Floodplain Restoration at the Old Orick Mill Site

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Abstract

The old Orick Mill site is located at the confluence of Redwood and Prairie Creeks, in the heart of Redwood National and State Parks in Northern California. The Redwood Creek and Greater Prairie Creek watersheds have been extensively logged since the 1930s, which has changed the landscape and led to serious degradation of floodplain habitats. In response to these problems, several organizations have partnered to restore the redwood forests and watershed habitats in the area. Our research focused on the lateral connectivity of the creeks at the Orick Mill site and found that the mill and connecting roads restricted the floodplain area and narrowed the creek, causing incision in the Prairie creek channel. We provide an analysis of problems at the mill site and offer recommendations that complement the floodplain restoration project.

Introduction

The old Orick Mill site is located in the Prairie Creek sub-basin of the Redwood Creek watershed in northwestern California (Figure 1). The mill was constructed in 1955 on the floodplain at the confluence of Redwood and Prairie creeks, at the present-day junction of U.S. Highway 101 and Bald Hills Road, about six miles upstream from the Pacific Ocean (Figures 2 & 4). Here, old-growth redwoods were processed for almost 60 years before the Orick Mill was shut down in 2009. In 2013, the property was purchased by Save the Redwoods League from Green Diamond Resource Co., which owns 400,000 acres of timber land in Del Norte and Humboldt counties. (Triplicate, 2013)

The Prairie Creek sub-basin includes the May Creek and Lost Man Creek watersheds and a large portion of the Skunk Cabbage Creek watershed (Figure 2). Prairie Creek drains approximately 40 square miles of the northwestern portion of the Redwood Creek basin and joins Redwood Creek at the south end of the Orick Mill site (Figure 3) (Cannata et al., 2006). The Prairie and Redwood Creek watersheds are underlain by metamorphic and sedimentary rocks with shallow marine and alluvial sedimentary deposits, cut by a series of shallow faults. The composition and distribution of bedrock units and faults influence slope profiles, gradients and drainage patterns within the basin. Steep slope gradients covered with fractured mudstone, incoherent sandstone and fine- grained schist deposits make the basin susceptible to erosion and large sediment flows during flood events (Cashman et al., 1995).

The floodplain at the confluence of two streams is one of the most dynamic, biologically rich and ecologically sensitive places in a riverine ecosystem. Healthy gravel-bed floodplains are biodiverse and productive places closely connected to the larger landscape. Hydraulic flood patterns constantly change and renew the subsurface of gravel floodplains, providing habitats that support a biodiverse food web (Hauer et al, 2016). High food-web productivity results from slower moving, warmer water across the floodplain, which supports a high production of algae, phytoplankton and zooplankton, as well as sheltering habitats for fish to spawn and feed. These floodplains create habitats for riparian plant and bird species and provide ecosystem services to humans such as carbon sequestration, recreation, and flood control. (Opperman et al., 2010).

The confluence of Prairie and Redwood Creeks is characterized by a gravel-bed floodplain that has been severely altered by land uses and infrastructure developments. Clear-cut logging in the Prairie Creek watershed and the construction of logging roads and mills has led to a disconnection of the Prairie Creek channel from its floodplain. These historical impacts and the high ecological potential of the floodplain at the Orick Mill makes this site a prime candidate for restoration. Understanding the impact of logging practices upstream and infrastructure developments around the site will shed light on problems limiting the floodplain processes.

Problem Statement

Prairie and Redwood Creek watersheds have been extensively logged since the 1930s, which has changed the landscape and led to serious degradation of the watershed and floodplains, including the floodplain at the Orick Mill site. The Prairie Creek watershed has an estimated 108 miles of logging roads and a road density of 2.7 road miles per square mile, with 42 percent percent of road miles built on areas of high landslide potential. Roads and landings supporting logging operations were constructed in or along water channels in the 1950s, causing high rates of erosion and sedimentation in Prairie Creek and tributary streams. The construction of the Highway 101 bypass in 1989 contributed additional sedimentation in Prairie Creek. (Cannata et al., 2006).

In the 1920s, SRL purchased approximately 14,000 acres to protect the old growth coastal redwoods in the upper Prairie Creek watershed. However, logging continued on privately owned land, accelerated by increased demand for timber during WWII, and the economic boom of the 1950s (Figure 8). It wasn’t until 1968 that Redwood State Parks was established to protect some of the few remaining stands of uncut redwoods. In

1978, Congress added more land to the parks, after more than half of the Prairie Creek watershed had been logged (Table 3) (Cannata et al., 2006).

