Chapter 14

Changed and Unforeseen Circumstances

Contents

14 CHANGED AND UNFORESEEN CIRCUMSTANCES 14-1

14.1 Introduction 14-1

14.2 Changed Circumstances vs. Unforeseen Circumstances 14-1
14.2.1 Natural events 14-2
14.2.2 Economic events 14-2
14.2.3 Technological and scientific advances 14-2
14.2.4 Identifying changed and unforeseen circumstances 14-3
14.2.4.1 Changed circumstance 14-4
14.2.4.2 Unforeseen circumstance 14-4
14.2.5 Standard procedure for a changed circumstance 14-4
14.2.6 Step up in intensity 14-5

14.3 Fire 14-5
14.3.1 Effects of fire on forest stands 14-6
14.3.1.1 Redwoods 14-6
14.3.1.2 Douglas fir 14-7
14.3.1.3 Hardwoods (tanoak) 14-7
14.3.2 Effects of fire on terrestrial covered species 14-7
14.3.2.1 Marbled murrelet 14-7
14.3.2.2 Northern spotted owl 14-7
14.3.3 Effects of fire on aquatic systems 14-8
14.3.4 Effects of salvage harvests after a fire 14-8
14.3.5 Fire occurrence in the assessment area 14-9
14.3.6 Changed and unforeseen circumstances for fire 14-10
14.3.6.1 Changed circumstance 14-10
14.3.6.2 Unforeseen circumstance 14-10
14.3.7 MRC response to fire 14-10
14.3.7.1 Fire does not trigger a changed circumstance 14-10
14.3.7.2 Fire triggers a changed circumstance 14-12

14.4 Climate 14-14
14.4.1 Drought 14-14
14.4.1.1 Effects of drought 14-15
14.4.1.2 Changed and unforeseen circumstances for drought 14-15
14.4.1.3 MRC response to drought as a changed circumstance 14-16
14.4.1.4 MRC response to drought as an unforeseen circumstance 14-17
14.4.2 Climate change 14-17
14.4.2.1 Effects of climate change 14-17
14.4.2.2 Literature review for impacts of climate change 14-17
14.4.2.3 Changed circumstances for climate change 14-21
14.4.2.4 MRC response to climate change 14-21

14.5 Windthrow 14-22
14.5.1 Effects of windthrow 14-22
14.5.2 Changed and unforeseen circumstances for windthrow 14-23
14.5.2.1 Changed circumstance 14-23
14.5.2.2 Unforeseen circumstance 14-23
14.5.3 MRC response to windthrow 14-24
14.5.3.1 Windthrow does not trigger a changed circumstance 14-24
14.5.3.2 Windthrow triggers a changed circumstance 14-24

14.6 Earthquake *14-26*
14.6.1 Changed and unforeseen circumstances for earthquakes 14-27

14.7 Mass Wasting *14-27*
14.7.1 Effects of mass wasting 14-27
14.7.2 Changed and unforeseen circumstances for mass wasting 14-28
14.7.2.1 Changed circumstance 14-28
14.7.2.2 Unforeseen circumstance 14-28
14.7.3 MRC response to mass wasting 14-28
14.7.3.1 Mass wasting triggers a changed circumstance 14-28

14.8 Floods *14-30*
14.8.1 Effects of floods 14-30
14.8.2 Changed and unforeseen circumstances for flood 14-30
14.8.2.1 Changed circumstance 14-30
14.8.2.2 Unforeseen circumstance 14-31
14.8.3 MRC response to flood 14-31
14.8.3.1 Flood triggers a changed circumstance 14-31

14.9 Pathogens and pests *14-31*
14.9.1 Effects of pests and pathogens 14-33
14.9.2 Changed and unforeseen circumstances for pathogens and pests 14-34
14.9.2.1 Changed circumstance 14-34
14.9.2.2 Unforeseen circumstance 14-34
14.9.3 MRC response to pathogens and pests 14-35
14.9.3.1 Outbreak of pathogens or pests does not trigger a changed circumstance 14-35
14.9.3.2 Outbreak of pathogens or pests triggers a changed circumstance 14-35

14.10 Toxic Spills *14-37*

14.11 Species interactions *14-37*
14.11.1 Bullfrogs 14-37
14.11.1.1 Changed and unforeseen circumstances for bullfrogs 14-38
14.11.1.2 MRC response to bullfrogs 14-38
14.11.2 Wild pigs 14-39
14.11.2.1 Changed and unforeseen circumstances for wild pigs 14-39
14.11.2.2 MRC response to wild pigs 14-40
14.11.3 Barred owls 14-40
14.11.3.1 Changed circumstance 14-40
14.11.3.2 Unforeseen circumstance 14-40
14.11.3.3 MRC response to barred owls 14-41
14.11.4 Other species interactions 14-41
14.11.4.1 Changed and unforeseen circumstances for other species interactions 14-41
14.11.4.2 MRC response to other species interactions 14-41

14.12 New species listing *14-41*
14.12.1 MRC response to new species 14-42

14 CHANGED AND UNFORESEEN CIRCUMSTANCES

14.1 Introduction

MRC recognizes that, while we can minimize management disturbances to species habitat, we cannot eliminate natural disturbances. Forest stands in the Pacific Northwest are dynamic ecosystems subject to natural forces such as floods, wind, fire, landslides, drought, pathogens, and earthquakes. MRC designed the conservation measures of the HCP/NCCP to cope with natural disturbances that routinely occur, such as small fires and small mass wasting events.

Scientific models can simulate forest landscapes and, to a degree, predict the frequency and intensity of natural disturbances; however, they cannot predict the time and location of the disturbance—or the impact it will have on the environment. Natural disturbances may significantly alter stream and forest habitats, producing, in the process, both positive and negative effects. Awareness of the important role natural disturbances play in maintaining animal populations and habitat characteristics is growing (Agee 1997; Perry and Amaranthus 1997; Schowalter et al. 1997). As we understand our environment better, our plans for protecting, restoring, and enhancing it will change as well.

14.2 Changed Circumstances vs. Unforeseen Circumstances

After each natural disturbance, MRC will determine whether a changed or unforeseen circumstance has occurred. MRC considers a changed circumstance to be a reasonably foreseeable condition that could affect covered species or covered land. Conversely, an unforeseen circumstance is a condition that (1) was not foreseeable at the time of HCP/NCCP development; (2) affects species, habitat, natural communities or lands covered by our HCP/NCCP; and (3) results in a substantial adverse change in the status of one or more covered species.

As explained in the *Implementing Agreement*, under an approved HCP/NCCP the wildlife agencies will require MRC to respond to changed circumstances with measures already identified in our HCP/NCCP. However, as long as our HCP/NCCP is properly implemented, the wildlife agencies will not require MRC, without their consent, to respond to unforeseen circumstances by expending more money, setting aside additional land, or implementing new conservation measures. The relevant notice from the Federal Register (63 FR 8868) is as follows:

> If additional conservation and mitigation measures are deemed necessary to respond to unforeseen circumstances, the Services may require additional measures of the permittee where the conservation plan is being properly implemented, but only if such measures are limited to modifications within conserved habitat areas, if any, or to the conservation plan's operating conservation program for the affected species, and maintain the original terms of the conservation plan to the maximum extent possible. Additional conservation and mitigation measures will not involve the commitment of additional land, water or financial compensation or restrictions on the use of land, water (including quantity and timing of delivery), or other natural resources otherwise available for development or use under the original terms of the conservation plan, without the consent of the permittee.

14.2.1 Natural events

As much as possible, MRC anticipates natural disturbances based on historical patterns. For phenomena that have estimable intervals of recurrence based on past occurrences (e.g., floods, earthquakes, and fires), MRC can anticipate the probability of potential future events over a given time period. Although most of these events occur randomly in nature, some are more likely than others to occur over the 80-year term of our HCP/NCCP. We understand that such events are out of the ordinary and may require conservation measures that go above and beyond our standard conservation measures. For phenomena that occur with little or no estimate of recurrence (e.g., climate change and pathogen invasion), MRC must be more flexible and creative in developing and applying conservation measures. In fact, MRC cannot be certain whether these conservation measures will ever be needed or applied. At best, we will select triggers that alert us to the need to apply more than just the standard conservation measures to protect covered species and natural communities. Most natural events will not precipitate revised or additional conservation measures.

14.2.2 Economic events

Changed circumstances may result as well from economic conditions affecting the log market; from that market, MRC earns revenue to fund our HCP/NCCP. In 2009, the log market was down. According to Random Lengths, an independent company which issues market reports for the timber industry, the framing lumber composite price (FLPC) was down 27% (27 February 2009). FLPC is the average of all the prices for different framing lumber used in home construction across the United States.

The 2008 global financial crisis affected everything from Wall Street to Main Street; its aftermath may persist for several years. Alan Greenspan, former Chairman of the Federal Reserve (1987-2006), described the banking and housing meltdown as a “once-in-a-century credit tsunami.” Economic uncertainty and the collapse of the housing market resulted in a significant reduction in timber sales for MRC and others in the industry. MRC sales volume was down 40%. Due to the economic downturn, MRC downsized its employee base by 60% in May 2009. In the ensuing year, as the lumber business started to pick up again, MRC was able to re-hire staff. By 2nd quarter 2010, the redwood log market showed some signs of improvement.

The source of funding for MRC monitoring programs is primarily revenue from our timber harvest. Over the 80-year term of our HCP/NCCP, the projected harvest levels will increase as the forest and the economy continue to recover. When this occurs, MRC will increase its milling capacity and customer base. If the future brings another financial meltdown like that of 2008, MRC will once again reduce harvest levels, staffing, milling, monitoring, and road repairs. Harvest cutbacks will not eliminate all monitoring programs; in some cases, MRC will monitor less frequently until harvest levels rebound. As harvest activities slow down, so does road repair since it usually occurs in conjunction with harvest operations. However, MRC will continue to adhere to overall timelines, such as the 30-year deadline for treating 1,302,000 yd^3 of controllable erosion (O§8.3.2-6).

14.2.3 Technological and scientific advances

There have been many new technologies and scientific advances over the last 30 years that have given us new opportunities for managing a commercial forest. Among these are

- Helicopter yarding.
- Cloning.
- Genetic engineering.

- Pre-fabricated building-block materials for road construction.
- Remote sensing of topographic data (e.g., LIDAR).
- Chemicals for plant growth or plant retardation.
- Chemicals for fighting fires (e.g., Thermo-Gel).
- GIS programs for pinpointing the location of fires in their early stages.

John Deere Logging Spider

Already we can assess what some of their benefits and drawbacks are. However, there will always be new technologies coming out of academic and industrial research that, when employed, might lead to "changed circumstances" in the forest environment. Several years ago, a Finnish company, Plustech Oy, which was a John Deere subsidiary, unleashed a prototype for a walking machine. Some dubbed it the "logging spider" and saw in it a way to improve maneuverability in confined forest spaces and minimize impact to habitat. As it turned out, the hexapod machine never made it into production.

Generally with new technology, we apply it in a limited scope and over a period of evaluation so we can "test the waters" and avoid any major disaster. Clearly, management has to be judicious and do research and testing before adapting a new technology. Like doctors administering what should be healing drugs, they have to have some antidote in their pocket in case things go wrong.

MRC will develop a company plan for addressing new technology and scientific research to decide what is right for us and how we should step things out to be innovative but cautious at the same time. We will confer with the wildlife agencies and seek their feedback on technological advances that might adversely impact HCP/NCCP conservation measures, habitat for covered species, or covered natural communities.

14.2.4 Identifying changed and unforeseen circumstances

MRC identifies the conditions for a changed and unforeseen circumstance in cases of

- Fire.
- Drought.
- Windthrow.
- Mass wasting.
- Flood.
- Pathogens and pests.
- Bullfrogs.
- Wild pigs.
- Barred owls.
- Other species interactions, like feral dogs and catfish.

14.2.4.1 Changed circumstance

In the event that USFWS, CDFG, or NMFS believes that a changed circumstance may exist in the plan area, they will notify MRC and the other signatory wildlife agencies. If MRC or any of the wildlife agencies concludes that a changed circumstance does in fact exist, they will explain the reason for their conclusion and propose in writing an appropriate response in accordance with the timelines listed in section 14.2.5. MRC will meet with the wildlife agencies within 21 days of receiving a written request in order to discuss their proposed response to the changed circumstance. If MRC cannot reach agreement with the wildlife agencies, the wildlife agencies will select a response from the alternatives listed in section 14.2.5 and MRC will implement the response.

14.2.4.2 Unforeseen circumstance

Under the regulatory assurances of our HCP/NCCP, MRC is not responsible for unforeseen circumstances, but only for what is covered in the plan, which includes changed circumstances. If an unforeseen circumstance occurs, it is the responsibility of the wildlife agencies to address it. MRC will confer and cooperate with the wildlife agencies in their efforts to do so.

14.2.5 Standard procedure for a changed circumstance

MRC will follow the procedures detailed in sections 7.2 through 7.3.1 of the *Implementing Agreement* if we believe a changed circumstance may have occurred.

- MRC will notify the wildlife agencies, as soon as practicable, when we undertake an assessment of a possible changed circumstance.
- MRC will notify the wildlife agencies within 7 calendar days of the date we actually determine a changed circumstance has occurred.
- MRC will prepare a proposal based on the best available science at the time of the changed circumstance and after preliminary consultation with the wildlife agencies.
- MRC will submit to the wildlife agencies our proposal within 60 calendar days of determining a changed circumstance and request the wildlife agencies to submit their comments within 10 working days.
- MRC will address any comments of the wildlife agencies and negotiate any changes.
- MRC will specify implementation schedules for any additional measures in a prompt and reasonable time-frame.
- MRC will create, in consultation with the wildlife agencies, a final draft with any additional measures.
- MRC will submit the final draft to the wildlife agencies and request that the wildlife agencies acknowledge receipt and acceptance of the proposal.
- MRC will enter into dispute resolution if the wildlife agencies and MRC cannot agree on the proposed measures in the final draft (see Appendix A, *Implementing Agreement*).
- MRC will begin implementing the measures within 30 calendar days of creating the final draft.

MRC, in consultation with the wildlife agencies, can modify the timelines outlined above. The intent of the timelines is to strike a balance between “rush to action” and “contributory delays.” Rushing to action before essential information is available might cause unintended consequences. On the other hand, delaying action that could prevent further damage is irresponsible.

