. 1983). Beavers may create habitat conditions that are particularly favorable for northern red-legged frogs (Jennings and Hayes 1994). Northern red-legged frogs have been observed frequently in association with beavers (Stebbins 1951, Brown 1975b; both as cited in Jennings and Hayes 1994).

During the non-breeding season, California red-legged frogs have been reported to use small mammal burrows and moist leaf litter up to 25.9 m (85 ft) from water in dense riparian vegetation for estivation (USFWS 1997a).

4.5.7.5 Water temperature

Northern red-legged frogs have the lowest embryonic critical thermal maximum of any native North American ranid frog (Licht 1971). Embryos in the early stages of development have a lower lethal temperature tolerance of 4°C (39°F) and an upper lethal temperature tolerance of 21°C (70°F), which are the lowest and highest known lethal limits among North American ranid frogs (Nussbaum et al. 1983). Adult California red-legged frogs exhibit stress when exposed to water temperatures at or above 29°C (Jennings and Hayes 1989, as cited in Davidson 1993). Chronic exposure to such temperatures may result in mortality (Davidson 1993).

4.5.8 Ecological interactions

4.5.8.1 Diet

Red-legged frog tadpoles are herbivorous grazers on algae. The prey of post-metamorph red-legged frogs includes a variety of terrestrial and aquatic invertebrates, such as beetles, caterpillars, spiders, crustaceans, and mollusks (Blaustein et al. 1995). Other amphibians, small fish, and even small mammals may also be eaten (Hayes and Tennant 1985, as cited in Davidson 1993).

4.5.8.2 Predators

The rough-skinned newt and northwestern salamander are likely among the most important predators of larval northern red-legged frogs throughout their range (Calef 1973, Licht 1974; both as cited in Jennings and Hayes 1994). Certain species of garter snakes are likely the most important predators of metamorphic and recent post-metamorphic individuals (Fitch 1941, Licht 1974; both as cited in Jennings and Hayes 1994). Rainbow trout, giant diving bugs, damsel and dragonflies, and garter snakes have also been found to be major predators of red-legged frog tadpoles (Licht 1986, Calef 1973). Wading birds may be significant predators on adult red-legged frogs (Jennings and Hayes 1988).

Introduced bullfrogs may be major predators of red-legged frogs. In laboratory studies, the presence of bullfrog adults and tadpoles was found to significantly reduce mass at metamorphosis, increase time to metamorphosis, and decrease survival to metamorphosis of red-legged frog tadpoles (Kiesecker and Blaustein 1998). Adult bullfrogs also significantly decreased the survival of red-legged frog post-metamorphs, and the presence of both bullfrog tadpoles and smallmouth bass appeared to contribute to negative developmental effects on larval red-legged frogs (Kiesecker and Blaustein 1998). A study conducted in coastal Washington wetlands, however, revealed that neither bullfrog nor exotic fish presence was related to the relative abundance of northern red-legged frogs (Adams 1999).

Doubledee et al. (2003) found a positive correlation between the absence of California red-legged frogs and the presence of introduced bullfrogs. These researchers modeled bullfrog predation rates upon red-legged frogs after various management treatments (shooting, pond draining, etc). The model indicated that killing or removing bullfrogs required an extreme effort to be effective. A combination of shooting bullfrogs and draining ponds proved the most effective approach to control bullfrog populations and facilitate conservation of red-legged frogs (Doubledee et al. 2003).

4.5.9 Sensitivity to anthropogenic disturbances

Jennings and Hayes (1994) identified habitat alteration from timber harvest, urban development, livestock grazing, and predation from introduced fish species and bullfrogs as potential threats to red-legged frogs. Little is known about the sensitivity of red-legged frogs to forest management activities. Logging and herbicide spraying were not found by Cole et al. (1997) to significantly alter capture rates of red-legged frogs in Oregon. In this study, capture rates were higher in uncut red alder stands than in Douglas-fir stands (Cole et al. 1997).

4.5.9.1 Physical barriers to movement and habitat fragmentation

Red-legged frogs likely exist in metapopulations on the landscape and are dependent on the existence of numerous breeding sites across the landscape for long-term viability of the metapopulation (Welsh et al. 1998). Because of this, suitable breeding locations (i.e., still water habitats, such as ponds and lakes) should be managed as red-legged frog habitat even if reproduction by the species at a certain location is not observed in any given year (Welsh et al. 1998). Because bullfrogs may eliminate red-legged frogs (Hayes and Jennings 1986), breeding locations should be free of this introduced species where possible.

Suitable dispersal habitat is necessary for maintaining populations of red-legged frogs across the landscape. Because red-legged frogs are able to use a variety of habitat types, especially during wet seasons, and because they are relatively mobile as adults, many habitat types appear to be suitable as movement corridors (Bulger et al. 2003). Bulger et al. (2003) suggest that specific protection of dispersal habitat for California red-legged frogs in forested habitat is likely

unnecessary because high-quality dispersal habitat is nearly ubiquitous in these landscapes. Methods for ensuring that suitable dispersal habitat for this species is maintained across the landscape could include protecting riparian habitats, maintaining downed wood in upland habitats, uneven-age management of forest stands, and maintaining understory vegetation.

Ann Allaye Chan-McLeod (2003) examined potential barrier effects posed by clearcuts on Vancouver Island, British Columbia, Canada by radio tracking 120 red-legged frogs. She found that young clearcuts (<12 years old) were significant barriers to movement. However, these results were highly dependent upon the weather (rain) and to a lesser extent the body mass of the frog. Perhaps barrier effects from clearcuts may be diminished in regenerating stands as young as 11-years old.

4.5.9.2 Loss or degradation of breeding habitats

Timber harvesting and road building adjacent to red-legged frog breeding sites may reduce habitat quality through sedimentation, reduction in hiding and thermal cover, changes to predator-prey dynamics, and changes to microclimate. Semlitsch (1998, as cited in Welsh et al. 1998) estimated that buffers around Ambystomid salamander breeding ponds of 164 m (534 ft) would protect 95% of the population at any given site. Welsh et al. (1998) believe that this buffer size represents a good "first cut" in proposing buffers to protect a high percentage of red-legged frogs at any particular breeding site, and would likely maintain red-legged frogs over the long term.

4.5.9.3 Artificial breeding habitats

Man-made ponds are an important habitat for red-legged frogs during breeding. The majority of the red-legged frog breeding sites discovered in the plan area have been in man-made ponds. In most cases, the ponds are a water source for dust abatement or road compaction and grading; drafting from the ponds leaves fish-bearing waters undisturbed. Our HCP/NCCP proposes conservation measures for water drafting (C§10.2.2.3-4 and C§10.2.2.3-5) which minimize impact to embryonic or larval frogs that rear in man-made ponds and manage for quality habitat in ponds. The demonstrated success of these man-made ponds as breeding habitat prompts MRC to construct new ponds for red-legged frogs.

4.5.9.4 Changes in water quality

Amphibians may be particularly sensitive to developmental disruption in the egg and early larval stages (Berrill et al. 1994, 1997; both as cited in Welsh et al. 1998). Developmental abnormalities that can cause mortality may be triggered by some herbicides at very low concentrations. Herbicides used on forest lands in northern California (e.g., 2,4-D; 2,4,5-T; and atrazine) mimic the female hormone estrogen (Colborn et al. 1993). They have been linked to deformities and mortalities in birds, mammals, amphibians, reptiles, and fish (Hall and Henry 1992; Colborn et al. 1993; Berrill et al. 1994, 1997). Adverse effects may occur at miniscule concentrations (parts per trillion) of some of these chemicals (Colborn and Clement 1992, Colborn et al. 1993, USEPA 1997). Welsh et al. (1998) believe that, apart from direct habitat destruction, the single greatest threat to red-legged frogs on managed forestlands may be the use of forest herbicides and pesticides that can contaminate breeding sites. Bettaso et al. (2000) sampled blood from male and sub-adult northern red-legged frogs from 15 populations in northwest California in 1999 and 2000 to determine if the female protein vitellogenin could be detected in quantities sufficient to use as an indicator of contamination by estrogen-mimicking compounds. The results of blood serum analysis showed that 4 of 7 populations analyzed had male frogs producing vitellogenin, indicating that an exogenous source of estrogen was present in north coast California.

4.5.10 Impacts of MLC (2008)

There were 5 CalWater planning watersheds, known to have red-legged frogs present, which experienced some impacts from the 2008 fires. The fires impacted only foraging and dispersal habitats of red-legged frogs. The fires did not directly affect any documented breeding sites. There were 10 documented red-legged frog breeding sites in planning watersheds impacted by the fires. Of these 10 sites, only 2 sites were in close proximity to a fire—Marsh Mallo Pond and Upper Railroad Pond. The fire line was roughly 100 meters east of the documented breeding site at Marsh Mallo Pond. Monitoring the number of egg masses deposited in each documented breeding site provides some evidence of the fire impacts to the population.

4.5.11 Key uncertainties

MRC management has identified the following key uncertainties:

- What is the current and historical distribution of red-legged frogs in the plan area?
- What past management activities have affected red-legged frog populations in the plan area?
- Are ponds and still water better breeding habitats than rivers?
- What effect will cooler water temperatures and increased shade have on survival of the red-legged frog?

4.6 Coastal Tailed Frog

4.6.1 Systematics and taxonomy

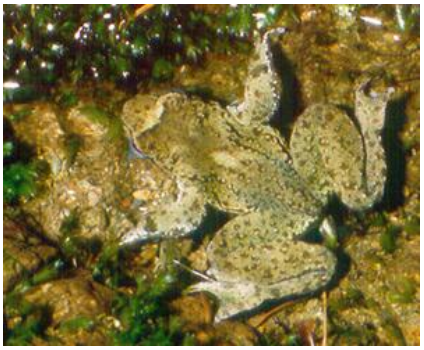

Photo by Brad Moon

The coastal tailed frog (*Ascaphus truei*) is one of only 2 living representatives of the genus *Ascaphus* (Jennings and Hayes 1994), the sole genus in the primitive frog family Ascaphidae. The second species is the Rocky Mountain coastal tailed frog, *Ascaphus montanus* (Neilson et al. 2001). Historically, the coastal tailed frog was included with a small group of similarly primitive New Zealand frogs in the genus Liopelma of the family Liopelmatidae. Recent phylogenetic analysis has identified a suite of unique features, and the weight of evidence led to placing coastal tailed frogs in their own family (Green and Cannatella 1994). Historically considered to belong to the most primitive group of living frogs (Nussbaum et al. 1983), this analysis also revealed that coastal tailed frogs exhibit a curious mix of primitive (e.g., possession of ribs) and derived characters (e.g., internal fertilization). Moreover, recent worldwide phylogenetic analysis of frog families indicates that coastal tailed frogs are the most likely sister group of all living anurans (Cannatella and Hillis 1993, Ford and Cannatella 1993). Interestingly, genetic material from coelacanths is very similar to that of coastal tailed frogs (Bogart et al. 1994). While only 2 species of coastal tailed frog are now recognized, biochemical and morphological variation across the range of the coastal tailed frog may conceal additional cryptic species (Stillwater Sciences 2001).

4.6.2 Geographic distribution

Metter and Pauken (1969) believed that coastal tailed frogs were more or less continuously distributed across the Pacific Northwest (coastal to inland) as recently as 25,000 years ago. As

the climate became drier at the end of the Pleistocene, inland system clusters were isolated from the coastal ones.

Coastal tailed frogs are known to occur from the central coast of British Columbia (Dupuis et al. 2000), through western Oregon and Washington, and south to northern California. Within California, coastal tailed frogs occur in the northwestern portion of the state from Del Norte County south to central Sonoma County and as far east as the southwest portion of Shasta County (Bury 1968, Stebbins 1985, Jennings and Hayes 1994). From the Rogue River system in Oregon south, this species has not been recorded outside of coastal forest areas, presumably due to its narrow habitat requirements (Bury 1968, Welsh et al. 1993). Coastal tailed frog distribution in California is patchy and restricted to areas having a very specific set of habitat conditions.

At present, little data exists to define an elevational cline with latitude (i.e., decreasing upper elevation limit with increasing latitude). Some investigators suggest that elevational limits may be more closely related to regional climate than latitude (Wahbe et al. 2001).

4.6.3 Local distribution

MRC biologists and foresters have collected information on amphibian presence in the plan area from (1) electrofishing and snorkeling surveys for fish (MRC 2002a); (2) diurnal amphibian surveys on Class II streams conducted in summer 2001 (MRC 2002d); (3) incidental observations during forestry and wildlife surveys (MRC 2002c, Incidental Sighting Database) and (4) baseline distribution surveys.

MRC has conducted baseline distribution surveys for coastal tailed frogs since 2003. As of 2010, we have surveyed 356 sites throughout the plan area and found over 75 occupied sites. We observed coastal tailed frogs in the following basins: Cottaneva Creek, Hardy Creek, Juan Creek, Howard Creek, Doyle Creek, Buckhorn Creek, Albion River, Navarro River, Greenwood Creek, Elk Creek, Mallo Pass Creek, Alder Creek, and Garcia River.

MRC has not detected coastal tailed frogs during surveys in the Hollow Tree, Noyo River, Big River, South Fork Albion River, Middle Albion River, South Branch Navarro, North Fork Navarro, Little North Fork Navarro, John Smith Creek, Ackerman Creek, South Fork Garcia and Rolling Brook planning watersheds.

Some information on coastal tailed frog distributions is available from surveys conducted in nearby areas by other timber companies. Information for Georgia-Pacific property (Jones & Stokes Associates, Inc. 1997) indicates that coastal tailed frogs were found to be present in the Ten Mile River and Usal Creek watersheds north of Fort Bragg. In the Jackson Demonstration State Forest, coastal tailed frogs have been documented from the South Fork Noyo River and Caspar Creek watersheds (CDFG 1996b).

Habitat for coastal tailed frogs in the HCP/NCCP plan area likely exists primarily in higher-gradient, perennial Class II streams and adjacent forest stands in both redwood and montane hardwood habitats. Coastal tailed frogs may also be found in some Class I (fish-bearing) streams, as the species has been found to co-occur with various fish species (Metter 1964a).

4.6.4 Population trends

Coastal tailed frog population trends have not been studied, although the species is thought to be declining by some and may now be at least regionally rare (Marshall et al. 1996). Neither

historical surveys nor population-level demographic analyses have been conducted on this species. Jennings and Hayes (1994) considered this species to be declining in California, especially in the upper Sacramento River system.

4.6.5 Life history

4.6.5.1 Reproduction

Tailed frogs, including the coastal tailed frog, reproduce with a mating strategy unique among frogs (Stebbins 1985). The male's tail-like sex organ, which can attain 10 mm (0.4 in.) in length when fully engorged, facilitates copulation and internal fertilization (Nussbaum et al. 1983, Stebbins 1985). Internal fertilization and subsequent laying of large, relatively scour-resistant eggs allows coastal tailed frogs to reproduce in high-gradient, high-velocity reaches. Males search underwater for females (Noble and Putnam 1931, Brown 1975a). Copulation, which also occurs underwater, may last 30 hours (Wernz 1969, Blaustein et al. 1995). The lung morphology and function of coastal tailed frogs facilitate the ability of males to stay underwater; the lungs are reduced in size and serve as hydrostatic organs (Noble and Putnam 1931).

The scientific literature describes few nests of coastal tailed frogs and the timing of egg laying is not well known (Karraker and Beyersdorf 1997). Coastal tailed frogs reportedly breed from late August to September, although pairs have been found in amplexus from March through October (Noble and Putnam 1931, Slater 1931, Wernz 1969, Brown 1975a, Nussbaum et al. 1983, Stebbins 1985). More recent reproductive studies suggest that June and July mark the peak of mating season in northwestern California (Sever et al. 2001). Metter (1964a) suspected that coastal populations (coastal tailed frogs) have more prolonged breeding seasons than inland populations (Rocky Mountain coastal tailed frogs). Female coastal tailed frogs store sperm in the oviducts for several months or possibly up to 2 years (Metter 1964b, Nussbaum et al. 1983, Hayes 1996). Data from a study conducted in northwest California indicated that a maximum of 1-year sperm storage appeared most likely (Sever et al. 2001). Female coastal tailed frogs likely retain sperm through the winter and lay eggs in the following spring or summer after spring runoff (Gaige 1920, Franz 1970a, Brown 1975b, Adams 1993, Karraker and Beyersdorf 1997). Some evidence suggests that females of inland populations (Rocky Mountain coastal tailed frogs) may lay eggs only every other year (Metter 1964b, Metter 1967, Daugherty and Sheldon 1982a). There are few studies on oviposition frequency in the coastal tailed frog; based on small clutch sizes, oviposition appears to be annual (Noble and Putnam 1931).

Larval Tailed Frog
Photo by Matt Goldsworthy

The eggs of coastal tailed frogs are among the largest of North American frogs (Wright and Wright 1949, as cited in Wahbe et al. 2001), averaging about 4 mm (0.16 in.) in diameter. The number of eggs laid per female ranges from 33 to 98 (Metter 1964b, Nussbaum et al. 1983, Daugherty and Sheldon 1982a). Coastal tailed frogs apparently have smaller clutch sizes than inland populations. Eggs are deposited in double strands attached to the underside of rocks (Gaige 1920, Metter 1964a, Franz 1970a, Brown 1975a, Adams 1993, Brown 1989, Capula 1989, Daugherty and Sheldon 1982a, Leonard et al. 1993, Noble and Putnam 1931, Nussbaum et al. 1983; all as cited in Wahbe et al. 2001). At one California site, eggs were attached to the underside of a boulder in a pool of a second-order stream (Karraker and Beyersdorf 1997). In August 2005, an MRC biologist discovered a nest site in a seep within Mendocino County (Goldsworthy 2007). The nest contained 25 eggs which further supports the

hypothesis that coastal populations produce smaller clutch sizes than inland populations. This was also the first observation of coastal tailed frogs using seep habitats for reproductive purposes.

4.6.5.2 Growth and development

Tailed frog embryos develop more slowly than any other North American species of frog (Daugherty and Sheldon 1982b, Blaustein et al. 1995, Hayes 1996). Eggs may take up to 9 months to hatch once they have been deposited, a time interval that may relate to water temperature (Brown 1977, Brown 1989, Hayes 1996). Hatching often occurs in August and September (Franz 1970a, Nussbaum et al. 1983, Adams 1993), after which larvae tend to remain in hatching areas until their yolk supplies are depleted the following spring (Metter 1964a). During this period, the mouthparts of tadpoles are not developed enough to allow them to leave their protected nest site. They would be carried downstream, unable to attach to the substrate and brace themselves against the swift-moving current (Brown 1975a). By the time yolk stores are fully absorbed, the tadpoles develop an adhesive oral sucker, by which they are able to attach to the substrate (Gradwell 1973, Nussbaum et al. 1983, Altig and Brodie 1972). These specialized mouthparts are a unique adaptation among Pacific Northwest frogs that allow feeding in high-velocity streams. Tadpoles of coastal tailed frogs do not often completely detach from the substrate and swim freely (Altig and Brodie 1972). Tadpoles of this species have been observed climbing on rocks 10–20 cm (4–8 in.) out of the water, possibly a means to obtain a richer source of food (Noble and Putnam 1931).

Tadpoles of coastal tailed frogs metamorphose into juvenile frogs 1 to 5 years after hatching, with development time generally increasing with elevation, latitude, and distance inland (Brown 1990, Bury and Corn 1991, Gray 1992, Wahbe 1996, Wallace and Diller 1998, Bury and Adams 1999). Recent work has demonstrated that coastal tailed frogs can frequently metamorphose in 1 year in the southern portion of its geographic range (i.e., southern Oregon and northern California), but may require 4 or 5 years at higher elevations and latitudes (Wallace and Diller 1998, Bury and Adams 1999). Shifts in the number of years required to reach metamorphosis can occur in the same stream as a function of inter-annual variations in climate (Bury and Adams 1999). Rates of development may relate to length of the growing season; aspect, gradient, elevation, snowpack, and number of frost-free days may also influence development (Dupuis 1999). Streams that Wallace and Diller (1998) reported as containing coastal tailed frogs that metamorphosed after 2 years at the southern end of their geographic range were at higher elevations and had higher flows. They hypothesized that the 2-year larval period at higher elevations was an adaptation to lower water temperatures. The lower elevation sites are more likely to have intermittent flows in late summer and early fall, thereby selecting for a 1-year larval period. Sites where there was a switch from a 1-year to a 2-year larval stage may have been the result of instream disturbance (Wallace and Diller 1998). Variables that were not statistically correlated with the length of the larval cycle included mean late summer water temperature, mean maximum water temperature, stream aspect, and cover type. Recently metamorphosed frogs are approximately 25 mm (1 in.) long (Nussbaum et al. 1983).

4.6.5.3 Movements and dispersal

Tadpoles in captivity preferentially take cover under rocks in turbulent water rather than in calm water and tend to seek cover in interstitial spaces of the stream substrate during the day (Altig and Brodie 1972).

Adult coastal tailed frogs generally emerge from the water at dusk and feed during the night on small terrestrial arthropods found along streams and in adjacent forest stands (Capula 1989, Leonard et al. 1993). In wet weather, coastal tailed frogs have been found to forage up to 90 m

(295 ft) or more from water (Metter 1967, Noble and Putnam 1931) During drier periods they tend to forage nearer to the stream; for the most part, Rocky Mountain coastal tailed frogs reportedly stray less than 1 m from streams (Metter 1964a, 1967). Daylight hours are usually spent resting under rocks in streams or on moist stream banks (Daugherty and Sheldon 1982a, Stebbins 1985). Studies in Washington and Oregon revealed that adult coastal tailed frogs were most often found under large rocks in turbulent areas of the stream (Bury et al 1991a). Lower humidity and higher ambient air temperatures over its geographic range likely influences the nocturnal behavior of the Rocky Mountain coastal tailed frog (Daugherty and Sheldon 1982b, Metter 1964a).

Female coastal tailed frogs make local movements during the mating season. Researchers have observed movement downstream from tributaries to larger mainstem streams during the mating season of Rocky Mountain coastal tailed frogs in the Wallowa Mountains of northeastern Oregon (Landreth and Ferguson 1967, as cited by Daugherty and Sheldon 1982a). There are also observations of upstream movement of females to egg deposition sites in June and July in western Washington (Brown 1975a, as cited by Daugherty and Sheldon 1982a).

Coastal tailed frogs are reportedly poor re-colonizers of streams from which they have disappeared, because they exhibit fidelity to natal streams (Bury et al. 1991a, Daugherty and Sheldon 1982a). However, some research suggests that substantial overland movements may occur during favorable (wet) conditions, so the potential for re-colonizing disturbed sites needs to be reconsidered (Aubry 2000; see also Hawkins et al. 1997, Crisafulli and Hawkins 1998). Moist, cool conditions, as occur in the Coast Range and Cascade Mountains, may facilitate movement to upland areas and migration between drainages (Daugherty and Sheldon 1982a). A recorded observation indicates a maximum dispersal distance of 360 m per year for a single juvenile female (Daugherty and Sheldon 1982b, as cited in Wahbe et al. 2001).

Recovery of streams following some channel disturbances can occur within 2 to 3 years by the undisplaced (terrestrial-bound) adults (Dupuis and Friele 1996). Following the 1980 eruption of Mt. St. Helens, important components of both plant and animal communities recovered to pre-disturbance levels within 3 to 5 years (Hawkins et al. 1997, Crisafulli and Hawkins 1998). Within 5 years of the disturbance, abundance of coastal tailed frog tadpoles in some streams within the blast zone represented more than 90% of the herbivore biomass and were at densities higher than had ever previously been reported for the area (Crisafulli and Hawkins 1998). Colonists likely came from epicenters of survival within the blast zone rather than from more distant, unaffected populations (Crisafulli and Hawkins 1998). Snow-pack over many high-elevations streams may have acted as a buffer from the effects of the eruption, allowing some life stages of coastal tailed frogs located in water or under snow to survive. While there is no distance data to confirm it, these individuals may have colonized streams at lower elevations, where aquatic biota appeared to have been completely extirpated (Crisafulli and Hawkins 1998).

Like many amphibians, coastal tailed frogs either reduce their activity or become completely inactive in areas with cold winters (i.e., inland, high altitudes, or high latitudes). During the cold period, Rocky Mountain coastal tailed frogs seek cover under large downed logs and boulders (Daugherty and Sheldon 1982a). In milder coastal areas, coastal tailed frogs may remain active and continue feeding all year (Daugherty and Sheldon 1982b). Gradwell's (1973) study implied that coastal tailed frog larvae select overwintering sites among the more protected interstices of a streambed.

4.6.5.4 Life span and age at sexual maturity

Little is known regarding coastal tailed frog survival rates and longevity (Wahbe et al. 2001). Daugherty and Sheldon (1982b) speculated that in a Montana population, Rocky Mountain coastal tailed frog females may live 15 to 20 years. Longevity estimates for coastal tailed frogs are unavailable, but Brown (1990) speculated that they might live up to 40 to 50 years. Bury and Adams (1999) pointed out that some coastal tailed frog larvae from high-elevation populations may require 5 years to metamorphose. Brown (1990) extrapolated that an additional 10 years may be needed for them to reach sexual maturity. This is longer than the maturation period in a Montana population of the Rocky Mountain coastal tailed frog, where males and females were estimated to begin reproducing at ages 7 and 8, respectively (Daugherty and Sheldon 1982b).

4.6.5.5 Population densities

Coastal tailed frogs are patchily distributed, but are often locally abundant in appropriate habitat. Bury (1988) found average densities of 4.5/m^2 (0.41/ft^2) in the southern Washington Cascade Range, including one 10-m (33-ft) reach with 109 individuals, 95% of which were larvae. Corn and Bury (1989) found coastal tailed frog densities of 0.76/m^2 (0.07/ft^2) in streams in unmanaged, old-growth forests and 0.37/m^2 (0.03/ft^2) in harvested areas of the Coast Range in western Oregon. Diller and Wallace (1999) reported that larval density varied from 0.04 to 0.73/m^2 (0.004 to 0.07/ft^2) and averaged 0.24/m^2 (0.02/ft^2) in managed landscapes at the southern end of coastal tailed frog range, which is less than the densities (0.58 to 4.40/m^2 or 0.05 to 0.41/ft^2) observed by Corn and Bury (1989) and Hawkins et al. (1988). Dupuis and Friele (1996) found coastal tailed frog densities averaged between 0.40/m^2 (0.04/ft^2) and 2.40/m^2 (0.22/ft^2) in managed landscapes in British Columbia, but averaged 1.80/m^2 (0.17/ft^2) in unmanaged landscapes in British Columbia. Similarly, coastal tailed frog densities averaged 2.37/m^2 (0.22/ft^2) in the unmanaged landscape of the Central Cascades, but densities averaged 1.01/m^2 (0.09/ft^2) in the managed landscape (Kelsey 1995). Adams and Bury (2000) found relatively low densities (0.37/m^2 or 0.03/ft^2) in the unmanaged forest landscape of the Olympic Peninsula. Unfortunately, due to differences in sampling methods, results from these studies cannot be compared directly.

4.6.6 Habitat requirements

4.6.6.1 General vegetational, climactic, and geological conditions

Streams with coastal tailed frogs typically flow through areas forested by Douglas-fir, coast redwood, Sitka spruce, western hemlock, and to a lesser extent ponderosa pine (Hayes 1996). Metter (1964a) found that the Rocky Mountain coastal tailed frog typically inhabited streams with close to 100% canopy cover; coastal tailed frogs are substantially more abundant in closed-canopy forests, including regenerated forests, than in clearcuts (Bury and Corn 1988, Bury et al. 1991b, Bury et al. 1991a). In some instances, adults may also use dense, moist, forests upslope from streams (Bury et al. 1991b).

Coastal tailed frogs are generally found in areas of high annual precipitation, but Metter (1967) listed several localities from the Pacific Northwest that receive less than 75 cm (30 in.) of annual precipitation. Most California coastal tailed frogs are known from areas with over 100 cm (40 in.) of annual precipitation, indicating that heavy precipitation may be important to the distribution of the frog in the southern part of its range by sustaining perennial flow in streams.

Diller and Wallace (1999) looked at relationships of various physical features on distribution of coastal tailed frogs in the redwood zone of northwestern California. Related variables included (1) landscape level—geologic formation; (2) reach level—percent fines, stream gradient, water temperature; and (3) microhabitat. In this study, coastal tailed frog larvae occurred in 75% of 72 streams surveyed. Out of 21 habitat variables measured, only 3 adequately predicted the presence

of coastal tailed frog larvae. Negative associations were found for both percent fine substrate particles and water temperature, and a positive association was found for stream gradient. Occurrence of larvae was positively associated with cobble, boulder, and gravel substrates with low embeddedness, and negatively associated with fine substrates. Larvae were found more often than expected in high gradient riffles and less frequently than expected in pools and runs (Diller and Wallace 1999). Aspect (northerly versus southerly), as measured on a landscape scale, was not significantly related to presence of coastal tailed frogs in this coastal study. Although the association of coastal tailed frog distribution with stream temperature was minimal, it was presumably because temperature variation was small due to the cool coastal climate. No significant correlation between water temperature and canopy closure or aspect was noted. Diller and Wallace concluded that coastal tailed frog distribution is not tied to old growth forest *per se*, but to specific microhabitats that are more likely to occur in undisturbed areas.