Subbasin or Planning Watershed	Harvest Acres by Period							
	1950-1964	1965-1974	1975-1983	1984-1992	1992-2000	Total Harvested	Total Acres	Percent Harvested
Prairie Creek Subbasin	11,236	1,387	919	0	0	13,542	25,305	53.5
May Creek	4,216	59	378	0	0	4,653	11,243	41.4
Lost Man Creek	6,426	1,288	475	0	0	8,189	12,704	64.4
Skunk Cabbage Creek Drainage	594	40	66	0	0	700	1,420	49.3

Table 1. Prairie Creek Subbasin timber harvest history, 1950-2000. From "Redwood Creek Basin Assessment" Cannata et al (2006)

To restore forests and watershed habitat, Redwood National and State Parks (RNSP) has partnered with California Department of Parks and Recreation (CDPR) and Save the Redwoods League (SRL) under the umbrella of the Redwood Rising collaborative. The Redwood Rising partnership has planned and implemented The Greater Prairie Creek Ecosystem Restoration Project, which covers 9,200 acres of the Redwood Creek watershed (Arguello, 2018). Restoration activities include thinning of dense second growth forests, removal or repair of logging roads to reduce sediment flows, and revegetation to improve riparian corridors and stream habitats. (NPS, 2018)

At the Orick Mill site, restoration plans aim to restore geomorphic function and connectivity of the Prairie Creek channel and floodplain, and improve improve habitat for salmonids, elk and other species (Corbaley, 2015). 25 acres of asphalt will be removed from the mill landing to support floodplain restoration and increase lateral connectivity with the surrounding forest. Public trails will also be expanded, and a visitor center constructed to educate visitors and increase social engagement with the RNSP watersheds (Corbaley, 2015).

The restoration project of the Orick Mill site seeks to restore vital floodplain processes. However, our research suggests that floodplain connectivity problems at the section of Prairie Creek under the existing Bald Hills Road overpass remain unsolved. Without a redesign and replacement of the overpass to accommodate the whole floodplain, the restoration efforts at the Orick Mill site will not fully restore lateral connectivity of Prairie Creek. Therefore, this report integrates a large scale perspective of geomorphic problems in the area to inform design recommendations for the overpass to improve the potential of floodplain restoration efforts.

Study Approach

From November 9th to November 11th, 2018 our research team visited the Orick Mill site and redwood forests in the Prairie Creek watershed. Neal Youngblood, a water restoration geologist who works on logging road removal for RNSP, introduced us to the logging history and geomorphology in the area and provided historical aerial photos of the Orick Mill site and logging operations in the Prairie Creek watershed.

At the mill site we observed and photographed the Prairie and Redwood Creek channels, and the geomorphology of the connecting floodplains. Upstream of the Orick Mill site we studied Prairie Creek tributaries and an old growth redwood stand in Prairie Creek Redwoods State Park. We observed the diversity of growth in the forest and studied the variable geomorphology and meander paths as well as many small fish inhabiting the waters of Prairie Creek tributaries. After exploring the old growth stands, we visited the May Creek watershed which was clear cut in the 1960s and is now packed with unmanaged second-growth trees and overgrown, unmaintained roads built across streams.

We interviewed Walt Lara, a member of the the indigenous Yurok tribe from the area who works with Youngblood on logging road removal. Lara explained how the tribe is rooted in the land and gave us context of the relationship between humans and nature in the area.

Our research team studied chronological aerial photos to gain further insight into channel and floodplain geomorphology. We identified historical changes to the floodplain and sought causal relations between land use change and impacts to geomorphology. With this we combined our field survey, interviews and a study of reports and restoration documents to portray a temporal and spatial connection between human activity and impacts to floodplain geomorphology and habitats. Based on our understanding of the site, we studied potential improvements to maximize the success of floodplain restoration efforts.