14.2.6 Step up in intensity

In subsequent sections of this chapter, MRC describes 2 conditions: (1) an event triggers a changed circumstance and 2) an event triggers an unforeseen circumstance. The events for condition 1 are subsumed under the events for condition 2. For example, a changed circumstance (condition 1) for a windstorm is a storm that results in windthrow of at least 10 ac in LACMA; an unforeseen circumstance (condition 2) for a windstorm is a storm that results in windthrow of at least 50 ac in LACMA. In this example, 50 ac is a “step up” from 10 ac.

14.3 Fire

Fire has a significant influence on the ecology of coastal coniferous forests. Fire frequency and intensity vary widely (Agee and Edmonds 1992), but generally increase with distance from the ocean and elevation (Sawyer et al. 2000b). Vegetation patterns follow this gradient; redwood-dominated stands along the coast phase inland into Douglas fir stands. For stand-replacing fires, the return interval is between 250-500 years in coastal old-growth forests, 150-200 years in transitional areas, and 33-50 years in inland areas (Veirs 1980, as cited in Sawyer et al. 2000b). The estimated fire return interval in Sonoma County for Douglas fir and hardwood-dominated forest stands with individual redwood trees is 6-23 years (Finney and Martin 1992, as cited in Sawyer et al. 2000b). Many studies of redwood forests found that fires hot enough to leave tree-ring evidence had, on average, fire return intervals than 25 years (Stephens and Fry 2005). Within these studies, uncommon.

Lightning Fire in MRC Plan Area
Late June 2008

Lightning is rare along the coast and fire conditions in coastal forests are seldom extreme; severe fires generally move into coastal redwoods from their eastern margins (Greenlee 1983, as cited in Sawyer et al. 2000b).

Fires often become catastrophic due to a combination of factors, including

- Climate.
- Inappropriate fuels management.
- Past timber management.

Agee predicts that it will take many decades to significantly reduce catastrophic fire potential at a landscape level (Agee 1997). In addition, the 21st century is facing global climate change. An increase of fire frequency is predicted for drier climates (Romme and Turner 1991, as cited in Agee 1997). In the past, catastrophic fires were associated with warming periods in the Pacific Northwest (Agee 1997).

Fire prevention and suppression is a common management tool in forested areas; as a result, combustible material that would normally be burned by more frequent, regular, low-intensity fires gradually builds up. Fuel load is the term to describe this potentially combustible material. Fire risk increases with greater fuel loads. Timber harvest can also increase fuel loads in the short-term, when slash (branches, needles, and leaves of cut trees) are left after harvest. Appropriate site preparation, however, such as pile burning, can decrease fire risks.

14.3.1 Effects of fire on forest stands

Predicting the impacts of fire on a particular forest stand is difficult due to differences in forest-stand characteristics and fire variability (Morrison and Swanson 1990). Fire impacts tree species differently and tree species recover from fire at different rates. Redwoods, for example, are fairly fire resistant, whereas Douglas fir and tanoaks require fire to be competitive with shade-tolerant shrub and tree species. Fires create certain beneficial habitat elements, such as snags and downed wood. However, they also can alter habitat dramatically and produce adverse effects for covered species.

Stand-replacing fires can

- Convert forested habitat into early successional habitat.
- Alter aquatic habitats by decreasing canopy cover and stream-stabilizing vegetation.
- Increase the potential for erosion.
- Remove or diminish pre-existing snags and LWD.
- Generate new snags and LWD.

14.3.1.1 Redwoods

Fire plays an important role in the ecology of coastal redwood forests. Longer fire-free intervals favor establishment of fire-tolerant redwood forest stands, as well as tanoak and western hemlock. Repeated fires with short return intervals favor the growth of young redwoods because of their ability to sprout (Rydelius and Libby 1983, as cited in Sawyer et al. 2000a). Large catastrophic fires are rare but do occur in redwood forests. A fire in 1945 burned 306,404 ac (124,000 ha) of redwood forest stands in northern Humboldt County (Sawyer et al. 2000a). In unlogged areas, this fire did almost no damage to old-growth stands, but did lead to an increase in western hemlock and redwood sprouts. Within selectively logged areas, the fire destroyed the remaining Douglas fir and hemlock, leaving shrubs and red alder among dense clumps of redwood sprouts.

The impact of fire on redwood trees depends on the size of a tree. The bark of small trees with a dbh less than 8 in. (20 cm) is too thin to protect the cambium. Cool-to-hot fires can top-kill trees, i.e., destroy the above-ground tissues of a plant without killing underground parts from which the plant may produce new stems and leaves (Finney and Martin 1991, as cited in USDA 2002). Bark of mature redwoods is thick and fires often only reduce the amount of bark (Olson et al. 2002). Stand-replacing fires can cause basal wounding and top-kill. However, intense fires that burn too much of the cambium near the ground will kill roots; healing growth will be inadequate to reconnect enough of the stem and root system (Olson et al. 2002). With less water transported to the crown, growth rates decrease and the probability of a tree surviving another fire will be lower (Sawyer et al. 2000b). Surveys in Redwood National Park indicate that surface fires in 1894 and 1974 did not influence stand structure, although there was less competition among trees, evidenced by the increased width of the growth rings after the fire (Abbott 1987, as cited in Sawyer et al. 2000b).

14.3.1.2 Douglas fir

Douglas fir benefits from fire. This species prefers open areas and, therefore, thrives in areas where fire has removed understory and canopy foliage (Sawyer et al. 2000b). Douglas fir re-generates by seeding (Mayer and Laudenslayer 1988) with good years for seed occurring irregularly. The proportion of Douglas fir in coastal forests increases with the distance from the ocean and with higher elevation, as does fire frequency.

14.3.1.3 Hardwoods (tanoak)

In northern California, tanoak is one of the primary successional species after timber harvesting or natural disturbances, such as fire and windthrow. Some previously logged areas in the plan area may have a higher component of tanoak than existed prior to commercial logging. Tanoak tends to dominate previously logged stands because of the long time frame required for conifers, like Douglas fir and redwood, to out-compete this hardwood species.

Tanoak re-generates by sprouting. Tanoak sprouts grow faster than Douglas-fir seedlings and coast redwoods (Mayer and Laudenslayer 1988); they may aggressively compete with Douglas fir and coast redwood in mixed coniferous forests (Little 1979, Burns 1983, Barrett 1995, all as cited in Piirto et al. 1997). Tanoak can form a nearly solid canopy for 60-100 years until natural mortality allows Douglas fir to eventually out-compete most tanoak and become dominant (Mayer and Laudenslayer 1988). The high stem densities in these stands may suppress growth of other trees and make these stands vulnerable to catastrophic fires, especially in the vicinity of ridge crests that are more prone to ignition by lightning strike.

14.3.2 Effects of fire on terrestrial covered species

14.3.2.1 Marbled murrelet

Because marbled murrelets depend on mature or old-growth stands for nesting and roosting, fires that destroy or reduce the size of these stands will probably have an adverse effect on marbled murrelet populations. However, marbled murrelets sometimes nest in unlogged mature stands or large sawtimber[1] stands burned 80 to 200 years ago; in these stands, open crown canopies or steep slopes provide access to and from large limbs (Marshall 1988). Marbled murrelets nest in habitat types characterized by long fire-free intervals. Sitka spruce stands in western Washington typically have a fire-free interval of 1146 years or more. Along the northern and southern Oregon coast, Sitka spruce has a fire-free interval of 200 to 400 years. Fires that do occur in Sitka spruce are usually stand replacing. Western hemlock forests along the coast have a fire-free interval of about 750 years (Agee 1993). Coastal redwood is tolerant of low-severity fires which appear to have occurred before the arrival of European settlers at 9-20 year intervals in coastal Mendocino County (Brown and Baxter 2003); stand-replacing fires occurred on 200-500 year intervals (Lehman 1989 and Agee 1993).

14.3.2.2 Northern spotted owl

Most northern spotted owl habitat in the Pacific Northwest owes its structure and species composition to fire (Lehman 1989). However, decades of timber harvest and timber management have created the spotted owl habitat in the plan area—not fire. The Mendocino Lightning Complex of 2008 reduced suitable owl habitat across the plan area, but MRC expects this habitat

[1] Trees with at least a 9 in. dbh (softwood) and an 11 in. dbh (hardwood)

to recover in a short ecological span. This will be the result of new growth in burnt areas and other areas growing into suitable habitat.

14.3.3 Effects of fire on aquatic systems

The effects of fire on aquatic systems are directly related to the intensity of the fire. Low intensity fires that burn the shrub layer may cause a slight increase in sediment loads because of exposed soils. High intensity fires, on the other hand, can cause a sharp increase in sediment loads by removing significant amounts of vegetation and killing trees whose roots help to maintain slope stability in sensitive terrain.

Low intensity fires are unlikely to significantly impact riparian areas, while high intensity fires can remove canopy and eliminate downed wood. Removal of canopy may lead to increased temperatures. Removal of existing downed wood reduces a stream's ability to meter the sediment load. High intensity fires, by killing trees, are more likely to recruit significant amounts of woody debris. However, this recruitment may not occur soon enough to meter the sediment load created by the fire.

Heavy rainfall following severe fires can move large quantities of soluble ash into streams. Ash contains nitrates and phosphorus; levels of these chemicals in streams increase after wildfires. The most pronounced effect of wildfire on water chemistry is usually an increase in nitrates (Gluns and Toews 1989). As a forest regenerates after fire, the dissolved chemical load of the stream generally returns to the levels observed before the fire.

> Changes in water regimes are most significant where fire has a large-scale impact on vegetation and water retention properties of soils. Annual water yield can be significantly increased after fire due to the reduction or elimination of vegetation. Loss of vegetation increases the speed at which water reaches soils during rainstorms, increasing the potential for sharp peaks in storm runoff to streams. Intensively burned soils can have their ability to retain water dramatically reduced, further heightening the magnitude and shortening the duration of water discharge to streams during storms. Evaporation of water on soils or in the top layer of soils may increase, but increases in evaporation are minimal compared to increases in the runoff. Summer flows may also increase due to vegetation loss, as water previously used by plants remains available in the summer to become stream flows. In dry areas this may be a significant benefit to aquatic (and terrestrial) systems. (Agee 1993)

Disturbances, whether caused by fire, storms, or volcanic eruptions, are important to the natural history of aquatic ecosystems. The biodiversity in many aquatic ecosystems is shaped by patterns of disturbance. Periodic large-scale disturbances of aquatic ecosystems are inevitable and often beneficial over long periods. Knowledge of the disturbance process can form an important ecological foundation for fire-related management (Bisson et al 2003).

14.3.4 Effects of salvage harvests after a fire

Harvesting all fire-damaged trees can inhibit the forest from developing significant habitat elements—like snags, goose pins, and downed wood—for several decades. A forest without such elements cannot support the diversity of wildlife desired by MRC and the wildlife agencies.

Un-restrained salvage operations after a fire can impact aquatic systems. Fires generally remove the duff and vegetative layer above the soil. Without specific erosion control measures, high impact yarding can promote increased sediment delivery into watercourses. Logging after a fire generally damages soil by (1) compacting it; (2) removing vital organic matter; and (3) increasing the amount and duration of topsoil erosion and runoff (Kattleman 1996, as stated in Karr et al. 2004). Increased runoff and erosion alter the river hydrology by increasing the frequency and magnitude of erosive high flows and raising sediment loads (Waters 1995, as stated in Karr et al. 2004) Removal of burned trees that provide shade may hamper tree regeneration, especially on high-elevation or dry sites (Perry et al. 1989, as cited in Karr et al. 2004).

After a fire, MRC will salvage trees likely to die or trees not viable for timber production (evident by reduced live crown and basal scarring); at the same time, we will retain other trees and woody debris according to the conservation measures in our HCP/NCCP for AMZ, TSU, snags, LWD, wildlife trees, and spotted owl core areas. Depending on the location and intensity of a fire, about 25-70% of merchantable trees will remain after a fire salvage resulting from a changed circumstance. Steep AMZ areas near watercourses or high hazard TSUs (i.e., TSU1 through TSU3) will likely have a large amount of tree retention, while flat areas near ridge tops will generally have much less retention.

14.3.5 Fire occurrence in the assessment area

The trend has been to exclude large fires in the assessment area, as evidenced below:

1. Historical record
   Prior to 2008, the most recent large fire in Mendocino County was the Comptche fire, which burned or scorched approximately 29,000 ac (11,736 ha) in September 1931. Individuals working with smaller fires in upper Big River apparently started the Comptche fire. Strong winds swept the smaller fires into the Albion watershed. Due to unfavorable wind conditions and limited available personnel, firefighters took several days to control the fire. Burned lands owned by Union Lumber Company covered 20,000 ac (8094 ha) and consisted mainly of second-growth forest stands, a small number of 20-year old trees, some replanted redwoods, and brush. In late June of 2008, a series of lightning strikes ignited approximately 23,196 ac (9387 ha) of the plan area. The two largest fires burned 9495 ac (3842 ha) at South Coast and 8839 ac (3577 ha) at Rockport (see Table 1-5).

Photos of Mendocino Lightning Complex (2008) in the Plan Area

South Coast Fire at Cliff Ridge
25 June 2008

Burnover from Hardy Ridge Fire (Rockport)
View from CAL FIRE Helicopter 21 July 2008

2. Research
   At Jackson Demonstration State Forest, located dead center in our HCP/NCCP assessment area, Brown and Baxter (2003) found surface fires were frequent prior to the early 20th century. In the coastal redwood forest, the fire-free interval was 6-20 years; however, Brown and Baxter found no fire scars after 1930.

3. Improved strategies and infrastructure
   Based on our data analysis,[2] the only fires in the assessment area since 1970 that covered more than 5000 ac were from the Mendocino Lightning Complex (2008). The reduction in the number of large fires is likely the result of improvements in fire prevention and control tactics (i.e., fire suppression) and in road systems and maintenance (i.e., access to forests). The large extent and number of fires in the Mendocino Lightning Complex indicate that these types of events, while rare, may occur within the 80-year term of our HCP/NCCP.

MRC believes the trend to exclude large fires will continue during the term of our HCP/NCCP.

14.3.6 Changed and unforeseen circumstances for fire

14.3.6.1 Changed circumstance

Fire, including wildfires from timber operations and prescribed burning, constitutes a changed circumstance if one or more of the following conditions apply, i.e., the fire

- Covers, in 1 fire season, more than 15% of the plan area (32,000 ac/12,950 ha) or more than 50% of a planning watershed in which MRC owns at least 500 ac.
- Covers more than 10 ac (4 ha) in LACMA.
- Results in a reduction of at least 500 ac (202 ha) of suitable habitat per territory for up to 4 northern spotted owl territories receiving high or moderate protection.