In Douglas-fir/hardwood forests of northwestern California and southwestern Oregon, Welsh and Lind (1991) found that mean relative abundances of coastal tailed frogs differed significantly between forest age-classes (p=0.001) and were 0.111, 0.555, and 0.810 for young (<100 yrs), mature (100-200 yrs), and old (>200 yrs) forests, respectively. Welsh (1990) and Welsh et al. (1993) hypothesized that forest structure rather than stand age determined coastal tailed frog occurrence. Important attributes of stand structure for coastal tailed frogs include (a) low ambient temperatures resulting from high canopy closure; (b) downed woody debris, particularly in and around streams, which contribute to greater habitat diversity, trap fine sediments, prevent cementation of aquatic substrates, and provide hiding and thermal cover for adults; and (c) a deep duff layer that filters clearer, cooler water and maintains cool, moist streamside microclimates. Welsh et al. (1993) reported a positive correlation between coastal tailed frog distribution and abundance and several attributes of late-seral stage forests, including high canopy cover, downed woody material, ground cover consisting of ferns and herbs (grass showed a negative correlation), litter depth, stream width, and flow rate. Coastal tailed frogs also exhibit a preference for extremely low-ambient light levels, a finding that suggests selection for darker microsites (Hailman 1982, Welsh et al. 1993).

Hawkins et al. (1988) compared larval densities of coastal tailed frogs in 3 types of sites in the Mt. St. Helens area shortly after the volcanic eruption: (1) both sample sites and headwaters were deforested due to the eruption; (2) sample sites were deforested but headwaters remained forested; and (3) both sample sites and headwaters remained forested (watershed received only heavy ash fall). They found that distribution of coastal tailed frog tadpoles correlated with high water velocity, low embeddedness of interstitial spaces, and large substrate (Hawkins et al. 1988). In this study, deforested sites with forested headwaters contained the highest larval densities (even greater than in forested sites with forested headwaters), while deforested sites with deforested headwaters had the lowest densities. The abundance of coastal tailed frogs at sites where only the headwaters were forested may have been due to the availability of suitable adult habitat upstream in the headwater forests, and the availability of abundant food for tadpoles on site (due to increases in primary productivity from reduced canopy cover). However, the authors caution that the adults produced from larvae in these sites may not fare well. The low densities of coastal tailed frogs in deforested watersheds may be due to high water temperatures and harsh terrestrial environments limiting adult survival and reproduction.

Gomez and Anthony (1996) found that coastal tailed frogs were more often recorded in riparian than upslope transects in their Lincoln County (OR) study sites. The coastal tailed frog was most abundant in large sawtimber and old-growth stands, compared with earlier successional stands and deciduous stands. In contrast, McComb et al. (1993) reported that within mature forests,

similar numbers of coastal tailed frogs were captured in stream and upslope transects (as cited in Gomez and Anthony 1996).

Diller and Wallace (1999) noted a correlation between coastal tailed frogs and younger forests, but believed that this resulted from a relationship with consolidated geological formations, which were subject to timber harvesting later than forest types on unconsolidated substrate.

At 3 survey locations in central Oregon, coastal tailed frogs selected streams within old-growth forests at the warmest location, mature stands at the location with intermediate temperatures, and young forest at the coolest location (Gilbert and Allwine 1991c). This finding further suggests that coastal tailed frogs may occur within a wider range of timber age classes than previously believed, particularly in the cool temperatures of the coastal redwood forest belt. However, Corn and Bury (1989) found significantly higher densities and biomass of coastal tailed frogs in old-growth versus logged forest stands, despite similar temperature regimes and a higher canopy closure in logged stands. The only measured difference between logged and unlogged stands other than canopy closure was size of the aquatic substrate resulting from increased sedimentation in logged sites. Nevertheless, logging activities appeared to be less detrimental in their coastal study plots than in their interior plots, presumably because of the maritime climate and more favorable temperature regime.

4.6.6.2 Stream habitat

Coastal tailed frogs are uniquely adapted to life in cold, fast-flowing, high-gradient, perennial mountain streams (Nussbaum et al. 1983). Coastal tailed frogs are not typically associated with seeps, although their post-metamorphic life stage may sometimes be found in seeps (Adams and Bury 2000) and, unlike the southern seep salamander, will often use trout-bearing streams to some extent (Nussbaum et al. 1983). Coastal tailed frogs prefer streams in mature and old-growth stands with dense, shaded habitat, low sediment loads, cool temperatures, high ambient humidity levels, and high water quality over much of their range (Bury and Corn 1988, Corn and Bury 1989, Welsh 1990, Hayes 1996). Perennial streams in which the substrate changes infrequently are likely to provide higher-quality habitat for coastal tailed frogs (Wahbe et al. 2001).

M.G. Hunter studied habitat use by coastal tailed frog larvae and post-metamorphs in the west-central Cascades of Oregon. Larvae were not detected in the smallest streams and only rarely in the largest streams, but they were common in moderately sized streams. Larvae were not detected in basins less than 37 ha (92 ac). Most larvae were found downstream of where surface water was intermittent. Habitat with high likelihood of occurrence of coastal tailed frog larvae consisted of “a moderate-sized stream, with a basin size of a few hundred ha (approximately 500 ac), with only very small amounts of particles as small as or smaller than pebbles, but rather a predominance of boulder and cobble, with wetted channel dimension of about 13 cm (5 in.) average depth (and an average maximum depth of about 25 to 30 cm (10 to 12 in.) and 3.5 to 4.0 m (11.5 to 13.2 ft) average width, moderate mid-level vegetation cover within a harvested stand, but only about 100 to 150 m (330 to 50 ft) away from unharvested forest” (Hunter 1998, p. 53).

Hunter found post-metamorphic coastal tailed frogs in all basin sizes, but at greater frequencies at higher elevations, above about 850 m (2788 ft). The elevation of the study area ranged from about 450 m (1476 ft) to 1300 m (4264 ft). The likelihood that they would occur in south-facing streams was 33% of that in north-facing streams. Hunter concluded that habitat likely to contain coastal tailed frogs consists of “a high elevation stream in a region of relatively steep topography, with at least a moderate percent of the glide channel unit, and a small

proportion of cascades, a moderate presence of boulders in the wetted channel, within or very near to unharvested forest" (Hunter 1998, p. 56). Because larvae must spend one or more winters in a stream, coastal tailed frogs cannot occupy ephemeral streams (Brown 1990). However, they can persist in streams in which some reaches are de-watered.

4.6.6.3 Stream substrate particle size

Optimal habitat for coastal tailed frogs has instream substrate with numerous interstitial spaces. In a study of Oregon and Washington streams, adult coastal tailed frogs were most often found under large rocks and boulders in riffle areas (Bury et al. 1991a). During winter, Rocky Mountain coastal tailed frog adults appear to use larger substrate materials for shelter than during summer (Metter 1964a).

Laboratory experiments by Altig and Brodie (1972) showed that coastal tailed frog larvae preferred substrates with smooth rocks greater than 55 mm (2.2 in.) in diameter and turbulent water and that they avoided high light intensities. They found that tadpoles preferred larger substrate particles (85 to 125 mm or 3.3 to 5 in.) slightly over gravel (55 to 96 mm or 2.2 to 3.8 in.), and strongly avoided sand and pebble substrates. Altig and Brodie (1972) indicated that, in general, tadpoles may require smooth-surfaced stones with a minimum diameter of about 55 mm (2.2 in.) because of the larvae's oral disk; substrates that are too small may not allow the larvae to become attached. Additionally, the substrate must be large enough to provide interstitial spaces for daytime retreats. Bury et al. (1991a) found that tadpoles appeared to prefer deeper water and smaller rocks for cover than adults and to occupy gravel, pebble, and cobble beds. Larvae also avoid mossy rocks and silt deposits (Nussbaum et al. 1983).

Hawkins et al. (1988) found tadpoles on large substrates (>30 cm or >12 in.) at night, but smaller substrates during the day. This may be because larger rocks are preferred for grazing, but because they were heavily embedded, interstitial spaces for cover were a limiting factor. During the day, larvae retreated to smaller, less embedded substrates. Corn and Bury (1989) noted that the mean size of rocks used by coastal tailed frogs for cover was 433 cm^2 (67 in^2), representing cobble-sized rock.

In one southwestern Washington study conducted in second-growth forests, coastal tailed frog larvae were found only in basalt sediment streams at elevations above 300 m (984 ft) with low levels of fine sediments, and not at all in marine sediment habitats (Wilkins and Peterson 2000). Even though appropriate-sized substrate might be available in marine sediment streams, the rocks and cobbles present were possibly too soft and porous for successful larval attachment (Wilkins and Peterson 2000).

Stream channels characterized by coarse cobble and boulder substrates and bedrock that breaks down into coarse particles (e.g., intrusive or highly metamorphic rock) maintains higher densities of larval coastal tailed frogs by providing interstitial habitat during natural and anthropogenic disturbances (Wahbe et al. 2001). Coarse substrates also provide stable sites for depositing eggs and cover from predation.

4.6.6.4 Stream gradient

Coastal tailed frog populations are found in streams across a wide range of gradients from 2% to 60% (Wahbe et al. 2001). They appear, however, to be less common in very steep (e.g., > 50% gradient) channels where bedload is likely to be mobilized more frequently (Dupuis et al. 2000). Coastal tailed frogs may be more abundant in higher gradient channels because these streams have a greater capacity for flushing fine sediments that may otherwise fill interstitial spaces

important to coastal tailed frogs. Dupuis et al. (2000) found coastal populations to be generally absent from lower-gradient (<10%) streams in British Columbia coastal lowlands. Rocky Mountain coastal tailed frog populations in British Columbia occur in streams with an average gradient of 4%, likely because the steeper headwater streams in this region were ephemeral or were subject to high bedload transport (Dupuis and Wilson 1999).

In the north coastal California redwood region, Wallace and Diller (1998) found coastal tailed frogs in reaches averaging 9.1% gradient. However, Welsh et al. (1998) found no correlation between stream gradient and the presence of coastal tailed frogs in the pristine streams of Prairie Creek Redwoods State Park in northern California. Likewise, Adams and Bury (2000) did not find a statistically significant association between gradient at the sample site and coastal tailed frog density in the Olympic peninsula.

4.6.6.5 LWD

Welsh et al. (1993) noted positive associations between the presence and abundance of coastal tailed frog larvae and LWD in northern California, both in the stream channel and on the surrounding forest floor. The authors believed that this relationship could be due to (1) increased flushing of sediment in the general area created by increased turbulence from the LWD; (2) entrapment of sediment by LWD; and (3) presence of increased densities of adult coastal tailed frogs, which use the downed wood for terrestrial cover. No association was found between the presence of coastal tailed frogs and LWD at sites in the southern Washington Cascade Range (Aubry and Hall 1991).

4.6.6.6 Water temperature

The coastal tailed frog is restricted to a narrow range of habitat types, in part because it has the lowest known temperature needs and one of the narrowest ranges of temperature tolerances of any frog species. Coastal tailed frogs typically live in waters between 5° and 16°C (41° and 61°F) (Marshall et al. 1996). Cool water temperature, especially during the warm egg-laying season, is critical to reproduction of coastal tailed frogs. Embryos of coastal tailed frog have the narrowest temperature tolerance range (5° to 18°C or 41° to 64°F) and the lowest lethal temperature limit among North American frogs (Brown 1975a). Streams with water temperatures above 15°C (59°F) for extended periods are not suitable for reproduction (Hayes 1996).

Laboratory tests indicate that young (first year) larvae of coastal tailed frogs prefer water temperatures less than 10°C (50°F), especially 5 to 8°C (41 to 46°F). Older larvae prefer waters above 10°C (50°F), especially 12° to 16°C (54° to 61°F), although they do not avoid colder waters and generally have less precise temperature preferences than first-year tadpoles (de Vlaming and Bury 1970). Tadpoles strongly avoid waters above 22°C (72°F) (de Vlaming and Bury 1970), and post-metamorphs also avoid high temperatures (Welsh 1990, Hayes 1996). Claussen (1973) suggested that mortality of post-metamorphs may occur at 23° to 24°C (73° to 75°F), and de Vlaming and Bury (1970) indicated a lethal maximum of approximately 30°C (86°F) for tadpoles.

Welsh (1990) found stream temperature to be an excellent predictor of coastal tailed frog abundance, accounting for 37.3% ($P = 0.00002$) of the variation observed, with higher numbers of coastal tailed frogs occurring in streams with lower temperatures. The highest stream temperature Welsh observed with the coastal tailed frog was 14.3^{o}C.

4.6.7 Ecological interactions

4.6.7.1 Diet

Larvae of coastal tailed frogs are primarily dependent upon diatoms, which they scrape off of rocks (Franz 1970b, Altig and Brodie 1972, Nussbaum et al. 1983), but small amounts of filamentous algae, tiny insects, and sand are incidentally ingested during feeding. The stomachs of Rocky Mountain tailed tadpoles collected from interior sites contain large amounts of conifer pollen (Nussbaum et al. 1983). Larvae of coastal tailed frogs are classic *aufwuchs* gleaners, although they take advantage of other temporarily available food sources, such as pulses of conifer pollen (Jennings and Hayes 1994). Although some researchers have speculated that larvae of coastal tailed frogs may filter feed, Altig and Brodie (1972) determined in laboratory studies that tadpoles feed entirely on material scraped from rocks (see also Gradwell 1973).

Adult coastal tailed frogs feed on a variety of aquatic and terrestrial larval and adult insects, arthropods, and snails (Metter 1964a). Bury (1970) compared diet data of metamorphosed coastal tailed frogs with that of the southern seep salamander and concluded that the 2 species depend on similar food resources. At their study site in the fall and winter, the food supply seemed abundant and no competition was observed between them.

Rocky Mountain coastal tailed frog adults primarily forage along stream banks, but will also feed underwater, where they are less efficient at capturing prey (Metter 1964a). Whereas Metter (1964a) noted that Rocky Mountain coastal tailed frog adults consumed a variety of aquatic and terrestrial larval and adult insects, arthropods, and snails, Bury (1970) reported that stomach samples of coastal tailed frogs contained primarily terrestrial arthropods.

4.6.7.2 Predators

Predators of coastal tailed frogs include garter snakes, fish (those documented include sculpins, brook and cutthroat trout), giant salamanders, American dippers, and dobsonfly larvae (Metter 1963, Daugherty and Sheldon 1982a, Feminella and Hawkins 1994, Jones and Raphael 1998). Tadpoles and juveniles are likely more vulnerable than adults to predation (Daugherty and Sheldon 1982b). Pacific giant salamander larvae eat coastal tailed frog tadpoles, and trout take Rocky Mountain coastal tailed frog tadpoles and adults (Metter 1964a). Hunter (1998) found that metamorphosed coastal tailed frogs did not coexist with crayfish at his Oregon Cascades study site, perhaps due to predation by crayfish.

Feminella and Hawkins studied how tailed frog tadpoles adjusted their feeding behavior in response to 4 of their known predators:

> In absence of predators, tadpoles usually emerged from under cobbles to feed at night (2000 to 0100 hours), and spent the remainder of the 24-hour interval hidden in crevices. In the presence of giant salamanders, cutthroat trout, and brook trout that were confined within separate *in situ* enclosures immediately upstream of tadpoles, tadpole activity was reduced two-, three-, and six-fold, respectively. In contrast, tadpoles appeared unable to detect upstream sculpins. (Feminella and Hawkins 1994, p. 310)

4.6.8 Sensitivity to anthropogenic disturbances

Narrow habitat requirements, limited mobility, an extensive time period required for development, and an apparent preference for conditions associated with old-growth forests is thought to make populations of coastal tailed frogs extremely vulnerable to extirpation (Welsh 1990, Bury and Corn 1988). These factors may restrict gene flow (Daugherty and Sheldon 1982a) and retard recovery after habitat alteration (Marshall et al. 1996). Diller and Wallace (1999)

believed that because coastal tailed frogs can occur lower in a watershed than seep salamanders, they were more likely to experience the indirect, cumulative effects of habitat disturbance.

4.6.8.1 Physical barriers to movement and habitat fragmentation

Given the dependence of coastal tailed frogs on stream corridors or continuous moist habitat for terrestrial movement, any of the following may prevent or limit its movements: (a) habitat fragmentation due to timber harvesting; (b) road construction; (c) drying of stream reaches due to flow diversions; and (d) physical barriers, such as dams, waterways, culverts, and private residences.

4.6.8.2 Changes in hydrologic regimes

Changes in timing, frequency, and duration of high and low flows may affect survival of coastal tailed frogs. Flushing flows are important because they remove sediment and maintain interstitial spaces between rocks and gravels, thereby providing both diurnal cover for larvae and adults, and egg-laying substrate. However, exceptionally high spring runoff may cause larval mortality (Metter 1968, as cited in Daugherty and Sheldon 1982b). Adults may be able to escape high flows by leaving streams (Daugherty and Sheldon 1982b). Mortality can occur when eggs and larvae are stranded as flows diminish. Clearcut logging and roads may alter hydrologic regimes within watersheds and accentuate peak flows and low summer flows (Jones and Grant 1996, as cited in Wahbe et al. 2001).

4.6.8.3 Changes in sediment dynamics

Increased fine sediment inputs to streams associated with timber harvesting and roads can reduce distribution and abundance of coastal tailed frogs (Corn and Bury 1989, Marshall et al. 1996). The filling of substrate interstices is likely detrimental for coastal tailed frogs because it reduces cover from predation and high flow events (Corn and Bury 1989, Hayes 1996). Direct tests (e.g., stream substrate and population measurements taken before and after harvest) have not been done, however, to confirm this hypothesis. If true, the extent of these impacts is likely dependent on the sensitivity of the channel habitat to disturbance (Dupuis and Steventon 1999). More specifically, areas with weak rocks or thick surficial material deposits may produce more landslides and sedimentation than areas with thin surficial cover and more competent bedrock. Welsh and Ollivier (1998) found reduced abundance of coastal tailed frog larvae in streams impacted by an erosion event even in high velocity habitats that were likely to have lower sediment loads, suggesting that something other than the filling of interstitial spaces was affecting their abundance in these streams. Welsh and Ollivier (1998) suggested that perhaps a thin layer of sediment may be sufficient to block light and inhibit the growth of the diatoms on which coastal tailed frog larvae feed. In addition, greater amounts of sediment in a stream may scour algae from substrates (Alabaster and Lloyd 1982, as cited by Welsh and Ollivier 1998) and reduce periphyton biomass available to coastal tailed frogs even when not contributing to embeddedness (Welsh and Ollivier 1998).

4.6.8.4 Changes in LWD

Logging in riparian areas and removal of in-channel LWD has substantially reduced this habitat element in many northern California streams. Reduced LWD results in reduced structural complexity in the channel and riparian zone and reduced storage of fine and coarse organic material that supports food webs upon which the species depends.

4.6.8.5 Changes related to timber harvesting

Timber harvesting can affect coastal tailed frogs through increased water and ambient temperatures, removal of the overstory canopy, increased fine sediment inputs resulting from

logging activities, and reduced recruitment of LWD to stream channels and riparian foraging areas (Nussbaum et al. 1983, Corn and Bury 1989). Numerous researchers have documented the negative effects of timber harvesting on population densities and relative abundance of coastal tailed frogs (see Wahbe et al. 2001).

Of all Pacific Northwest frogs, coastal tailed frogs may be the species most vulnerable to degradation or loss of old-growth forest habitat (Blaustein et al. 1995). A number of studies have documented negative effects of timber harvesting on coastal tailed frogs. In western Oregon, Corn and Bury (1989) found that coastal tailed frogs were present in only 35% of stream reaches in logged areas, compared with 96% of reaches in unlogged areas; mean densities were twice as high in uncut reaches as in logged areas. Welsh (1990) documented relationships between the frequency of coastal tailed frog detections and forest age class; significant differences were found between young and mature, young and old, and mature and old age classes. Welsh did not find a significant relationship between coastal tailed frog densities and stand age when all study sites were pooled; however, he noted that his study sites in southwestern Oregon tended to occur at higher elevations in forests dominated by true fir, compared with sites in California, which tended to be at lower elevations and dominated by Douglas-fir. When higher elevation sites (>1000 m or 3280 ft) were excluded from the analysis, the relationship between coastal tailed frog density and forest age was significant.

Metter (1964a) thought that timber harvesting led to the disappearance of a Rocky Mountain coastal tailed frog population in Oregon's Blue Mountains. Coastal tailed frogs may be less sensitive to deforestation in coastal streams where maritime influences can maintain cool temperatures during the summer (Bury 1968, Corn and Bury 1989). In the drier climate of northeastern Oregon, however, Bull and Carter (1996) found no significant difference in the numbers of larval or post-metamorphic Rocky Mountain coastal tailed frogs in streams with low, medium, or heavy timber harvest, although coastal tailed frog numbers decreased with increasing harvest intensity. Based on a very general conceptual model, Bury and Corn (1988) predicted that timber harvesting reduces abundance of coastal tailed frogs in the Cascades of Oregon and Washington, and may extirpate the more vulnerable populations of the Coast Range of Oregon and northern California.

P.S. Corn and R.B. Bury compared Pacific giant salamander, southern torrent salamander, coastal tailed frog, and Dunn's salamander populations in harvested (14- to 40-year-old) and uncut (60- to 400+-year-old) stands in central coastal Oregon. "Physical comparisons between types of streams were similar," they wrote "except that streams in logged stands had generally smaller substrate, resulting from increased sedimentation" (Corn and Bury 1989, p. 39). The likelihood of occurrence, density, and biomass of coastal tailed frogs were significantly greater in uncut than in previously logged forest. Although the densities of Pacific giant salamanders and southern torrent salamanders were higher in steeper stream reaches within previously logged stands, the density of coastal tailed frogs was unrelated to stream gradient in both uncut and previously logged sites. At previously logged sites, coastal tailed frogs were more likely to be found where uncut timber was present upstream. Timber harvesting upstream from uncut forests had no effect on the presence, density or biomass of any of the study species.

The coastal tailed frog's sensitivity to timber harvesting may reflect its dependence on cold waters for breeding and larval development and on forested, late-seral riparian habitats for shade and fine sediment retention (Bury and Corn 1988, Corn and Bury 1989, Bury et al. 1991b). Timber harvesting of riparian canopy cover may increase stream temperatures and fine sediment inputs, and may lower streamside humidity. Increased insolation following timber harvesting

appears to cause shifts in periphyton away from diatoms, which are the preferred food of larval coastal tailed frogs, towards filamentous green algae, which is less palatable (see Kupferberg 1996) and may inhibit the ability of tadpoles to attach to rocks (Bury and Corn 1988, Beschta et al. 1987). Reductions in LWD in stream channels following timber harvesting may harm coastal tailed frog populations by reducing cover availability and increasing water temperatures. Diller and Wallace (1999) believed that the larval stage of coastal tailed frogs, which is restricted to streams, is the most sensitive to the impacts of timber harvest.

In areas with more stable streams (streams that provide suitable microhabitats during channel disturbances), timber harvesting may have beneficial short-term effects due to temporary increases in light penetration and subsequent stream productivity (Richardson and Neill 1998, Kim 1999). This is particularly true in areas where metamorphosis occurs more rapidly (one to 2 years) and where summer temperatures do not become lethal, or where periphyton abundance is nutrient limited, as suggested by Kiffney and Richardson (2001). Hawkins et al. (1988) noted that some environmental parameters of their study sites that were deforested from the Mt. St. Helens eruptions were comparable to clear-cut logged sites. These parameters include higher temperatures, high primary production by algae, and low input of terrestrial litter. The authors found high densities of coastal tailed frog larvae in the deforested sites where the headwaters of the study streams remained forested. However, Bury and Corn stated that "The bloom of productivity following clear-cutting is short-lived, and once shade is reestablished over a stream, invertebrate, salmonid, and salamander populations decline (Murphy et al. 1981, Hawkins et al. 1982, 1983)." The latter likely also applies to the coastal tailed frog. In the long-term (25–80 years), coastal tailed frog populations can persist in managed forests, but their numbers may be reduced (Corn and Bury 1989, Aubry and Hall 1991, Corn and Bury 1991a, Richardson and Neill 1998, Aubry 2000, Welsh and Lind 2002).

4.6.9 Impacts of MLC (2008)

There were 10 CalWater planning watersheds, known to have coastal tailed frogs present, which experienced some impacts from the 2008 fires. Of the 79 sites known to be occupied by coastal tailed frogs, 38 sites (roughly 48% of all occupied sites) experienced some impacts from the fires. Of the 38 sites affected, 20 sites had over 50% of their drainage acres burnt over by the fires. There were 8 sites with coastal tailed frogs present which had 100% of their drainage acres burnt over by fires. Monitoring the presence or absence of coastal tailed frogs throughout all of the burnt sites may provide more evidence of the fire impacts to the population.

4.6.10 Key uncertainties

MRC management has identified the following key uncertainties:

- What is the current and historical abundance and distribution of coastal tailed frogs in the plan area?
- What past management activities have affected populations of coastal tailed frogs in the plan area?

Chapter 5

Covered Terrestrial Species

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5 COVERED TERRESTRIAL SPECIES

5.1 Introduction

Chapter 5 includes species accounts for each terrestrial species covered by our HCP/NCCP. A species account is a brief description and history of the species from the scientific literature. Species accounts are the starting point for conservation planning—a process that must begin with awareness and understanding. The general topics developed for each species account in this chapter are geographic distribution, local distribution, life history, habitat requirements, ecological interactions, sensitivity to disturbance, and key uncertainties. Key uncertainties address gaps in MRC knowledge, such as the historical or current abundance of a species in the plan area, factors that might limit its recovery, impacts of land management upon species populations, and what exactly "species friendly" silviculture might be. MRC has italicized and flagged (▶) the key uncertainties that become hypotheses in the validation monitoring programs; Chapter 13, *Monitoring and Adaptive Management*, discusses these programs in detail.

5.1.1 Mendocino lighting complex (2008)

MRC has not fully assessed the impacts to the habitat and population of covered terrestrial species as a result of the lightning fires (see 1.18). Such assessment will require extensive monitoring of these species and their habitat. Under the individual species accounts, we have presented our preliminary determinations about the fire impacts.

5.2 Northern Spotted Owl

5.2.1 Geographic distribution

Spotted Owl in the Albion (2011)

The spotted owl has 3 subspecies. A recent genetic study supports the delineation of these 3 subspecies through mitochondrial DNA (Barrowclough et al 2005). The authors of a recent status assessment of the northern spotted owl (Courtney et al 2004) also state that the northern spotted owl is a distinct subspecies. Two of the subspecies, the northern spotted owl (*Strix occidentalis caurina*) and the California spotted owl (*S. o. occidentalis*), occur in California and are thought to be closely related. The third subspecies, the Mexican spotted owl (*S. o. lucida*), is federally listed and found from southeastern Utah and central Colorado southward through the mountains of Mexico (Gutierrez et al. 1995).

Of the 2 California subspecies, only the northern spotted owl is federally listed as threatened (USDI 1990). It breeds from southwestern British Columbia through western Washington and Oregon to Marin County, California (USFWS 1994b). A few confirmed sightings of spotted owls from the Santa Cruz Mountains were not identified to the level of subspecies (Small 1994). Northern spotted owls are considered to be an uncommon resident species in northwestern California (Harris 1993). The California spotted owl, a U.S. Forest Service sensitive species, is found mostly in the western portion of the Sierra Nevada range. It can also be found in mountainous regions of Monterey and Santa Barbara counties and a few localized sites in southern California (USDA Forest Service 1992).

5.2.2 Local distribution and regional status

5.2.2.1 Distribution inside and outside the plan area

Northern spotted owls are found across the assessment area. MRC surveyed approximately 250 individual territories on or adjacent to MRC land from 1988-2010. By the fall of 2010, 237 of these territories were still active[1]. Of these 237 active territories, 224 were either (a) in the plan area or (b) outside the plan area but within 1000 ft of the plan area boundary.