Results

Sedimentation and Species Decline

The lowest mile of Prairie Creek has been altered by logging, construction of Highway 101 and the former mill site. It is incised and disconnected from its floodplain and off-channel habitat. This has resulted in reduced flow capacity, an increased risk of flooding, and limited habitat for native salmon trout species (Corbaley, 2015). A timeline of events in the larger Redwood Creek watershed shows a causal relationship between land use and increased sediment flows during flood events (Table 2). These impacts are reflected in the Prairie Creek watershed and at the Orick Mill site.

Year	Event
Pre-European Settlement	Yurok, Chilula and Whilkut people occupied Redwood Creek region.
1850s	Settlement of Orick with first white settlers. Conversion of spruce, redwood and hardwood forests for farm and grazing land.
1860s	Introduction of cattle and sheep into Redwood Creek region.
1920s	Establishment of Prairie Creek Redwood State Park. Save the Redwoods League purchases 14,000 acres of sanctuary old growth forests.
1927	Hatchery established on Prairie Creek (Prairie Creek Hatchery) for collection of coastal cutthroat trout, steelhead, and salmon eggs.
1936	Hatchery moved to its location on Lost Man Creek just upstream of its confluence with Prairie Creek.
1040s	Post WWII. Large scale logging with the use of tractors and gasoline-powered chainsaws.
1950	January cold spell with heavy snowfall followed by heavy rains caused Redwood Creek to overflow its banks and the residents of Orick had to flee their homes. Approximately 3 feet of water was reported in the center of town with up to 6 feet at the southern approach (Van Kirk 1994).
1955	December 22, 1955 flood carried a peak discharge of 50,000 cubic feet per second (cfs).
1964	December 22, 1964 flood had a peak discharge of 50,500 cfs on. Caused tremendous damage to the town of Orick and deposited tremendous sediment loads in middle and lower portions of Redwood Creek. Although peak discharge of the 1964 flood was only slightly higher than flood of 1955 on Redwood Creek, the total volume and damage to stream banks and hillslopes is considered the most damaging event of the century in the North Coast region (Harden et al. 1978).
1965	On January 22 the Arcata Union reports that silt and debris clog streams. "The recent flood was extremely damaging to wildlife" according to Captain Walter L. Gray of the Department of Fish and Game. "We know the loss of fish life was much greater than in 1955." "Many large fish were found in pastures buried in silt." "Streams were damaged by siltation, logging debris, and erosion. To make matters more complex, heavy runoff in many small tributaries have created deltas at the mouth which will go dry during periods of low water and will prevent fish from migrating"(Van Kirk 1994).
1968	Establishment of Redwood National Park. Completion of flood control levees along the lower 3.4 miles of Redwood Creek.
1973	New forest practice law established to improve protection of water quality, timber productivity, and other forest values.
1975	March 18, 1975 flood had a peak discharge of 50,200 cfs on and continued to deposit large sediment loads throughout Redwood Creek.
1978	Expansion of Redwood National Park.
1989	Construction of 101 By-Pass and related large sediment delivery to Prairie Creek basin.
1992	Closure of Prairie Creek Hatchery due to insufficient funding sources
1996	Flood re-charges upper basin with sediment.
1997	Coho salmon of the Southern Oregon/Northern California ESU listed "threatened" under the Federal Endangered Species Act.
1998	Total Maximum Daily Load allocation for sediment established for the Redwood Creek basin by EPA.
1999	Chinook Salmon of the California Coastal ESU listed as "threatened" under the Federal Endangered Species Act.
2000	Steelhead of the Northern California ESU listed as "threatened" under the Federal Endangered Species Act.
2002	Coho salmon warranted listing as threatened, as defined under the California Endangered Species Act.

Table 2. Historical events affecting fishery resources of Redwood Creek. From "Redwood Creek Basin Assessment" Cannata et al (2006)

The populations of coho, steelhead and chinook salmon are at high to moderate risk of extinction in the Redwood Creek system due to restricted spatial structure, diversity and productivity. Prairie Creek and its eight major tributary streams support populations of these salmonids as well as coastal cutthroat trout. Although some of the upper Prairie Creek watershed is relatively undisturbed, the fish species that spawn here still face risk of extinction (Cannata et al., 2006). Today, the coho population found in Prairie Creek constitutes the majority of the coho salmon found in the entire Redwood Creek system (CDFW 2006). This indicates that even with the lower reach in a degraded state, Prairie Creek provides critical rearing habitat for coho and other species. Therefore, restoration of Prairie Creek is a priority for the protection of fish in the Redwood Creek system. (Corbaley, 2015)

A linear relationship exists between the proportion of fine sediment and odds of Pacific salmon egg-to-fry survival. For example, a 1% change in <0.85mm fines decreased the odds of survival by 16.9% in Chinook salmon (Jensen et al., 2009). This indicates the damaging impacts of increased erosion and damaging sediment flows on salmonids in the Prairie Creek watershed.