14.3.6.2 Unforeseen circumstance

Fire constitutes an unforeseen circumstance if 1 or more of the following conditions apply, i.e., the fire

- Results in a change of structure class to more than 30% of the plan area (63,973 ac/ 25,889 ha) within 1 fire season.
- Results in a change of structure class to more than 50% of the plan area (106,622 ac/ 43,148 ha) over 10 years.
- Covers more than 50 ac (20 ha) in LACMA.
- Results in a reduction of more than 800 ac (324 ha) of suitable habitat per territory for 5 or more northern spotted owl territories receiving high or moderate protection.
- Results in the direct mortality of 5 or more northern spotted owls receiving high or moderate protection.

14.3.7 MRC response to fire

14.3.7.1 Fire does not trigger a changed circumstance

In the event fire burns more than 30 ac (12 ha) but does not constitute a changed circumstance, MRC will take the following action:

[2] Data is from Fire Perimeters: 1950-2009. Maps are from CAL FIRE and Resource Assessment Program (FRA). http://frap.cdf.ca.gov/webdata/maps/statewide/firep_map.pdf (accessed April 7, 2011).

- MRC may harvest timber in burned areas to salvage trees that are likely to die or that are not viable for timber production,[3] in accordance with the following prescriptions:
  - MRC will retain, per acre, 1 additional snag and wildlife tree over and above the number specified in C§9.2.3.1-1 to C§9.2.3.1-3.
  - MRC may harvest hard snags if the objective for hard snag retention is already met prior to harvest.
  - MRC will not harvest (a) old growth trees; (b) trees in which the diameter of the entrance hole leading to a cavity is greater than 3 in. and 10 ft or more above the ground; (c) nest trees of northern spotted owls; (d) trees that are potential habitat for marbled murrelet; (e) trees over 24 in. dbh with basal hollows that are more than 12 in. in any horizontal dimension and extend at least 6 in. vertically inside the cavity from the topmost point of the entrance hole; (f) trees with known raptor nests; or (g) granary trees.
  - MRC will meet, in Class I and Large Class II AMZ, objective O§9.2.2-1 (namely, retain 6 hard logs *on average per acre* that are (a) ≥ 16 in. average diameter, (b) ≥ 6 ft long, and (c) derived from at least 3 trees).

    NOTE

    If proposing harvest of downed wood, MRC will survey to ensure that enough downed wood exists in the stand to complete such a harvest.
  - MRC will meet, in general forested areas, objective O§9.2.2-2 (namely, retain 5 hard logs *on average per acre* that are (a) ≥ 16 in. average diameter, (b) ≥ 6 ft long, and (c) derived from at least 3 trees.)

    NOTE

    If proposing harvest of downed wood, MRC will survey to ensure that enough downed wood exists in the stand to complete such a harvest.
  - MRC will not reduce the conservation measures for AMZs, including the prohibition on salvaging, unless the wildlife agencies concur.
  - MRC will not reduce the conservation measures for TSUs, including the prohibition on logging in inner gorges of TSU1 and TSU2, unless the wildlife agencies concur.
  - MRC will conduct a rare plant survey during the blooming season, if the burned area has over-wintered since the fire event.

    NOTE

    During the summer and fall following a ground fire, there would be no rare plants for an observer to see. In the 2008 Navarro Fire, for example, the soil was bare and there were only standing conifer and hardwood trees.
  - MRC will protect known and newly detected rare plants with the conservation measures specified in Chapter 11, *Conservation Measures for Rare Plants*.
  - MRC, after consulting and concurring with the wildlife agencies, will suspend efforts at reforestation and erosion control (unrelated to watercourses) at the site of a rare plant occurrence for 2 years to allow its seed bank to replenish.
- MRC will develop site-specific erosion control, in accordance with the following prescriptions:
  - MRC will not construct sediment traps, gabions, instream structures, bank stabilization, weirs, or check dams in and along watercourses without a commitment to maintain such structures and concurrence of the wildlife agencies.
  - MRC will design yarding systems to minimize sediment delivery to watercourses.
  - MRC will not broadcast seed with persistent exotics (i.e., annual rye grass).

[3] Trees have reduced viability for timber production if they survive a fire with little possibility of healthy growth. To make this determination, MRC personnel will observe the extent of the burn on trees, including insect damage or bole damage that may result in a future insect problem and, subsequently, poor log quality, e.g., termite damage in redwoods.

  - MRC will perform erosion control per Appendix E, section E.10, *Standards for Surface Erosion Control*.
  - MRC will construct waterbars on truck and skid roads to high EHR (Erosion Hazard Rating) standards.
  - MRC will construct waterbars on cable roads where runoff may drain into a watercourse.
  - MRC will review watercourse crossings, which receive flow from a burned area, and commit to 1 of the following actions:
    1. Remove the crossing and excavate as close as feasible to the natural channel grade.
    2. Upgrade the crossing to a rock ford, bridge, or culvert capable of passing a 100-year event.
    3. Install a vented ford culvert crossing.
  - MRC will inspect watercourse crossings with drainage from a burned area (a) once a month during the first winter period after a fire and (b) after storm events producing 4 in. or more of rain during the second winter period after a fire.
  - MRC will maintain inspected watercourse crossings, as necessary, to retain their flow conveyance capacity.
  - MRC, with concurrence of the wildlife agencies, may adopt other measures required by a specific fire incident.
- MRC, with concurrence of the wildlife agencies, will restore damaged red-legged frog breeding sites or create new sites in adjacent, unaffected areas.
- MRC will receive approval from the wildlife agencies before taking any actions after a fire in LACMA.

14.3.7.2 Fire triggers a changed circumstance

In the event of a fire that constitutes a changed circumstance, MRC will take the following action:

- MRC may harvest timber in burned areas[4] to salvage trees that are likely to die or that are not viable for timber production, in accordance with the following prescriptions:
  - MRC may harvest up to 50% of the burned stems during the same year as the fire event to aid in fire suppression and restoration efforts.
  - MRC may harvest more than 50% of the burned stems during the same year as the fire event with the concurrence of the wildlife agencies; the trees retained must encompass all the diameter sizes within the pre-harvest stand.

    NOTE
    Criteria for agency concurrence is that MRC maintain ecological function while recouping financial loss in the burned area.
  - MRC will consult with the wildlife agencies in the first winter following the fire event to develop a comprehensive plan for additional fire salvage and restoration efforts relevant to future timber damage.
  - MRC will retain snags according to the conservation measures for snag retention (C§9.2.3.1-1 to C§9.2.3.1-3).
  - MRC will retain, in addition, 1 snag > 24 in. dbh and more than 40 ft high per acre, if present.
  - MRC may harvest hard snags if the objective for hard snag retention is already met prior to harvest.
  - MRC will not harvest (a) old growth trees; (b) trees in which the entrance holes leading to cavities are >10 in. and 10 ft or more above the ground; (c) nest trees of northern

[4] A burned area is within the outer extent of the fire and may include pockets or islands of unburned areas.

spotted owls; (d) trees that are potential habitat for marbled murrelet; (e) trees >24 in. dbh with basal hollows that are >12 in. wide and extend vertically above the outside cavity; (f) trees with known raptor nests; or (g) granary trees.

- MRC will exceed, in Class I and Large Class II AMZ, objective O§9.2.2-1 (namely, retain at least 6 hard logs *on average per acre* that are (a) ≥ 16 in. average diameter, (b) ≥ 6 ft long, and (c) derived from at least 3 trees) by leaving 1 additional log/ac, i.e., at least 7 logs/ac.

  NOTE
  If proposing harvest of downed wood, MRC will survey to ensure that enough downed wood exists in the stand to complete such a harvest.
- MRC will exceed, in general forested areas, objective O§9.2.2-2 (namely, retain at least 5 hard logs *on average per acre* that are (a) ≥ 16 in. average diameter, (b) ≥ 6 ft long, and (c) derived from at least 3 trees) by leaving 1 additional log/ac, i.e., at least 6 logs/ac.

  NOTE
  If proposing harvest of downed wood, MRC will survey to ensure that enough downed wood exists in the stand to complete such a harvest.
- MRC will fell trees and place LWD in streams, if the instream LWD is at or below the current objective (see Appendix S, S.2.1, *Future Targets for LWD).*

  NOTE
  The trees should be at least key-piece size or larger and be placed with the least amount of impact to the riparian area.
- MRC will only place LWD in a stream section, with concurrence of the wildlife agencies, if fire reduces shade canopy within an AMZ by more than 15%.

- MRC will not reduce the conservation measures for AMZs, including the prohibition on salvaging, unless the wildlife agencies concur.
- MRC will not reduce the conservation measures for TSUs, including the prohibition on logging in inner gorges of TSU1 and TSU2, unless the wildlife agencies concur.
- MRC will fell trees parallel to the contours of a site when leaving logs in the woods, if this proves feasible.
- MRC will conduct a rare plant survey prior to any operations, if the burned area has over-wintered after the fire.

  NOTE
  During the summer and fall following a ground fire, there would be no rare plants for an observer to see. In the 2008 Navarro fire, for example, the soil was bare and there were only standing conifer and hardwood trees.
- MRC will conduct an additional rare plant survey during the blooming season.
- MRC will protect known and newly detected rare plants with the conservation measures specified in Chapter 11, *Conservation Measures for Rare Plants*.
- MRC will, with concurrence of the wildlife agencies, suspend efforts at reforestation and erosion control (unrelated to watercourses) at the site of a rare plant occurrence for 2 years to allow its seed bank to replenish.
- MRC will not harvest within extended protection areas of northern spotted owl territories receiving high or moderate protection unless the wildlife agencies concur (a) that the proposed harvest will improve conditions for the owls or (b) that MRC can replace the affected extended protection area and core area with high-producing territories currently receiving limited protection within the same inventory block.
- MRC will rehabilitate affected areas by planting conifers within the first winter following a fire or the first winter following a salvage operation.
- MRC will develop site-specific erosion control in consultation with the wildlife agencies, in accordance with the following prescriptions:

  - MRC will not construct sediment traps, gabions, instream structures, bank stabilization, weirs, or check dams in and along watercourses without a commitment to maintain such structures and concurrence of the wildlife agencies.
  - MRC will design yarding systems to minimize sediment delivery to watercourses.
  - MRC will not broadcast seed with persistent exotics (i.e., annual rye grass).
  - MRC will perform erosion control per Appendix E, section E.10, *Standards for Surface Erosion Control*.
  - MRC will follow up mulching with control of any persistent exotics resulting from the erosion control, when using straw containing weeds.
  - MRC will construct waterbars on cable roads where runoff may drain into a watercourse.
  - MRC will review watercourse crossings, which receive flow from a burned area, and commit to 1 of the following actions:
    1. Remove the crossing and excavate as close as feasible to the natural channel grade.
    2. Upgrade the crossing to a rock ford, bridge, or culvert capable of passing a 100-year event.
    3. Install a vented ford.
  - MRC will inspect watercourse crossings with drainage from a burned area (a) once a month during the first winter period after a fire and (b) after storm events producing 4 in. or more of rain during the second winter period after a fire.
  - MRC will maintain inspected watercourse crossings, as necessary, to retain their flow conveyance capacity.
  - MRC may adopt other measures required by a specific fire incident and in concurrence with the wildlife agencies.
- MRC will receive approval from the wildlife agencies before taking any actions after a fire in LACMA.
- MRC will initiate surveys for red-legged frog breeding sites in burned areas and assess damage in the first year following a changed circumstance resulting from a fire.
- MRC will restore damaged red-legged frog breeding sites or create new sites in adjacent, unaffected areas within the same planning watershed, in concurrence with the wildlife agencies.
- MRC will initiate distribution surveys for tailed frogs, coho salmon, Chinook salmon, and steelhead in burned areas and assess damage in the first year following a changed circumstance resulting from a fire.

14.4 Climate

Extreme climatic events can greatly affect vegetation growth, as well as stand dynamics and habitats for aquatic and terrestrial species. In addition to re-occurring events, such as droughts, change in global climate can influence the composition and abundance of local species by changing (a) temperatures; (b) frequency of drought and flood events; and (c) dispersal of plant and animal species, along with any subsequent inter-specific competition.

14.4.1 Drought

Droughts occur regularly and reflect variations in climate. In general, a drought occurs when there is “a period of abnormally dry weather sufficiently prolonged for the lack of water to cause serious hydrological imbalance” (Huschke 1959). Recent drought periods have occurred on decadal time scales and lasted approximately 3-5 years (CDWR 2002a). Data from the past 400 years indicates that recent droughts have been only moderately severe and relatively short compared to historical records (Woodhouse and Overpeck 1998). Droughts, such as the Dust Bowl of the 1930s, were not unusual events. The Dust Bowl was actually a series of droughts over a period of 10 years. In the Central Valley, flows during that period dropped to about 55% of a 90-year average. Evidence indicates that there were two major droughts in the 13th to the 16th centuries that "probably significantly exceeded the severity, length, and spatial extent of 20th century droughts" (Woodhouse and Overpeck 1998, p. 2699).

Unlike other natural disasters, droughts occur gradually. Determining when dry conditions reach an important threshold is a matter of observing their effects on affected receptors. The California Department of Water Resources, for example, used two primary criteria—runoff and reservoir storage—when they declared a drought to water users (agricultural and domestic) during the 1987-92 dry period (CDWR 2002b). If reservoir storage dropped below 70% of average, for example, this was considered a drought threshold. Single drought years have to be taken into account along with previous droughts because the effects of cumulative water depletion can manifest for several years.

14.4.1.1 Effects of drought

Lack of water limits tree growth. Insufficient water impairs tree tissues and physiological processes, causing wilting, leaf shedding, reduction in photosynthesis, growth inhibition, and eventual death (Coder 1999). Rainfall and soil moisture affect cambial growth. Droughts affect the width of annual growth rings, duration of cambial growth, proportions of xylem and phloem, and timing and duration of wood production in mature trees (Coder 1999).

Trees with efficient root systems will increase root growth during drought to increase water absorption. However, extended droughts lead to roots that are suberized or converted to impassive cork tissue to prevent water loss. Trees with a high root-to-shoot ratio reflect high water-absorbing capacity. When coupled with a low transpiration rate, this can increase the ability of trees to survive droughts. Redwoods, however, have an inefficient root system and cannot withstand low soil moisture stress; they have poor control over water loss from transpiration. Redwood seedlings wilt long before other moisture-sensitive plants (Stone 1965). Other species such as Douglas fir can continue drawing water from the soil and remain alive for longer periods of time during periods of water stress. Thus, a very prolonged drought can result in a species shift in forests.