5.2.2.2 Distribution in assessment area

MRC obtained information for northern spotted owl territories in both Mendocino County from the most recent CDFG database as of August 2010.[2] CDFG maintains this database and tracks all known northern spotted owl territories throughout the state of California. The database lists 534 territories in Mendocino County (up to MEN0614). Although MRC received the database in late 2010, most of the data is from 2009 and earlier. Of the 534 territories listed in Mendocino, 25 have been designated "abandoned" in consultation with USFWS and only 278 have been visited or surveyed since 2007. The plan area contains 142 of the 278 recently surveyed territories in Mendocino County or 51% of the total.

Owlets

5.2.2.3 Spotted owl density in northern California

Over the last 10-12 years, crude density[3] (i.e., the number of owls per square kilometer) has been calculated for several forest lands in northwestern California; all fall within a close range. As of 2011, the density of northern spotted owls in the plan area is 0.209 owls/km^2. In Marin County the density is 0.3 owl pairs/km^2 (Fehring et al. 2004). Over a decade ago, a biological opinion for Pacific Lumber Company (PALCO) cited a density of 0.325 owls/km^2 (NMFS and USFWS 1999). In July 2008, the sister company of MRC, Humboldt Redwood Company (HRC), was formed from PALCO lands. HRC biologists report that, as of 2011, the owl density remains steady at .30 owls/ km^2.[4] Densities similar to that of the plan area were also found in (a) Willow Creek in Humboldt County— 0.235 owls/km^2 (Franklin et al. 1990); (b) Simpson lands in northern California—0.209 owls/km^2 (Diller and Thome 1999); and (c) Redwood National Park—0.163 owls/km^2 (Tanner 1999).

5.2.3 Population trends

Research in California indicates that several study populations for the northern spotted owl may be stable or slightly declining (Franklin et al. 1996, Franklin et al. 2002). A minimum population estimate for northern spotted owls in California during the late 1980s and early 1990s was 1111 pairs (Gutièrrez et al. 1995). Although populations may be stable in northern California, northern spotted owl populations are declining across a large portion of their range due to destruction, fragmentation of old-growth habitat (Noon and McKelvey 1996), and, perhaps, barred owls (see section 5.2.6.3). A recent metapopulation study (Anthony et al 2004) indicated that, across the range of the northern spotted owl, lambda (or the population growth) was less than 1.0 for 12 of 13 demographic study areas. A lambda < 1.0 indicates a declining population. This is equivalent

[1] The term "active" refers to territories that had spotted owl occupancy at least once during the period from 1988-2007.
[2] Email to Robert Douglas (MRC) from Gordon Gould (CDFG) on 08/17/2006.
[3] MRC defines crude density as the number of owls in each territory (pairs or resident singles) divided by the area of the plan area: 181 owls/863 km^2 = 0.209 owls/km^2.
[4] 254 ows/846.6 km^2 = .30 owls/ km^2

to a 4.1% decline in the northern spotted owl population per year. Fragmentation of old-growth habitat has isolated populations and reduced prey for spotted owls outside northern California as well (Thomas et al. 1990).

Extensive loss and degradation of habitat, primarily due to forestry practices, such as clearcutting and even-aged tree-management, generally have been regarded as a principal threat to spotted owls (Gutièrrez et al. 1995). Moreover, some timber managers consider selective harvest to be a largely unsuccessful management technique where spotted owls are concerned (Driscoll 2000). However, there is scant scientific literature addressing this issue (King et al. 1997). Therefore, only further research will determine the cumulative effects of various logging practices on spotted owls and their prey (Ward et al. 1998, Driscoll 2000).

5.2.4 Life history

5.2.4.1 Reproduction and growth

Northern spotted owls establish or re-establish pair bonds in early February and March as pairs begin to roost together (Forsman et al. 1984). Nest-site selection follows, usually in March and April. These owls typically have only 1 brood per season, and rarely re-nest if the first nest fails (Lewis and Wales 1993, as cited in Gutièrrez et al. 1985). A recent study in southern Oregon indicates that males with previous reproductive experience contributed more to the reproductive rate than inexperienced males (Dugger et al 2005). Northern spotted owls do not usually nest every year; one study found an average nesting rate of once every 2-3 years in northern California (Thome et al. 2000). For the most part, eggs are laid in April and clutch size varies from 1 to 4, although only 1 or 2 offspring usually survive. The female incubates the eggs for approximately 30 days (Forsman et al. 1984). The male generally feeds the female throughout the incubation and early brooding period. The female broods young for an additional 10 days after hatching; at that point, the owlets become active and the female begins to leave the young to forage for progressively longer periods (Forsman et al. 1984). Both the male and female continue to forage for the owlets and feed them directly until they leave the nest at approximately 35 days old, from mid-May through June. Both parents primarily roost near the young through August, although one parent may roost apart. The siblings often roost together but may move farther apart as they mature. Young become independent by late summer and dispersal typically begins in early September and continues through October (Gutièrrez et al. 1985). Females may breed as early as their second year (Gutièrrez 1985).

5.2.4.2 Movement and dispersal

Dispersal of the young facilitates colonization of unoccupied habitat, replacement of breeding pairs in an established territory, and increasing local genetic variation. Initial dispersal direction appears to be random (Miller 1989). Observed dispersal distances averaged 12 mi (19 km) for females and 4 mi (6 km) for males (Thomas et al. 1990); overall, the median distance was 27 mi (44 km). Gutièrrez et al. (1985) observed straight-line distance dispersal of 12–62 mi with a mean of 28.3 mi (45 km).

While juvenile dispersal is the norm, adult owls are known to disperse occasionally due to habitat disturbance, displacement by barred owls, death of a partner, or unknown reasons. One early researcher hypothesized that a reserve supply of birds might be necessary to replace territorial individuals who die (Nice 1941). The mechanisms involved in adult dispersal, however, are not as well understood as those associated with juvenile dispersal.

5.2.4.3 Turnover

Territory turnover occurs when a resident owl dies or shifts territories and another owl takes its place. Long-term pair bonds characterize spotted owl mating. Spotted owls are generally monogamous—they maintain the same home ranges and re-unite with their previous mates each year, if possible (Verner et al. 1991, as cited in Thome et al. 2000). Thome et al. (2000) rarely observed separations of spotted owl pairs, although occasionally an owl would re-pair with a new mate. Reproductive success was lower for owls occupying sites where turnover had previously occurred. This could reflect a new pair's inexperience at nesting, roosting, foraging, or paternal care.

5.2.4.4 Home range

Northern spotted owls have relatively large home ranges compared with other owls (Forsman et al. 1984). In one study in California (Thomas et al. 1990), home ranges of individual northern spotted owls varied in size between 1258 ac (503 ha) and 7823 ac (3129 ha). In Mendocino County, Pious and Ambrose (1994) studied 9 radio-tagged owls on Georgia-Pacific land and adjoining Louisiana-Pacific land, which is now MRC land. Both G-P and L-P were major landowners in Mendocino County. Home ranges in the Pious and Ambrose study varied from 806 to 4442 ac (326 to 1798 ha). A more recent study conducted by researchers in Mendocino County estimated the mean home-range size of northern spotted owls there as 1559 ac (using 95% minimum convex polygons) for 9 territories (Irwin et al. 2004).

There is significant overlap between home ranges of members of the same pair (Forsman et al. 1984, Solis and Gutièrrez 1990) and less overlap among adjacent pairs. Home range sizes vary geographically (Carey et al. 1992) and are often correlated with prey use. They are larger when flying squirrels are the primary prey and smaller when woodrats are the primary prey (Zabel et al. 1995, as cited in Gutièrrez et al. 1995). In Oregon, Forsman et al. (1984) found increasing home range size with a decreasing amount of old-growth forest.

5.2.5 Habitat requirements

5.2.5.1 Forest types

In northern California, spotted owls are found in younger stands with less canopy cover compared with other regions (Pious 1994, Noon and McKelvey 1996, and Folliard et al. 2000). However, in general, spotted owls are found in older forests characterized by high canopy closure (>70%), multi-layered canopy structure, large-diameter trees, downed logs, and snags (Thomas et al. 1990, Buchanan 1991). The multi-layered canopy provides foraging, roosting, and nesting habitat, as well as various microclimates, which help spotted owls regulate their body temperature.

Platform Branch in Conifer

Northern spotted owls prefer forests with a high degree of complexity, probably because this forest type provides both older trees with cavities or snags for nesting and understory habitat for perching and foraging. In California, spotted owls prefer stands dominated by conifers with hardwood understories (Pious 1994). Spotted owls occur in stands with less brush (Gutièrrez et al. 1998) compared to surrounding areas unpopulated by owls. Gould (1977) noted that 98% of all spotted owl observations made in California were within 1970 ft (600 m) of water, although water has not been established as a key habitat variable for spotted owls.

Thome et al. (1999) compared random sites with spotted owl nest sites and found that nest sites had a lower proportion of younger forest stands. However, within those nest sites, reproductive success was greater in areas with a higher proportion of such stands. Moreover, lower proportions of the largest basal-area class also characterized sites with greater reproductive success. This is probably due to availability of prey, which appears to be negatively correlated with forest age in northern California. Mature stands allow maneuverability and provide optimum nesting habitat and protection from predation, whereas younger stands can provide additional complexity or increased prey base (Thome at al. 1999).

Overall, Thome et al. (1999) showed that northern spotted owls are associated with mature stands having some 21-40 year-old trees and stands with basal areas of 100-196 ft^2/ac (23–45 m^2/ha) and 200-301 ft^2/ac (46–69 m^2/ha). Residual trees in managed stands are beneficial for northern spotted owls and increase reproductive success. Large areas of young stands apparently can support reproductive success if a high residual tree component is retained. However, owls in the cited study may have occupied stands of younger and smaller trees in areas that had a higher abundance of prey, especially woodrats. The researchers emphasize that these results are only applicable to California north-coast forests managed with clearcut silvicultural practices (Thome et al. (1999).

5.2.5.2 Four habitat types

In order to better understand the needs of spotted owls, MRC parses habitat into nesting/roosting, foraging, dispersal, and non-suitable habitat. Though there are separate habitat types for both nesting/roosting and foraging, overlap often occurs. For instance, nesting/roosting habitat also can provide foraging habitat for owls, although foraging habitat generally does not provide nesting/roosting habitat. Furthermore, since distinguishing nesting and roosting habitat is difficult, we have combined these categories, though there may be some nesting/roosting stands that provide more structures and requirements for nesting than others. The needs for dispersal habitat are generally met by both nesting/roosting and foraging habitat. Non-suitable habitat is any habitat type that does not currently provide for either the nesting/roosting or foraging needs of spotted owls, i.e., open stands with low tree density. Additionally, we have described the prey habitat for the spotted owl in northern California as this does not always match its foraging habitat.

5.2.5.3 Nesting habitat

While nests are mainly in mature stands in other areas of the Pacific Northwest, observers have commonly spotted them in younger stands in northern California, where rapid growth allows for development of habitat before trees reach the old-growth stage. On MRC land, a study of nest sites in 2000 and 2001 indicated that nest trees were of greater dbh than trees selected randomly in random plots, and basal area around the nest tree was greater than basal area in random plots. Mean nest tree diameter on MRC land was 34.6 in. (89 cm) dbh, compared with 26.4 in. (66 cm) dbh in random plots. Nest tree plots were generally multi-layered (>2 vegetative layers) and mean canopy cover at nest sites was 89%.

Nests tend to be in tree or snag cavities, on platforms (in abandoned raptor or raven nests, squirrel nests, mistletoe brooms, or debris accumulations), or on broken-top snags. In more mature forests, spotted owls tend to use broken-top trees and cavities more frequently than platforms (LaHaye 1988, Buchanan 1991, Gutièrrez et al. 1995). Researchers located nests in northwestern California on the lower portions of slopes, probably because lower slopes and river terraces provide large trees (Sawyer et al. 1988, LaHaye and Gutièrrez 1999). Nesting habitat commonly consisted of Douglas-fir trees with an average age of 300 yrs, an average height of 92 ft (28 m), and a diameter in the range of 46.8–61.8 in. (119–157 cm) dbh (LaHaye and Gutièrrez 1999).

Forest cover was approximately 70% at the nest site (LaHaye and Gutièrrez 1999). In coastal Mendocino County, Pious (1995) noted that the majority of nests occurred in coastal redwood (73%), with fewer in Douglas fir (14%), and tanoak (8%).

5.2.5.4 Roosting habitat

The characteristics for roosting sites, especially during the summer, are dense canopy cover dominated by large-diameter trees, multiple canopy layer, and north-facing slopes (Barrows 1981, Gutièrrez et al. 1995). In the summer, spotted owls typically roost in cooler areas within well-shaded stands or near streams. Some have observed owls roosting low to the ground in understory trees that form an umbrella of leaves over the perch site during the summer months (Barrows and Barrows 1978). Winter roost sites are not necessarily identical to sites used during the summer months and can be in more open habitat (Barrows 1981). Multi-layered forests with sheltered roost sites appear to be essential to the owl's survival.

5.2.5.5 Foraging habitat

Dusky-footed Woodrat
Photo by Glenn Vargas

Foraging habitat varies more than roosting and nesting habitat (Thomas et al. 1990) but generally includes high canopy closure and complex structure (USFWS 1994c). Several studies have investigated foraging habitat requirements. Although spotted owls appear to avoid crossing clearcut areas and recently logged forests (Gutierrez et al. 1995), researchers have recorded foraging along forest edges (Ward 1990, as cited in Gutierrez et al. 1995; Zabel et al. 1995). However, Ward et al. (1998) reported that the optimal ratio between young forest edge and remaining late-seral forest is indeterminate. Thomas et al. (1990) found that foraging owls consistently avoided young stands and pole stands. In contrast, Blakesley et al. (1992) found no tendency of owls to avoid young stands of approximately 11–21 in. (28–53 cm) dbh. In a study by Blakesly et al. (1992), owls used stands with diverse compositions and complex structures produced by natural processes.

Overall, old-growth forests are apparently the preferred foraging and roosting habitat for the spotted owl in its northern range. However, some open areas are also important foraging habitat in northern California, as the availability of prey is higher in disturbed areas (Folliard et al. 2000). Spotted owls are probably not able to maneuver well in the young stands with the highest prey abundance (Zabel et al. 1993, as cited in Thome et al. 1999); therefore, they are likely to forage in stands that are young enough to contain an abundance of prey, such as woodrats, but old enough to allow the owls to fly under the canopy (Thome et al. 1999).

5.2.5.6 Dispersal habitat

Requirements for dispersal habitat for the northern spotted owl are not well known. The 50-11-40 rule, suggested by Thomas et al. (1990), recommends that 50% of a landscape be in trees with an average dbh of 11 in. providing a minimum of 40% canopy cover for spotted owl dispersal.

5.2.5.7 Prey habitat

While mechanisms limiting and regulating northern spotted owl populations are unclear, prey abundance and availability are important factors in northern spotted owl survival (Gutierrez et al. 1995, Ward et al. 1998, Driscoll 2000). Spotted owls select for the largest, most available prey (Ward et al. 1998), such as dusky-footed woodrats in northern California. However, they are

somewhat opportunistic and will also prey on smaller mammals, such as deer mice, red-tree voles, and red-backed voles, among others (Gutierrez et al. 1995). In northern California, Ward (1990, as cited in Gutierrez et al. 1995) reported radio-marked male spotted owls foraging at sites with an abundance of woodrats, as well as deer mice.

Woodrats, the primary prey species in northern California (Gutierrez et al. 1985, Ward et al. 1998), prefer live oaks and other thick-leafed trees and shrubs with dense shrub cover (Kelly 1990). Hamm (1995) found them to be most abundant in seedling-shrub and sapling-pole seral stages. The second most important prey, northern flying squirrels, are found in coniferous and mixed forests, but may also occur in hardwoods with a high abundance of old and dead trees with numerous nesting cavities.

Flying Squirrel
Photo from Burke Museum

Although northern flying squirrels are more abundant in late-seral forests and, therefore, are more accessible to spotted owls, individuals have only about one-half of the biomass of woodrats (Ward et al. 1998). Thus, spotted owls with a high proportion of woodrats in their diets have smaller home ranges than those that eat mostly flying squirrels (Zabel et al. 1995). Franklin et al. (2000) stated that northern spotted owls in California prefer woodrats over any other prey item and select for foraging habitat of a mid-successional forest, where woodrats were both abundant and accessible (Franklin et al. 2000).

Red-tailed Hawk
Photo by W.S. Clark

A prey-base study conducted in southwest Oregon found greater woodrat abundance in mixed-conifer forests than in Douglas-fir forests (Center et al. 1991). Woodrats were most abundant in young (<80 years) stands and in disturbed portions of old stands (>80 years) where dense re-vegetation occurred in mixed-conifer forests (Center et al. 1991). This same study also indicated a positive correlation between percentage of woodrat abundance and ground cover of fine and coarse litter. In coastal northwestern California, dusky-footed woodrat abundance typically peaks approximately 10–20 years after a clearcut (Driscoll 2000). In coastal redwood forests of northern California, Fitts and Northen (1991) reported the greatest woodrat abundance occurred in 7- and 11-year-old clearcuts.

In northwestern California, Sakai and Noon (1993) reported that radio-marked woodrats move between different habitat types, which suggested that sapling/brushy pole-timber stands adjacent to mature and old-growth Douglas-fir/tanoak forests may be sources for woodrats preyed upon by spotted owls. Sakai and Noon (1993) found woodrat densities were highest in (a) sapling/brushy pole-timber, 4.8-10.6 in. (12.1-27.0 cm) dbh and 15-40 yrs; (b) seedling/shrub, 0-4.7 in. (0-12 cm) dbh; and (c) large old-growth stands, 35.4 in. (>90.1 cm) dbh and >180 yrs. Woodrats did not occur in small saw-timber stands (41-80 yrs) and were rarely found in large saw-timber stands (81-180 yrs) (Sakai and Noon 1993). Moreover, the cited study suggested that implementing specific silvicultural practices that provide open areas for woodrats adjacent to suitable spotted

owl habitat may directly benefit spotted owl populations by providing an abundant and available prey source. Ward et al. (1998) reported that northern spotted owls may select conifer-hardwood edge sites as a possible compromise between finding abundant versus accessible dusky-footed woodrat populations.

Little is known about woodrat abundance patterns in coastal northwestern California (Hamm 1995), patch sizes required by woodrats to maintain self-sustaining populations (Sakai and Noon 1993), or the most effective silvicultural strategies to maintain woodrat habitat within regenerating clearcuts (Sakai and Noon 1993). Consequently, it is necessary to test hypotheses associated with timber management practices and determine the optimal spatial distribution of forest types and stages for spotted owls in a managed landscape (Sakai and Noon 1997, Ward et al. 1998). Specifically, MRC forests currently support a high density of tanoaks, woodrats, and spotted owls. Whether our restoration of conifer-dominated forest will result in a reduction of woodrats—the primary prey of spotted owls in northern California—is unclear.

5.2.6 Ecological interactions

5.2.6.1 Diet

Diet varies with season and includes a variety of mammals, birds, and insects. Overall, 92% of prey items are mammals (Forsman et al. 1984). Pious and Ambrose (1994) described the diet of northern spotted owls in coastal Mendocino County as consisting by biomass primarily of dusky-footed woodrats (74% in 1989, 82% in 1990) and brush rabbits (16% in 1989, 10% in 1990) with other species consisting of < 5% of the biomass.

5.2.6.2 Predators

Cooper's hawks, red-tailed hawks, northern goshawks, and great horned owls can prey on spotted owls. Great horned owls occur throughout the distribution of spotted owls and prey especially on juveniles, which are easily caught in open habitats such as woodlands, clearcuts, and grasslands. Forest fragmentation leads to increased numbers of great horned owls which may prey on juvenile spotted owls (Gutièrrez 1985). However, the authors of a recent status review of the northern spotted owl state that scientific findings no longer support the earlier perception that forest fragmentation increases the threat of predation (Courtney et al. 2004).

5.2.6.3 Interspecific competition with barred owl

Barred owls have expanded their distribution into the western United States and are now found throughout southwestern Canada, Washington, Oregon, and northern California. There were no observations of barred owls in California before the late 1970s and 1980s (Dark et al. 1998). Increased sightings of barred owls are probably due to (1) an actual increase in numbers through immigration and the subsequent successful establishment of breeding populations; and (2) a recent increase in surveying effort for spotted owls that has led to more observations of barred owls. Barred and spotted owls are ecologically similar. They forage in similar habitats and have overlapping diets, although barred owls appear to be more tolerant of disturbance and habitat fragmentation (Dark et al. 1998). Barred owls exhibit a behavioral dominance over spotted owls, which can lead to either displacement of spotted owls (Hamer 1988) or hybridization between the species (Hamer et al. 1994). Hybridization reduces reproductive success of existing spotted owl populations by, in essence, removing reproductive spotted owls from the breeding population. Additionally, the Endangered Species Act does not list hybrids (Dark et al. 1998). There is also some indication that barred owls may actually prey on spotted owls (Leskiw and Gutièrrez 1998).

A review of known hybrids in Oregon and Washington indicates that only 28 known territories in those states had examples of hybridization through 1999. This is a low number considering the

hundreds of known spotted owl territories in Oregon and Washington (Kelly and Forsman 2004). Moreover, modeling efforts indicate barred owls have the potential to invade the entire range of northern spotted owls, though researchers do not yet know the effect this may have (Peterson and Robins 2003). One study indicates that the occupancy of northern spotted owl territories decreased after barred owls were detected within 0.8 km of a spotted owl site center (Kelly et al 2003). Occupancy was only minimally reduced when barred owls were detected more than 0.8 km from a spotted owl site center (Kelly et al 2003). Another experimental study found that spotted owls responded less to spotted owl calls after exposure to barred owl calls; northern spotted owls responded less frequently in areas with a greater number of barred owls (Crozier et al 2006). Courtney et al. (2004) list competition from barred owls as a major threat but remain uncertain about its magnitude.

Barred Owls
Photo by Robert Suplee

The Northern Spotted Owl Recovery Plan was more confident of the threat of barred owls and the need to respond. "At this time," the report states, "it appears long-term lethal control of significant numbers of barred owls should be assessed to recover the spotted owl" (USFWS 2008, p. 8). Gutierrez et al (2007) concluded that lethal control is the most effective method for controlling barred owls, but recommended that this method be initiated in designed experiments before using it as a management tool.

Barred owls compete with and on rare occasions prey on northern spotted owls; in the last 20 years or so, their range has expanded into northern California (Dark et al. 1998, Leskiw and Gutierrez 1998). Barred owls were first detected in Mendocino County in 1978.[5/1] By the end of the 2008 breeding season, MRC biologists had detected barred owls within 1 km of 30 individual spotted owl territories. Since 2005, the number of barred owl territories detected within 1 km of spotted owl territories has increased steadily (1 in 2005, 4 in 2006, 6 in 2007, 9 in 2008, 4 in 2009, and 22 in 2010). While some territories had barred owl detections in some years and not others, 9 territories have had barred owl detections in at least 2 of the past 4 years. There are likely more undocumented occurrences of barred owls in Mendocino and Sonoma counties.

5.2.6.4 Disease

The first detection of West Nile Virus (WNV) in California was in 2002. WNV is an arbovirus spread mainly by infectious mosquitoes; birds are often the source of infection (Boyce et al. 2004). The extent to which WNV will be a major threat to spotted owl populations is unknown. Crows experimentally infected with WNV exhibited a 100% mortality rate (Komar et al. 2003). If forest corvids (ravens and jays) behave like crows, then spotted owls that live in close proximity to them on covered lands may contract the virus and face uncertain survival. Courtney et al (2004) rated the West Nile Virus as a threat to spotted owls although they were uncertain of its magnitude.

[5/1-3] Email to Sarah Billig (MRC) from John Hunter (USFWS) on 11/14/2006.

5.2.7 Sensitivity to anthropogenic disturbances

5.2.7.1 Changes to forest stand structure

Timber harvesting and road building have direct effects on nesting, roosting, and foraging habitat by removing large trees and opening the canopy layer. Spotted owls are sensitive to habitat disturbance, due to their low tolerance for high temperatures and their association with late seral stages of forest and snags or cavity trees. In addition, forest fragmentation isolates populations, provides clearings where great horned owls may be more successful at preying on spotted owls (Forsman 1976), and provides habitat that competing barred owls may utilize better than spotted owls.

According to Wasser et al. (1997), timber harvesting and road building activities can also affect northern spotted owls by increasing physiological stress and contributing to decreased reproductive success. Male northern spotted owls exhibit a significant rise in fecal corticosterone levels when they occupy territories centered within 0.27 mi (0.41 km) of a major logging road or recent (within 10 yrs) timber activity (Wasser et al. 1997). No differences were recorded among females. Moreover, male corticosterone levels were higher in home ranges near clear-cut areas than in home ranges near selectively logged areas. There was a short-term elevation of stress hormones in female owls during the 1.5-month interval when their young began to fledge; this factor could prove important in developing guidelines for seasonal limitations on harvests in close proximity to nesting owls. “Management-related factors reflecting habitat condition and proximity to roads,” according to other researchers, “were not correlated with fecal corticosterone” (Tempel and Gutierrez 2004, p. 538).

5.2.7.2 Disturbance

Additional studies have examined the effect of disturbance on spotted owl behavior. Delaney et al. (1999) studied the effects of both chainsaw and helicopter noise on Mexican spotted owls (MSO). They found 345 ft (105 m) was the furthest distance at which MSOs flushed due to helicopter noise. Roads provide open space for predators, such as great horned owls, to prey on spotted owls. One reported case of a barred owl preying upon a spotted owl occurred on a trail (Leskiw and Gutièrrez 1998).

Noise is a source of disturbance and a potential threat to northern spotted owls, especially during the breeding season (USFWS 1997c), as it can cause the abandonment of nest and young. Noise includes road traffic, use of mechanized equipment, and recreational activities, such as boat use, off-road vehicle use, and hunting. Measurements in Redwood National Park and State Parks showed that chainsaw noise 100 ft (31 m) away from a nest was still 1.5–2 times louder than natural background noise (Redwood National and State Parks 1998).

5.2.8 Status assessment and strategies for recovery

5.2.8.1 Status assessment of northern spotted owl

The authors of the scientific evaluation of the status of the northern spotted owl (Courtney et al 2004) list 3 major threats to this subspecies:

1. Results of past and current timber harvests.
2. Loss of habitat to wildfire.
3. Barred owls.

In order to finalize the *Northern Spotted Owl Recovery Plan*, USFWS convened a panel of seven experts on June 1, 2006. The panel rated and identified the most pressing threats to the spotted owl (USFWS 2008, p. 7):

1. Past habitat loss.

2. Current habitat loss.
3. Competition from barred owls.

5.2.8.2 USFWS recovery plan for habitat retention

The *Northern Spotted Owl Recovery Plan (USFWS 2008)* designates Managed Owl Conservation Areas (MOCA) and Conservation Support Areas (CSA). These create a network of habitat and population density to support spotted owls. MOCAs are mapped areas that "contain or will develop suitable habitat considered essential for spotted owl recovery" (USFWS 2008, p. 13). The USFWS intent is that MOCAs will generally be static, though there may be minor adjustments to their boundaries consistent with the plan. There are two types of MOCAs.

- MOCA 1 is capable of supporting 20 or more breeding spotted owl pairs now or in the future.
- MOCA 2 is capable of supporting 1-9 pairs of breeding spotted owls.

CSAs are adjacent to or near MOCAs. They retain spotted owl habitat either though HCPs or through protected areas, such as state and federal parks.

5.2.8.3 USFWS recovery criteria

The *Northern Spotted Owl Recovery Plan* lists 3 criteria for recovery.

- **Criterion 1**
  The population trend of spotted owls appears stable or increasing throughout 10 years of monitoring, as measured by a statistically reliable method, in each province including Western Washington Lowlands and the Willamette Valley, with a low probability that the population is actually declining.

- **Criterion 2**
  The distribution of spotted owls, within each state, is such that at least 80% of Category 1 MOCAs contain 15 or more occupied spotted owl sites when surveyed over a 5-year period.

- **Criterion 3**
  At least 30% of each province—Eastern Cascade Provinces in Washington and Oregon and California Cascades Province— contains high quality habitat; 75% of this habitat is within at least one home-range radius of an activity center of a territorial pair of spotted owls, as measured over a 5-year period.

5.2.9 Impacts of MLC (2008)

The lightning fires of 2008 burned through the core areas of 23 northern spotted owl territories. Of these territories, 14 had produced young in the past and 3 were high producers (i.e., they produced more than 0.8 fledglings per year averaged over a 10-year period). Just 3 of these 20 territories had nests in 2008, while 15 were occupied, 3 unoccupied, and 2 unknown.

5.2.10 Key uncertainties

MRC management has identified the following key uncertainties, with cross references to validation monitoring programs in parentheses:

- What is the degree to which barred owls will invade the plan area in Mendocino County?
- Are there conservation measures related to land management and disturbance that could favor spotted owls over barred owls?