Historical Anecdotal Evidence

Anecdotal stories from local residents describe the decline in fish populations, pointing to the impact of pollution on fish populations in addition to sedimentation. An old story describes fish runs so thick that one could walk across the streams on the backs of the fish (Lara, 2018). Other accounts from long term residents report fish migrations so abundant that it sounded like there were "horses in the creek", and stories describe swimming in the creek was like "swimming on top of fish" (Cannata et al., 2006).

In addition to sedimentation problems, pollution from logging operations also impacted fish populations. Youngblood told us that slag from the Orick Mill operations was dumped in the creeks, and a story from Lara's grandfather tells of "black water" that paralleled an abrupt decline in fish runs in the Prairie and Redwood Creek watersheds. Although there has been no research into what caused the "black water", Lara recalls a purple slime covering the rocks in the streams when he was younger, making the water in the streams appear black. The resembled the redwood sap would stain his hands in later years when he worked with the redwood trees, suggesting a correlation between redwood sap and the 'black water' phenomenon (Youngblood and Lara, 2018).

There is little data for species other than salmon, although salmon are not good indicator species for habitat quality due to their resiliency. Smaller animals such as crayfish, caddisflies and amphibians are more sensitive to problems in the watershed, so their presence is the best indicator for ecosystem health. Historical anecdotes from local residents provide stories of abundant crayfish populations prior to 1964, which are now rarely observed in Prairie and Redwood Creeks, however the decline of crayfish in the Redwood Creek watershed has been studied. (Cannata et al., 2006).

Amphibians are also better indicators of ecosystem stress than anadromous species such as salmons. This is because amphibians are philopatric, long-lived and maintain relatively stable populations in undisturbed habitats, and are sensitive to a range of environmental disturbances (Welsh and Ollivier, 1998). As a result of these qualities, measuring and monitoring density and population of stream amphibians can be a reliable barometer of ecological stress. Ongoing analysis of the effects of land uses on microorganisms, invertebrates, and other small species besides fish is needed in the Greater Prairie Creek Watershed to fully understand the biological health of the ecosystems, as well as the progress of restoration.

In addition to species decline, local anecdotes chronicle changes to the geomorphology and riparian corridors in the Redwood Creek watershed. Long term residents describe thicker canopies and cooler temperatures, as well as deep swimming holes along Prairie and Redwood creeks. Accounts include reports of a 15-20 ft deep hole at the mouth of Prairie Creek which no longer exists due to the streams 'filling up' with sediment. (Cannata et al., 2006)

Indigenous History

The problems at this site are inseparable from the history of the larger region and the problems that have evolved over time since the first arrival of westerners in the 1850s. Anthropogenic changes to the creeks and floodplain habitats at the Orick Mill site reflect a long history of land use changes and exploitation of resources in the redwood forests.

The creation story of the indigenous Yurok people is closely linked to the creation of abundant habitats and food in the rivers of the Northern California coast. The story tells of the beginning of time, when the creator left his children near the mouth of the river. The creator called on the spirit of the river, Pulekukwerek, to provide food for his children so that they would have everything they needed. Pulekukwerek created a variety of fish and eel to be sent at different times to keep the people fed and happy all year, and taught them how to catch and prepare the food from the river and the land. (Most, 2006)

Before the arrival of westerners, indigenous people lived as stewards of the land. The Yurok people viewed themselves as caretakers in a mutually beneficial relationship with nature, understanding that if they took care of the land, the land would take care of them (Lara, 2018). Evidence of diverse resource management techniques of indigenous people can be connected to not only abundant food subsistence but also to the once healthy, resilient, diverse and productive landscape-gardens throughout California. Natural disturbances, such as fire and flooding, were encouraged to helped to promote habitat diversity and biologically rich ecosystems, and montane meadows, riparian forests and floodplains habitats were regularly maintained through controlled burning (Anderson, 2013). With the arrival of westerners, the land land was easily taken from indigenous people who did not believe in land ownership. (Lara, 2018).