Droughts can

- Increase the risk of fire due to increased fuel loads from dead and dying vegetation
- Lower fuel moisture of both live and dead vegetation.
- Increase disease and pest outbreaks as a result of stressed and dying vegetation (Franklin et al. 1991, as cited in Agee 1997; Coder 1999).
- Limit the quantity and quality of instream habitat by reducing stream flows.
- Reduce the amount of vegetative growth and, therefore, the amount of forage for wildlife.
- Reduce drinking water availability for wildlife and affect habitat use patterns and movement patterns.

14.4.1.2 Changed and unforeseen circumstances for drought

A drought (or series of droughts) constitutes a changed circumstance if it continues over several months or up to 1 year with rainfall less than 33% of average; 2 consecutive years with rainfall less than 50% of average; or 3 or more consecutive years with annual rainfall less than 75% of average.[5]

A drought (or series of droughts) constitutes an unforeseen circumstance if it continues beyond 3 consecutive years with rainfall less than 33% of average; beyond 6 consecutive years with rainfall less than 50% of average; or beyond 10 consecutive years with annual rainfall less than 75% of average.

Data from South Fork Caspar Creek (Figure 14-1) shows only one year from 1963 to 2009, namely 1977, when average annual rainfall totals were less than 33% of the average annual total of 45.6 inches. The rainfall records from 42 locations across Mendocino County from 1945 to 1995 show that average annual rainfall never fell below 33% of the average annual total of 45.6 inches. According to the data, none of these locations in Mendocino County met the drought criteria for unforeseen circumstances.

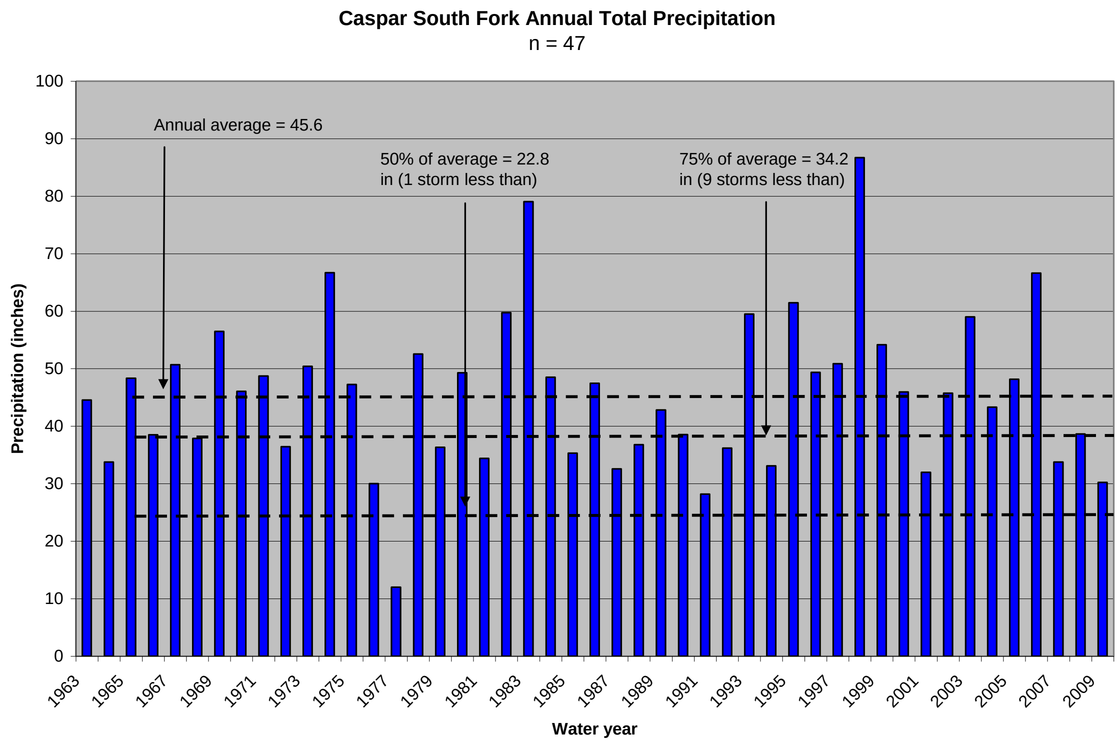


Figure 14-1 Rain Data from Caspar South Fork

14.4.1.3 MRC response to drought as a changed circumstance

- MRC will consult with the wildlife agencies on measures which reduce the amount of water pumped from streams to water roads; such measures affect road closures, traffic limitations, rocking or other surfacing of roads segments that otherwise require dust abatement.

[5] MRC will use the South Fork Caspar rain gauge.

- MRC will create or enhance, in consultation with the wildlife agencies, a minimum of 5 red-legged frog breeding sites across the plan area; the new breeding sites will be near known breeding sites that have failed due to the drought and in locations more likely to retain water until July1.
- MRC may close our lands to unnecessary activities (e.g., recreation, fire-wood cutting) during any period of extreme fire danger.

14.4.1.4 MRC response to drought as an unforeseen circumstance

MRC may propose measures which reduce the amount of water pumped from streams to water roads.

14.4.2 Climate change

Researchers predict that average surface temperature will increase by 2.5-10.4°F (1.4-5.7°C) from 1990 to 2100 (PEW 2002), with an average increase of 1-4.5°F (0.6-2.5°C) in the next 50 years. Often referred to as "global warming" in the media, climate change is a better term because the expected changes include: (1) regionally variable temperatures (some may be cooler than present); (2) regional changes in precipitation patterns and amounts; and (3) more extreme weather events.

14.4.2.1 Effects of climate change

The effects of climate change are both direct and indirect. Temperature changes that exceed a species tolerance range may directly impact them. Changes in precipitation may indirectly impact species by altering different aspects of their environment.

A predicted 3.6°F (2°C) warming could shift the ideal range for many North American forest species by about 200 mi (300 km) to the north (USEPA 2001b). Forested areas in California could decrease 25-50% depending on many variables (USEPA 2001b). However, determining vegetation change in the western United States is more difficult due to topographic complexity (Malcolm and Pitelka 2000).

Some experts expect that climate-sensitive plants will decline and only invading species that can disperse fast enough to keep up with the changing climate will survive. Climate change may also shift plant and animal communities that currently exist adjacent to each other; for example, in the redwood region, chaparral and oak woodland communities may expand their range. Most models predict more small-scale changes rather than broad northward shifts (Malcolm and Pitelka 2000).

Climate change could affect the processes causing upwelling of cold water along the California coast (Union of Concerned Scientists 2001). The increasing frequency of El Niño events or altered processes that cause less cold water to well up could significantly reduce coastal fog. Along the central western coast, warmer ocean waters could cause complex changes in the marine food web, altering food availability for species such as the marbled murrelet.

14.4.2.2 Literature review for impacts of climate change

ICF Jones & Stokes conducted a literature review for MRC on the impacts of climate change within the redwood forest region using (1) internet keyword searches, (2) academic databases, and (3) professional contacts. The reviewed articles and reports provide the basis for our predictions in section 14.4.2.

Literature search and review

The internet provided many generic (i.e. non-scientific) texts on the effects of climate change on coastal redwoods. Broadening the search to include the factors that influence coastal redwood growth and productivity (precipitation, temperature, fire frequency, and fog patterns) uncovered more varied scientific papers. The likely impacts on redwood forests in northern California were changes in temperature, precipitation, and fog patterns, along with changes in the disturbance regimes of fire, pests, tree falls, and flooding.

- **Global change**
  A report of the Intergovernmental Panel on Climate Change (IPCC 2001, 2007) provides assumptions and scenarios about climate change at the global scale on which regionally specific models are based.

- **Regional change**
  Bell et al. (2004), Hayhoe et al. (2004), Kim (2005), Leung and Ghan (1999) and Snyder et al. (2002) created climate change models to predict the effects of changes in temperature, precipitation, and coastal moisture on the vegetative communities of California.

- **Influence of redwood characteristics on species range**
  Busing and Fujimori (2005), Lenihan et al. (2003), Rogers and Westfall (2007), and reports by the California Climate Change Center (2006) and Field et al. (1999) discuss the role of disturbance on redwood forests and vegetative distribution. Dawson (1998), Herbert et al. (2003), Millar (2003), and Field et al. (1999), as well as reports by the California Climate Change Center (2006) and California Department of Forestry (CAL FIRE 2007) focus on the role of fog, ocean upwelling, temperature, and precipitation on the coastal redwood system and range.

- **Climate change in Sierra region**
  Stephenson and van Mantgem (2007) identify the current climate change effects within the Sierra region as it applies to mortality and juvenile recruitment in old growth forests.

- **Impacts of fire**
  Fried et al (2004) address the expected increase of fire frequency in northern California and its impact on the vegetative communities. Lloret et al (2005) explain the relationship between fire frequency and community ecology.

Summary and conclusions

The climatic factors of temperature, precipitation and fog patterns, along with the disturbance regimes of fire, pests, tree falls, and flooding affect redwood forests in northern California. Based on the IPCC report (2001), most climate models postulate that the atmospheric concentration of CO_2 has increased 2 times that of pre-industrial levels. These models predict that the climatic factors cited above will continue to change.

The effects of such changes are not clear. More rainfall, for example, may be beneficial to redwoods, especially if it occurs during what are now the drier periods of the year, when low soil moisture impacts growth. No one, of course, can predict the future patterns and duration of wet and dry seasons in the redwood region. Too much soil moisture during the normal dry periods of summer could also alter forest regimes. The net effect on soil moisture will likely determine if redwood benefits from the climate changes or if it is impeded by them.

Recent research indicates that there may have been a 33% decrease in the frequency of summer fog days on the northern California coast during the 20th century (Johnstone and Dawson 2010). Elevated global temperatures, however, could increase fog intrusion along most of the coastal redwood range. Fog drip is an important factor in the growth and survival of coastal redwoods (Dawson 1998). During the growing season, June to November, rainfall is at its lowest and fog-days are at their highest, with water uptake 2-4 times higher in the summer months (Dawson 1998). At the global scale, temperatures are expected to increase by 2-4.5^{o} C during the 21st century before leveling off, with approximately 0.2^{o} C increase per decade. Warming causes more water to evaporate into the atmosphere which, in turn, causes the atmosphere to warm further. Water vapor, therefore, will be the largest *feedback* to temperature increases (IPCC 2007).

The rise in global temperature will also warm the oceans. During the last interglacial period, warming of the oceans favored expansion of the redwood range due to increased fog during summer months (Millar 2003, Herbert et al. 2000). Depending on wind and ocean upwelling effects, the proposed temperature increases would likely cause an increase in inland fog intrusions on the coast and create conditions more favorable to redwoods (CAL FIRE 2007, Herbert et al 2001).

Increases in quantity and intensity of winter precipitation will accompany increases in summer fog intrusions and favorable conditions for fog production. Researchers predict that heavy precipitation will increase in the mountainous regions of the northern California Coastal Range (Kim 2005). Increases in the influx of water vapor from the Pacific Ocean during the cold season (Kim 2005) could enhance moisture convergence along the coast as well (Leung and Ghan 1999). Within the redwood forest range, the North Coast and North Lahontan basins may have a 1-3% increase in mean annual rainfall (Bell et al. 2003). This includes an average of 2.5 additional events of heavy rainfall per year (Bell et al. 2003).

At the regional scale, researchers expect temperatures to warm across California by 1.4-3.8^{o} C (Snyder et al 2002). This regional warming may lead to vegetation shifts within California. The most significant changes would be the reduction in the extent of alpine/subalpine forest and the displacement of evergreen conifer forest, including redwoods, by mixed evergreen forests (Hayhoe et al 2006). Although mixed evergreen forests will displace evergreen conifer forests across their historic range, the latter may experience a net increase in percentage of coverage (Lenihan 2003). The warmer, wetter scenario predicted along the coast will favor the expansion of redwood and closed-cone pines from remnant, fragmented groves into live oak-madrone forests and chaparral in surrounding canyons (Lenihan 2003).

Forest disturbances include fire, flooding, tree falls, and pests. In old growth forests, there is typically a slow canopy turnover rate where disturbances are infrequent (Busing and Fujimori 2005). Climate change scenarios predict increases in fire frequency and flooding which would alter the present disturbance regimes within redwood-dominated ecosystems. Increased frequency of disturbance, including fire, flooding, and tree falls, will alter the age composition of redwood forests (Rogers and Westfall 2007), while increases in forest pests may have no effect (California Climate Change Center 2006).

Humidity, precipitation, temperature, and wind could affect fire behavior, ignitions, fire management (i.e., suppression), and vegetation fuel loads. Extrapolating for expected climate change scenarios, we can expect warmer, less windy, more humid conditions, with increased precipitation in the northern coastal redwood range; the southern part of the range may experience drier, windier and warmer conditions, favoring an increase in fire (Fried et al 2004).

As a disturbance regime, fire influences a variety of early growth conditions including soil sterilization, mineralization, vegetative sprouting, and over-story removal (Rogers and Westfall 2007). In chaparral communities, increases in fire frequency decreases the number of fire-sensitive species, and favors growth of seeder species (sexual reproduction), with no change in the competitive ability of those species that regenerate by re-sprouting (asexual reproduction) (Lloret 2004). This reproductive observation holds true for coastal redwoods, as well. In old growth upland sites where fire is more frequent, there are a higher number of individuals from seed recruitment than lowland sites, where there are more clonal recruits (Rogers 2007). Given that chaparral post-fire competition occurs in redwood communities, increased fire frequency could lead to increased genetic variety within the coastal redwoods, as conditions increase the germination and recruitment of seeds.

Fire falls into 2 categories: contained fires and escaped fires. Under a climate change scenario in which the levels of CO_2 increase twofold, the number of escaped fires should not change for the North Coast, but may increase by 51% in the South San Francisco Bay area and by 125% in the Sierra Nevada region. Model results indicate that the northern coastal redwoods will be the least effected by fires due to fire management and climatic factors that favor slower burning fires and more intense fire management (Fried et al 2004). In the southern part of Northern California, drier, warmer summers could lead to an increase in fire activity (Brown and Heyda 1998). Based on the assumption that redwood forest will continue to have coastal fog, fire tolerance, and rapid regeneration after fire disturbance, these conditions would favor the spread of redwood in a mixed woodland system (Fried et al 2004, California Climate Change Center 2006). However, if the drier and warmer conditions combine with a decrease in fog, these conditions could have adverse effects in the southern portions of the redwood range, leading to lower productivity (California Climate Change Center 2006). Conversely, increased fire frequency in the southern part of the redwood range could allow for redwood persistence and competitive advantage over less tolerant species.