- *Will removing barred owls from the plan area have a positive effect on spotted owls (M§13.9.1.4-7)?*
- How does land management influence the interactions between barred owls and northern spotted owls?
- *Are the population and number of spotted owl territories on covered lands increasing, stable, or decreasing (M§13.9.1.4-1)?*
- *Does MRC habitat typing for spotted owls accurately reflect actual habitat available on the landscape (M§13.9.1.4-2)?*
- *Can the pattern, arrangement, or acreage of nesting/roosting and foraging habitat affect spotted owl demographic rates (M§13.9.1.4-5)?*
- *Are spotted owl demographic parameters (e.g., productivity, survival, etc.) affected by the amount of protection they receive, i.e., do larger core areas provide for greater spotted owl productivity (M§13.9.1.4-3)?*
- *What is the effect of harvesting within 1000 ft of a spotted owl activity center with limited protection (M§13.9.1.4-4)?*
- What are the redwood forest metrics for northern spotted owl nest-roost requirements; e.g., basal area, canopy closure, dbh distribution?
- What effect will more frequent harvest entries into MRC forests as a result of uneven-aged management have on northern spotted owls in the plan area?
- What effect will uneven-aged management have on the availability of spotted owl prey?
- What effect does herbicide applications have on woodrat populations?
- *Is there a direct correlation between the density of hardwoods, especially tanoaks, within spotted owl territories and the demographic parameters of spotted owls (M§13.9.1.4-6)?*
- What effect will West Nile Virus have for spotted owl survival in the plan area?

5.3 Marbled Murrelet

5.3.1 Geographic distribution

The marbled murrelet (*Brachyramphus marmoratus)* breeds from the Aleutian Archipelago and the eastern Bering Sea in Alaska to Monterey Bay in central California (USFWS 1997c, Ralph et al. 1995). Marbled murrelets winter throughout this breeding range and also occur in small numbers offshore from southern California (USFWS 1997c). Researchers completing genetics work on murrelet populations recently recommended five genetic management units: western Aleutian, central Aleutian Islands, mainland Alaska and British Columbia, northern California, and central California (Friesen et al 2005).

Photo from USDA

In California, suitable marbled murrelet forest habitat currently exists in 3 areas, 2 of which are separated by a large gap of approximately 298 mi (Cooperrider et al. 2000, p. 162):

- In the northern portion of Del Norte and Humboldt counties (mostly Redwood National Park).
- In the central portion of Humboldt County (mostly Humboldt Redwood Company and Humboldt Redwoods State Park).

- In San Mateo and Santa Cruz counties.

Miller et al. (1995) reported that nesting probably once occurred in a more or less continuous distribution along the California coast. Much of the area between Del Norte and Santa Cruz counties, including Mendocino County, probably supported significant numbers of murrelets prior to extensive timber harvesting. The distribution gap in Mendocino and Sonoma counties is part of Recovery Zone 5, according to the *Marbled Murrelet Recovery Plan* (USFWS 1997c). Little historical information regarding murrelet abundance is available for these areas. Based on their current range and scientific understanding of their habitat requirements, however, it seems likely that murrelets nested in substantial numbers along the Mendocino County coast prior to the removal of much of its old-growth forest (Carter and Erickson 1988).

In winter, marbled murrelets may be found as far south as San Diego County (Nelson and Singer 1994). In the southern portion of their range, marbled murrelets have been observed making winter flights into coastal forests. The reason is unknown but it may be to maintain nest sites, territories, and pair bonds, or to select nesting areas (Naslund 1993, Nelson 1997).

5.3.2 Local distribution

The potential distribution of murrelets on or in the vicinity of the plan area was determined by reviewing records from MRC, Georgia Pacific, CDFG, and USFWS on murrelet detections in Mendocino and Sonoma counties.[6]

There are few terrestrial breeding season (or "inland") records for marbled murrelets in Mendocino County (Paton and Ralph 1990, Miller et al. 1995). Detections further than 5 miles inland appear to be uncommon in Mendocino and Sonoma counties. However, in 1997 and 2003 murrelets were detected as far as 9.75 miles inland indicating that potential habitat and murrelet use does occur up to 10 miles inland. There has been only 1 confirmation of marbled murrelets nesting in Mendocino County; eggshell fragments were found beneath a residual old-growth Douglas fir in 1993 near Alder Creek in what is now the plan area.

There are currently 6 known occupied murrelet sites in Recovery Zone 5. The area most consistently occupied in Recovery Zone 5 is Lower Alder Creek drainage. Lower Alder Creek is the only known occupied site in the plan area. MRC monitors activity levels on this drainage annually using radar surveys. There are 3 known occupied sites within this drainage: (1) the "occupied tree" approximately 2.8 miles inland; (2) the "eggshell fragment tree" approximately 3.1 miles inland; and (3) the West Brushy stand approximately 3.9 miles inland. We are also presuming murrelet occupancy at a fourth site with old-growth characteristics that is south of the main branch of Alder Creek but connected to the Alder Creek drainage by Tramway Gulch. All sites within Lower Alder Creek Drainage are within redwood/Douglas-fir stands; major components of these stands are large Douglas firs with platform branches required for potential murrelet nests. Additionally, 2 occupied sites are currently located on Hawthorne Timber lands: Horsetail and Gulch 16. The 2 sites are located at 6.4 and 9.8 miles inland, respectively.[7] The Horsetail site is on a north-facing slope with multiple potential platforms and an abundance of moss on the branches. The Gulch 16 site has few potential platforms and widely spread platforms. Russian Gulch State Park, where a murrelet occupied site has been identified, has been a continuous source of detections. CDFG detected a murrelet on the Gualala River in the vicinity of

[6] Esther Burkett and Staci Martinelli (CDFG), as well as John Hunter (USFWS), assisted MRC in this review process.
[7] Email to Sarah Billig (MRC) from Scott Fullerton (The Campbell Group) on 2/23/2006.

Stewart's Point, as well as one near the convergence of the Wheatfield Fork of the Gualala River and Haupt Creek. Though CDFG has yet to identify an occupied stand for either of these detections, it is likely that the occupied stand is close by.

Murrelet detections at other sites, including Admiral Standley State Recreation Area and Angelo Preserve, indicate these sites were occupied at one point, but are likely unoccupied now. Both sites mentioned contain a significant component of mature and old growth Douglas fir and redwoods.

Murrelet detections outside of occupied sites have been rare throughout the assessment area. However, unoccupied habitat located near occupied habitat may be more important for the recovery of the species than suitable isolated habitat (USFWS 1995a, as cited in USFWS 1996b). Occupation of a stand will eventually enhance the value of younger stands as they mature because marbled murrelets are more likely to colonize new nesting sites if there are other murrelets nesting nearby (USFWS 1996b).

Few terrestrial observations of marbled murrelets in the vicinity of the HCP/NCCP assessment area have been reported. Detections were recorded at Russian Gulch State Park in 1976 and 1 km (0.6 mi) east of the town of Mendocino in 1988 (Paton and Ralph 1988). Additionally, an observer was "fairly sure" that murrelets were detected during a Russian Gulch/Van Damme transect survey conducted in 1988 (Paton and Ralph 1988). Later in the summer of 1998, 6 stations (4 in Jackson Demonstration State Forest near Russian Gulch State Park, 1 at Russian Gulch State Park, and 1 near the mouth of the Big River) were each surveyed once (CDFG 1998a). These surveys produced additional marbled murrelet detection at the Russian Gulch State Park station. CDFG has detection records on the Gualala River in the vicinity of Stewart's Point Road, including 20 detections on one occasion in 1999.

Efforts to survey for marbled murrelets within Jackson Demonstration State Forest (JDSF), which is contiguous with the plan area in coastal Mendocino County, have not resulted in any detection of marbled murrelets (Stillwater Sciences 1999, Table 2 and Map 12). JDSF researchers recommended further surveys in old-growth forest habitat, on other possible flight corridors, and in subsequent years because the presence of El Niño conditions may have precluded nesting of marbled murrelets during the survey period (Cota and Papke 1994).

Georgia-Pacific (G-P) lands in the Big River area were surveyed for marbled murrelets in 1994. Limited surveys conducted elsewhere on G-P lands indicated that murrelets traveled across G-P property in some areas to get to nesting sites. A pair of murrelets, for example, was observed flying across G-P land near the Wages Creek/Rider Gulch confluence, and other murrelets were detected in the Admiral Standley State Recreation Area on land directly adjacent to G-P. G-P did not think that suitable nesting habitat for the marbled murrelet was present on their land (G-P 1997). In 2003, observers heard and saw murrelets on 2 additional sites on Hawthorne Timber lands (previously G-P lands). In both these locations murrelets were displaying behavior indicative of occupancy. The 2 sites were located at 6.4 and 9.8 miles inland.[8] However, absence of detections during terrestrial marbled murrelet surveys does not necessarily imply that murrelets are not present or nesting since marbled murrelets can be extremely difficult to detect (CDFG 1997b). Marbled murrelets fly very rapidly over or through the forest and are only briefly present over survey stations. Extraneous noise, visibility from survey stations, and skill of the observers can influence survey results (O'Donnell 1995). Researchers in Oregon have documented the

[8] Email to Sarah Billig (MRC) from Scott Fullerton (The Campbell Group) on 2/23/2006.

presence of active murrelet nests after climbing trees in stands that did not yield detections through the use of the survey protocol (CDFG 1996c).

For a list of murrelet detections in Mendocino County refer to Table 10-20. This table records detections from 1976-2005 for Mendocino County as a whole and detections from 1998-2010 on what became MRC land. Appendix L, *Marbled Murrelet Data and Protocol*, records the murrelet surveys on MRC land going back to the previous LP ownership in 1994 and continuing with MRC efforts from 1998-2010.

5.3.2.1 Critical habitat in the plan area

USFWS has designated areas adjacent to the plan area as critical habitat for marbled murrelets (USFWS 1996b).[9] These areas include Jackson Demonstration State Forest and Bureau of Land Management lands east and north of Rockport, Hendy Woods State Park, Montgomery Woods State Reserve, and Mailliard State Reserve. As of 2011, USFWS has not officially designated any part of the plan area as critical habitat. A 2007 proposal by USFWS for critical habitat, however, includes small portions of private timberlands as critical habitat including the occupied areas of Lower Alder Creek (MRC) and the Ten Mile Drainage (Campbell Timberlands).[10]

Critical habitat has been designated not only in zones where relatively large populations nest, but also in areas of current low use. The goal has been to fill in nesting distribution gaps, thereby buffering the species from future catastrophic events, such as oil spills and forest fires. In California, 71,040 ha (175,500 ac) of state lands were designated as critical habitat—of which adjacent JDSF land constitutes approximately 29%. Once critical habitat is designated, any federal agency wishing to take action on that land must first consult with the USFWS.

5.3.3 Population trends

Historical estimates indicate that 60,000 marbled murrelets once nested on the California coast (Larsen 1991, as cited in Cooperrider et al. 2000). The current California breeding population is estimated at approximately 2000 (Carter and Erickson 1992, Carter et al. 1992; both as cited in USFWS 1997c), with a state total of approximately 6500 breeding and non-breeding birds (Ralph and Miller 1995). While monitoring at sea shows murrelet populations may be stable, recruitment is low and demographic models indicate the population will decrease by 4-6% per year (Raphael 2006). This decrease is primarily due to loss of breeding habitat in old growth forests and poor reproductive success due to increased nest predation (McShane et al 2004). When the ratio of hatch-year to after-hatch-year was corrected using data from a recent study (Peery et al 2007), murrelet productivity proved poor in central California. Demographic models also suggest the population decline will continue for 50 years with the largest relative declines in California (McShane et al 2004). The production of only 1 egg per year, combined with a low recruitment rate complicates recovery efforts for this species. Most experts consider that at least 100 to 200 years will be necessary for marbled murrelet populations to recover to sustainable population levels because that is the time period necessary for second-growth forests to grow trees large enough to provide appropriate nesting habitat.

[9] USFWS reopened the public comment period for its proposal to revise the critical habitat designation for the marbled murrelet. New comments were accepted until March 13, 2009. The pending decision of USFWS may necessitate changes to the final draft of the HCP/NCCP.

[10] This proposal for critical habitat was retrieved at http://www.fws.gov/pacific/marbledmurrelet/map13.html on 9/19/2007

The murrelet recovery plan (USFWS 1997c) stated that it would take 100-200 years for forests to grow to a stage suitable for murrelet nesting if all harvesting was halted. It would then take an additional 64 years for murrelet populations to reach their original size (USFWS 1997c). The marbled murrelet recovery plan delineates 6 marbled murrelet conservation zones based on current population, habitat distribution, threats, and geopolitical boundaries (USFWS 1997c). The plan area is located in Recovery Zone 5, which extends from the southern boundary of Humboldt County, California, south to the mouth of San Francisco Bay. It includes offshore areas within 2 km (1.2 mi) of the shoreline, and extends inland for a distance of up to 40 km (25 mi) from the Pacific Ocean. The majority of marbled murrelet nesting habitat that remains in this area is located on private lands. The murrelet population occurring off shore of the Mendocino County coast is small; however, it, along with small populations occurring off the coasts of Sonoma and Marin counties, may be important for reconnecting murrelet populations in northern and central California. Very little suitable nesting habitat remains in these areas, and most of what does exist is on private lands. Stabilizing and enhancing this small but potentially critical population will require considerable cooperation between state, federal, and private landowners (USFWS 1997c).

5.3.3.1 Population sizes and densities in recovery zone 5

Because detecting murrelets in their forest breeding habitat is difficult, offshore surveys of foraging birds have generated the most reliable population density estimates available for the Mendocino County coast. Strong et al. (1997) used line-transect analyses based on data collected 500 m offshore to estimate densities between the Oregon border and Bodega Bay in 1994 and 1995. Between Cape Mendocino and Arena Cove, these estimates ranged from 0.66 to 2.70 birds/km^2 in 1994, with population estimates in that region of 133–385 birds. Variation in densities and population size is due to recruitment of hatch-year birds as summer progressed. In 1995, densities ranged from 0.70 to 5.95 birds/km^2; population estimates were 133–966 murrelets.

In 2001, there were an estimated 117 murrelets in Recovery Zone 5; in 2002, approximately 250 murrelets; in 2003, approximately 48 murrelets; in 2004, approximately 84 murrelets; and in 2005, approximately 289 murrelets.[11] South of Arena Cove to Bodega Bay, data is available only for July of 1995. The estimated density of murrelets based on this data was 2.40 birds/km^2; the population size was 286 (Miller et al 1995). These estimates can be compared with those detected near the Oregon border, which ranged from 29.9 to 36.3 birds/km^2 in 1994 and from 10.3 to 28.2 birds/km^2 in 1995. Estimated population sizes generated by these surveys ranged from 2835 to 3450 birds in 1994 and from 2135 to 3008 birds in 1995 (Miller et al 1995). The densities and population sizes of murrelets off the coasts of Mendocino and northern Sonoma counties thus appear to be very low. An important note is that this data does not necessarily provide specific information regarding breeding densities or population sizes. A relatively large proportion of some alcid populations do not breed for lack of nest sites or limitations of other resources (Strong et al. 1997). However, data generated by offshore transects can be used to estimate population productivity, as it provides information on juvenile to adult ratios.

5.3.4 Life history

5.3.4.1 Reproduction

Based on the rate of successful fledging of young from observed nests, marbled murrelet populations have had one of the lowest reproductive rates of any species in the seabird family Alcidae thus far studied (De Santo and Nelson 1995, USFWS 1997c). Although marbled

[11] Email to Sarah Billig (MRC) from John Hunter (USFWS) on 07/21/2006.

murrelets feed and roost on the water, they nest in stands of old-growth coniferous forest located within 81 km (50 mi) of the coast (Miller et al. 1995); some birds may nest much farther inland in British Columbia (Hull et al. 2001).

The breeding season for murrelets is from March 24th through September 15th. Nesting typically begins between early April and early July. Marbled murrelets are not as social as many other species in the family Alcidae, most of which nest in dense colonies. Although they will sometimes nest in the proximity of other pairs, marbled murrelets will also frequently nest alone. Small groups have often been observed flying over potential nesting sites. Marbled murrelets are extremely faithful to their nest sites; they may return to the same stand and even the same tree year after year (Miller et al. 1995).

Marbled murrelets do not build a traditional nest, but lay a single egg on a large branch or natural platform with large amounts of canopy cover at heights greater than 30 m. The egg is usually prevented from rolling off the branch by a small depression or cup made in moss or other natural debris on the limb (Miller et al. 1995). In Douglas-fir and redwood forests, eggs are frequently placed on duff platforms (Hamer and Everett 1996). Marbled murrelet nests are extremely difficult to locate.

5.3.4.2 Movement and dispersal

Marbled murrelets feed closer to shore than other alcids, usually within 3.2 km (2 mi) of the coast, and can also be found in bays, lagoons, and coves (USFWS 1996b, Nelson 1997). They often preferentially forage near kelp beds or at the mouths of streams. During the breeding season, marbled murrelets form congregations at dawn and dusk near the shore close to the breeding grounds (Nelson 1997). Hull et al. (2001) reported travel distances up to 102 km from inland nesting sites to offshore foraging areas.

The movements of marbled murrelets at sea during the non-breeding season are not well understood. In Washington and British Columbia, marbled murrelets were found to be year-round residents (Rodway et al. 1992, Speich and Wahl 1995; both as cited in Beauchamp et al. 1999); other surveys indicate partial shifts in seasonal distribution in Alaska, British Columbia, Oregon, and California (Campbell et al. 1990, Burger 1995, Courtney et al. 1996, Naslund 1993, Strong et al. 1995, Agler et al. 1998; all as cited in Beauchamp et al. 1999). Naslund (1993) reported that marbled murrelets in central California visited nesting areas throughout the non-breeding season (October–March), although in reduced numbers; some hypothesize the murrelets may be visiting previous nest sites, prospecting for new nest sites, or maintaining or forming pair bonds (USFWS 1997c). Based on the distribution of murrelets at sea following the breeding season, it appears that some California murrelets disperse south in some years although there is little movement of northern murrelet populations to the central coast of California (Sealy et al. 1991, as cited in Naslund 1993). Although the majority of murrelets appear to remain close to breeding locations throughout the year, Beauchamp et al. (1999) recaptured a banded bird approximately 220 km from the breeding site where it was originally banded; they then captured it again at the breeding location the following season, presenting the first evidence of long-distance migration between breeding and non-breeding areas for this species. Age differences may also play a role in seasonal migratory patterns (Kuletz and Kendall 1998, as cited in Beauchamp et al. 1999).

5.3.5 Habitat requirements

5.3.5.1 Breeding habitat

For nesting in California, marbled murrelets generally require old-growth coniferous forest located close to ocean waters, typically within 10 km (6.5 mi); abundant food resources should be near shore (Miller et al. 1995). The general characteristics of preferred nesting habitat in the Pacific Northwest include a dominance of old-growth trees in a multistoried stand with moderate to high canopy closure (Miller et al. 1995).

In California, stand dominance by redwood (> 50%, Miller et al. 1995, as cited in Cooperrider et al. 2000) in conjunction with dense canopy cover is important in predicting marbled murrelet occupancy (Nelson 1997). Only a few observations (and no nests) of marbled murrelets have been recorded in Douglas-fir dominated forests in California (Hunter et al. 1998). Recently, researchers in central California studied 17 nests and found that all of them were in old redwood forest (Baker et al 2006); 3 of these nests were in harvested stands. Redwood distribution in California is associated with the inland influence of marine air and summer fog (Hunter et al. 1998). Farther inland, where these influences are diminished, Douglas-fir and tanoak forests dominate. Although these stands may contain trees with large limbs and nesting platforms, summer temperatures are higher, resulting in a lack of moss on tree branches and hot, dry conditions that may be unsuitable for murrelet nesting (Hunter et al. 1998). Increasing the distance of murrelets to offshore feeding areas would likely increase energy demands on them during the breeding season (Hunter et al. 1998).

Miller and Ralph (1996) found dense crown cover of old-growth trees to be a dominant characteristic of occupied stands in northwestern California. The mean canopy cover over identified nests is 85% (USFWS 1995a). A typical old-growth forest used for nesting by marbled murrelets is characterized by large trees > 80 cm (32 in) dbh (Miller et al. 1995). In some areas in California, marbled murrelet activity has been documented in “residual” old-growth stands; however, these stands were directly adjacent to large old-growth stands and no nests were found (CDFG 1992a, as cited in USFWS 1995a). Mature second-growth forest stands are not believed to support nesting if they are isolated from old-growth forest stands (Larsen 1991, as cited in Miller et al. 1995). Baker et al (2006) concluded that murrelets primarily use old growth redwood stands for nesting but would use partially harvested stands if they retained some old growth characteristics.

According to Hamer and Nelson (1995), nesting habitat features are chosen in part to reduce predation. Nest sites are not located directly on the coast to avoid the heaviest concentrations of predators, such as gulls and corvids (ravens, crows, and jays). Elements that decrease predator detection of the nest include murrelet selection of dense old growth with multi-layered canopy cover and utilization of limbs with high overhead and horizontal cover located near tree trunks where the trunk itself contributes to the nest concealment. Other murrelet behavioral adaptations to reduce predation include shifting incubation duties and feeding chicks infrequently, thus minimizing the frequency of flights from the ocean to the nest (Nelson and Hamer 1995). Stands farthest from human activity also tend to have the least predation (Marzluff et al. 1997).

The first recorded sighting of a murrelet tree nest was 1974 (Binford et al. 1975). By 2000, a total of more than 170 nests had been located, only 18 of which were in California (Cooperrider et al. 2000). Detailed measurements were taken on 47 of these nest trees across the Pacific Northwest (California, Oregon, Washington, and British Columbia), including 10 nest trees in California (Hamer and Nelson 1995). Most of the nest trees were in old-growth stands, and the nests were placed on mossy limbs. In the Pacific Northwest, the diameter of the trees averaged

83 in (211 cm), while in California the diameter averaged 108 in (278 cm) (Hamer and Nelson 1995). Researchers in central California found the mean dbh of nest trees was 83.8 in (209.5 cm) (Baker et al 2006). The smallest trees used for nesting had an average dbh of 34 in (88 cm) in the Pacific Northwest and 54 in (139 cm) in California. Nests were placed on large branches; the average branch diameter at the nest was 13 in (34 cm) (Pacific Northwest and California). Across the Pacific Northwest breeding range, the most common tree species used by marbled murrelets was Douglas fir but murrelets also nested in Sitka spruce, western hemlock, coast redwood, and western red cedar. In California, the murrelets used redwoods (5 nests), Douglas fir (4 nests), and western hemlock (1 nest). The research of Baker et al (2006) in central California located 15 nests—12 in Douglas fir and 3 in broken-top redwoods. The specific trees selected for nesting generally had wide branches or natural deformities to provide suitable support for the egg and incubating adult.

The smallest branch diameter observed for a murrelet nest in California was 6 in. while the smallest branch diameter for a nest in the Pacific Northwest was 4 in. These branches are from mistletoe brooms, decay, or tree damage (Hamer and Nelson 1995). They are typically found in 50-91% of the crown height and are generally not found on lower portions of the tree, though in Oregon nests have been found at 26% the crown height. Though generally there is a large amount of canopy cover over the nest (mean in California = 87%) the range of canopy over the nest for known nests in California is 5-100%.

Most research indicates that large, contiguous blocks of older-aged forests provide higher quality nesting habitat than small, fragmented stands. Hamer and Nelson (1995) noted that, in the Pacific Northwest, murrelet nest trees were in stands that ranged from 3 to 1100 ha (7 to 2718 ac), with a mean ranging from 31 ha (77 ac) in Alaska to 354 ha (875 ac) in Washington. In California, stands containing nest trees ranged in size from 100-1100 ha with a mean of 352 ha (range 247-2718 ac, mean 870 ac). Marbled murrelets appear to be fairly intolerant of ecological habitat alterations; the edge effects associated with habitat fragmentation probably explain murrelets preference for large tracts of contiguous forest and their nesting success there.
Topography also appears to be important for nest site selection. In northern California, detection levels for marbled murrelets were 3 times higher in major drainages than on major ridges (Miller and Ralph 1996). Both lower Alder Creek and Russian Gulch, areas in which murrelet occupied behavior has been observed, exhibit steep topography. Trees are generally larger and limb breakage from wind is likely reduced in large drainages. Lower elevations, i.e., < 100 m (330 ft), have more occupied stations than higher elevations, i.e., > 200 m (660 ft).

5.3.5.2 Foraging habitat

In California, marbled murrelets forage in coastal waters at the edge of the open ocean (Hunt 1995) at surface and mid-water depths typically less than 50–100 m (164-328 ft) (USFWS 1997c). These areas typically lack obvious features that result in concentrations of prey, with the exception of the occasional river delta or headland area (Hunt 1995).

5.3.6 Ecological interactions

5.3.6.1 Diet

Marbled murrelets feed primarily on invertebrates and fish (Miller et al. 1995). Little data on food preferences is available for the California coast, but sand lance may be a primary component of the diet. Other fish taken include Pacific herring, northern anchovy, osmerids, and sea perch. At the southern end of the marbled murrelet range, sardines and rockfish may be the most important prey items. Invertebrate prey is most important in the winter and spring, and includes euphausiids, mysids, and amphipods (USFWS 1996b). Recently, researchers discovered that pre-

breeding murrelets in central California are preying on marine life lower on the food chain then they did historically, resulting in a lower energy return per catch (Becker and Bessinger 2006).

5.3.6.2 Predators

Observers have noted high rates of predation at the relatively few marbled murrelet nests monitored to date. Common ravens and Steller's jays are frequent nest predators, but other potential predators include great horned owls, American crows, and sharp-shinned hawks. Human disturbance often results in higher corvid populations, thereby potentially reducing murrelet reproductive success.

5.3.6.3 Competition

Unlike marbled murrelets found along the coast from Washington to Alaska that have been observed foraging in mixed species flocks, murrelets in the southern portion of their range tend to forage in pairs or small monospecific flocks of up to 25 individuals (Ainley et al. 1995; Strachan et al. 1995; all as cited in Hunt 1995). The lack of participation in mixed foraging flocks may be tied to avoidance of competition with larger, more aggressive seabirds, particularly gulls (Chilton and Sealy 1987, as cited in Hunt 1995). However, differences in ocean conditions or distribution and behavior of fish aggregations may also contribute to the lack of mixed species foraging among marbled murrelets in the southern portion of their range (Hunt 1995).

5.3.7 Sensitivity to anthropogenic disturbances

Threats to marbled murrelet populations are numerous. The principle threat to these birds is the loss and fragmentation of nesting habitat due to timber harvesting (Miller et al. 1995). Other factors include

- Increases in predation.
- Oil spills.
- Gill netting.[12]
- Fluctuations in food supply due to El Niño.
- Changes in stream sediment that could affect prey base.
- Windthrow.
- Wildfires.
- Over-fishing of prey base.
- Additional human disturbances.

5.3.7.1 Loss and fragmentation of nesting habitat

Because this species relies on old-growth coniferous forest located close to marine waters for nesting habitat, timber harvesting presents a significant threat. Fragmented forests often have extensive tracts with reduced canopy closure, which allows predators to more easily access both eggs and adult birds. Forest fragmentation also leads to a general increase in reproductive habitat for avian predators, such as ravens and crows; this results in greater predator densities (Miller et al. 1995). Many nests found to date have been located at stand edges; these nests have been subjected to high levels of predation and affected by human disturbance. Successful nests tend to be farther from forest edges (mean = 155.4 m versus 27.4 m, USFWS 1995b). Fragmentation of forest habitat (resulting in smaller stand size and edge effects) are important factors that appear to reduce nest success (Nelson and Hamer 1995b, as cited in Cooperrider et al. 2000). A study by Peery et al (2004) found that food availability in some years and nest predation in other years limited murrelets in central California; nest availability was not a limitation.

[12] Eliminated in California and reduced in Washington (McShane et al 2004)

Populations of corvids and other predators are expanding due to development, forest fragmentation, and opening of the forest canopy; this ultimately increases corvid nesting and foraging habitat (Ehrlich et al. 1988, Shuford 1993). Compared with other alcids that typically do not nest in forest habitats, marbled murrelets are believed to be more vulnerable to nest predation (USFWS 1997c). The increased role of predation in the decline of this species is probably strongly linked with anthropogenic influences, particularly forest fragmentation and associated edge effects. Human recreational activities may also result in increased densities of avian predators, including crows, ravens, and Steller's jays.

Raphael (2006) reports that since the inception of the Northwest Forest Management Plan, there has been a loss of 2% of higher suitability breeding habitat on federal forest lands; a 12% decrease in the same habitat has occurred on private timberlands (due to timber harvest). There is evidence that at-sea estimates of population size are positively correlated with amounts of nesting habitat nearby, though at-sea conditions continue to have a meaningful impact on murrelet populations (Raphael 2006).