While scenarios for climatic change predict vegetative shifts, they also predict extension of ranges for forest pests previously limited by climatic factors. Coastal redwoods are not very susceptible to forest pests, and those that do attack cause minor damage. For this reason, forest pests should have no effect on coastal redwoods (California Climate Change Center 2006). However, if forest pests adversely affect other competing trees within the coastal redwood range and increased mortality ensues, coastal redwoods could have an increase in juvenile recruitment in gaps where trees fall. Such gaps are an important form of disturbance in redwood forests. They allow more light to penetrate the understory and reach redwood saplings. Access to light promotes sapling recruitment and survival.

Climate change in the Sierra Nevada region has increased tree mortality for giant sequoias but has not affected juvenile recruitment (van Mantgem and Stepheson 2007). Greater old growth mortality could change the age structure of a stand, favoring dominance of younger trees. If this scenario occurs in the coastal redwoods, we can expect an increase in juvenile stands within redwood forests. The increase in fire frequency due to drier, warmer summers could have negative impacts on these juvenile trees since they are not as fire resistant as old growth trees.

As stated earlier, precipitation should increase during the winter months in most of the redwood range. In addition, snow pack should decrease. Decreases in snow pack cause increases in winter run-off; higher winter precipitation in the form of rain could allow for an increase in flooding events within the redwood region (Hayhoe et al 2004). Flooding replenishes nutrients, deposits sediments, and influences understory tree survival. Within coastal redwood forests, establishment of seedlings is common after major floods (Sawyer et al. 2000). An increase in flooding events would increase regeneration within redwood stands.

Overall, MRC anticipates that changes in the climatic factors of temperature, precipitation, and fog pattern, along with the disturbance regimes of fire, pests, tree falls, and flooding will be mixed, depending on site specific variables, particularly aspect, that influence soil moisture. The net effect is likely to be neutral.

14.4.2.3 Changed circumstances for climate change

Accurately predicting and reversing any effects of climate change in the plan area is very difficult if not impossible. We have addressed many of the potential manifestations of climate change (e.g., wildfires, drought, wind throw, flooding) in other sections of our HCP/NCCP.

Climate change constitutes a changed circumstance if a significant number (i.e., at least 10%) of culverts and crossings previously designed for 100-year events in the plan area are no longer fully controlled under new calculations for a 100 year event.

14.4.2.4 MRC response to climate change

The global nature of this problem places it outside of MRC control. University scientists, research institutes, think tanks, environmental agencies, the United Nations, international political summits—all are hotly debating the issue of climate change. The scientific consensus on the occurrence and cause of climate change is clear. On July 21, 2005, Ralph Cicerone, the Chancellor of the University of California (Irvine) and President of the National Academy of Sciences, testified before the U.S. Senate Committee on Energy and Natural Resources. "Nearly all climate scientists today believe," Cicerone said, "that much of earth's current warming has been caused by increases in the amount of greenhouse gases in the atmosphere, mostly from the burning of fuels." While burning of fossil fuels is a major cause of climate change, deforestation is also a factor. Until there is a global strategy for reducing the emissions of our automobiles, using cleaner sources of power to generate our electricity, and protecting the world's forests, warming trends will continue. In managing 213,244 ac of forest land that might otherwise be developed for industrial and residential use, MRC is contributing to the solution. In addition, over the term of our HCP/NCCP, MRC will increase timber inventory; this will sequester more carbon than an inventory that remains stable or declines.

MRC does anticipate that climate change may increase the frequency and intensity of severe droughts in northern California. Rising sea levels and changing weather conditions could also increase the frequency and magnitude of major floods in the plan area. Seasonal timing of precipitation may shift. Air and water temperatures may decrease. We cover the changed and unforeseen circumstances for climate change under specific events that may result, i.e., fires, droughts, and windthrow.

- MRC, in designing new crossings and reconstructing crossings, will use the best and latest information to calculate the 100-year storm size.
- MRC may adjust erosion control specifications (e.g., waterbar spacing) to achieve the same benefits that the specifications currently provide or better, if storm size or frequency increase.

- MRC will meet and confer with the wildlife agencies to adjust critical dates or take other actions in response to changes in precipitation patterns (e.g., definitions of "winter period").
- MRC will include propagules of trees from drier areas in our planting program.
- MRC will manage for species diversity to ensure increased forest tolerance to environmental impacts.
- MRC will continue to review and evaluate existing science in consultation with wildlife agencies to determine if we should take other actions.
- MRC will meet with the wildlife agencies at 10-year intervals after commencement of our HCP/NCCP to determine whether, by mutual agreement, we should modify any conservation measures because of climate change.

14.5 Windthrow

DEFINITION

Windthrow is the uprooting and felling of trees by wind, and is primarily affected by wind direction, soil moisture, soil depth, and topography.

Wind is one of the major disturbances influencing coastal forests in the Pacific Northwest (Agee and Edmonds 1992). Windthrow occurs when strong winds topple or break individual trees or clumps of trees (Noss 2000). Hurricane force winds are often recorded several times each winter on the Pacific Northwest Coast (Badura et al. 1974, as cited in Spies and Cline 1988), although winds are generally stronger in Washington and Oregon than along the Mendocino coast.

Conifer Trees Flattened by Wind

Windthrow adds wood directly to the forest floor, in contrast to fire which can leave dead trees standing for many years (Maser et al. 1988). The impact of winter storms on forests decreases with distance from the coast and from the forest edge. Forest stands growing on ridge tops or other locations exposed to high winds are also vulnerable. Most conifer and hardwood species are subject to windthrow, particularly when winter rains saturate soils.

14.5.1 Effects of windthrow

Small and large-scale windthrow can have positive and negative effects on both terrestrial and aquatic habitat. Winter storms can create large quantities of coarse woody debris both suspended by other trees and on the forest floor. Downed wood resulting from windthrow provides growing opportunities for wood-decay fungi, which can create rotten hollows and areas colonized by vascular plants including other trees and shrubs. Downed logs, in various states of decay, provide habitat for terrestrial species, such as the Pacific fisher.

Large woody debris that is spanning a stream or in a stream will provide shading, sediment storage and routing, and cover for fish until the forest canopy regenerates (Maser et al. 1988, Meehan et al. 1984), as well as "bridges" for terrestrial species. Smaller logs are also beneficial, although they are more easily mobilized by higher flows and may not persist in the watercourse for as long as larger wood. Logs in riparian areas help stabilize slopes and store sediment (Wilford 1984, as cited in Meehan et al. 1984) and provide habitat for fish, invertebrates, and amphibians (Shrivell 1990, Welsh et al. 1993). Logs in flood prone areas may eventually be delivered to the stream through floods or bank cutting. Redwood logs are rot resistant and may persist for centuries buried in sediment or submerged in water. A migrating watercourse can exhume fallen logs in the CMZ that then become functioning LWD.

MRC does not expect small-scale windthrow to have long-term adverse impact on stream shading and water temperature. Zwieniecki and Newton (1999) reported that where water temperatures in streams were warmed due to a lack of canopy, temperatures re-cooled after re-entering shaded areas for 492-984 ft (150-300 m).
Windthrown trees or snapped off stems may be beneficial to a variety of wildlife by providing nesting cavities or refuge. Upturned root masses provide complex structures useful for some nesting birds. However, the loss of particular wildlife trees due to windthrow, such as northern spotted owl nesting trees, can have direct negative effects to wildlife populations. Large areas of dense debris generated by windthrow can form obstacles to wildlife movement. Windthrown trees are also more susceptible to pathogen and pest infestations and can increase the fuel load in the forest. Pest outbreaks occur within the dead wood of the windthrown trees. Pests can rapidly spread into neighboring live trees, causing further mortality. In small pockets, pest outbreaks can be beneficial to many species further up the food chain. More widespread wind events can cause an over-abundance of pests that wreak havoc on neighboring forested areas.

14.5.2 Changed and unforeseen circumstances for windthrow

14.5.2.1 Changed circumstance

A windstorm constitutes a changed circumstance if one or more of the following conditions apply, i.e., the storm results in

- Windthrow of more than 200 ft (61 m), measured along a Class I or Class II watercourse, and a decrease of 60% of the trees > 16 in. dbh within the AMZ.
- Windthrow of at least 100 ac (40.5 ha) outside the AMZ.
- Windthrow of at least 10 ac (4.05 ha) in LACMA.
- Windthrow that reduces more than 150 ac of suitable habitat per territory for up to 4 northern spotted owl territories receiving high or moderate protection.

14.5.2.2 Unforeseen circumstance

A windstorm constitutes an unforeseen circumstance if one or more of the following conditions apply, i.e., the storm results in

- Windthrow of more than 500 ft (152 m), measured along a Class I or Class II watercourse, and a decrease of more than 75% of the trees >16 in. dbh within the AMZ.
- Windthrow of more than 500 ac (202 ha) outside the AMZ.
- Windthrow of more than 50 ac (20 ha) in LACMA.
- Windthrow that reduces more than 400 ac (162 ha) of suitable habitat per territory for 5 or more northern spotted owl territories receiving high or moderate protection.

14.5.3 MRC response to windthrow

14.5.3.1 Windthrow does not trigger a changed circumstance

In the event windthrow does not constitute a changed circumstance but does occur on more than 5 ac, MRC will take the following action:

- MRC may propose timber harvesting in areas affected by windthrow to salvage trees that are likely to die or that are no longer viable for timber production as well as downed wood, in accordance with the following prescriptions:
  - MRC will retain snags according to the snag retention policy.
  - MRC, in addition to the conservation measures for snags and wildlife trees, will retain 1 snag > 24 in. dbh and more than 40 ft high, if present.
  - MRC will meet, in Class I and Large Class II AMZ, objective O§9.2.2-1 (namely, retain 6 hard logs *on average per acre* that are (a) ≥ 16 in. average diameter, (b) ≥ 6 ft long, and (c) derived from at least 3 trees).

    NOTE

    If proposing harvest of downed wood, MRC will survey to ensure that enough downed wood exists in the stand to complete such a harvest.
  - MRC will meet, in general forested areas, objective O§9.2.2-2 (namely, retain 5 hard logs *on average per acre* that are (a) ≥ 16 in. average diameter, (b) ≥ 6 ft long, and (c) derived from at least 3 trees.)
  - MRC may harvest hard snags if the objective for hard snag retention is already met prior to harvest
  - MRC will not harvest (a) old growth trees; (b) trees in which the diameter of the entrance hole leading to a cavity is greater than 3 in. and 10 ft or more above the ground; (c) nest trees of northern spotted owls; (d) trees that are potential habitat for marbled murrelet; (e) trees over 24 in. dbh with basal hollows that are more than 12 in. in any horizontal dimension and extend at least 6 in. vertically inside the cavity from the topmost point of the entrance hole; (f) standing trees with known raptor nests; or (g) granary trees.
  - MRC will not reduce AMZ conservation measures, including the prohibition on salvaging, unless the wildlife agencies concur.
  - MRC will harvest downed wood to prevent a pest outbreak by removing the brood material.
  - MRC will remove logs or portions of logs within Class I or Class II watercourses to prevent a diversion or reduce the risk of pest outbreak, with concurrence of the wildlife agencies.
  - MRC will not reduce conservation measures in TSUs.
  - MRC will provide rare plant protection measures for known occurrences that may be affected by the harvest.
  - MRC will not harvest within extended protection areas of northern spotted owl territories with moderate or high protection unless the wildlife agencies concur that (a) the proposed harvest will improve conditions for the owls or (b) MRC can replace the affected extended protection areas and core areas with high-producing owl territories currently receiving high or moderate protection within the same inventory block.
- MRC will receive approval from the wildlife agencies before taking any actions after a windthrow incident in LACMA.

14.5.3.2 Windthrow triggers a changed circumstance

In the event windthrow does constitute a changed circumstance, MRC will take the following action:

- MRC may propose timber harvesting in areas affected by windthrow to salvage trees that are likely to die or that are no longer viable for timber production as well as downed wood, in accordance with the following prescriptions:
  - MRC will retain snags according to the snag retention policy.
  - MRC, in addition to the conservation measures for snags and wildlife trees, will retain 1 snag > 24 in. dbh and more than 40 ft high, if present.
  - MRC may harvest hard snags if the objective for hard snag retention is already met prior to harvest.
  - MRC will not harvest (a) old growth trees; (b) trees in which the diameter of the entrance hole leading to a cavity is greater than 3 in. and 10 ft or more above the ground; (c) nest trees of northern spotted owls; (d) trees that are potential habitat for marbled murrelet; (e) trees over 24 in. dbh with basal hollows that are more than 12 in. in any horizontal dimension and extend at least 6 in. vertically inside the cavity from the topmost point of the entrance hole; (f) standing trees with known raptor nests; or (g) granary trees.
  - MRC will exceed, in Class I and Large Class II AMZ, objective O§9.2.2-1 (namely, retain at least 6 hard logs *on average per acre* that are (a) ≥ 16 in. average diameter, (b) ≥ 6 ft long, and (c) derived from at least 3 trees) by leaving 1 additional log/ac, i.e., at least 7 logs/ac.

    NOTE

    If proposing harvest of downed wood, MRC will survey to ensure that enough downed wood exists in the stand to complete such a harvest.
  - MRC will exceed, in general forested areas, objective O§9.2.2-2 (namely, retain at least 5 hard logs *on average per acre* that are (a) ≥ 16 in. average diameter, (b) ≥ 6 ft long, and (c) derived from at least 3 trees) by leaving 1 additional log/ac, i.e., at least 6 logs/ac.