5.3.7.2 Oil spills

Oil spills pose a significant threat to marbled murrelets. Because marbled murrelets forage primarily in waters near shore, they have one of the highest index values for oil spill vulnerability among seabirds (King and Sanger 1979, as cited in Miller et al. 1995). Oil spills not only cause direct mortality to murrelets, but also reduce the species' prey base.

Large numbers of marbled murrelets were killed in the 1989 Exxon Valdez spill in Alaska. After the Apex Houston oil spill in central California in 1986, at least eleven dead marbled murrelets were recovered (Miller et al. 1995) and mortality levels were likely much higher. Mortality due to oil spills may be part of a cumulative effect along with other anthropogenic factors to reduce the likelihood of population recovery in affected areas.

5.3.7.3 Commercial fishing

Gill-nets often entangle murrelets underwater. In British Columbia and Alaska, hundreds to thousands of marbled murrelets are killed annually in gill-nets. Gill-net fishing is prohibited in northern California from Point Reyes north, resulting in a concomitant reduction in seabird mortality.

5.3.7.4 Changes in prey availability

Marbled murrelets often forage at the mouths of streams where they meet marine waters, and thus may be indirectly affected by forest management activities that increase fine sediment loading to streams. It has been noted that "these habitats and associated prey organisms have been degraded from increased sediment loads due to timber harvesting operations and other land management practices that reduce natural vegetation and increase runoff and erosion" (Miller et al. 1995, p. 6). Natural climatic cycles such as El Niño affect many seabird populations by changing ocean conditions, thereby decreasing primary productivity. The effects of El Niño may be somewhat reduced because marbled murrelets consume a very diverse group of prey species (Miller et al. 1995).

5.3.7.5 Management efforts

Little is known regarding the historical distribution and population sizes of marbled murrelets in Mendocino County. Because of the difficulty of identifying the areas where murrelets nest, there are uncertainties in how best to manage habitat to protect the species on private property. Information that would lead to the development of appropriate strategies for enhancing previously disturbed and fragmented habitat so that it becomes suitable for nesting murrelets is largely

lacking. Wildlife managers are uncertain whether to protect stands where murrelets have been known to nest previously (and where other murrelets may perhaps be attracted by their presence) or to protect a larger number of smaller patches of habitat surrounding suitable nest trees. Tolerance to various management-related disturbances during the nesting season is unknown.

Experts in murrelet biology agree that the recovery of the murrelet population in Mendocino and Sonoma counties is critical to the recovery of the species as a whole since there is a distribution gap in populations (USFWS 1997c). The extremely small population size of murrelets that currently exists in coastal Mendocino and Sonoma counties makes the probability of recovery tenuous at best. However, many steps can be taken to increase the chance that these populations may return to sustainable sizes. Section 5.3.7.6 outlines short-term and long-term strategies developed by USFWS (1995a). Although the strategies address murrelet population recovery throughout California, Oregon, and Washington, they can also provide guidance for developing appropriate measures on private lands. During a recent status review of the marbled murrelet, panelists concluded that the long-term survival of the species in Washington, Oregon, and California was uncertain (McShane et al 2004).

5.3.7.6 Short-term actions to stabilize marbled murrelet populations

The purpose of these short-term strategies, developed by USFWS (1995a), is to stabilize current murrelet populations and prevent further declines. Following are forest management strategies relevant to murrelets:

- Maintain and protect occupied nesting habitat and minimize loss of unoccupied but suitable nesting habitat.

  Particular emphasis should be placed on maintaining potential and suitable habitat in large contiguous blocks. This will provide more nesting and hiding opportunities, provide multiple nesting options for pairs, facilitate social interactions, and provide greater interior forest habitat, minimizing edge effects. Larger stands may even lead to a core of birds that ultimately breed as sub-adults or are available to replace breeding birds lost through natural or anthropogenic causes.

- Maintain and enhance buffer habitat surrounding potential nesting stands.

  Maintaining buffers will help to mediate edge effects of all types. To have the greatest benefit, buffer zones, of whatever stand age present, should be a minimum of 100–200 m (328-656 ft).

- Maintain current north/south and east/west distribution of nesting habitat throughout the historical geographical range of the species.

  Maintaining a contiguous habitat distribution is critical for preventing large gaps in distribution that might result from fire or other catastrophic events. In addition, researchers do not know how nesting success varies with distance from coast. Therefore, some assume that inland nesting sites are as important to recruitment as those closer to shore.

- Increase recruitment by minimizing disturbances at nests.

  Low juvenile to adult ratios have been documented throughout the range of the marbled murrelet. Current evidence suggests that this is due to high rates of predation on eggs and nestlings. Breeding adult alcids are generally sensitive to nest site disturbances during the incubation period and the first few days of chick rearing. Human activities near nesting areas that result in increased numbers of avian predators could exacerbate this problem; flushing adults off of nests leads to increased exposure to predation or to accidental losses of eggs and chicks due to falling off or being knocked off nest platforms. Adjusting human activity in nesting areas to minimize impacts on courtship, mating, and nesting could minimize impacts of disturbances. While human activities attract higher than average numbers of predators to nesting areas, forest fragmentation per se is the more important consideration.

5.3.7.7 Long-term actions to facilitate continued recovery of the species

Long-term strategies recognize the complexity of ecosystems; creating mature forest habitat and improving marine habitat requires long time-frames. The following are long-term strategies:

- Increase the amount and quality of suitable nesting habitat.

  This goal, important in all conservation zones, is especially crucial in Mendocino and Sonoma counties. Because so little nesting habitat remains in this area, long-term strategies to restore habitat should be a major priority. A panel of experts (Carey et al 2003) concluded that efforts can and should be made to develop young stands (40-80 yrs old) into potential murrelet habitat. The panel recommended that targeted stands be initially thinned from below (in a uniform fashion); the goal of a second entry would be to develop large branches on potential murrelet trees.

- Decrease forest fragmentation by increasing the size of suitable stands to provide a larger area of interior forest conditions.

  The majority of suitable nesting habitat for murrelets, particularly in Mendocino County, exists as isolated stands subject to edge effects and associated problems described above. A research priority should be to develop judicious ways to use silvicultural techniques, such as thinning in young unoccupied stands to hasten development of large trees with appropriate structural characteristics (e.g., large protected branches suitable for nesting) and to decrease vulnerability of habitat fragments to wind, fire, and predators.

- Protect existing younger forest stands with good potential to buffer and enlarge existing stands, reduce fragmentation, and provide replacement habitat for suitable nesting habitat lost to disturbance.

  Stands that are currently greater than 80 years old are the most immediate source of new habitat and are the only replacement for existing habitat that may be lost to disturbance over the next century. These stands should not be subjected to any silvicultural treatment that diminishes their capacity to provide quality nesting habitat in the future. Within secured areas, these “recruitment” stands should not be harvested or thinned.

- Use silvicultural techniques to increase speed of development of new habitat.

  Several such techniques may be appropriate to increase the area of suitable nesting stands and the rate at which they develop. For example, thinning accelerates tree growth and can be used as a tool to produce large trees more quickly than under normal stand development. Producing trees that have the large moss or mistletoe covered branches required for murrelet nesting can be achieved by growing at least some trees on long rotations, such as "green-tree retention," which designates approximately 20 to 40 trees per hectare to be retained at harvest, with a new crop of younger trees established beneath the older tree canopy.

- Improve and develop north/south distribution of nesting habitat.

  Current gaps in the distribution of nesting habitat include most of the Mendocino Zone. Such gaps represent partial barriers to gene flow between breeding populations; providing suitable habitat within these areas will help to buffer existing populations against poor breeding success and catastrophic losses.

- Improve and develop east/west distribution of nesting habitat.

  Many areas within the range of marbled murrelets, including most of California, no longer have large amounts of suitable nesting habitat close to the coast, forcing murrelets to fly considerable distances inland to nest. A better understanding of the inland boundary of suitable nesting habitat will aid in the development of suitable nesting habitat.

5.3.8 Key uncertainties

Stabilizing current population levels of marbled murrelets and developing an effective recovery program for the species will require a much more complete understanding of the basic biology, ecology, and behavior of these birds than is currently available. At the same time, the recovery of this species is largely dependent on the protection and management of the marine and terrestrial habitats upon which it depends.

MRC management has identified the following key uncertainties, with cross references to validation monitoring programs in parentheses:[13]

- *Will specific silvicultural prescriptions generate suitable marbled murrelet habitat quicker than not managing a stand silviculturally (M§13.9.2.2-2)?*
- How can MRC ensure that the lower Alder Creek population of murrelets is not jeopardized?
- *Does the current boundary of the Lower Alder Creek Management Area (LACMA) cover all areas of murrelet habitat in the Lower Alder Creek drainage (M§13.9.2.2-1)?*
- Will West Nile virus have a positive or negative effect on murrelet populations, i.e., will it reduce the number of murrelet predators or the number of murrelets?
- *Will marbled murrelets re-colonize other areas of the plan area (M§13.9.2.2-3)?*

[13] This list from USFWS (1995a) summarizes key research issues that must be addressed before recovery efforts can be fully realized.

5.4 Point Arena Mountain Beaver

5.4.1 Geographic distribution

Mountain beavers (*Aplodontia rufa)* are generally distributed from California to Washington, with some populations extending into British Columbia (Canada). The distribution of mountain beaver sites is often patchy; sites tend to be localized and uncommon in areas inland from the coast. There are 7 mountain beaver subspecies, 4 of which are endemic to California. Two of these— the Point Reyes mountain beaver (*Aplodonta rufa phaea)* and the Point Arena mountain beaver (*Aplodontia rufa nigra)*—occur only in small areas, even though additional suitable habitat may be available. Sites of Point Arena mountain beavers occur as far north as Bridgeport Landing and just south of Point Arena. There are presently 262 known sites of Point Arena mountain beavers.[14]

Mountain Beaver
Sierran Sub-species
Photo by Dr. Lloyd Ingles
Photo Details from Dale Steele, CDFG

Most of the available information is on subspecies other than the Point Arena mountain beaver, although all mountain beaver subspecies likely have similar life histories. Unless otherwise noted, the information in this species account pertains to the Point Arena mountain beaver.

5.4.2 Local distribution

Data on distribution of sites in the plan area are sparse, but Point Arena mountain beavers have been observed in Mallo Pass Creek, Mills Creek, Alder Creek, Owl Creek, and the Garcia River watersheds (USFWS 1998a, MRC unpublished data 2007). There are currently 14 known Point Arena mountain beaver sites[15] on covered lands in 13 burrow systems; 10 of those burrow systems have been mapped for a total of 1.87 ac ranging in size from 0.06 to 0.57 ac in size (MRC unpblished data 2007).

5.4.3 Population trends

The Point Arena mountain beaver apparently occupies only a portion of its historical range (Steele 1989). The subspecies currently exists in small disjunctive sites separated by unsuitable habitat (Steele 1989). Habitat loss resulting from livestock grazing and urbanization is the most likely cause of this decline (Steele 1989). Although land use, such as forest logging, may have created suitable habitat, other land use, such as livestock grazing, has reduced coastal scrub habitat used by mountain beavers (Steele 1986), offsetting any gains from forest conversions. Furthermore, urban development and associated activities, such as trash dumping, increased predation by pets, construction of roads, and off-trail hiking, have adverse effects on Point Arena mountain beaver sites (USWFS 1998a). Due to urban development along the California coast, the potential for population declines from habitat loss is great (Steele 1989, USFWS 1998a).

5.4.4 Life history

Mountain beavers live in extensive underground burrow systems with multiple entrances (Camp 1918). Most nests are built 0.9 m (3 ft) or more below the surface in a dome-shaped chamber that is packed with vegetation. From the nest chamber, a series of tunnels radiate outward to other

[14] Email from John Hunter (USFWS) to Craig Hansen (ICF J & S) on 01/08/09.

[15] Two sites which we originally identified as separate burrow systems were actually within 50 ft of each other and part of the same burrow system. We still considered them separate sites.

Baby Mountain Beaver,
Northern Sub-species,
Washington
Photo Details from Dale Steele, CDFG

chambers used for caching food and depositing feces (Sleeper 1997). Along with nest chambers, 4 other chambers occur in mountain beaver burrows including food storage, refuge, fecal deposit, and a chamber for depositing rocks and clumps of hard clay ("earthballs") encountered during digging activities (Voth 1968). Female and male nests differ in the types of nest materials used in construction of burrows and it has been shown that female nests contain fewer parasites. Only 1 animal occupies the burrow; the exception is during the breeding season or while females are rearing young (USFWS 1998a). The burrow system provides optimal microclimates for mountain beavers as they are cool and moist in the summer and warm and protected in the winter.

Mountain beavers are active year-round and do not hibernate (Scheffer 1929), but activity generally decreases during the winter (Voth 1968). They are primarily nocturnal but are occasionally active during the day as well (Maser et al. 1981). Ingles (1959) observed that mountain beavers are active for about 8 out of 24 hours each day.

5.4.4.1 Reproduction

Data collected from Point Reyes mountain beavers indicates breeding occurs from mid-December to early March, with a peak in activity in February (Pfeiffer 1958). Mountain beavers have a relatively low reproductive rate (Pfeiffer 1958). Females begin breeding at about 2 years of age and breeding females ovulate at the same time. Gestation is believed to last approximately 28 to 30 days and litters average 2 to 3 young (range = 1–5). Although specific data on reproduction is not available for the Point Arena mountain beaver subspecies, their life history is assumed to be similar to other populations of mountain beavers.

5.4.4.2 Growth and development

Young are born from February to June, although birth rates peak between March and May (Polite 1999). Young are born blind and naked but growth is rapid and newborns are completely covered with hair within 2 weeks (Lovejoy and Black 1974). Lactation lasts about 2 months. Juveniles acquire the coarse adult pelage within a year. Although juveniles have a sex ratio of 1:1, trapping of adult animals showed a ratio biased towards males. While this may be the result of either a demographic shift or trapping bias, Lovejoy and Black (1974) posit that this is indeed an indication of shifting sex ratios rather than a sampling artifact. They did not, however, offer an explanation as to why this might occur.

The mountain beaver breeding season is December 1st through June 30th. This time period encompasses the physiological changes associated with the initiation of breeding through the end of lactation (Hubbard 1922, Scheffer 1929, Pfeiffer 1958, Lovejoy and Black 1974).

5.4.4.3 Movements and dispersal

Mountain beavers move around burrow systems throughout the year, though their movements appear to be restricted outside of the dispersal season. Results of radio-telemetry studies on mountain beavers in Washington by Martin (1971) showed that 9 of 11 animals remained near their initial site of capture. Ninety percent of Martin's study animals remained within 80 ft (24 m) of their nest chambers though they have been recorded up to 350 ft (107 m) away from nest chambers (Martin 1971).

Surveying Mountain Beaver Habitat
Owl Creek

Burrows of
Point Arena Mountain Beaver
Photo by Dennis Deck

The extent that juvenile mountain beavers will disperse outside the burrow system is unknown. One study indicates mountain beavers could disperse up to 1850 ft (564 m) from their nest sites (Martin 1971) while another (Hacker and Coblentz 1993) suggests they could disperse up to 1476 ft (450 m). Such dispersal is believed to take place through excavation of the existing burrow system (USFWS 1998a), but above-ground dispersal has also been observed (Martin 1971). Dispersing juveniles may make several attempts to establish a nest before finding a suitable location where they generally remain for a long period of time (Martin 1971). Unoccupied nests may be taken over quickly by other mountain beavers (Martin 1971), indicating that available nest sites are limited. The juvenile dispersal season is likely complete by early fall (USFWS 1998a). The time period in which mountain beaver are thought to disperse is April 15th through September 30th (Pfeiffer 1958, Martin 1971).

5.4.5 Habitat requirements

Mountain beavers are a highly endemic species found in the Pacific Northwest. In general, they are associated with wooded coastal environments typically characterized by

- Cool moist environment.
- Dense stands of perennial vegetation.
- High percentage of small woody material.
- Well drained soft soil.
- North-facing slopes and gullies.

Hacker and Coblentz (1993) also found that, in re-colonizing clearcuts in Oregon, mountain beavers selected areas with greater quantities of large and small downed wood. Point Arena mountain beavers live in a relatively mild climate due to the proximity of their habitat to the ocean (USFWS 1998a). They appear to have a very limited ability to thermoregulate (USFWS 1998a). Their specialized physiology restricts them to cool, moist habitats (Sleeper 1997). Because their kidneys do not concentrate urine, mountain beavers require a large daily intake of water, which may be obtained by drinking or ingestion of adequate succulent vegetation (Zeiner et al.1990a). In the northern portions of their range, surface water may be diverted down burrows; mountain beavers do not avoid partially flooded tunnels (Scheffer 1929).

5.4.5.1 Vegetation

Point Arena mountain beavers occur in a variety of habitat types, including coastal scrub, coastal prairie, riparian areas, freshwater seeps, and brushy areas (Fitts 2002, unpublished report). Mountain beavers are associated with dense, perennial vegetation where food is abundant year

round and water is easily available (Scheffer 1929). Their sites are usually found in coastal areas, such as

- Northern coastal scrub.
- Coastal bluff scrub.
- Northern riparian scrub.
- North coast riparian.
- Coastal prairie.
- Northern dune scrub.

In the forest, sites of Point Arena mountain beavers are generally in riparian areas, as well as areas where there are freshwater seeps and brush.

Burrow sites of Point Arena mountain beavers are also found in conifer stands though this is a rare occurrence. One Point Arena mountain beaver site has been recently discovered on the south side of the Garcia River about 15 m (50 ft) from the river, between a riparian zone dominated by red alder and California laurel and a hillslope dominated by redwood and grand fir (USFWS 1998a). The area inhabited is covered by dense, high vegetation—3-4 ft (1.0-1.2 m)—dominated by cow parsnip, stinging nettle, horsetail, and California blackberry.

Based on known habitat use, potential habitat is any area with herbaceous or brushy vegetation (excluding grasses) on the ground. The likelihood of encountering Point Arena mountain beavers in areas solely comprised of redwoods and Douglas fir, however, is very low. Due to the clumpy distribution and generally small size of potential habitat in the plan area, MRC has not been able to map all potential habitat using aerial photographs or our structure classes. Table 10-8 lists the MRC structure classes.

5.4.5.2 Soils

Mountain beaver burrows are associated with deep and friable soils (Polite 1999). Although the burrows are generally found in moderately firm soil, mountain beavers also excavate in other soil types, such as sticky clay (Hubbard 1922) and sandy soils stabilized by plants, including ice plants and European beach grass (Fitts 1996).

5.4.6 Ecological interactions

5.4.6.1 Diet

Mountain Beaver Haystack
Photo by Dale Steele

Mountain beavers are voracious eaters (Ingles 1959) that eat a wide variety of food items (Camp 1918, Scheffer 1929). Ingles (1959) estimated that individuals spend approximately 73% of their time foraging and eating. Mountain beavers gather food and bring it back to the burrows where they consume it in the feeding chamber adjacent to the nest. Overall, mountain beavers store about 2.5 times more food than they actually consume (Voth 1968). Voth (1968) noted that 85% of the diet of non-breeding males and females consisted of ferns, while 34% of the diets of reproductive females consisted of coniferous plant material. Mountain beavers forage on the ground and to a height of 15 ft (4.6-m) in trees. Their diet includes plants that are unpalatable or toxic to other mammals, including foxglove and larkspur; this diet choice allows them to exploit a large, uncontested food niche. Mountain beavers have been observed cutting bundles of plants and laying them out to wilt ("haystacking"). Scheffer (1929) suggested that this provided dried vegetation for nesting

and food storage; however, other explanations include the possibility that dried plants aid in regulating the moisture content of stored foods by mixing wilted with fresh vegetation (Voth 1968).

5.4.6.2 Predators

Bobcats, long-tailed weasels, fishers, coyotes, great horned owls, striped skunks, golden eagles, and minks, as well as domestic and feral dogs and cats may prey on mountain beavers (Ingles 1965, Knick 1984, USFWS 1998a).

5.4.6.3 Interspecific interactions and competition

Mountain beaver burrow systems support a large community of vertebrates and invertebrates, including salamanders, moles, shrews, woodrats, mink, hares, brush rabbits, gophers, mice, and ground squirrels (Scheffer 1945, Pfeiffer 1953, Voth 1968, Maser et al. 1981). Whether their presence in the burrows is due to commensalism, predation, or is simply accidental is unknown. The invertebrate community found within the burrows is also unique. The world's largest flea, *Hystricopsylla schefferi*, which is 0.35 in (9 mm) in length, is associated with mountain beaver burrows (Scheffer 1929). An invertebrate community that aids in fecal decomposition is found within the fecal pellet chambers (Voth 1968). Mountain beavers are hosts to species-specific mites, ticks, and tapeworms (Canaris and Bowers 1992). Parasites specific to the Point Arena mountain beaver have not been investigated (USFWS 1998a).

5.4.7 Sensitivity to anthropogenic disturbances

Little is known about the sensitivity of mountain beavers to disturbance (USFWS 1998a). Because of their clumped and fragmented distribution, the subspecies is very vulnerable to localized natural or anthropogenic catastrophic disturbances, such as storms, fire, flooding, landslides, disease, or prolonged drought (USFWS 1998a).

5.4.7.1 Livestock grazing

Cattle and sheep grazing have resulted in the loss and degradation of coastal scrub habitat used by mountain beavers (Steele 1989). Cattle may also adversely impact mountain beaver habitat by trampling burrows and crushing runways, as has been observed at Alder Creek (Steele 1989). Livestock grazing could be an important factor limiting the expansion of existing sites of Point Arena mountain beaver (USFWS 1998a).

5.4.7.2 Urban development

Urban development and associated activities have been an important factor resulting in the loss and degradation of coastal scrub habitat within the range of the Point Arena mountain beaver. Predation by feral and non-feral dogs and cats likely increases near areas of human habitation and may be affecting some sites (USFWS 1998a). Rodent and pest control by residents of urban development could result in negative effects to the Point Arena mountain beaver. The construction of private and county roads and the existence of State Highway 1 within the distribution of the Point Arena mountain beaver likely results in barriers that prevent or impede dispersal between sites or into potentially suitable, unoccupied habitat (Steele 1989), as well as direct mortality (USFWS 1998a). Housing developments planned for the Irish Gulch area of Mendocino County may result in additional indirect and direct effects on Point Arena mountain beavers (USFWS 1998a).

Fiber optics projects have tunneled beneath Point Arena mountain beaver sites and created noise, vibration, and physical impacts to habitat (USFWS 1998a). Wildlife managers do not know how these activities have affected overall health of the subspecies.

Gopher control programs have resulted in Point Arena mountain beaver mortality because of a mistaken belief that they were gophers (USFWS 1998a). Trapping and poison baiting of rodents is common along the Mendocino County coast (Steele 1986). Use of other chemicals, such as pesticides and herbicides, may also result in mortality (USFWS 1998a).

5.4.7.3 Recreational activities

Crushing of vegetation and burrows by campers and hikers may adversely affect sites of Point Arena mountain beavers (USFWS 1998a). Closure of sensitive areas to recreation has resulted in an increase in activity by mountain beavers (USFWS 1998a).

5.4.7.4 Forest management

Mountain beavers may adapt relatively well to habitat changes resulting from logging because of their subterranean habits and preference for dense vegetation that may be present following logging or wildfire (Sleeper 1997). Animals may remain in their burrows despite the clearing of vegetation and burning. Evidence indicates that mountain beavers may use openings in conifer stands and readily colonize areas where conifers have been removed (Scheffer 1929, Hooven 1973, Neal and Borrecco 1981). When there has been logging in an area, mountain beavers appear to select sites where coarse woody debris remains (Hacker and Coblentz 1993). Other subspecies of mountain beaver are considered pests that merit control actions in recent timber harvest areas since they consume newly planted seedlings.

5.4.8 Impacts of MLC (2008)

The lightning fires of 2008 were only in a small portion of the mountain beaver assessment area in Mallo Pass Creek. The fires did not burn through any known burrow systems of the mountain beaver. In fact, they were at least 670 meters from any such burrow.

5.4.9 Key uncertainties

MRC management has identified the following key uncertainties, with cross references to validation monitoring programs in parentheses:

- What are the numbers and distribution of Point Arena mountain beavers occurring in the plan area?
- What are the effects of covered activities on connectivity, dispersal, habitat quality, and use?
- What buffering (if any) is needed to protect Point Arena mountain beaver sites form disturbance?
- *Can MRC timber harvests and management create new habitat for Point Arena mountain beavers and allow for expansion of burrow systems into new areas* (M§13.9.3.2-2)?
- *Does our current habitat definition correctly describe potential habitat for Point Arena mountain beaver (M§13.9.3.2-1)?*

Chapter 6

Covered Plant Species

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6 COVERED PLANT SPECIES

6.1 Introduction

Chapter 6 includes species accounts for each plant covered by our HCP/NCCP, including conservation status, distribution, description and life history, habitat requirements, threats, population trend, and sensitivity to timber management. An explanation of the California Rare Plant Rank (CRPR) under the "conservation status" sub-headings for each covered plant is in Appendix R, *Plant Rankings*, along with clarification of the relationship between the CRPR and the California Native Plant Society (CNPS) lists. For those covered rare plant species found in the plan area, MRC will develop more detailed information through the monitoring program outlined in section 13.10, *Monitoring Rare Plants*. Finally, section 1.9.1, *Choosing Species for Plan Coverage*, gives the rationale for including in our HCP/NCCP the plants described in subsequent sections.

In consultation with CDFG and USFWS, MRC developed our covered plant list to include any rare plants subject to possible impact by the proposed covered activities. Three main sources of information were used, namely, the state and federal lists of rare and endangered plants and the CNPS inventory.

Our primary sources for plant information only provided general guidance. Clearly, data derived from a few plant occurrences is imprecise. The elevational range for a taxon with few occurrences, for example, may not reflect its true elevation limits. Consequently, MRC will not restrict our surveys or management to only those parameters given here for each taxon.

6.1.1 Plant designations

Sandwiched between the Pacific Ocean to its west and mountains and deserts to its east, with both the highest and the lowest elevations in the continental United States, California has a rich and diverse native flora. A native plant is one that grew in California prior to European contact. Having evolved with animals, fungi, and micro-organisms in a complex ecosystem, these plants are at the center of natural community conservation. Non-native plants have been purposely or accidentally introduced to California as a result of human actions. While many non-native plants do no harm, some are aggressive invaders of wildlands, capable of eliminating native plants.

6.1.2 Counties and quadrangles

The species accounts in this chapter refer to plant distribution in various California counties. Figure 6-1shows the counties in northern California. In describing plant distribution, the species accounts also refer to "quadrangles." A quadrangle is a rectangular area covered by a map, usually bounded by specified meridians of longitude and parallels of latitude. Figure 6-2 shows a partial quad map of Mendocino County.[1]

[1] The United States Geological Survey (USGS) took responsibility for mapping the U.S. in 1879 and has been the primary civilian mapping agency ever since. The best known USGS maps are the 1:24,000-scale topographic maps, also known as 7.5-minute quadrangles. A 7.5-minute map shows an area that spans 7.5 minutes of latitude and 7.5 minutes of longitude. A degree of latitude is approximately 69 miles, so a minute of latitude is 69/60 or 1.15 miles. A degree of longitude varies in size. At the equator, it is about the same size as a degree of latitude—69 miles. The size gradually decreases to zero, however, as the meridians converge at the poles.