    NOTE

    If proposing harvest of downed wood, MRC will survey to ensure that enough downed wood exists in the stand to complete such a harvest.
  - MRC will not reduce AMZ conservation measures, including the prohibition on salvaging, unless the wildlife agencies concur.
  - MRC will harvest downed wood to prevent a pest outbreak by removing the brood material.
  - MRC will remove logs or portions of logs within Class I or Class II watercourses to prevent a diversion or reduce the risk of pest outbreak, with concurrence of the wildlife agencies.
  - MRC will not reduce conservation measures in TSUs.
  - MRC will conduct a rare plant survey prior to any operations, even if such operations fall outside the blooming season.
  - MRC will conduct an additional rare plant survey during the blooming season if we do not complete salvage operations prior to blooming season.
  - MRC will protect known and newly detected rare plants with the conservation measures specified in Chapter 11, *Conservation Measures for Rare Plants*.
  - MRC will not harvest within extended protection areas of northern spotted owl territories with moderate or high protection unless the wildlife agencies concur that (a) the proposed harvest will improve conditions for the owls or (b) MRC can replace the affected extended protection areas or core areas with high-producing owl territories currently receiving high or moderate protection within the same inventory block.
  - MRC will re-forest windthrown areas by planting conifers and by other silvicultural treatments, within the first winter following the windthrow or the first winter following a salvage operation.

- MRC will receive approval from the wildlife agencies before taking any actions after a windthrow incident in LACMA.

14.6 Earthquake

Several earthquake zones, including the San Andreas Fault and the Maacama Fault, affect the plan area. An earthquake of 7.0 or higher on the Richter scale is considered a major earthquake. The Tohoku earthquake, for example, that occurred on 11 March 2011 near the northeast coast of Honshu, Japan was a 9.0, while the earthquake that struck Haiti on 12 January 2010 was a 7.0. Earthquakes of magnitude 4.0 and less are common in California. Since 1975, however, at least 8 earthquakes of magnitude 5.0 or higher have been recorded near the plan area (Table 14-1). On August 1-2, 1975, 3 earthquakes spread out from an epicenter near Oroville, CA, about 65 mi. (point-to-point) from the eastern boundary of our Ukiah inventory block. Another 4 earthquakes originated from an epicenter south of Eureka and off the coastline—again about 65 miles (point-to-point) from the northwestern border of the plan area; these occurred on 16 March 2000, 19 July 2006, 26 February 2007, and 9 May 2007. Finally, on 10 January 2010, a more powerful earthquake—6.5— radiated again from this approximate location out in the ocean. Events of this magnitude are not predictable.

Table 14-1 Earthquakes Above 5.0 Near Plan Area: 1975-2011

Date	Latitude	Longitude	Magnitude
08/01/1975	39.4322	121.546	5.7
08/02/1975	39.4493	121.480	5.1
08/02/1975	39.4378	121.485	5.2
03/16/2000	40.3887	125.239	5.7
07/19/2006	40.2807	124.433	5.0
02/26/2007	40.6428	124.863	5.4
05/09/2007	40.3745	125.016	5.2
01/10/2010	40.6520	124.693	6.5
05/17/2011	39.2200	123.170	3.8

TABLE NOTE
The information in this table is from the Northern California Earthquake Data Center (NCEDC), a joint project of the University of California Berkeley Seismological Laboratory (BSL) and the United States Geological Survey (USGS). See the complete data at http://www.ncedc.org/ncedc/catalog-search.html (accessed 11 April 2011).

Landslides from earthquakes can occur in areas with high topographic relief and unstable surface soils. MRC produces maps of areas susceptible to mass wasting (*HCP/NCCP Atlas*, MAPS 5A-C). Tsunamis can also be triggered by earthquakes. Since 2000, the most lethal tsunamis across the globe were those resulting from the Sumatra-Andaman earthquake in 2004 and the Japanese earthquake in 2011. In the latter case, the tsunami surged 5000 miles across the Pacific Ocean and slammed into the coast of northern California on March 12, 2011, causing scattered damage to boats and harbors from Santa Cruz to the Oregon border. While there have been various tsunamis from distant earthquakes to strike northern California, the one generated from the 1964 earthquake in Prince William Sound, Alaska (magnitude 9.2—the 2nd largest in history) was the most destructive. However, these events, and their magnitude and frequency, are unpredictable. Since the magnitude and frequency of tsunamis are unpredictable, any tsunami that affects covered lands is considered an unforeseen circumstance.

14.6.1 Changed and unforeseen circumstances for earthquakes

The changed and unforeseen circumstances for earthquakes are covered under other sections, such as mass wasting.

14.7 Mass Wasting

Most mass wasting occurs during large storms, particularly on slopes weakened by logging (Kelsey et al. 1995). Climate-based models suggest that the frequency of mass wasting has increased since the late 1930s due to the frequency of high-intensity storms (Reid 1998b). Without proper land management, failure frequency increases for a given storm frequency, resulting in higher rates of landslide erosion (Kelsey et al. 1995).

14.7.1 Effects of mass wasting

Mass wasting has a significant impact on the forest ecosystem. Impacts may include changes to existing plant communities and changes in the amount of sediment delivery to streams. Such changes may impact wildlife and aquatic habitat in a positive or negative way. Mass wasting, for instance, may provide coarse sediment and large woody debris to stream channels that are important sources of spawning, rearing, and over-wintering habitat. Conversely, mass wasting can fill pools and scour riffles, block fish access, disturb side-channel rearing areas, and add fines to spawning gravels.

2006 Landslide at Headwaters of South Fork Garcia (Plan Area)

MRC has designed the conservation measures for riparian areas, road use, road construction, and mass wasting to reduce management-induced mass wasting events. However, we estimate that it will take about 30-40 years to address legacy issues.[6] A storm with a return interval of 50 years or more could be problematic for meeting HCP/NCCP objectives in that time frame, because a majority of the existing crossings only meet 50-year standards. Large mass wasting events (man-made or natural) could obliterate habitat for covered species, e.g., filling in breeding sites of red-legged frogs or silting over salmon spawning gravels. The proximity of a mass wasting event to covered species and the ability of the watershed to transport the additional sediment determine the level of impact. In 1995, the Floodgate slide—so called because it was near Floodgate Creek— was one of the largest mass wasting events in the plan area. The slide occurred during a heavy rain event and delivered approximately 84,000 tons (about 70,000 yd^3) of sediment into the mainstem Navarro, temporarily damming it. Although large in size, we do not believe that such an event, occurring today, would prevent MRC from meeting our HCP/NCCP objectives. The Navarro was able to move the sediment relatively quickly through the remainder of the watershed. However, an event of the same magnitude in the upper reaches of a much smaller watershed could have a severe impact on covered species for a longer period of time. In a smaller watershed, sediment remains

[6] Sections 8.3.3.2.1 to 8.3.3.2.3 detail the MRC schedule for treating controllable erosion. Basically, during the first 20 years of HCP/NCCP implementation, MRC will treat controllable erosion sites which have a high or moderate priority and are within coho core watersheds. MRC will treat all high and moderate sites by Year 30 of HCP/NCCP implementation and all low priority sites by Year 40.

in the system longer, precluding breeding or spawning and shrinking available rearing habitat for an indefinite period of time.

14.7.2 Changed and unforeseen circumstances for mass wasting

14.7.2.1 Changed circumstance

A mass wasting event constitutes a changed circumstance if it delivers more than 20 yds^3 of sediment per acre of upstream drainage (upstream of the affected watercourse) to a Class I or Large Class II watercourse in 3 years.

14.7.2.2 Unforeseen circumstance

A mass wasting event constitutes an unforeseen circumstance if one or more of the following conditions apply, i.e., the event or combination of events

- Coincides with a storm that has a return interval equal to or greater than 100 years.
- Delivers more than 50 yds^3 of sediment per acre of upstream drainage (upstream of the affected watercourse) to a Class I or Large Class II watercourse in 3 years.

14.7.3 MRC response to mass wasting

14.7.3.1 Mass wasting triggers a changed circumstance

In the event of mass wasting that constitutes a changed circumstance, MRC will take the following actions:

- MRC will re-forest affected areas by planting conifers and by other silvicultural treatments within the first winter following a mass wasting event or the first winter following a salvage operation.
- MRC will complete a watershed analysis, including road inventory, for the affected planning watershed or watershed analysis unit within 2 years of the mass wasting event, unless the wildlife agencies extend the time period because of the scope of the required effort.

  NOTE
  MRC will use watershed analysis to develop sediment prevention plans for activities and roads in the watershed, based on the condition of stream channels after a mass wasting event.
- MRC will add, with the approval of the wildlife agencies, key pieces of LWD to watercourses that fall below HCP/NCCP objectives.
- MRC will repair watercourse crossings within 3 years of watershed analysis, starting with those that still have uncontrolled fill, compromised capacity, or structural problems.

  NOTE
  Depending on the amount of work entailed, MRC may extend the time for the repairs with concurrence from the agencies.
- MRC will initiate surveys for red-legged frog breeding sites and assess damage in the first year following a mass wasting event that triggers a changed circumstance.

  NOTE
  Sites are no longer viable when mass wasting events fill in the breeding site.
- MRC may restore, with the approval of the wildlife agencies, damaged red-legged frog breeding sites or create new sites in adjacent areas within the same planning watershed that were not affected by mass wasting.
- MRC will initiate distribution surveys for tailed frogs, coho salmon, Chinook salmon, and steelhead, and assess damage in the first year following the mass wasting event.

- MRC will evaluate a landslide to determine causes and, if due to land management, will propose enhancements to relevant practices such as road and landing specifications.
- MRC may propose timber harvesting in areas affected by mass wasting to salvage trees that are likely to die or that are no longer viable for timber production as well as downed wood, in accordance with the following prescriptions:
  - MRC will retain snags according to the snag retention conservation measures (C§9.2.3.1-1 to C§9.2.3.1-3).
  - MRC, in addition to the conservation measures for snag and wildlife trees, will retain 1 snag > 24 in. dbh and more than 40 ft high, if present.
  - MRC may harvest hard snags if the objective for hard snag retention is already met prior to harvest.
  - MRC will not harvest (a) old growth trees; (b) trees in which the diameter of the entrance hole leading to a cavity is greater than 3 in. and 10 ft or more above the ground; (c) nest trees of northern spotted owls; (d) trees that are potential habitat for marbled murrelet; (e) trees over 24 in. dbh with basal hollows that are more than 12 in. in any horizontal dimension and extend at least 6 in. vertically inside the cavity from the topmost point of the entrance hole; (f) trees with known raptor nests; or (g) granary trees.
  - MRC will exceed, in Class I and Large Class II AMZ, objective O§9.2.2-1 (namely, retain at least 6 hard logs *on average per acre* that are (a) ≥ 16 in. average diameter, (b) ≥ 6 ft long, and (c) derived from at least 3 trees) by leaving 1 additional log/ac, i.e., at least 7 logs/ac.

    NOTE

    If proposing harvest of downed wood, MRC will survey to ensure that enough downed wood exists in the stand to complete such a harvest.
  - MRC will exceed, in general forested areas, objective O§9.2.2-2 (namely, retain at least 5 hard logs *on average per acre* that are (a) ≥ 16 in. average diameter, (b) ≥ 6 ft long, and (c) derived from at least 3 trees) by leaving 1 additional log/ac, i.e., at least 6 logs/ac.

    NOTE

    If proposing harvest of downed wood, MRC will survey to ensure that enough downed wood exists in the stand to complete such a harvest.
  - MRC will not reduce AMZ conservation measures, including harvesting of downed wood, unless the agencies concur that is beneficial.
  - MRC will harvest downed wood to prevent a pest outbreak by removing the brood material.
  - MRC will not remove logs or portions of logs within Class I or Class II watercourses (e.g., to prevent a diversion or reduce the risk of pest outbreak), unless the wildlife agencies concur.
  - MRC will not reduce conservation measures in TSUs.
  - MRC will not fell trees from the toe of a slide unless a professional geologist concurs that the felling is necessary to stabilize the toe; removal of the trees is permitted only with concurrence of the wildlife agencies.
  - MRC will note in reports on canopy and shade conditions in planning watersheds the number, timing, and size of any mass wasting event that results in a changed circumstance during the prior 20 years.
  - MRC will conduct a rare plant survey prior to any operations, even if such operations fall outside the blooming season.
  - MRC will conduct an additional rare plant survey during the blooming season.
  - MRC will protect known and newly detected rare plants with the conservation measures specified in Chapter 11, *Conservation Measures for Rare Plants*.

- MRC will not harvest within extended protection areas of northern spotted owl territories receiving high or moderate protection unless the wildlife agencies concur (a) that the proposed harvest will improve conditions for the owls or (b) that MRC can replace the affected extended protection areas and core areas with high-producing territories currently receiving limited protection within the same inventory block or (c) that MRC should remove brood material from the eroded area to prevent a pest outbreak.

14.8 Floods

Stream flows are responsive to rain, particularly heavy rainfall that saturates soil. Along the north coast, the majority of the precipitation and floods occur in the late fall and winter. Flow data for the Navarro and Noyo rivers from the last 50 years indicates that there have been 4 floods with a magnitude greater than a 20-year recurrence and 4 with a magnitude greater than a 10-year recurrence. These floods have the capacity to re-shape stream channels and transport sediment and large woody debris.

14.8.1 Effects of floods

Large floods affect fluvial processes, such as sediment transport, and can impact riparian habitat. During floods, hill slope stability decreases due to increased moisture in the soil. This, in turn, results in increased frequency and magnitude of mass wasting events and increased sediment delivery to streams. Channel alterations can be extreme, with scour or deposition of coarse sediment, changes to the course of a stream, and decreased stream bank stability. Riparian vegetation is affected by loss of bank stability and deposition of sediment on inundated floodplains. Increased transport of debris in streams can cause failure of stream crossings.

Redwoods are more tolerant to periodic flooding and subsequent burial of their root system than species such as tanoak and Douglas fir (Stone 1965). After their roots are buried, roots first grow vertically through the deposited sediments and then later horizontally to keep the root system just below the surface (Stone 1965; Stone and Vasey 1968, as cited in Sawyer et al. 2000b). With each new deposit, a new root system is developed.

MRC has designed new stream crossings to pass a 100-year flood. Previous owners of the land designed stream crossings to pass a 25-year flood. Conservation measures for riparian areas, road use, road construction, and mass wasting should reduce the effects of management-induced mass wasting events.

14.8.2 Changed and unforeseen circumstances for flood

14.8.2.1 Changed circumstance

- A flood with a magnitude ≥ 25-year recurrence, as determined by any gauging station near the watershed in question with a flood record covering at least 20 years, constitutes a changed circumstance.

14.8.2.2 Unforeseen circumstance

- A flood of magnitude > 100-year recurrence, as determined by any gauging station near the watershed in question with a flood record covering at least 20 years, constitutes an unforeseen circumstance.[7]

14.8.3 MRC response to flood

14.8.3.1 Flood triggers a changed circumstance

In the event a flood constitutes a changed circumstance, MRC will take the following actions:

- MRC may re-set priorities for road re-construction or decommissioning, as well as channel and slope stabilization.
- MRC will complete a rapid road assessment and crossing inventory (noting any changes to controllable volume and treatment priority from the initial inventory) within 1 year of the flood event, unless the wildlife agencies extend the time period because of the scope of the required effort.
- MRC will revise the watershed analysis, as necessary, for the affected planning watershed or watershed analysis unit (WAU) within 2 years of the flood event, unless the wildlife agencies extend the time period because of the scope of the required effort.