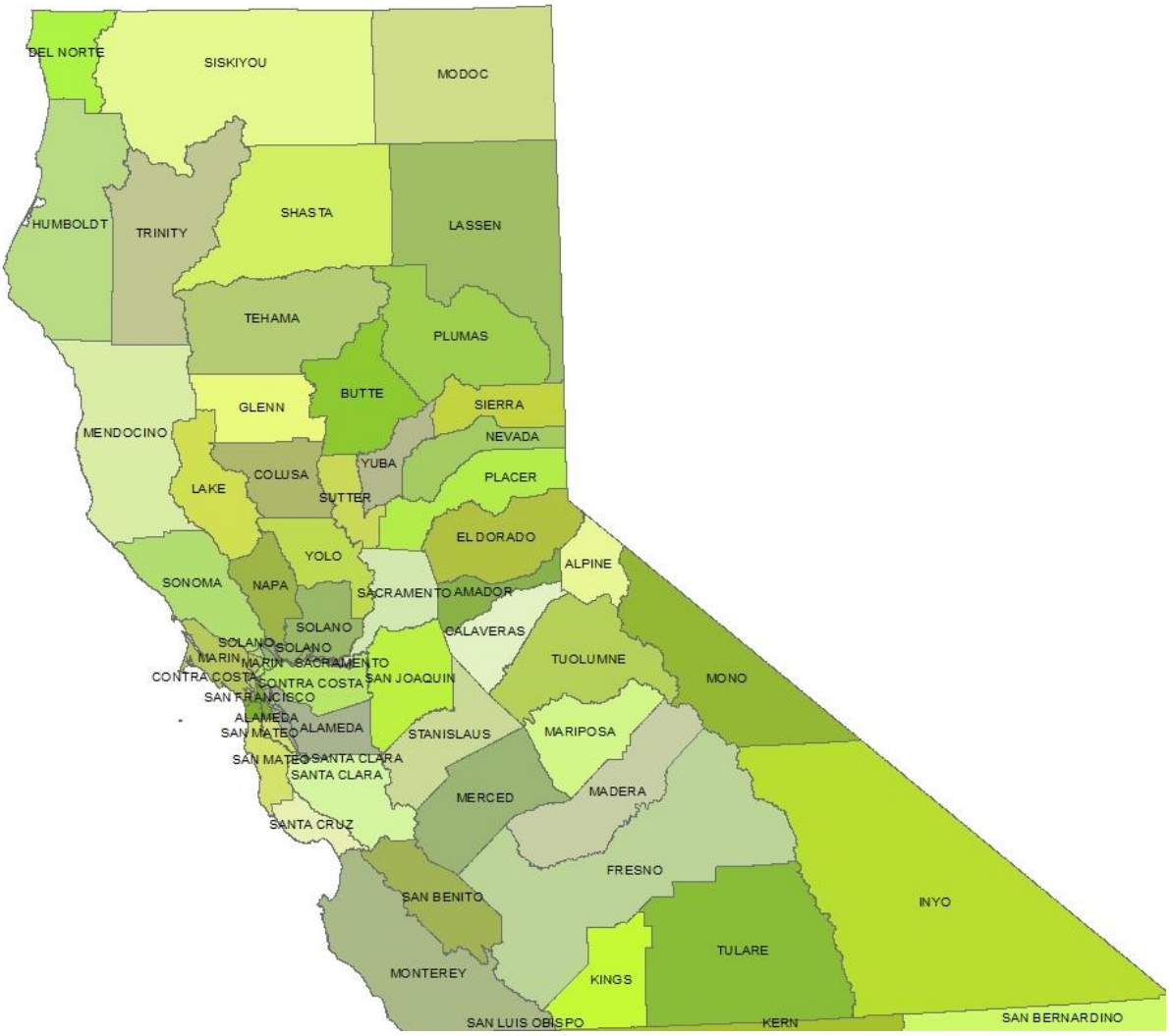

Figure 6-1 Counties of Northern California

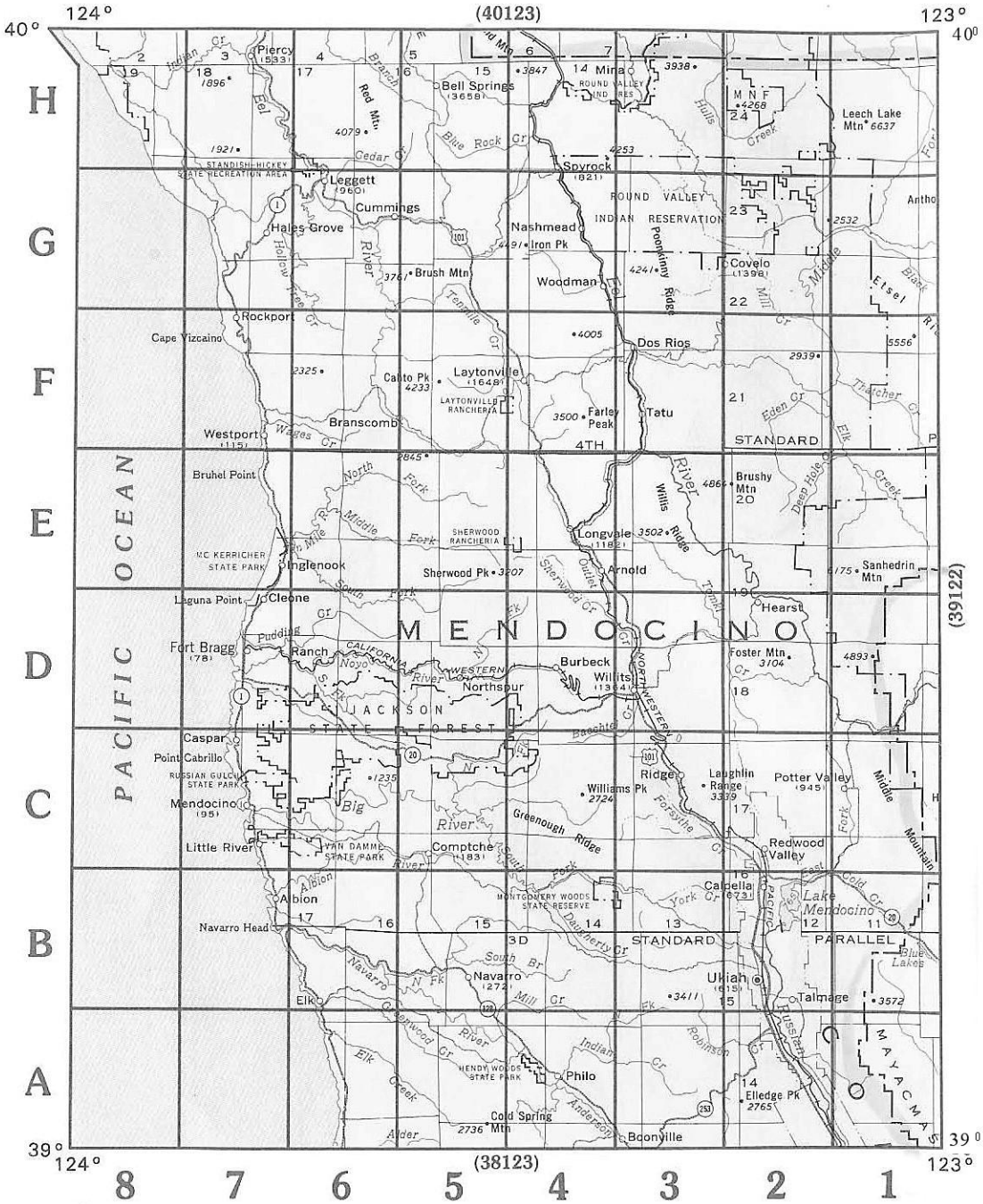

Figure 6-2 Partial Map of Mendocino County with 7.5 Minute Quadrangles

6.2 Sensitivities of Rare Plants to Timber Management

In the species accounts that follow in the remainder of this chapter, we indicate which plants are in the plan area, as well as those that occur in quadrangles into which the plan area borders or extends. Timber management has the potential to affect any covered plant species in the plan area. Potential effects include direct and indirect impacts to habitats and individual plants, as summarized in Table 6-1.

The terms *direct impact* and *indirect impact* are conceptually on a continuum. Direct impacts will be relatively more immediate, on-site, and easily ascribed to a covered activity. Indirect impacts may be delayed, on-site or remote, and mediated by intermediate processes related to a covered activity (e.g., mass wasting). Likewise, impacts on habitat and individuals are tied together. Damage from a mechanical device is an obvious direct impact on an individual plant. Even if a plant shows no damage from a mechanical device, resultant changes in the adjacent habitat may reduce the plant's ability to persist and, therefore, be a direct impact on the individual plant.

Table 6-1 Potential Impacts of Covered Activities on Rare Plant Species and Habitats

	Direct Impacts	Indirect Impacts
Potential Effects on Habitats	▪ Direct loss or modification of habitat; usually immediately obvious but may extend over a longer time period; characterized by on-site soil disturbance and changes in vegetation that affects temperature and humidity.	▪ Loss or modification of habitat; often delayed over an extended time period, such as accelerated erosion; weed invasion; hydrologic changes; and changes in competitor, predator, or commensal (e.g., mycorrhizal fungi) communities.
Potential Effects on Species	▪ Death or injury to individual plants, or reduced vigor, longevity, or changes in reproductive capacity, from mechanical damage, burying, or uprooting, and the immediate changes brought about by these direct effects on habitat.	▪ Death or injury to individual plants or loss of reproductive capacity, from accelerated erosion; weed invasion; hydrologic changes; reduced pollinator abundance; and changes in competitor, predator, or commensal (e.g., mycorrhizal fungi) communities. .

Unless timber operations avoid individual plants and their habitats, such operations could potentially harm most covered plant species. However, covered species vary in their sensitivity to habitat modification as a result of timber management. Humboldt milk-vetch (*Astragalus agnicidus*), for example, is often associated with logged areas and sites with recent ground disturbance (Berg and Bittman 1988, Hiss and Pickart 1992, Nakamura and Nelson 2001, CNDDB 2006). According to our monitoring results, ground disturbance from logging and road maintenance, which may mimic in some respects natural forest disturbance, appears to promote the reproduction of Humboldt milk-vetch. Likewise, maple-leaved checkerbloom (*Sidalcea malachroides*) is often found on disturbed sites (Nakamura and Nelson 2001, CNDDB 2006). Data indicates that long-beard lichen (*Usnea longissima*) is also more abundant in younger, previously harvested timberlands than in old-growth forests within national and state parks (Doell 2004). At present, the "strongest" populations of long-beard lichen in California are thought to occur on Pacific Lumber Company land in Humboldt County (Peterson 2005).

6.3 Humboldt Milk-vetch *(Astragalus agnicidus)*

6.3.1 Conservation status

Federal Status	State Status	CRPR
None	SE	1B.1

Photo from CNPS

6.3.2 Distribution

6.3.2.1 General distribution

Humboldt milk-vetch is endemic to California, occurring only in Humboldt and Mendocino counties. The first discovery of several small populations was in Humboldt County on a ranch south of Miranda. During the 1920s, ranch owners targeted the plant for weed eradication, reportedly implicating it in the death of lambs. After 1954, Humboldt milk-vetch was presumed extinct since there were no further sightings. Efforts to relocate Humboldt milk-vetch were unsuccessful during the 1970s. In 1987, the species was rediscovered on a ranch near Miranda (Berg and Bittman 1988). Some thought that dormant seeds, which had persisted in the soil for decades, were stimulated to germinate when a tree on the ranch was felled, opening up the tree canopy. After its rediscovery, the ranch owner agreed to protect the milk-vetch in coordination with The Nature Conservancy (TNC) and the California Native Plant Society (CNPS) (CDFG 2001). Since the rediscovery of populations of Humboldt milk-vetch in the Miranda Quadrangle, occurrences have been reported from the Bridgeville, Myers Flat, and Redcrest quadrangles in Humboldt County (CNPS 2006, CNDDB 2005).

In 1999, the first occurrences of Humboldt milk-vetch in Mendocino County were discovered in the Noyo Hill Quadrangle on a ridgetop logging road in Jackson Demonstration State Forest (JDSF) during a THP survey. Since the JDSF discovery, several occurrences have been identified in Mendocino County, primarily in openings on timberland within the Lincoln Ridge, Sherwood Peak, Bailey Ridge, Dutchmans Knoll, Westport, Hales Grove, Northspur, Cahto Peak, Greenough Ridge and Gualala quadrangles (CNDDB 2005). Approximately 47 occurrences of Humboldt milk-vetch are known (CNDDB 2009).

6.3.2.2 Plan area

Table 6-2 shows the occurrences of Humboldt milk-vetch in the plan area.

Table 6-2 Humboldt Milk-vetch in the Plan Area

Humboldt Milk-vetch in the Plan Area						
Project	**NDDB OCC #**	**USGS Quad**	**Watershed and Inventory Block**	**Year Found**	**# Plants**	**Habitat**
1-00-437 MEN	n/a	Greenough Ridge	Russell Brook Big River	2000	20	NCFrs (road)
1-01-059 MEN	4	Gualala	Doty Creek Garcia	2001	5	NCFrs (landing)
1-01-183 MEN	22	Lincoln Ridge	Howard Creek Rockport	2002	77	NCFrs (road)
1-01-183 MEN	23	Lincoln Ridge	Howard Creek	2002	21	NCFrs (road)

Humboldt Milk-vetch in the Plan Area						
Project	**NDDB OCC #**	**USGS Quad**	**Watershed and Inventory Block**	**Year Found**	**# Plants**	**Habitat**
			Rockport			
1-01-220 MEN	10	Lincoln Ridge and Westport	Cottoneva Creek Rockport	2001	1427	NCFrs (road/landing)
1-02-057 MEN	16	Hales Grove	Cottoneva Creek Rockport	2001	8195	NCFrs (road/burn piles/skid trails/ clearcut)
1-02-266 MEN	14	Hales Grove	Cottoneva Creek Rockport	2001	4315	NCFrs (road)
1-02-274 MEN	9	Westport	Cottoneva Creek Rockport	2001	120	NCFrs (road/ burn pile)
1-02-274 MEN	11	Westport	Cottoneva Creek Rockport	2001	12	NCFrs (road)
1-02-274 MEN	12	Westport	Cottoneva Creek Rockport	2001	40	NCFrs (road/ landing)
Meese, D (OBS)	13	Westport	Juan Creek Rockport	2001	205	NCFrs (road)
1-02-305 MEN	15	Hales Grove	Cottoneva Creek Rockport	2001	75	NCFrs (road/ burnpile)
Road abandonment	21	Bailey Ridge	Little North Fork Navarro Navarro East	2002	1	NCFrs (road)
Hollow Tree Creek Watershed Restoration Project – Phase I	n/a	Lincoln Ridge	Upper Hollow Tree Creek Rockport	2003	200	NCFrs (road)
Road abandonment	n/a	Sherwood Peak	Middle Fork Noyo River Noyo	2004	100	NCFrs (road)
1-04-004 MEN	n/a	Westport	Hardy Creek Rockport	2005	7379	NCFrs (road)
1-04-290 MEN	n/a	Hales Grove	Cottoneva Creek and Middle Hollow Tree Creek Rockport	2004	1002	NCFrs (road/ skid trails)
1-04-264 MEN	n/a	Greenough Ridge	Rice Creek Big River	2007	45	NCFrs (road)
1-05-104 MEN	n/a	Lincoln Ridge	Howard Creek Rockport	2004	673	NCFrs (road)
1-06-143 MEN	n/a	Greenough Ridge	Russelbrook Big River	2007	5	NCFrs (road)
1-06-212 MEN	n/a	Bailey Ridge	Little North Fork Navarro Navarro East	2007	3	NCFrs (road)
1-07-117 MEN	n/a	Bailey Ridge	Little North Fork Navarro Navarro East	2007	225	NCFrs (road)
1-08-169MEN	n/a	Mallo Pass Creek	SF Elk Creek South Coast	2008	50	NCFrs (road)

6.3.3 Description and life history

Humboldt milk-vetch, a member of the pea family (Fabaceae), is a low, shrubby perennial up to 3.5 ft (1.1 m) tall, with hollow stems, pinnately-divided leaves, and many small white-pink flowers on a flower stalk. Its main blooming period is from June to September (CNPS 2006);

however, the plant has been observed blooming in the plan area as late as November.[2] Observations suggest that Humboldt milk-vetch is a short-lived perennial with an estimated life-span of 5-10 years (Bencie 1997).

Humboldt milk-vetch has a mixed mating system; seed production is through either selfing or out-crossing (Bencie 1997). The plant requires insect visitation for pollination, with a native bumblebee (*Bombus* sp.) the likely pollinator (Bencie 1997). Observations of bumblebee behavior indicate that most seed is produced through self-fertilization (Bencie 1997). Self-compatibility has been demonstrated in Humboldt milk-vetch (Bencie 1997); however, scientific studies have not determined the contribution of self-fertilization to overall seed production in the field. According to genetic data from one population, Humboldt milk-vetch may be subject to inbreeding depression (Bencie 1997). Optimum germination requires scarification of the seeds (Hiss and Pickart 1992). There is a persistent soil seed bank, presumed to be genetically diverse (Bencie 1997).

6.3.4 Habitat requirements

Humboldt milk-vetch grows in North Coast coniferous forest and broadleaved upland forest, typically on ridgetops at elevations ranging from 585-2250 ft (195-750 m) (CNPS 2006). Humboldt milk-vetch often occurs in forest canopy openings and edge habitats where there is soil disturbance. Results from monitoring indicate that Humboldt milk-vetch is an early successional species that requires disturbance to be self-sustaining (Hiss and Pickart 1992). Most often found in openings in the forest canopy, the species presumably is shade-intolerant. Occurrences of Humboldt milk-vetch in the plan area are typically within or adjacent to areas subject to recent disturbance, such as timber harvest, road construction, and road maintenance; a post-harvest survey may reveal plants undetected in a pre-harvest survey.

6.3.5 Threats

Threats to Humboldt milk-vetch include road maintenance and construction; interspecific competition, mainly with pampas grass (*Cortaderia jubata*); and canopy closure (CDFG 2001).

6.3.6 Population trend

Although the number of Humboldt milk-vetch occurrences has increased to 47 since rediscovery of the species in Humboldt County in 1987, there are no reported population trends for this species. MRC is monitoring some occurrences of Humboldt milk-vetch on our land.

6.3.7 Mendocino lighting complex (2008)

Fires or fire suppression activities affected approximately 88% of the Humboldt milk-vetch plants recorded on MRC timberlands, all of which occurred in the Rockport inventory block. Fire-fighters used roads, landings, and skid trails as fire breaks and staging areas. Such actions impacted approximately 16,400 individual plants or 96% of all affected milk-vetch.

[2] Personal observation of Dale Meese, RPF (MRC), Fort Bragg, CA, 2003

6.4 Small Groundcone (*Kopsiopsis hookeri*)

6.4.1 Conservation status

Federal Status	State Status	CRPR
None	None	2.3

Photo by
Doreen L. Smith, 2001

6.4.2 Distribution

6.4.2.1 General distribution

Small groundcone occurs along the Pacific coast from Marin County, north to British Columbia, Canada (Hickman 1993). In California, this species occurs in Del Norte, Humboldt, Mendocino, and Marin counties (CNPS 2006, CNDDB 2005). In Mendocino County, small groundcone occurs in Purdys Gardens and Elk quadrangles (CNPS 2006, CNDDB 2005). The Elk Quadrangle occurrence in 2002 consisted of 5 plants found along a maintained rock road within pygmy transition forest (CNDDB 2005). In California, there are 15 known occurrences of small groundcone—7 of them based on herbarium specimens collected from the 1940s to 1980. The current status of these 7 occurrences is unknown (CNDDB 2005).

6.4.2.2 Plan area

Table 6-3 shows the occurrence of small groundcone in the plan area.

Table 6-3 Small Groundcone in the Plan Area

Project	NDDB OCC #	USGS Quad	Watershed and Inventory Block	Year Found	# Plants	Habitat
1-02-059 MEN	9	Elk	Lower Albion River Albion	2002	5	NCFrs (pygmy) – road side

6.4.3 Description and life history

Small groundcone is a rhizomatous perennial herb in the broom-rape family (Orobanchaceae) that is parasitic on the roots of madrone, salal, and huckleberry (CNPS 2006). The plant has a fleshy purplish-to-pale yellow spike-like inflorescence with bracts that densely overlap resembling a pine cone. The reddish-brown flowers appear from April to August (CNPS 2006).

6.4.4 Habitat requirements

This species occurs in open and shrubby areas (Hickman 1993) within North Coast coniferous forest and closed-cone coniferous forest at elevations from 295 ft-2900 ft (90-885 m) (CNPS 2006).

6.4.5 Threats

Threats to small groundcone include road construction and maintenance (CNDDB 2004).

6.4.6 Population trend

The population trend for small groundcone is unknown.

6.5 Pygmy Cypress (*Hesperocyparis pygmaea*)

6.5.1 Conservation status

Federal Status	State Status	CRPR
None	None	1B.2

Photo by
Br. Alfred Brousseau

6.5.2 Distribution

6.5.2.1 General distribution

Pygmy cypress is endemic to Sonoma and Mendocino counties. In Mendocino County, there are reported occurrences in the following quadrangles: Gualala, Saunders Reef, Point Arena, Eureka Hill, Mallo Pass Creek, Elk, Mendocino, Comptche, Mathison Peak, Fort Bragg, and Noyo Hill (CNPS 2001, CNDDB 2005). In total, 35 occurrences have been documented; with one exception, all are presumed extant and most are recently documented (CNDDB 2005).

6.5.2.2 Plan area

Table 6-4 shows the occurrences of pygmy cypress in the plan area. Moreover, the plan area extends into Gualala, Saunders Reef, Point Arena, Eureka Hill, Mallo Pass Creek, Elk, Mendocino, Comptche, Mathison Peak, and Noyo Hill quadrangles where there are reported occurrences for this species (CNPS 2006, CNDDB 2005).

Table 6-4 Pygmy Cypress in the Plan Area

Project	NDDB OCC #	USGS Quad	Watershed and Inventory Block	Year Found	# Plants	Habitat
1-01-182 MEN	27	Mendocino	Russian Gulch Albion	2002	300	NCFrs (RW/pygmy transitional) – road/ landing/ skid trails
n/a	n/a	Mendocino	Little River Albion	2007	several	CCFrs (pygmy)
n/a	n/a	Mathison Peak	Lower Albion Albion	2007	several	CCFrs (pygmy)
n/a	n/a	Elk	Lower Albion Albion	2007	several	CCFrs (pygmy)

6.5.3 Description and life history

Pygmy cypress is a small, evergreen, closed-cone coniferous tree in the cypress family (Cupressaceae). The tree reaches 3-7 ft (1-2 m) in height in podzolized soil and 33-164 ft (10-50 m) in nutrient rich soil. The trees have a long whip-like terminal shoot and dark green 4-ranked

scale-like leaves. Seed cones are small, 12-25 mm wide (Hickman 1993). Cone production is abundant on dwarfed and mature trees that are 4 years of age or older, but is rare or absent on young trees. The cones require 2 years to mature and persist on trees until opened by the heat of a fire or from desiccation due to age. Seed dispersal is primarily by wind and rain. Bare mineral soil conditions are required for seed germination and establishment (Esser 1994).

6.5.4 Habitat requirements

Pygmy cypress occurs in podzolized soils within closed-cone coniferous forest at elevations from 90-1500 ft (30-500 m) (CNPS 2006). This tree is often found associated with Bolander's pine and bishop pine within Mendocino Pygmy Forest. Pygmy cypress is also found in North Coast coniferous forest habitats that are adjacent to and integrate with pygmy forest, locally called "transitional pygmy" forest.[3]

6.5.5 Threats

Threats to pygmy cypress include development, vehicles, and fire suppression (CNPS 2006, Esser 1994).

6.5.6 Population trend

The population trend for pygmy cypress is unknown.

6.6 Swamp Harebell (*Campanula californica*)

6.6.1 Conservation status

Federal Status	State Status	CRPR
None	None	1B.2

Photo by
Doreen L. Smith, 2001

6.6.2 Distribution

6.6.2.1 General distribution

Swamp harebell is endemic to California, occurring along the coast of northern California in Marin, Sonoma, and Mendocino counties, and extirpated from Santa Cruz County (CNPS 2006). In Mendocino County this plant occurs in the Gualala, Saunders Reef, Point Arena, Navarro, Elk, Albion, Mathison Peak, Mendocino, Noyo Hill, Fort Bragg, Dutchmans Knoll, and Inglenook quadrangles (CNPS 2006, CNDDB 2005). Approximately 100 occurrences are known from California; 4 are thought to be extirpated, and 30 occurrence records are historic (date from before 1985) (CNDDB 2005).

6.6.2.2 Plan area

Table 6-5 shows the occurrences of swamp harebell in the plan area. Moreover, the plan area extends into Gualala, Point Arena, Navarro, Elk, Albion, Mathison Peak, Mendocino, and Noyo

[3] Teresa Sholars (College of the Redwoods) relayed this information in a telephone conversation with Ann Howald (MRC consultant) in November 2005.

Hill quadrangles, where this species does occur.

Table 6-5 Swamp Harebell in the Plan Area

Project	NDDB OCC #	USGS Quad	Watershed and Inventory Block	Year Found	# Plants	Habitat
1-01-113 MEN	n/a	Gualala	Point Arena Creek Garcia	2001	several	NCFrs (crossing culvert)
1-06-152 MEN	n/a	Gualala and Saunders Reef	Point Arena Creek Garcia	2007	>5400	NCFrs/CCFrs mesic (roads, ditches, skid trails, crossings)
1-06-165 MEN	n/a	Eureka Hill	Rolling Brook Garcia	2007	>40,000	NCFrs (wet landing, mesic grass opening)
1-06-211 MEN	n/a	Gualala	South Fork Garcia River Garcia	2007	>2000	NCFrs/CCFrs mesic (Class II watercourse, in and adjacent to existing roads)
1-06-218 MEN	n/a	Mallo Pass and Cold Spring	Mallo Pass Creek Alder	2007	≅ 600	NCFrs/CCFrs mesic (Class III watercourse, wet areas)

6.6.3 Description and life history

Swamp harebell is a rhizomatous perennial herb in the bellflower family (Campanulaceae). The stems are reclining to erect with stiff hairs and thin leaves that have a distinct crenate margin. The plants reach 4 to 12 in. (10-30 cm) in height and produce pale blue, bell-shaped flowers (Hickman 1993) from June through October (CNPS 2006).

6.6.4 Habitat requirements

Swamp harebell occurs in several wetland habitat types along the coast, such as bog and fen, meadow and seep, and freshwater marsh and swamp. The species also occurs in mesic sites within coastal prairie, closed-cone coniferous forest, and North Coast coniferous forest habitats at elevations from 3-1215 ft (1-405 m) (CNPS 2006). Swamp harebell is an obligate (OBL) wetland species.

6.6.5 Threats

Threats to swamp harebell include livestock grazing, development, loss of marsh habitat, and logging (CNPS 2006). Overstory growth resulting from fire suppression, habitat alteration, and succession may shade the open habitats preferred by this species.

6.6.6 Population trend

The population trend for swamp harebell is unknown.

6.7 California Sedge (*Carex californica*)

6.7.1 Conservation status

Federal Status	State Status	CRPR
None	None	2.3

Photo by
Rick York, 1986

6.7.2 Distribution

6.7.2.1 General distribution

California sedge occurs in coastal northern California, Oregon, Washington, Idaho, and other states. In California the species occurs only along the coast of Mendocino County within Eureka Hill, Point Arena, Elk, Albion, Noyo Hill, Mathison Peak, Fort Bragg, and Mendocino quadrangles (CNPS 2006, CNDDB 2005). Reports from California cite 28 occurrences, of which 26 date from the mid-1980s (CNDDB 2005).

6.7.2.2 Plan area

California sedge has not been found in the plan area; however, the plan area extends into Eureka Hill, Point Arena, Elk, Albion, Noyo Hill, Mathison Peak, and Mendocino quadrangles where there are reported occurrences of this species.

6.7.3 Description and life history

California sedge is a rhizomatous perennial herb in the sedge family (Cyperaceae). The plants reach 8-28 in. (20-70 cm) in height, with gray-green grass-like leaves; basal blades are minute. The pistillate flower bracts are purplish-brown and glandular-papillate along the midstripe (Hickman 1993). California sedge blooms from May to August (CNPS 2006).

6.7.4 Habitat requirements

California sedge occurs in wetlands such as bogs, fens, and along the margins of marsh and swamp habitats; the species also occurs in mesic sites within closed-cone coniferous forest (including pygmy forest), and coastal prairie, at elevations from 270-1005 ft (90-335m) (CNPS 2006). California sedge is a facultative (FAC) plant species.

6.7.5 Threats

Threats to California sedge include illegal dumping, road maintenance and construction, off-road vehicle use, and development (CNDDB 2005).

6.7.6 Population trend

The population trend for California sedge is unknown.

6.8 Bristly Sedge (*Carex comosa*)

6.8.1 Conservation status

Federal Status	State Status	CRPR
None	None	2.1

Photo by
Dr. Dean Wm. Taylor, 1973

6.8.2 Distribution

6.8.2.1 General distribution

Bristly sedge occurs in California; in Idaho, where the species is endangered; and in Washington, where bristly sedge is listed by the state as sensitive. The species is extirpated in Oregon. In California, bristly sedge occurs in Contra Costa, Lake, Mendocino, Shasta, San Joaquin, and Sonoma counties (CNPS 2006, CNDDB 2005). The species has been extirpated from San Bernardino, San Francisco, and Santa Cruz counties. Occurrences in Mendocino County have been documented in the Hopland quadrangle (CNPS 2006, CNDDB 2005). Approximately 6 extant occurrences are known from California, including 3 recent sightings (1988, 1997, and 1999) (CNDDB 2005). The other 3 are based on herbarium specimens from the 1920s and 1940s (CNDDB 2005).