  NOTE
  MRC will use the revised watershed analysis to develop sediment prevention plans for activities and roads in the watershed. We will determine the need for such plans based on the condition of stream channels after the flood event.
- MRC will repair, within 1 year of the rapid road and crossing assessment, all watercourse crossings designated high priority as a result of the flood event (starting with those at risk of imminent failure) and do so according to the most current 100-year standard,
- MRC will complete repairs of watercourse crossings upgraded to high priority as a result of the flood event within 3 years of the revised watershed analysis.

  NOTE
  The wildlife agencies may extend the time period because of the scope of the required effort.

14.9 Pathogens and pests

Dying Tanoaks in a Redwood Forest in Marin County
College of Natural Resources, University of California, Berkeley

Insects, fungi, and pathogens, including viruses, underlie the stability and productivity of the forest ecosystem (Bormann and Likens 1979, Edmonds 1982, Swank and Crossley 1987, as cited in Schowalter et al. 1997). These organisms can increase primary productivity through pruning, thinning, and stimulating nutrient cycling (Mattson and Addy 1975, Wickman 1980, Alfaro and Shepard 1991, as cited in Schowalter et al. 1997). Changes in stand characteristics caused by pathogens and insects usually occur slowly, with a few exceptions such as some bark beetle outbreaks (Schowalter et al. 1997). Outbreaks of any of these organisms do not pose a threat to forests in

[7] As of 2005, the 25-year flood event at the Navarro River (USGS gauging station #11468000) had a peak discharge of about 54,000 cfs, while the 100-year flood event had a peak discharge of about 72,950 cfs. Refer to http://waterdata.usgs.gov/ca/nwis/uv?site_no=11468000

general (Schowalter et al. 1997).
Researchers predict that epidemic outbreaks in many forests will increase due to past timber practices, such as establishing monocultures and fire suppression.

Overcrowding and climate change may also exacerbate these outbreaks; however, appropriate forest practices, such as thinning and uneven-aged management, can control pathogens and pests (Schowalter et al. 1997). Within the term of our HCP/NCCP, additional non-native pathogens will likely find their way onto covered lands, especially given global travel and trade.

Viruses, fungi, and other pathogens can impact wildlife in the plan area. Chytrid fungus may infect covered amphibians, and West Nile virus may infect northern spotted owls.

Several plant pathogens and pests present potential risks to MRC forests. The greatest threat is from introduced pathogens, such as Sudden Oak Death (SOD). Native trees can coexist with native pathogens and insects, but have little or no resistance to introduced pathogens (Schowalter et al. 1997).

Sudden Oak Death
Photo by Pavel Svihra, UCCE

SOD has occurred on approximately 0.25 ac of MRC forest land in 2 locations of the Annapolis tract. MRC suspects SOD in portions of Willow Creek as well. None of these locations are within the plan area. Although not confirmed, SOD may be in Mendocino County at Rockpile Creek in the Gualala River watershed. If the Rockpile Creek area does have SOD, it could affect the Garcia inventory block in the plan area, since the suspected infestation is within the Gualala River drainage. Upper Garcia River, well above the plan area, has confirmed SOD in the Mailliard Redwoods Reserve. SOD also appears to be downstream of this reserve. While many of the aforementioned infestations have not been confirmed through tissue analysis, large swaths of tanoak have died, in some cases denuding the canopy along large creeks in Anchor Bay.[8]

There are pockets of Douglas fir, approximately 2 ac in size, which have died in the Lower Albion as a result of the Douglas fir beetle (Dendroctomus pseudotsuga) and the flathead fir borer (Melanophila drumondi). The pockets, observed in 1999 by CAL FIRE Forest Pathologist Jack Marshall, are mainly contained within the Watercourse and Lake Protection Zone (WLPZ) of the plan. The age of the mortality suggests the infestation has passed (Marshall 1999). The infestation was the result of large concentrations of windthrow. MRC is also in the zone of infestation for pine pitch canker, but there are no documented cases in the plan area. The closest known site is located adjacent to HWY 1 in Anchor Bay.

Pathogens Cause Die-back to Conifer Branches
Photo by Dr. David Rizzo
University of California, Davis

[8] Email to Elicia Wise (MRC) from Jack Marshall (CAL FIRE) on September 28, 2006

14.9.1 Effects of pests and pathogens

Although there are a few pathogens and insects that infect redwoods, large outbreaks in redwood forests are uncommon; there are currently no known pathogens that kill redwoods past the seedling stage (Sawyer et al. 2000b).

Several different pathogens and pests can affect Douglas-fir stands. Likewise, several insects, including the Douglas-fir tussock moth and the western spruce budworm, can heavily defoliate forest stands, sometimes over several years. The Douglas-fir beetle is a key pathogen for Douglas-fir stands (Schmitz and Gibson 1996). Outbreaks occur sporadically and are of short duration, although usually severe, especially after episodes of windthrow or fire. Coastal Douglas fir is more resistant to the beetles than inland Douglas fir. The higher moisture content in the soil and air prevents wood from drying and beetles from thriving in the green or moist wood.

Chytridiomycosis is an infectious disease, caused by the chytrid fungus, which results in mass mortality in frog populations. The chytrid fungus attacks a substance called keratin, a tough, fibrous protein that forms a resistant layer in amphibian skin; in frogs infected by chytrid fungus, this layer is damaged. The fungus can also damage or destroy teeth, which are composed of keratin as well. MRC biologists have only observed absent teeth in bullfrogs in the plan area; however, there is no evidence that ties this condition to chytrid.

West Nile virus (WNV) is a mosquito-borne disease. Originally seen in Africa, it was detected in the eastern United States as early as 1999. Subsequently, it has spread throughout the United States, likely arriving in California around 2003. Mosquitoes are the primary carriers of the disease. They become infected when they feed on infected birds. Studies suggest a higher susceptibility to the disease in corvids and raptors (Ellis, et. al., 2007). A bite from an infected mosquito can then spread WNV to humans and other animals. The website of the California Department of Health publishes information and statistics on the disease (Table 14-2). As of 1st quarter 2011, only Sacramento and Riverside Counties in California had reportable cases of WNV—1 infection in a dead bird and the other in a single mosquito sample. Between January 2007 and April 2011, Mendocino County reported a total of 7 cases of WNV (Table 14-3).

Table 14-2 California Statistics: West Nile Virus (2003-2011)

California West Nile Virus Summary: 2003-2011										
Type Case	2003	2004	2005	2006	2007	2008	2009	2010	2011	Total
Human (fatal)	3(0)	779(29)	880(19)	278(7)	380(21)	445(15)	112(4)	111(6)	0	2988(101)
Horses	1	540	456	58	28	32	18	19	0	1152
Dead Birds	96	3232	3046	1446	1396	2569	515	416	1	12,717
Mosquito Samples	32	1136	1242	832	1007	2003	1063	1305	1	8621
Sentinel Chickens	70	809	1053	640	510	585	443	281	0	4391
Squirrels	0	49	48	32	26	32	10	24	0	221

TABLE NOTE
Table 14-2 is adapted from a similar table at http://www.westnile.ca.gov/. The numbers were last updated on 03/09/2011.

Table 14-3 Mendocino County Statistics: West Nile Virus (2007-2011)

Mendocino County West Nile Virus Summary: 2007-2011						
Type Case	2007	2008	2009	2010	2011	Totals
Human (fatal)	2					2
Horses						
Dead Birds	3	1				4
Mosquito Samples						
Sentinel Chickens						
Squirrels	1					1

TABLE NOTE
Table 14-3 is adapted from information at http://www.westnile.ca.gov/. The numbers were last updated on 04/19/2011.

Outbreaks of pests or pathogens could adversely impact the ability of MRC to meet some HCP/NCCP objectives. Pathogens, such as sudden oak death, could reduce forest canopy and alter the food web of associated communities. This could negatively affect streamside canopy along sensitive AMZ areas. LWD may increase due to the breakdown of hardwoods; however, tanoak decays more rapidly than conifers, so the increase may only be temporary. Upslope areas may also become denuded of tanoak, which is a valuable food source for many wildlife species. Currently, MRC employees inspect areas for signs of SOD, and insure that material moved off of plan sites stays within the "zone of infestation." Licensed timber operators (LTOs) inspect material on log trucks to avoid moving small leaves and branches, which are more susceptible to the spread of the pathogen.

14.9.2 Changed and unforeseen circumstances for pathogens and pests

14.9.2.1 Changed circumstance

Pathogens or pest outbreaks constitute a changed circumstance if one or more of the following conditions apply, i.e. the outbreak

- Covers more than 100 ac, in total, within a plan area watershed where MRC owns 10% or more of the land—for causes not related to SOD.
- Covers more than 1000 ac, in total, within a plan area watershed where MRC owns 10% or more of the land—for causes related to SOD.
- Covers more than 10 ac in LACMA.
- Reduces more than 150 ac of suitable habitat per territory for up to 4 northern spotted owl territories receiving high or moderate protection—for causes not related to SOD.
- Reduces more than 300 ac of suitable habitat per territory for up to 4 northern spotted owl territories receiving high or moderate protection—for causes related to SOD.
- Results in the direct mortality of up to 4 northern spotted owls whose territories received high or moderate protection.

14.9.2.2 Unforeseen circumstance

Pathogens or pest outbreaks constitute an unforeseen circumstance if one or more of the following conditions apply, i.e. the outbreak

- Covers more than 500 ac, in total, within a plan area watershed—for causes not related to SOD.
- Covers more than 2000 ac, in total, within a plan area watershed—for causes related to SOD.
- Covers more than 50 ac in LACMA.
- Results in a reduction of more than 400 ac (162 ha) of suitable habitat per territory for 5 or more northern spotted owl territories receiving high or moderate protection.
- Results in the direct mortality of 5 or more northern spotted owls whose territories received high or moderate protection.
- Results in the loss of more than 5 active red-legged frog breeding sites detected during initial survey within a planning watershed.
- Results in coho salmon, Chinook salmon, or steelhead remaining undetected in more than 3 stream reaches for more than 3 years.
- Results in the loss of coastal tailed frogs from more than 75% of known occupied coastal tailed frog sites within a planning watershed.

14.9.3 MRC response to pathogens and pests

14.9.3.1 Outbreak of pathogens or pests does not trigger a changed circumstance

MRC understands that prevention and early intervention are essential to successfully and efficiently confront outbreaks of pathogens and pests, especially those that are not native to the area. To that end, MRC aquatic specialists already follow a policy designed to prevent the transfer of aquatic pathogens from one watershed to another (see Appendix X, *Pathogen Transfer*).

- MRC will cooperate and participate as possible with individuals and organizations working on early detection activities relative to new pathogens and pests.
- MRC will consult with a professional regarding unexplained forest health issues or fish and wildlife die-offs, such as a forest or wildlife pathologist, and with the wildlife agencies to determine the causes for the outbreak and alternatives for remediation.
- MRC will inform the wildlife agencies of any proposed actions regarding outbreaks of pathogens.
- MRC will cooperate and participate as possible with individuals and organizations working on rapid response and eradication activities relative to new pathogens and pests.
- MRC will follow guidelines proposed by state or federal agencies relative to prevention, quarantine, and treatment of pathogens and pests.
- MRC will develop a plan to address outbreaks of invasive exotic species on covered lands (C§9.7.3-1 to C§9.7.3-4).

14.9.3.2 Outbreak of pathogens or pests triggers a changed circumstance

- MRC will consult with a professional, such as a forest or wildlife pathologist, and with the wildlife agencies to determine the causes for the outbreak and possible remediation.
- MRC will re-forest areas affected by pests or pathogens.
- MRC may propose timber harvesting in infected areas to harvest trees that are likely to die or are no longer viable for timber production in accordance with the following prescriptions:
  - MRC will retain snags according to the snag retention conservation measures (C§9.2.3.1-1 to C§9.2.3.1-3).
  - MRC, in addition to conservation measures for snags and wildlife trees, will retain 1 snag > 24 in. dbh and more than 40 ft high, if present.

  - MRC may harvest hard snags, if the objective for hard snag retention is already met.
  - MRC will not harvest the following trees unless a forest pathologist determines that they need to be removed to stop the spread of a pathogen: (a) old growth trees; (b) trees in which the diameter of the entrance hole leading to a cavity is greater than 3 in. and 10 ft or more above the ground; (c) nest trees of northern spotted owls; (d) trees that are potential habitat for marbled murrelet; (e) trees over 24 in. dbh with basal hollows that are more than 12 in. in any horizontal dimension and extend at least 6 in. vertically inside the cavity from the topmost point of the entrance hole; (f) trees with known raptor nests; or (g) granary trees.
  - MRC will exceed, in Class I and Large Class II AMZ, objective O§9.2.2-1 (namely, retain at least 6 hard logs *on average per acre* that are (a) ≥ 16 in. average diameter, (b) ≥ 6 ft long, and (c) derived from at least 3 trees) by leaving 1 additional log/ac, i.e., at least 7 logs/ac.

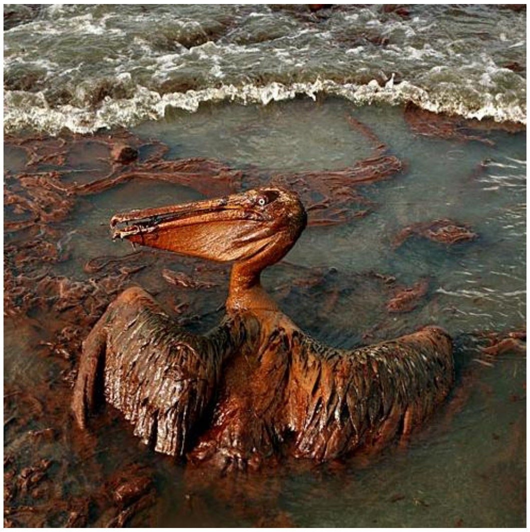
    NOTE

    If proposing harvest of downed wood, MRC will survey to ensure that enough downed wood exists in the stand to complete such a harvest.
  - MRC will exceed, in general forested areas, objective O§9.2.2-2 (namely, retain at least 5 hard logs *on average per acre* that are (a) ≥ 16 in. average diameter, (b) ≥ 6 ft long, and (c) derived from at least 3 trees) by leaving 1 additional log/ac, i.e., at least 6 logs/ac.

    NOTE

    If proposing harvest of downed wood, MRC will survey to ensure that enough downed wood exists in the stand to complete such a harvest.
  - MRC will not reduce AMZ conservation measures, unless to prevent an outbreak of a pathogen by harvesting downed wood with brood material.
  - MRC will not remove logs or portions of logs within Class I or Class II watercourses unless the wildlife agencies concur that such removal is beneficial, e.g., in preventing a diversion or eliminating brood material.
  - MRC will not reduce TSU conservation measures, unless the wildlife agencies concur.
  - MRC will conduct 1 rare plant survey during the first blooming season after an outbreak of pests or pathogens in any location where the outbreak necessitates sanitation or a salvage timber harvest.
  - MRC will protect any known or discovered occurrences of rare plants with the protection measures specified in Chapter 11, *Conservation Measures for Rare Plants*.
  - MRC will not harvest within the extended protection areas of northern spotted owl territories receiving high or moderate protection unless the wildlife agencies concur that (a) the proposed harvest would improve habitat; (b) the proposed harvest is necessary to remove brood material and prevent a pest outbreak; or (c) the extended protection area and core area can be replaced by high producing owl territories currently receiving limited protection.
  - MRC may, with concurrence of the wildlife agencies, harvest trees and logs below the standards mentioned above, if retaining the trees and logs is contrary to the goal of reducing or eliminating the pest or pathogen outbreak.
- MRC will restore damaged red-legged frog breeding sites or create new sites in adjacent, unharmed areas within the same planning watershed, in concurrence with the wildlife agencies.
- MRC will not draft water from an infected watershed in the event there are water borne pathogens without taking precautions approved by the wildlife agencies.

14.10 Toxic Spills



Oil-soaked Pelican in Barataria Bay, LA
Photographer: Carolyn Cole - *Los Angeles Times*
4 June 2010

In May 2010, the oil spill that resulted from the explosion and sinking of the oil rig, Deep Horizon, in the Gulf of Mexico became the worst such incident in U.S. history, creating devastation for wildlife and ecosystems. It drew public attention once again to concerns about toxic contamination of our environment. MRC has developed, in-house, a prevention and response plan for toxic spills in our forestlands. Because this plan is already in place and is outside the purview of the HCP/NCCP, we will not propose any additional procedures. When required, MRC will inform the necessary governmental agencies of toxic spills. Mendocino County Department of Environmental Health is the lead agency for spills in Mendocino County. The RWCB, CDFG, EPA and CEPA would also be part of remediation.

14.11 Species interactions

In a healthy ecosystem, native species evolve to co-exist. However, sometimes community structure and processes can change in undesirable ways (e.g., species irruptions and declines). Achieving management goals and objectives may demand intervention.

Non-native species are often more tolerant to disturbances and can out-compete native species. Although many of these non-native species are known, MRC cannot predict their long-term effect on endangered or threatened species and community processes in the plan area. The introduction of non-native species or the extension of their geographical range can have detrimental effects, possibly irreversible, on the abundance and composition of native species. Prevention is a critical element in management. Sections 14.11.1 to 14.11.3 focus on 3 species in the plan area: bullfrogs, wild pigs, and barred owls. Section 14.11.4 describes the MRC response to invasions of these species during the 80-year term of our HCP/NCCP.

If MRC discovers new invasive animal species during the term of the plan which threaten our biological objectives for covered species, we will develop with the wildlife agencies a plan to control the spread of these infestations or develop a landscape-level plan to manage the infestations. As part of the conservation measures for invasive species (C§9.7.3-1), MRC will also develop an Invasive Plant Control Program (9.7.3.1) with similar goals.

14.11.1 Bullfrogs

The bullfrog is the largest frog in North America, reaching over 6 in. (15 cm) in length. Bullfrogs occur in a variety of aquatic habitats, including rivers, lakes, streams, swamps, and marshes. Bullfrogs require permanent bodies of water, such as lakes, sloughs, creeks, and ponds for breeding. They are voracious feeders and eat almost anything that they can swallow, including insects, crayfish, earthworms, spiders, snails, salamanders, other frogs, snakes, turtles, fish, birds, small rodents, and bats.

Bullfrog
Photo by
Michael P. Gadomski

Red-legged frogs are California's largest native frog. They have been listed as a threatened species since 1996 due in part to the introduction of the American bullfrog, a non-native species. In laboratory studies, researchers found that the presence of bullfrog adults and tadpoles significantly reduced mass-at-metamorphosis, increased time-to-metamorphosis, and decreased survival-to-metamorphosis of red-legged frog tadpoles (Kiesecker and Blaustein 1998). Adult bullfrogs also significantly decreased the survival of post-metamorphs of northern red-legged frogs. The presence bullfrog tadpoles and small-mouth bass appeared to hinder development of larval red-legged frogs (Kiesecker and Blaustein 1998).

Bullfrogs are present in some Class I watercourses and ponds within the plan area, e.g., near occupied breeding habitat of red-legged frogs in the Albion River, Navarro River (Ray Gulch), and Greenwood Creek. MRC has engaged in bullfrog control in Greenwood Creek. We have detected bullfrogs in the following basins within the plan area: Noyo River, Big River, Little River, Albion River, Navarro River, Greenwood Creek, and Garcia River. There were no detections in Hollow Tree, Cottaneva, Juan Creek, Howard Creek, Hardy Creek, Elk Creek, and Mallow Pass Creek.

14.11.1.1 Changed and unforeseen circumstances for bullfrogs

Changed circumstance

Bullfrog invasion constitutes a changed circumstance if there is

- Loss of 3 or more active red-legged frog breeding sites within a planning watershed, which MRC assumes is the result of bullfrogs since bullfrogs are at the site.

Unforeseen circumstance

Bullfrog invasion constitutes an unforeseen circumstance if there is

- Loss of 5 or more active red-legged frog breeding sites detected within a planning watershed, which MRC assumes is the result of bullfrogs since bullfrogs are at the site.

14.11.1.2 MRC response to bullfrogs

Number of bullfrogs does not trigger a changed circumstance

If the number of bullfrogs does not constitute a changed circumstance, MRC will take the following action:

- MRC will implement the bullfrog control plan (C§10.2.2.3-6 and C§10.2.2.3-7).
- MRC will construct new upslope ponds with fixtures that allow the pond to be drained if bullfrogs invade.

Number of bullfrogs triggers a changed circumstance

If the number of bullfrogs does constitute a changed circumstance, MRC will take the following action:

- MRC will continue to implement the bullfrog control plan (C§10.2.2.3-6 and C§10.2.2.3-7) and consult the wildlife agencies for additional measures.
- MRC will drain affected ponds manually or mechanically upon bullfrog invasion after red-legged frogs have metamorphosed.

14.11.2 Wild pigs

Wild pigs include formerly domestic swine, Eurasian wild boars, and hybrids of the two. Wild pigs have undergone a dramatic range expansion in California—from 10 counties in the 1960s to 49 of the 58 counties by 1996 (Waithman et al. 1999). This range expansion is due to natural dispersal, hunting, and release of domestic pigs (Mayer and Brisbin 1991). In the plan area, the population of wild pigs is generally in medium-to-high densities (Waithman et al. 1999); however, in isolated pockets of the plan area, there may be dense populations of wild pigs.

Wild Pigs
Photo by Rick Sweitzer

Land Rooted by Pigs
Photo by Rick Sweitzer

Wild pigs are very fecund; females can produce up to 2 litters of 5-6 piglets per year. This makes it extremely difficult to control populations once they are well-established. According to research from New Zealand, removal of up to 70% of wild-pigs in areas with moderate-to-high densities may be necessary to reduce or maintain wild-pig populations (Dzieciolowski et al. 1992). The percentage could be less in areas where there are natural predators such as mountain lions, black bears, and coyotes and where there is persistent hunting of wild pigs. Although there are predators of wild pigs in the plan area, hunting pressure is low. As a result, predators and sport hunting alone are unlikely to control pig populations.

Wild pigs in the plan area could cause significant damage by rooting out endemic plants (Kastadalen 1982), altering soil processes (Lacki and Lancia 1983), and destroying the burrows of Point Arena mountain beavers. Wild pigs also may compete with some native species for food resources (Ilse and Hellgren 1995).

Although no studies have assessed the damage wild pigs may cause to mountain beaver burrows, wild pigs could destroy an entire burrow system while rooting in the area. They could also disturb or destroy amphibian breeding sites by creating wallows in streams, seeps, and springs.

14.11.2.1 Changed and unforeseen circumstances for wild pigs

Prior to reaching a changed circumstance

- MRC may allow wild pig hunting on covered lands consistent with safety, Fish and Game laws, and other sections of our HCP/NCCP.

Changed circumstance

Damage from wild pigs constitutes a changed circumstance if it

- Leads to destruction of more than 20% of the vegetation growing on an occupied Point Arena mountain beaver burrow system, as shown by a comparative measure of damaged and non-damaged vegetation above the burrow system.

- Leads to significant destruction of a burrow system of Point Arena mountain beaver within a planning watershed (i.e., at least 10% collapse of the burrow), as shown by a measure of the burrow extent before and after damage.
- Results in a loss of 2 or more active red-legged frog breeding sites within a planning watershed.
- Results in a significant reduction of coastal tailed frogs (i.e., a decline outside the range of natural variability) in 1or more index reaches.
- Results in a loss of any known MC1 core occurrence, more than 10 % of monitored MC2 core occurrences, or more than 25% of monitored MC3 sites for any covered plant species within a planning watershed (see section 11.7).

Unforeseen circumstance

Damage by wild pigs constitutes an unforeseen circumstance if it

- Results in a loss of 3 or more active red-legged frog breeding sites within a planning watershed.
- Results in loss of 50% or more of known MC1 and monitored MC2 and MC3 sites for any rare plant within a planning watershed (see section 11.7).

14.11.2.2 MRC response to wild pigs

Damage from wild pigs triggers a changed circumstance

In the event damage from wild pigs constitutes a changed circumstance, MRC will take the following action:

- MRC will initiate surveys for red-legged frog breeding sites the first year after the wild pigs have damaged such sites.
- MRC will initiate surveys for coastal tailed frog sites the first year after wild pigs have damaged such sites.
- MRC will meet with the wildlife agencies and implement a program to control feral pigs based on the particular situation and available options.

    NOTE
    Our intent in developing a program to control feral pigs is to stop damage to our landscape.

14.11.3 Barred owls

During the drafting of this plan, MRC and the wildlife agencies concluded that control of barred owls is necessary to conserve northern spotted owls. We have incorporated this understanding in our conservation measures and adaptive management program. However, we may not actually receive a permit to control barred owls within the prescriptions of our HCP/NCCP.

14.11.3.1 Changed circumstance

MRC does not receive a permit to control barred owls as part of our HCP/NCCP.

14.11.3.2 Unforeseen circumstance

Barred owl populations in the plan area increase to the point where it is not possible for MRC to achieve our HCP/NCCP objectives for northern spotted owls.

14.11.3.3 MRC response to barred owls

If MRC does not receive a permit to control barred owls and barred owls impact spotted owl territories (M§13.9.1.4-7), we will implement contingency strategies (Y§10.3.1.2.5-6).

14.11.4 Other species interactions

In the 80-year term of the HCP/NCCP, there may be other species that merit inclusion in the MRC proposal for changed circumstances. Species extant in the plan and adjustment areas which are potentially problematic include feral dogs and cats, turkeys, cowbirds, starlings, centrarchids (fish in the bass family), ictalurids (fish in the catfish family), and cyprinids (especially pikeminnow). Currently, there is little information about whether there are interactions between these species and covered species or communities in the plan area and the extent of such interactions.

14.11.4.1 Changed and unforeseen circumstances for other species interactions

Changed circumstance

Damage from other species interaction constitutes a changed circumstance if it

- Leads to destruction of more than 20% of the vegetation growing on an occupied Point Arena mountain beaver burrow system, as shown by a comparative measure of damaged and non-damaged vegetation above the burrow system.
- Leads to significant destruction of a burrow system of Point Arena mountain beaver within a planning watershed (i.e., at least 10% collapse of the burrow), as shown by a measure of the burrow extent before and after damage.
- Results in a loss of 2 or more active red-legged frog breeding sites within a planning watershed.
- Results in a significant reduction of coastal tailed frogs (i.e., a decline outside the range of natural variability) in 1 or more index reaches.
- Results in a loss of any known MC1 core occurrence, more than 10 % of monitored MC2 core occurrences, or more than 25% of monitored MC3 sites for any covered plant species within a planning watershed (see section 11.7).

Unforeseen circumstance

Damage by other species interactions constitutes an unforeseen circumstance if it

- Results in a loss of 3 or more active red-legged frog breeding sites within a planning watershed.
- Results in loss of 50% or more of known sites of MC1 and monitored MC2 and MC3 sites for any rare plant within a planning watershed (see section 11.7).

14.11.4.2 MRC response to other species interactions

In the event damage from other species interactions constitutes a changed circumstance, MRC will meet with the wildlife agencies and implement a program to reduce or eliminate the negative impacts from such interactions. Moreover, MRC will develop a plan to address outbreaks of invasive exotic species on covered lands (see section 9.7.3.1).

14.12 New species listing

If the wildlife agencies, subsequent to approval of our HCP/NCCP, list additional species in the plan area as threatened, endangered, or a state candidate species, this constitutes a changed circumstance according to the "no surprises rule." The wildlife agencies will immediately notify MRC if they plan to list a new species that might occur on covered lands.

14.12.1 MRC response to new species

In the event the wildlife agencies list new species that might occur on lands covered by our HCP/NCCP, MRC will take the following action:

- MRC will seek technical assistance and implement take-avoidance measures prescribed by the wildlife agencies for newly listed species.
- MRC will consult with USFWS and, in some cases, with other wildlife agencies to ensure that covered activities in the plan area do not jeopardize plants listed in the future.
- MRC will confer with the wildlife agencies about necessary amendments to the existing HCP/NCCP as a result of a new listing of *threatened* or *endangered* species.
- MRC will decide whether to pursue an amendment to our HCP/NCCP in order to provide coverage for a newly listed species.
- MRC will, if we decide to amend the plan, follow the procedures set forth in the Implementing Agreement for adding a new species to our HCP/NCCP, including consultation with the wildlife agencies.