6.8.2.2 Plan area

Bristly sedge has not been found in the plan area, nor does the plan area extend into quadrangles where this species occurs. However, there are known occurrences of bristly sedge within the *adjustment area* of this HCP/NCCP.

6.8.3 Description and life history

Bristly sedge is a rhizomatous perennial herb in the sedge family (Cyperaceae). The plants grow 20-40 in. (50-100 cm) tall, with the lower spikelets on a distinct long, nodding stalk. The awned pistillate flower bracts are white or cream with a pale reddish center. The fruits have perigynia (sac-like structures enclosing the seeds) that are green to gold (Hickman 1993). Bristly sedge is seen blooming from May to September (CNPS 2006).

6.8.4 Habitat requirements

Bristly sedge occurs along lake margins, in mesic areas within coastal prairie, valley, and foothill grassland, and in marsh and swamp habitats with elevations below 990 ft (3-230m) (CNPS 2001). As an obligate (OBL) wetland species, bristly sedge has at least a 99% likelihood of occurring in wetlands (Reed 1988, USFWS 1997d).

6.8.5 Threats

Threats to bristly sedge include agriculture, grazing, and loss of marsh habitat (CNDDB 2005).

6.8.6 Population trend

The population trend for bristly sedge is unknown.

6.9 Deceiving Sedge (*Carex saliniformis*)

6.9.1 Conservation status

Federal Status	State Status	CRPR
None	None	1B.2

Drawing from Texas A&M University

6.9.2 Distribution

6.9.2.1 General distribution

Deceiving sedge is endemic to California, occurring along the coast of northern California in Sonoma, Mendocino, and Humboldt counties, but has been extirpated from Santa Cruz County (CNDDB 2005). In Mendocino County, occurrences have been documented within the following quadrangles: Point Arena, Elk, Mallo Pass Creek, Mendocino, Noyo Hill, Fort Bragg, and Inglenook (CNDDB 2005). Of the 14 extant occurrences, 10 are based on herbarium specimens collected prior to 1940 and 4 have been recorded since 1980 (CNDDB 2005).

6.9.2.2 Plan area

Deceiving sedge has not been found in the plan area; however, the plan area extends into Point Arena, Elk, Mallo Pass Creek, Mendocino, and Noyo Hill quadrangles where there are reported occurrences of this species.

6.9.3 Description and life history

Deceiving sedge is a rhizomatous perennial herb in the sedge family (Cyperaceae). Plants are densely tufted with narrow grass-like leaf blades that are 2-5 mm wide. Inflorescences are long-stalked with leaf-like pistillate flower bracts that have stout awns and are green with a white or red-brown margin (Hickman 1993). Flowering occurs from May to August (Jepson Online Interchange 2006).

6.9.4 Habitat requirements

Deceiving sedge occurs in meadow, seep, coastal salt marsh and swamp wetlands; the species also occurs in mesic areas of coastal prairie and coastal scrub habitats at elevations from 9-690 ft (3-230 m) (CNPS 2001). As a facultative wetland (FACW) species, deceiving sedge has a 67-99% likelihood of occurring in wetlands (Reed 1988, USFWS 1997d).

6.9.5 Threats

Threats to deceiving sedge include residential development near marshes (CNDDB 2005).

6.9.6 Population trend

The population trend for deceiving sedge is unknown.

6.10 Green Sedge (*Carex viridula* var. *viridula*)

6.10.1 Conservation status

Federal Status	State Status	CRPR
None	None	2.3

6.10.2 Distribution

6.10.2.1 General distribution

Within California, known occurrences of green sedge are only in Del Norte, Humboldt, and Mendocino counties. However, the species is widespread outside of California (CNPS 2001). In Mendocino County, 1 occurrence has been documented within the Inglenook Quadrangle, based on a herbarium specimen from before 1910 (CNPS 2006, CNDDB 2005). Approximately 6 occurrences are known from California; 5 of these are based on herbarium specimens from 1944 or earlier (CNDDB 2005).

6.10.2.2 Plan area

Green sedge has not been found in the plan area, nor does the plan area extend into quadrangles where this plant occurs in Mendocino County. However, 1 occurrence of green sedge is within the *adjustment area* of this HCP/NCCP.

6.10.3 Description and life history

Green sedge is an herbaceous perennial belonging to the sedge family (Cyperaceae). Plants are densely tufted, reaching 16 in. (40 cm) in height with narrow (1.5-3 mm) leaf blades. Inflorescences are dense with lower spikelet bracts that are taller than the height of the inflorescences. Pistillate flower bracts are reddish with a green center and perigynia are narrowly conic, ribbed, and yellow-green to brown (Hickman 1993). Green sedge blooms from June to September (CNPS 2006).

6.10.4 Habitat requirements

Green sedge occurs within wetlands, such as freshwater marsh, swamp, bog, and fen, and in mesic sites within North Coast coniferous forest at elevations from 3-4800 ft (0-1600m) (CNPS 2006). As an obligate (OBL) wetland species, green sedge has at least a 99% likelihood of occurring in wetlands (Reed 1988, USFWS 1997d).

6.10.5 Threats

Specific threats to green sedge are unknown.

6.10.6 Population trend

The population trend for green sedge is unknown.

6.11 Oregon goldthread (*Coptis laciniata*)

6.11.1 Conservation status

Federal Status	State Status	CRPR
None	None	2.2

Photo by Elicia Wise, 2007

6.11.2 Distribution

6.11.2.1 General distribution

In the California floristic province, Oregon goldthread is known from the North Coast and Klamath Ranges (Hickman 1993). This species occurs throughout Oregon and Washington and is not considered rare outside of California. Oregon goldthread has been reported from Mendocino, Humboldt, Del Norte and Siskiyou Counties. In Mendocino, this species occurs in the Mathison Peak, Noyo Hill, Elk, Northspur, Comptche, Leggett, Point Arena and Cold Spring Quadrangles (CNDDB 2008).

6.11.2.2 Plan area

Table 6-6 shows the occurrences of Oregon goldthread in the plan area. The plan area extends into the Noyo Hill and Northspur quadrangles where there are reported occurrences for this species (CNDDB 2008).

Table 6-6 Oregon Goldthread in the Plan Area

Oregon Goldthread in the Plan Area						
Project	**NDDB OCC #**	**USGS Quad**	**Watershed and Inventory Block**	**Year Found**	**Est. # Plants**	**Habitat**
1-05-207 MEN	4	Elk	SF Albion River Albion	2006	65	NCFrs – riparian/ stream banks
1-06-223 MEN	n/a	Mathison Peak	SF Albion River Albion	2007	60	NCFrs – riparian ≅ 100’ upslope of SF Albion
Goldsworthy, M. (OBS)	n/a	Leggett	Middle Hollow Tree Creek Rockport	2007	30	NCFrs – riparian/ stream banks at confluence
Goldsworthy, E. (OBS)	n/a	Comptche	Upper Albion River Albion	2007	25	NCFrs – riparian/ stream banks
Ulrich, D. (OBS)	n/a	Comptche	Two Log Creek Big River	2007	40	NCFrs – riparian/ stream banks

Oregon Goldthread in the Plan Area						
Project	**NDDB OCC #**	**USGS Quad**	**Watershed and Inventory Block**	**Year Found**	**Est. # Plants**	**Habitat**
Goldsworthy, M. (OBS)	n/a	Point Arena	Lower Alder Creek South Coast	2007	25	NCFrs – riparian/ stream banks
Douglas, R. (OBS)	n/a	Cold Spring	Lower Alder Creek South Coast	2007	50	NCFrs – riparian/ stream banks

6.11.3 Description and life history

Oregon goldthread is a perennial herb in the Ranuculus family (Ranunculaceae). The species is low growing from a slender yellowish rhizome or stolon. The stems are short, simple, stout, and scaly. There are typically 3 to 8 basal leaves which are generally 1-ternate, long-petiolate, leathery, and evergreen. The leaflets are ovate to triangular, generally terminal stalked with 3 very deep, irregularly toothed lobes. The inflorescence peduncle is generally shorter than the leaves when in flower and longer than leaves when in fruit (Hickman 1993). This species is an early bloomer, flowering in March and April. The flowers are radial, bisexual, or sometimes staminate and the sepals are petal-like and early-deciduous.

6.11.4 Habitat requirements

Oregon goldthread typically occurs in mesic sites such as meadows and seeps in coniferous forest and is often found on streambanks (CNPS 2008). The species occurs at elevations less than 3300 ft. (1000m).

6.11.5 Threats

No threats are currently known for Oregon goldthread.

6.11.6 Population trend

The population trend for Oregon goldthread is unknown.

6.12 Streamside Daisy (*Erigeron bioletti*)

6.12.1 Conservation status

Federal Status	State Status	CRPR
None	None	3

Photo by
Dr. Dean Wm. Taylor, 1996

6.12.2 Distribution

6.12.2.1 General distribution

Streamside daisy is endemic to California, occurring in Humboldt, Mendocino, Sonoma, Marin, Napa, and Solano counties. Only 1 occurrence in Mendocino County has been reported, within the Philo Quadrangle (CNPS 2006). RareFind3 (CNDDB 2005) currently does not track

occurrences for this species, although data is on file; likewise, no other database has summarized accurate occurrence information for this species. As a result, the total number of extant occurrences is difficult to determine. The Jepson Online Interchange (2006) lists 24 herbarium specimens of this species; however, all but 2 of these were collected prior to 1950. In 2005, the type locality for streamside daisy, near the summit of Hood Mountain in Sonoma County, was relocated after lack of documentation for more than 50 years.[4]

6.12.2.2 Plan area

Streamside daisy has not been found in the plan area; however, the plan area extends into Philo Quadrangle where there are documented occurrences for this species.

6.12.3 Description and life history

Streamside daisy is an herbaceous perennial in the sunflower family (Asteraceae). The plant branches from a woody caudex, is densely glandular, and reaches 36 in. (90cm) in height. The alternate cauline leaves are narrowly oblanceolate and evenly sized and spaced. Its inflorescences are flat-topped clusters of yellow discoid heads (Hickman 1993) that bloom from June to September (CRPR 2006, 2005).

6.12.4 Habitat requirements

Streamside daisy occurs in rocky substrates along dry slopes and mesic river ledges within broadleaved upland forest, cismontane woodland, and North Coast coniferous forest habitats at elevations from 90-3300 ft (30-1100m) (CNPS 2006, Hickman 1993).

6.12.5 Threats

Specific threats to streamside daisy are unknown.

6.12.6 Population trend

The population trend for streamside daisy is unknown.

6.13 Coast Fawn Lily (*Erythronium revolutum*)

6.13.1 Conservation status

Federal Status	State Status	CRPR
None	None	2.2

Photo from CNPS

6.13.2 Distribution

6.13.2.1 General distribution

Coast fawn lily occurs from California to British Columbia, Canada. The species is state-listed as sensitive in Washington and on a watch list in Oregon. In California, coast fawn lily is within Del Norte, Siskiyou, Humboldt, Mendocino, and Sonoma counties. In Mendocino County, 6

[4] Personal observation of Ann Howald (MRC consultant) in 2005

occurrences have been reported from the Sherwood Peak, Leggett, Piercy, Comptche, Navarro, and Philo quadrangles (CNPS 2006, CNDDB 2009). From California, 79 occurrences are known (CNDDB 2009), of which 14 are historic (reported between 1897 and 1933) and have not been relocated. On privately managed timberlands in Humboldt County, 23 new occurrences have been confirmed since 2002 (CNDDB 2005).

6.13.2.2 Plan area

Coast fawn lily has not been found in the plan area; however, the plan area extends into the Comptche, Leggett, Navarro, Philo, and Sherwood Peak quadrangles where there are reported occurrences of this species.

6.13.3 Description and life history

Coast fawn lily is a bulb-forming herb within the lily family (Liliaceae). The plant has two basal leaves when in flower, which are mottled with brown or white. Inflorescence stalks reach 6-20 in. (15-50 cm) with 1-3 showy flowers that are pink with a yellow band at the base (Hickman 1993). This species blooms from March to June (CNPS 2006).

6.13.4 Habitat requirements

Coast fawn lily occurs in wetlands, such as bogs and fens, and in mesic areas within North Coast coniferous forest and broadleaved upland forest habitats. Often the plant occurs along streambanks, at elevations below 3200 ft (0-1065 m) (CNPS 2006). Coast fawn lily is a facultative (FAC) plant species.

6.13.5 Threats

Threats to coast fawn lily include road maintenance and habitat alteration due to timber harvesting (CNDDB 2005).

6.13.6 Population trend

The population trend for this species is unknown.

6.14 Roderick's Fritillary (*Fritillaria roderickii*)

6.14.1 Conservation status

Federal Status	State Status	CRPR
None	SE	1B.1

Photo by Robert Potts, 2001

6.14.2 Distribution

6.14.2.1 General distribution

Roderick's fritillary is known from approximately 12 sites within the Saunders Reef, Philo, Boonville, Laughlin Range, and Fort Bragg quadrangles in Mendocino and Sonoma counties (CNPS 2006). All of the Sonoma County occurrences were introduced from plants salvaged in

Mendocino County; none of these introductions has led to successful establishment (CNDDB 2005). Of the 8 known occurrences in Mendocino County, 5 are native and 3 are introduced. From the Point Arena Quadrangle, 1 native occurrence is thought to be extirpated. The native population in Boonville's Evergreen Cemetery had several hundred plants in 2004. A second population, which is on private land with a portion in a CalTrans right-of-way, was partially destroyed during work to improve State Hwy 1; some plants were transplanted in 1985 during construction, none of which survived. CalTrans now works to avoid impacts to the remaining plants within its right-of-way at this location. A third population, first reported in 1992 from private land in the Saunders Reef Quadrangle, had 1000 plants in 1992 but declined sharply by 1998 (CNDDB 2005). The most recent CDFG information from the fourth population dates from 1991, when 10 plants were observed (CDFG 2001). In Mendocino County, 3 populations are introduced: 2 in the Gualala Quadrangle and 1 on private land in the Saunders Reef Quadrangle (CNDDB 2006).

6.14.2.2 Plan area

Roderick's fritillary has not been found in the plan area; however, the plan area extends into quadrangles where there are reported occurrences of this species.

6.14.3 Description and life history

Roderick's fritillary, a member of the lily family (Liliaceae), is a slender perennial that arises from a bulb, with narrow strap-like leaves, and nodding, greenish-brown to purplish-brown flowers (Hickman 1993). The blooming period is from March through May (CNPS 2006).

6.14.4 Habitat requirements

Roderick's fritillary occurs in heavy clay soils in oak woodland, valley foothill grassland, coastal bluff scrub, and coastal prairie habitats, at elevations from ±48-384 ft (15-120 m) (CNPS 2006).

6.14.5 Threats

Threats to Roderick's fritillary include road maintenance, residential development, grazing, and erosion (CNPS 2006).

6.14.6 Population trend

Population levels of Roderick's fritillary are declining (CDFG 2001).

6.15 Pacific Gilia (*Gilia capitata* ssp. *pacifica*)

6.15.1 Conservation status

Federal Status	State Status	CRPR
None	None	1B.2

Photo from CA Academy of Sciences

6.15.2 Distribution

6.15.2.1 General distribution

Pacific gilia occurs along the Pacific Coast of California and Oregon. In California, this plant has been documented within Del Norte, Humboldt, and Mendocino counties. Occurrences have been reported from Point Arena, Elk, Albion, Mendocino, Fort Bragg, Bear Harbor, and Willits quadrangles within Mendocino County (CNPS 2006, CNDDB 2005). From California, 30 occurrences are currently known, of which 17 are based on records older than 20 years; the current status of these occurrences is unknown (CNDDB 2005). On commercial timberlands in Humboldt County, 8 new occurrences have been found since 2003 (CNDDB 2005).

6.15.2.2 Plan area

Pacific gilia has not been found in the plan area; however, the plan area extends into quadrangles where there are reported occurrences of this species.

6.15.3 Description and life history

Pacific gilia is an annual herb in the phlox family (Polemoniaceae). Its stems are branched, with twice-pinnate leaves. Inflorescences are terminal spheric heads with 50-100 pale-to-bright blue-violet flowers (Hickman 1993) that bloom from May to August (CNPS 2006).

6.15.4 Habitat requirements

This species occurs in coastal bluff scrub and coastal prairie habitats at elevations from 15-900 ft (5-300m) (CNPS 2006).

6.15.5 Threats

Threats to Pacific gilia include development, recreational activities, and logging (CNPS 2006, CNDDB 2005).

6.15.6 Population trend

The population trend for pacific gilia is unknown.

6.16 Glandular Western Flax (*Hesperolinon adenophyllum*)

6.16.1 Conservation status

Federal Status	State Status	CRPR
None	None	1B.2

Photo by John Game, 2002

6.16.2 Distribution

6.16.2.1 General distribution

Glandular western flax is endemic to California and is known only from Lake and Mendocino counties. Historically, this plant was known from Humboldt County where today the species is thought to be extirpated (CNPS 2006). In Mendocino County, occurrences have been reported from Highland Springs, Van Arsdale Reservoir, Cow Mountain, Redwood Valley, Potter Valley,

Willits, Burbeck, Greenough Ridge, Sanhedrin Mountain, and Longvale quadrangles (CNPS 2001, CNDDB 2005). Approximately 40 extant occurrences are known for this species, of which 22 are historic and have not been relocated for 20 or more years (CNPS 2006, CNDDB 2005).

6.16.2.2 Plan area

Glandular western flax has not been found in the plan area.

6.16.3 Description and life history

Glandular western flax is an annual herb in the dwarf flax family (Linaceae). Plants reach 4-20 in. (10-50 cm) in height. The leaves are whorled or opposite below and alternate above, lanceolate, keeled, and clasping, with margins that have 1 or 2 rows of gland-tipped teeth. Inflorescences are generally open cymes with yellow flowers that are often veined or tinged orange (Hickman 1993); blooming time is from May to August (CNPS 2006).

6.16.4 Habitat requirements

Glandular western flax occurs on serpentine substrates within valley and foothill grassland, cismontane woodland, and chaparral habitats at elevations from 450-3945 ft (150-1,315 m) (CNPS 2006).

6.16.5 Threats

Threats to glandular western flax include geothermal development, recreation, and grazing (CNPS 2006).

6.16.6 Population trend

The population trend for this species is unknown.

6.17 Thin-lobed Horkelia (*Horkelia tenuiloba*)

6.17.1 Conservation status

Federal Status	State Status	CRPR
None	None	1B.2

Photo by Doreen L. Smith, 1994

6.17.2 Distribution

6.17.2.1 General distribution

Thin-lobed horkelia occurs only in coastal northern California within Marin, Sonoma, and Mendocino counties. In Mendocino County, occurrences have been reported from McGuire Ridge, Willis Ridge, Point Arena, Saunders Reef, and Gualala quadrangles (CNPS 2006, CNDDB 2005). In California, 27 occurrences for this species are known; several are based on herbarium collections that predate 1960, and are from sites that lack current information (CNDDB 2005).

6.17.2.2 Plan area

Thin-lobed horkelia has not been found in the plan area; however, the plan area extends into quadrangles where there are reported occurrences of this species.

6.17.3 Description and life history

Thin-lobed horkelia is a loosely matted perennial herb within the rose family (Rosaceae). Plants are green to reddish in color with appressed hairy herbage. The leaves are pinnately dissected with 8-15 narrow and deeply lobed, crowded leaflets per side. The inflorescence is a dense or open cyme with few-to-many white flowers (Hickman 1993) that bloom from May to July (CNPS 2006).

6.17.4 Habitat requirements

Thin-lobed horkelia occurs in sandy soils and mesic openings within coastal scrub, chaparral, and broadleaved upland forest habitats at elevations from 150-1500 ft (50-500m) (CNPS 2006, CNDDB 2005).

6.17.5 Threats

Threats to thin-lobed horkelia include invasive pest plants, trail maintenance, and development (CNDDB 2005).

6.17.6 Population trend

The population trend for thin-lobed horkelia is unknown.

6.18 Hair-leaved Rush (*Juncus supiniformis*)

6.18.1 Conservation status

Federal Status	State Status	CRPR
None	None	2.2

Photo by Kerry Dressler

6.18.2 Distribution

6.18.2.1 General distribution

Hair-leaved rush occurs in California, as well as other states. In California, the species is in Del Norte, Humboldt, and Mendocino counties. In Mendocino County, the species has been reported from Mendocino and Fort Bragg quadrangles (CNPS 2006). Mendocino County occurrences are all historic; herbarium specimens verifying these occurrences were collected in 1866 and 1937 (CalFlora 2005). The location data on the herbarium specimens is not specific enough for the CNDDB to map these occurrences or to determine the exact number of locations where this species has been found. Herbarium specimen data indicate this species has been found in 2-4 separate locations in Mendocino County (Jepson Online Interchange 2006).

6.18.2.2 Plan area

Hair-leaved rush has not been found in the plan area; however, the plan area extends into Mendocino Quadrangle where there are reported occurrences of this species.

6.18.3 Description and life history

Hair-leaved rush is a rhizomatous perennial herb in the rush family (Juncaceae). When young, this herb is a submerged aquatic species and grows to be a caespitose plant reaching 3.2-16 in. (8-40 cm) in height with matted rhizomes that are slender and spreading. The stem nodes often root, giving rise to new plantlets. Erect flower stems appear as the water recedes. Submerged leaves are often hair-like and membranous; cauline leaves are cylindrical with crosswalls that are complete but obscure. Inflorescences are terminal with 2-6 clusters of 3-9 flowers (Hickman 1993) that bloom from April to June (CNPS 2006).

6.18.4 Habitat requirements

Hair-leaved rush occurs in wetlands such as freshwater marsh, swamp, bog, and fen habitats along the coast at elevations from 60-300 ft (20-100 m) (CNPS 2006). As an obligate (OBL) wetland species, hair-leaved rush has at least a 99% likelihood of occurring in wetlands (Reed 1988, USFWS 1997d).

6.18.5 Threats

Specific threats to hair-leaved rush are unknown.

6.18.6 Population trend

The population trend for this species is unknown.

6.19 Coast Lily (*Lilium maritimum*)

6.19.1 Conservation status

Federal Status	State Status	CRPR
None	None	1B.1

Photo by Br. Alfred Brousseau

6.19.2 Distribution

6.19.2.1 General distribution

Coast lily is endemic to California occurring only in Mendocino, Sonoma, Marin, and possibly San Francisco counties. Historical occurrences of this species were from San Mateo Quadrangle, where the species is thought to be extirpated (CNPS 2006). In Mendocino County, there are reported occurrences from Eureka Hill, Point Arena, Saunders Reef, Gualala, Elk, Albion, Noyo Hill, Mathison Peak, Comptche, Fort Bragg, Mendocino, Westport, and Inglenook quadrangles (CNPS 2006, CNDDB 2005). Of the 66 reported occurrences for coast lily, 13 are historic (CNDDB 2005).

6.19.2.2 Plan area

Table 6-7 shows the occurrence of coast lily in the plan area; however, the plan area extends into most of the quadrangles where there are reported occurrences of this species.

Table 6-7 Coast Lily in the Plan Area

Project	NDDB OCC #	USGS Quad	Watershed and Inventory Block	Year Found	# Plants	Habitat
1-06-211 MEN	n/a	Gualala	Rolling Brook Garcia	2007	≅ 5-10	CCFrs
Shively, R. (OBS)	n/a	Cold Spring	Lower Alder Creek South Coast	2007	2-3	NCFrs – drafting site
Shively, R. (OBS)	n/a	Cold Spring	Lower Alder Creek South Coast	2007	3-4	NCFrs – below existing road

6.19.3 Description and life history

Coast lily is a bulbiferous perennial herb in the lily family (Liliaceae). Plants reach 1-8 ft (0.3-2.7m) in height, and have linear leaves in whorls or scattered along the stems. The nodding flowers are bell-shaped and the sepals and petals are reflexed or rolled back about 1/3 to 1/2 the length of the corolla (Skinner 2004). The flowers are orange-to-reddish with maroon spots concentrated on the mid-to-basal portions of the flowers (Hickman 1993). This species blooms from May to July (CNPS 2006).

6.19.4 Habitat requirements

Coast lily occurs in broadleaved upland forest, freshwater marshes and swamps, closed-cone coniferous forest, coastal prairie, coastal scrub, and North Coast coniferous forest habitats at elevations from 15-1005 ft (5-335 m), typically within 1-2 miles of the coast. Coast lily is a facultative wetland (FACW) species.

6.19.5 Threats

Threats to coast lily include roadside and trail maintenance, urbanization, horticultural collecting, habitat fragmentation, timber harvesting, prescribed burning, and grazing by deer (CNPS 2006, CNDDB 2005).

6.19.6 Population trend

The population trend for this species is unknown.

6.19.7 Mendocino lighting complex (2008)

Lightning fires impacted 2 of the 4 known sites on MRC property with coast lilies. Both sites were in bishop pine/pygmy habitat in the vicinity of “brushy opening” on the South Coast inventory block; the Mallo Pass fire burned approximately 6 coast lily plants. There were no direct impacts from suppression efforts, like fire line construction. The 2 impacted sites represent 100 % of the known coast lilies on the South Coast and 67% of the known coast lilies on MRC property. An MRC botanist will re-visit the sites during the blooming period in 2009 to determine the severity of the fire impacts.

6.20 Baker's Meadowfoam (*Limnanthes bakeri*)

6.20.1 Conservation status

Federal Status	State Status	CRPR
None	SR	1B.1

Illustration from CDFG HCP Branch

6.20.2 Distribution

6.20.2.1 General distribution

Baker's meadowfoam is endemic to Mendocino County. There are approximately 20 reported occurrences from Laytonville, Covelo East, Ukiah (extirpated), Willits, and Mina quadrangles; all are on private land (CNPS 2006, CDFG 2001, CNDDB 2005).

6.20.2.2 Plan area

Baker's meadowfoam has not been found in the plan area; however, the plan area extends into the Ukiah Quadrangle where this species, found in 1993, is now extirpated (CNDDB 2005).

6.20.3 Description and life history

Baker's meadowfoam is an herbaceous annual in the false mermaid family (Limnanthaceae) with dissected leaves and funnel-shaped flowers that are white or creamy yellow (Hickman 1993). Its blooming period is from April through May (CNPS 2006).

6.20.4 Habitat requirements

Baker's meadowfoam occurs in seasonally saturated or inundated clay soil in low swales, meadows, vernal pools, valley foothill grassland, roadside ditches, and along margins of marshy areas, at elevations from 560-2912 ft (175-910 m) (CNPS 2006). As an obligate (OBL) wetland species, Baker's meadowfoam has at least a 99% likelihood of occurring in wetlands (Reed 1988, USFWS 1997d).

6.20.5 Threats

Threats to Baker's meadowfoam include grazing, development, and road construction; however, meadowfoam populations appear to tolerate light disturbance from farming equipment or grazing (CNDDB 2005). Apparently, the greatest threats to this species are alteration of local drainage patterns and removal of standing water for agriculture and residential development (CDFG 2001).

6.20.6 Population trend

The population trend for Baker's meadowfoam is one of stability to decline (CDFG 2001).

6.21 Running-pine (*Lycopodium clavatum*)

6.21.1 Conservation status

Federal Status	State Status	CRPR
None	None	4.1

Photo from Lakehead Forestry

6.21.2 Distribution

6.21.2.1 General distribution

Running-pine occurs in California, Oregon, and Washington, as well as throughout the United States. In California, the species occurs from Sonoma, Mendocino, and Humboldt counties (CNPS 2006, CNDDB 2005). Most of the 120 known occurrences in California are recent records from commercial timberlands in Humboldt County (CNDDB 2005). From Mendocino County, within the Noyo Hill Quadrangle (CNDDB 2005), there are 4 report occurrences. In Sonoma County, there is 1 occurrence from McGuire Ridge Quadrangle (CNDDB 2005).

6.21.2.2 Plan area

Running-pine has not been found in the plan area; however, the plan area extends into Noyo Hill and McGuire Ridge quadrangles where there are reported occurrences of this species.

6.21.3 Description and life history

Running-pine is a rhizomatous herb in the club-moss family (Lycopodiaceae). The species is not a flowering plant. Plants are creeping to vine-like and occur on bare soil, downed logs, or other plants. Stems are branched and often forked unequally. Leaves are spirally arranged, small and needle-like or scale-like. The cones are terminal on erect stems (Hickman 1993) and are present from July to August (CNPS 2006).

6.21.4 Habitat requirements

Running-pine occurs in mesic areas within North Coast coniferous forest, as well as freshwater marsh and swamp habitats at elevations from 180-2370 ft (60-790 m) (CNPS 2001). The species also grows in wet inboard ditches along logging roads.[5] Running-pine is a facultative (FAC) plant species.

6.21.5 Threats

Threats to running-pine include logging (CNDDB 2005, CNPS 2006).

6.21.6 Population trend

The population trend for running-pine is unknown.

[5] Personal communication from T. Sholars (College of the Redwoods, Fort Bragg, CA) to Ann Howald (MRC consultant) August 2004

6.22 Mendocino Bush Mallow (*Malacothamnus mendocinensis*)

6.22.1 Conservation status

Federal Status	State Status	CRPR
None	None	1A

6.22.2 Distribution

6.22.2.1 General distribution

Mendocino bush mallow is known from only 2 historical collections (1937 & 1939) within Elledge Peak and Boonville quadrangles in Mendocino County (CNPS 2001, CNDDB 2005). Intensive field surveys to relocate this species have been unsuccessful; the species is currently considered extinct (CNPS 2006, CNDDB 2005).

6.22.2.2 Plan area

Mendocino bush mallow has not been found in the plan area; however, the plan area extends into Boonville Quadrangle where there is an historic occurrence.

6.22.3 Description and life history

Mendocino bush mallow is a deciduous shrub within the mallow family (Malvaceae). The shrub has sparse to densely hairy herbage. Leaves are generally round and thin with upper surfaces that are sparsely hairy. Inflorescences are spike-like to openly panicle-like with clusters of many pale pinkish-purple flowers (Hickman 1993) that bloom from May to June (CNPS 2006).

6.22.4 Habitat requirements

This species occurs in cismontane woodland habitats at elevations from 1275-1725 ft (425-575 m).

6.22.5 Threats

Threats to Mendocino bush mallow include road-widening that may destroy historical sites where this species was known to occur (CNDDB 2005).

6.22.6 Population trend

Mendocino bush mallow is presumed extinct (CNDDB 2005).

6.23 Seacoast Ragwort (*Packera bolanderi* var. *bolanderi*)

6.23.1 Conservation status

Federal Status	State Status	CRPR
None	None	2.2

Photo by Maralyn Renner, 2005

6.23.2 Distribution

6.23.2.1 General distribution

Seacoast ragwort occurs in California, Oregon, and Washington. In California, there are approximately 22 occurrences in Del Norte, Humboldt, and Mendocino counties—12 of these have been found on commercial timberland since 2004 (CNDDB 2005). Within the Mendocino Quadrangle, there is 1 reported occurrence, based on a 1921 herbarium specimen (CNPS 2001).

6.23.2.2 Plan area

Seacoast ragwort has not been found in the plan area; however, the plan area extends into Mendocino Quadrangle where there is an historic occurrence of this species.

6.23.3 Description and life history

Seacoast ragwort is a rhizomatous perennial herb in the sunflower family (Asteraceae) with 1 or more erect stems that reach 4-24 in. (10-60 cm) in height. The herbage mostly lacks hairs; the leaves are basal and found in reduced forms along the stems. The basal leaves are thin (fleshy near the coast) in texture with heart-shaped blades and long petioles. The blades are shallowly, palmately lobed; each lobe is toothed or angled. Cauline leaves are similar to basal leaves yet become smaller and more pinnately dissected further up the stems. The inflorescence is a compact cyme with individual flower heads that consist of yellow disk and ray flowers (Hickman 1993) that bloom from June to July (CNPS 2006).

6.23.4 Habitat requirements

Seacoast ragwort occurs in coastal scrub and North Coast coniferous forest at elevations from 98-2132 ft (30-650 m) (CNPS 2006).

6.23.5 Threats

Threats to seacoast ragwort include trail use and road maintenance (CNDDB 2005).

6.23.6 Population trend

The population trend for this species is unknown.

6.24 Bolander's Beach Pine (*Pinus contorta* ssp. *bolanderi*)

6.24.1 Conservation status

Federal Status	State Status	CRPR
None	None	1B.2

Photo by Halleh Paymard, 2002

6.24.2 Distribution

6.24.2.1 General distribution

Bolander's beach pine is endemic to Mendocino County, occurring in Elk, Albion, Noyo Hill, Mathison Peak, Fort Bragg, and Mendocino quadrangles (CNPS 2006, CNDDB 2005). In

California, there are 28 reported occurrences of Bolander's beach pine (CNDDB 2005); many of these are based on distribution maps by Sholars and Barrows (1983).

6.24.2.2 Plan area

Table 6-8 shows the occurrence of Bolander's beach pine in the plan area. Moreover, the plan area extends into other quadrangles where this species occurs.

Table 6-8 Bolander's Beach Pine in the Plan Area

Project	NDDB OCC #	USGS Quad	Watershed and Inventory Block	Year Found	# Plants	Habitat
n/a	n/a	Mathison Peak	Lower Albion Albion	2007	several	CCFrs (pygmy)
n/a	n/a	Elk	Lower Albion Albion	2007	several	CCFrs (pygmy)

6.24.3 Description and life history

Bolander's beach pine is a small evergreen tree in the pine family (Pinaceae). The trees reach less than 7 ft (<2 m) in height and have scaly thin bark. Leaves are needle-like with two per bundle. The cones are small and asymmetrical; they remain closed on the stems for many years (Hickman 1993).

6.24.4 Habitat requirements

Bolander's beach pine is restricted to podzolized soils within closed-cone coniferous forest at elevations from 225-750 ft (75-250 m) (CNPS 2002). This tree is often associated with pygmy cypress and bishop pine within Mendocino Pygmy Forest (Holland 1986). Bolander's beach pine is a facultative (FAC) plant species.

6.24.5 Threats

Threats to Bolander's beach pine include residential development; off-road vehicles; trash dumping; road construction and maintenance; and logging (CNDDB 2005).

6.24.6 Population trend

The population trend for Bolander's beach pine is unknown.

6.25 White-Flowered Rein Orchid (*Piperia candida*)

6.25.1 Conservation status

Federal Status	State Status	CRPR
None	None	1B.2

Photo by Tabi Bolton, 2008

6.25.2 Distribution

6.25.2.1 General distribution

White-flowered rein orchid is known to occur throughout northwestern California, Oregon, Washington, Alaska, and British Columbia. In California, this species has been reported from Santa Cruz, San Mateo, Santa Clara, Sonoma, Del Norte, Humboldt, Mendocino, Siskiyou and Trinity Counties (CNDDB 2008). In Mendocino County this orchid is known to occur in the Philo, Comptche, Sherwood Peak, Laytonville, Piercy and Noble Butte Quadrangles (CNDDB 2008).

6.25.2.2 Plan area

Table 6-9 shows the occurrences of white-flowered rein orchid in the plan area. The plan area extends into quadrangles where there are known occurrences.

Table 6-9 White-Flowered Rein Orchid in the Plan Area

Project	NDDB OCC #	USGS Quad	Watershed and Inventory Block	Year Found	# Plants	Habitat
1-06-140MEN	n/a	Eureka Hill	Rolling Brook Garcia	2007	2	NCFrs
Hollow Tree Creek Watershed Restoration Project – Phase IV	n/a	Leggett	Rockport Middle Hollow Tree	2007	1	NCFrs

6.25.3 Description and life history

White-flowered rein orchid is a perennial herb in the orchid family (Orchidaceae). The leaves are basal, 7-18 cm long and 12-30 mm wide. The inflorescence ranges from 7 to 30 cm and is generally one sided and open. The upper flower sepal is pointed forward and colored white or green with white margins. The lower sepals are white with a mid-vein green and the lip is 1.5 - 3.5 mm, narrowly triangular, recurved toward spur, and white. The spur is 1.5 - 3.5 mm and pointed down. According to the description in the Flora of North America, this species has flowers which are whiter and more ephemeral than other species in the genus.[6]

6.25.4 Habitat requirements

White-flowered rein orchid prefers open to shaded sites within broadleaved upland forests, lower montane coniferous forests, and north coast coniferous forests. The species occurs at elevations ranging from 100 to 4300 ft. (30-1310 m).

6.25.5 Threats

Threats to white-flowered rein orchid include damage from timber operations such as road construction and maintenance, log skidding, and slash piling (CNDDB, 2008).

6.25.6 Population trend

The population trend for white-flowered rein orchid is unknown.

[6] http://hua.huh.harvard.edu/FNA/volumes.shtml, last revised 07/18/07, last accessed 9/8/2009.

6.26 North Coast Semaphore Grass (*Pleuropogon hooverianus*)

6.26.1 Conservation status

Federal Status	State Status	CRPR
None	ST	1B.1

Photo by Bart Eisenberg, 2001

6.26.2 Distribution

6.26.2.1 General distribution

North Coast semaphore grass is endemic to California. There are 17 reported occurrences of the species in approximately 8 disjunct locations on private land in Mendocino, Marin, and Sonoma counties. New locations of this species found in the plan area in 2006 will likely result in the addition of at least 2 new occurrences to CNDDB. The estimated total area of occupied habitat within all 3 counties is 14-18 acres (CDFG 2002). North Coast semaphore grass has been recorded from Hopland, Elledge Peak, Orrs Springs, Boonville, Willits, Comptche, Laytonville, Longvale, and Cahto Peak quadrangles (CNPS 2006, CNDDB 2005); the species is possibly extirpated from the Comptche and Cahto Peak locations (CNDDB 2005).

6.26.2.2 Plan area

Table 6-9 shows the occurrences of North Coast semaphore grass in the plan area. Some of these are the easternmost known locations for this species. The plan area extends into the Comptche quadrangle where there are reported occurrences of this species.

Table 6-9 North Coast Semaphore Grass in the Plan Area

North Coast Semaphore Grass in the Plan Area						
Project	**NDDB OCC#**	**USGS Quad**	**Watershed and Inventory Block**	**Year Found**	**# Plants**	**Habitat**
1-00-436 MEN	22	Orrs Springs	Upper Ackerman Creek Ukiah	2001	>10,000	NCFrs and VFGrs – springs, seeps, and vernal pool
1-01-032 MEN	21	Orrs Springs	Upper Ackerman Creek Ukiah	2001	10	NCFrs and VFGrs – class III watercourse
1-01-032 MEN	23	Orrs Springs	Upper Ackerman Creek Ukiah	2001	2	NCFrs and VFGrs – moist roadside area
Hovland, P. (OBS)	25	Orrs Springs	Upper Ackerman Creek Ukiah	2002	2000	NCFrs and VFGrs – moist roadside area

North Coast Semaphore Grass in the Plan Area						
Project	**NDDB OCC#**	**USGS Quad**	**Watershed and Inventory Block**	**Year Found**	**# Plants**	**Habitat**
Ramaley, J. (OBS)	26	Orrs Springs	Upper Ackerman Creek Ukiah	2006	200	NCFrs and VFGrs – mesic grassland area
1-06-180 MEN	27	Orrs Springs	Upper Ackerman Creek Ukiah	2006	7050	NCFrs and VFGrs – roads, hillside bench, mesic grasslands,
Ramaley, J. (OBS)	28	Orrs Springs	Upper Ackerman Creek Ukiah	2006	1500	NCFrs and VFGrs – mesic grassland near Class III headwaters

6.26.3 Description and life history

North Coast semaphore grass is a rhizomatous perennial in the grass family (Poaceae). The species has long flat ribbon-like leaves, which are often drooping. Flowering stems are erect and reach heights of more than 36 in. (90 cm). The inflorescences, which have 7-9 widely spaced linear spikelets, are terminal, unbranched, and nodding (Hickman 1993). This species blooms from April to June (CNPS 2006).

6.26.4 Habitat requirements

North Coast semaphore grass occurs in mesic sites within broadleaved upland forest, meadow, North Coast coniferous forest, vernal pools, and freshwater marsh and swamp habitats at elevations from 32-2032 ft (10-635 m) (CNPS 2006). North Coast semaphore grass is a facultative wetland (FACW) plant species.

6.26.5 Threats

Threats to North Coast semaphore grass include habitat modification, roadside maintenance practices, competition of non-native species, grazing, trampling, and disruption of natural hydrological conditions (CDFG 2002).

6.26.6 Population trend

Recent discoveries of new occurrences of North Coast semaphore grass in the plan area may result in a change in overall population trend, which has been reported as declining (CDFG 2002).

6.27 Great Burnet (*Sanguisorba officinalis*)

6.27.1 Conservation status

Federal Status	State Status	CRPR
None	None	2.2

6.27.2 Distribution

6.27.2.1 General distribution

Great burnet occurs in California, Oregon, Washington, and elsewhere in the United States. In California, the species occurs along the North Coast within Del Norte, Humboldt, and Mendocino counties. There are approximately 11 occurrences within California, including 7 in Mendocino County (Smith and Wheeler 1991, CNDDB 2005, Jepson Online Interchange 2006), within Ukiah, Albion, Mendocino, Elk, Longvale, Laytonville, and Cahto Peak quadrangles (CNPS 2006, CNDDB 2005).

6.27.2.2 Plan area

Great burnet has not been found in the plan area; however, the plan area extends into quadrangles where this species occurs.

6.27.3 Description and life history

Great burnet is a rhizomatous perennial herb in the rose family (Rosaceae). Plants are creeping and stems are 20-56 in. (50-140 cm) in height. The basal leaves are 1-pinnate with 3-6 leaflets per side that are evenly lobed or toothed. Inflorescences are spike or head-like with many (>20) dark purplish flowers (Hickman 1993) that bloom from July to October (CNPS 2006).

6.27.4 Habitat requirements

Great burnet occurs in mesic sites, such as meadows, marshes, seeps, bogs, fens, and riparian areas, on serpentine substrates, sometimes within broadleaved upland forest and North Coast coniferous forest, at elevations from 180-4200 ft (60-1400 m) (CNPS 2001). As a facultative wetland (FACW) species, great burnet has a 67-99% likelihood of occurring in wetland habitats (Reed 1988, USFWS 1997d).

6.27.5 Threats

Threats to great burnet include erosion from logging (CNDDB 2005).

6.27.6 Population trend

The population trend for this species is unknown.

6.28 Maple-Leaved Checkerbloom (*Sidalcea malachroides*)

6.28.1 Conservation status

Federal Status	State Status	CRPR
None	None	4.2

Photo by Lindsay Herrera, 2001

6.28.2 Distribution

6.28.2.1 General distribution

Maple-leaved checkerbloom occurs in California and in Oregon, where it is thought to be extirpated and is state-listed as endangered. There are more than 200 occurrences of maple-leaved checkerbloom in California (CNDDB 2005), from Del Norte, Humboldt, Mendocino, Monterey, Santa Clara, Santa Cruz, and Sonoma counties. More than 50 occurrences of this species have been identified within privately managed timberlands in Humboldt and Mendocino counties since 1995 (CNDDB 2005). In Mendocino County, this species occurs within Navarro, Point Arena, Gualala, Mallo Pass Creek, Albion, Noyo Hill, Comptche, Dutchmans Knoll, Westport, Inglenook, and Bear Harbor quadrangles (CNPS 2006, CNDDB 2005).

6.28.2.2 Plan area

Table 6-10 shows the occurrences of maple-leaved checkerbloom in the plan area, documented from the CNDDB (2005) as well as from observations of MRC staff. The plan area extends into Albion, Comptche, Gualala, Mallo Pass Creek, and Noyo Hill quadrangles, where this species also occurs.

Table 6-10 Maple-leaved Checkerbloom in the Plan Area

Project	NDDB OCC#	USGS Quad	Watershed and Inventory Block	Year Found	# Plants	Habitat
Swingle, T (OBS)	140	Westport	Cottoneva Creek Rockport	2001	13	NCFrs – road side
1-01-113 MEN	n/a	Saunders Reef	Point Arena Creek Garcia	2001	6	NCFrs – road
1-03-110 MEN	n/a	Westport	Cottoneva Creek Rockport	2003	80	NCFrs – road side
1-04-261 MEN	n/a	Mallo Pass Creek	Mallo Pass Creek South Coast	2004	11	NCFrs – road side
1-05-121 MEN	n/a	Navarro	Navarro River Navarro West	2005	3	NCFrs – landing
1-07-039 MEN	n/a	Westport	Juan Creek Rockport	2007	70	NCFrs (coastal) roadside

6.28.3 Description and life history

Maple-leaved checkerbloom is a stout woody perennial sub-shrub in the mallow family (Malvaceae). Plants are bristly throughout and reach 1-5 ft (4-15 dm) in height. Leaf blades are grape-leaf-like and coarsely crenate. Inflorescences are dense and spike-like with small white 5-pedaled flowers subtended by prominent bracts (Hickman 1993). The blooming period for this species is from April through August (CNPS 2006).

6.28.4 Habitat requirements

Maple-leaved checkerbloom occurs in disturbed areas within broadleaved upland forest, coastal prairie, coastal scrub, and North Coast coniferous forest habitats at elevations from 6-2100 ft (2-700 m) (CNPS 2006).

6.28.5 Threats

Threats to maple-leaved checkerbloom include timber harvest, road maintenance, competition with surrounding vegetation, and herbivory (CNDDB 2005).

6.28.6 Population trend

The population trend for maple-leaved checkerbloom is unknown.

6.28.7 Mendocino lighting complex (2008)

Fire suppression activities, including road grading and widening, impacted the majority of the maple-leaved checkerbloom in the Juan Creek drainage. This occurrence accounted for 67% of the known checkerbloom individuals within MRC forestlands and 84% within the Rockport inventory block. An MRC botanist will re-visit the Juan Creek sites during the blooming period in 2009 to determine the severity of these impacts.

6.29 Purple-stemmed Checkerbloom (*Sidalcea malviflora* ssp. *purpurea*)

6.29.1 Conservation status

Federal Status	State Status	CRPR
None	None	1B.2

6.29.2 Distribution

6.29.2.1 General distribution

Purple-stemmed checkerbloom is endemic to California and occurs in Mendocino, Sonoma, San Mateo, and possibly Marin counties. In Mendocino County, the species occurs from Gualala, Point Arena, and Fort Bragg quadrangles (CNPS 2006, CNDDB 2005). Approximately 14 extant occurrences of purple-stemmed checkerbloom are known (CNDDB 2005).

6.29.2.2 Plan area

Purple-stemmed checkerbloom has not been found in the plan area; however, the plan area extends into quadrangles where this species occurs.

6.29.3 Description and life history

Purple-stemmed checkerbloom is a rhizomatous perennial herb in the mallow family (Malvaceae). Plants are purple-tinted and have decumbent hairy stems. Lower leaves are coarsely crenate and unlobed with bristly hairs on both surfaces. Inflorescences are dense-to-open with leaf-like lower bracts. Flowers are generally densely stellate and bristly with petals that are bright-to-deep pink with white veins (Hickman 1993). This species blooms from March to June (Jepson Online Interchange 2006).

6.29.4 Habitat requirements

Purple-stemmed checkerbloom occurs in broadleaved upland forest and coastal prairie habitats at elevations from 45-195 ft (15-65 m) (C CNPS 2006).

6.29.5 Threats

Threats to purple-stemmed checkerbloom include cattle grazing, trail maintenance, recreation, and competition from invasive pest plants (CNDDB 2005).

6.29.6 Population trend

The population trend for purple-stemmed checkerbloom is unknown.

6.30 Beaked Tracyina (*Tracyina rostrata*)

6.30.1 Conservation status

Federal Status	State Status	CRPR
None	None	1B.2

6.30.2 Distribution

6.30.2.1 General distribution

Beaked tracyina is endemic to California and occurs in Humboldt, Lake, Mendocino, and Sonoma counties. In Mendocino County, beaked tracyina occurs within Hopland and Purdys Gardens quadrangles (CNDDB 2005).

6.30.2.2 Plan area

Beaked tracyina has not been found in the plan area. Moreover, the plan area does not extend into quadrangles where beaked tracyina occurs. However, the *adjustment area* for this HCP/NCCP includes a portion of the range of this species.

6.30.3 Description and life history

Beaked tracyina is a slender annual herb in the sunflower family (Asteraceae). Plants are less than 14 in. (<35 cm) tall with smooth erect stems that are branched above. Leaves are alternate and narrowly lanceolate with hairy entire margins. Inflorescences are radiate heads that are terminal with greater than 22 flowers. Ray flowers are thread-like and inconspicuous; their color is greenish-yellow tinged reddish (Hickman 1993). This species blooms from May to June (CNPS 2002).

6.30.4 Habitat requirements

Beaked tracyina occurs in open grassy meadows within cismontane woodland and valley and foothill grassland at elevations from 30-1705 ft (90-520 m) (CNDDB 2005, CNPS 2006).

6.30.5 Threats

Threats to beaked tracyina include competition from invasive pest plants, a proposed transmission line, and grazing (CNDDB 2005).

6.30.6 Population trend

The population trend for beaked tracyina is unknown.

6.31 Santa Cruz Clover (*Trifolium buckwestiorum*)

6.31.1 Conservation status

Federal Status	State Status	CRPR
None	None	1B.1

6.31.2 Distribution

6.31.2.1 General distribution

Santa Cruz clover is endemic to California, occurring in Monterey, Santa Cruz, Sonoma, and Mendocino counties. In Mendocino County, there are 2 reported occurrences from 2006 on the Eureka Hill Quadrangle (CNDDB 2009).

6.31.2.2 Plan area

Santa Cruz clover has not been found in the plan area; however, the plan area extends into the Eureka Hill Quadrangle where this species occurs.

6.31.3 Description and life history

Santa Cruz clover is an annual herb in the pea family (Fabaceae). Stems are spreading to erect, and glabrous. Leaves are elliptic to obovate, finely serrate; stipules have many bristle-tipped teeth. Flowers are pink to white, in heads with bowl-shaped involucre; first heads are enclosed in stipules, seemingly cleistogamous (Hickman 1993). This species blooms from April to October (CNPS 2006).

6.31.4 Habitat requirements

Santa Cruz clover grows in moist grassy areas within broadleaved upland forest, cismontane woodland, and on coastal prairie margins, at elevations from 35-205 ft (105-610 m) (CNPS 2005).

6.31.5 Threats

Threats to Santa Cruz clover include land-clearing and non-native pest plants (CNPS 2006, CNDDB 2005).

6.31.6 Population trend

The population trend for this species is unknown.

6.32 Long-beard Lichen (*Usnea longissima*)

6.32.1 Conservation status

Federal Status	State Status	CRPR
None	None	Not Applicable

Photo from Lichens of North America, Yale University Press, 1998

6.32.2 Distribution

6.32.3 General distribution

Long-beard lichen occurs throughout the Northwest from California to Alaska (McCune 1997). The species is widespread, although declining, in northern Europe and Siberia (Brodo et al. 2001). Currently, there are more than 400 reported occurrences of long-beard lichen in California; most of these are recent reports from privately managed timberlands in Humboldt County (CNDDB 2005). There are also documented occurrences of this species within Mendocino, Sonoma, San Mateo, and Santa Clara counties (CNDDB 2005). In Mendocino County, long-beard lichen occurs within the Yorkville, Point Arena, Bear Harbor, Orrs Springs, Hales Grove, Dutchmans Knoll, Noble Butte, Noyo Hill, Leggett, Mathison Peak, Piercy and Elk quadrangles (CNDDB 2005).

6.32.3.1 Plan area

Table 6-11 shows the known occurrences of long-beard lichen in the plan area, documented from CDDDB (2005) as well as from observations of MRC staff.[7] The plan area extends into other quadrangles where this species also occurs.

Table 6-11 Long-beard lichen in the Plan Area

Long-beard lichen in the Plan Area						
Project	**NDDB OCC#**	**USGS Quad**	**Watershed and Inventory Block**	**Year Found**	**# of Host Trees**	**Habitat**
1-01-410 MEN	131	Mallo Pass Creek	Lower Elk Creek South Coast	2002	Several	NCFrs – ridgetop
1-02-059 MEN	120	Elk	Lower Albion River Albion	2002	20	NCFrs – ridgetop
1-02-277 MEN	140	Elk	Lower Albion River Albion	2002	25	NCFrs – ridgetop

[7] Emails from Elicia Goldsworthy (MRC) to Ann Howald (MRC consultant) from November 2005 to January 2006

Long-beard lichen in the Plan Area						
Project	**NDDB OCC#**	**USGS Quad**	**Watershed and Inventory Block**	**Year Found**	**# of Host Trees**	**Habitat**
1-02-304 MEN	n/a	Mallo Pass Creek	Mallo Pass Creek South Coast	2003	several	NCFrs – ridgetop
1-03-110 MEN	n/a	Westport	Cottoneva Creek Rockport	2003	50	NCFrs – ridgetop
Hollow Tree Creek Watershed Restoration Project – Phase I	n/a	Lincoln Ridge	Upper Hollow Tree Creek Rockport	2003	45	NCFrs – on Madrone and Douglas-fir
1-03-149 MEN	n/a	Eureka Hill	Rolling Brook Garcia	2004	3	NCFrs – ridgetop
1-04-237 MEN	n/a	Mallo Pass Creek	Lower Elk Creek South Coast	2005	15	NCFrs – ridgetop
1-04-264 MEN	n/a	Greenough Ridge	Rice Creek Big River	2007	>20	NCFrs – dispersed throughout post-harvest area
1-05-056 MEN	n/a	Mallo Pass Creek	Upper Elk Creek South Coast	2005	2	NCFrs – ridgetop
1-05-207 MEN	n/a	Elk	Flynn Creek Navarro West	2005	4	NCFrs – ridgetop
Goldsworthy, E. (OBS)	n/a	Elk	Big Salmon Creek Albion	2005	3	NCFrs – ridgetop
1-06-101 MEN	n/a	Elk & Navarro	South Fork Albion Albion	2006	several	NCFrs – ridgetop on Douglas fir
1-06-143 MEN	n/a	Greenough Ridge	Russell Brook Big River	2007	3-10	NCFrs – on Douglas-fir
1-06-223 MEN	n/a	Elk and Mathison Peak	South Fork Albion River Albion	2007	4	NCFrs – on redwood and Douglas-fir
1-07-117 MEN	n/a	Bailey Ridge	Little North Fork Navarro Navarro East	2007	3	NCFrs – ridgetop

6.32.4 Description and life history

Long-beard lichen is long, pendulous fruiticose lichen which reaches up to 6.5 ft (2 m) in length. The thallus (body) is pale-greenish or yellow-tinged, consisting of single, unbranched (or sparsely branched) central strands and numerous short, perpendicular lateral branchlets (Brodo et al. 2001). The cortex (outer layer) of the main branches scales-off and leaves a rough, dull surface (McCune 1997, Brodo et al. 2001).

6.32.5 Habitat requirements

Long-beard lichen occurs in the canopy of both conifers and hardwoods within North Coast coniferous forest and broadleaved upland forest habitats at elevations less than 2000 ft (<610 m) (CNDDB 2005).

6.32.6 Threats

Threats to long-beard lichen include air pollution, logging, and road-related disturbances (CNDDB 2005, McCune 1997). Long-beard lichen is one of the most pollution-sensitive lichens (Brodo et al. 2001).

6.32.7 Population trend

The population trend for this species is currently unknown.

6.33 Oval-leaved Viburnum (*Viburnum ellipticum*)

6.33.1 Conservation status

Federal Status	State Status	CRPR
None	None	2.3

Photo by
Br. Alfred Brousseau

6.33.2 Distribution

6.33.2.1 General distribution

Oval-leaved viburnum occurs in California, Oregon, and Washington. In California, there are at least 20 extant occurrences of oval-leaved viburnum (CNDDB 2005, Jepson Online Interchange 2006)—many consisting of fewer than 5 individuals. These reported occurrences are from Contra Costa, Fresno, El Dorado, Glenn, Humboldt, Mendocino, Napa, Shasta, and Sonoma counties (CNDDB 2005) There are 11 occurrences based on herbarium specimens from the 1940s and earlier (CNDDB 2005). In Mendocino County, oval-leaved viburnum occurs within Hopland, Purdys Gardens, Burbeck, Laytonville, Bell Springs, Leggett, and Tan Oak Park quadrangles (CNDDB 2005).

6.33.2.2 Plan area

Oval-leaved viburnum has not been found in the plan area; however, the plan area extends into Leggett Quadrangle where this species occurs.

6.33.3 Description and life history

Oval-leaved viburnum is a deciduous shrub in the honeysuckle family (Caprifoliaceae). The slender plants are generally hairy and glandular. Leaves are three-veined from the base, elliptic to round or cordate, and coarsely dentate (except base). Inflorescences are terminal flat-topped cymes with oblanceolate bracts. Flowers are deeply saucer-shaped and white (Hickman 1993). This species blooms from May to June (CNPS 2006).

6.33.4 Habitat requirements

Oval-leaved viburnum occurs in chaparral, cismontane woodland, and lower montane coniferous forest at elevations from 705-460 ft (215-1400m) (CNPS 2006).

6.33.5 Threats

Specific threats to this species are unknown.

6.33.6 Population trend

The population trend for oval-leaved viburnum is unknown.