Historical Timeline Analysis

The oldest existing photo of the Orick Mill Site was taken in 1931, after some changes in land use had already taken place. An analysis of these photos reveals ongoing changes to the floodplain influenced by historical events since the 1930s. In 1931 and 1936, Redwood Creek was a transient, meandering channel on a wide open floodplain that shifted in response to flood disturbances. During that time the confluence of Prairie and Redwood Creek covered a wide the floodplain (Figure 5). In later aerials, the floodplain becomes choked by infrastructure, including the construction of the old and new Bald Hills Rd bridges as well as flood control levees. The photos show an accumulation of sediment on the floodplain followed by the propagation of shrubs and large trees along flood control levees and infrastructure developments. (Figure 6)

Field Observations

The lateral connectivity of the creeks is severely restricted by several causes. The Old Bald Hills Road, built prior to 1931, acted as a levee, ponding floodwaters and inducing sediment deposition. This has resulted in an elevation difference of three feet between the north side of the mill site and the south pasture. A flood control levee and pasture constructed parallel to Prairie Creek in the 1960s further confined the creek channel and floodplain. The new Bald Hills Road overpass, constructed on fill in the 1960s, cuts through the remaining floodplain at the confluence of Prairie and Redwood Creeks. The new overpass and the adjacent gravel mine built across from the mill site on private property caused an increase in sediment deposition, floodplain elevation and incision of the Prairie Creek Channel (Figures 9 & 10). The construction of Highway 101 in the 1980s further confined the Prairie Creek channel along the east side of its floodplain. Vegetation has gradually taken over the banks along the creeks indicating compromised hydrologic and geomorphic processes of Prairie Creek and reduced lateral connectivity of the floodplain. (Figures 11)

Conclusion & Recommendations

The reach of Prairie Creek that passes under the Bald Hills Road overpass is restricted by the bridge, gravel mine fill and Highway 101 on either side of the channel. Incision is evident in the elevation difference between the floodplain and the creek channel, and is likely to worsen if the surrounding infrastructure is not changed to accommodate dynamic flood processes. Restoration efforts at the mill site should work towards addressing the confinement of the creek channel and floodplain disconnection created by the Bald Hills Road overpass and the adjacent gravel mine. Restoration at the mill site would benefit by expanding efforts to include the whole historic floodplain area of the Redwood and Prairie creek confluence.

Changes to the road would require substantial planning and funding, including an expansion of public-private partnerships and acquisition of private land. Full restoration of the floodplain would have to involve removal of tons of fill, equipment, and vegetation from around the Bald Hills Road overpass through the gravel mine. These obstacles are currently outside the scope of the Orick Mill restoration efforts, however addressing these problems would increase the potential for success.

We suggest widening and relocating the overpass to allow for a larger floodplain . A redesign of the Bald Hills Road overpass to pass flow would allow natural hydrologic and geomorphic cut and fill processes and channel migration thereby improving the floodplain habitats. In order to accomodate variable flood events, the Bald Hill Road levee should be replaced with an elevated roadway passes flow and allows sediment to pass naturally through this system. An elevated roadway such as a mini-causeway or a series of long arch culverts with minimal interference would be ideal solutions (Figure 12). A causeway would enable lateral movement of floodwaters, but the many structural foundations in a typical causeway would still limit sediment transport, requiring maintenance and removal of sediment. Therefore we recommend a longer span bridge with foundations every 30-40 feet. A longer span bridge would allow dynamic movement of the creek and natural cut and fill processes across the gravel bed floodplain.

Current restoration efforts in the Prairie and Redwood Creek watersheds focuses primarily on reducing erosion and sediment flows to improve habitats deteriorated by logging and developments. Greater data collection and quantitative studies monitoring changes to hydrology, geomorphology and biology are recommended for post project evaluation of restoration efforts are recommended. Further modeling and comparative assessment of potential infrastructure improvements would benefit this research.

The proposed restoration at the Orick Mill site has a great potential to reconnect lateral life-cycle processes from the creek to the floodplain and surrounding redwood forest watersheds. The restoration project can also provide valuable ecosystem service benefits to humans, such as education about redwood forests, creeks and floodplains for visitors. The visitor center can also provide historical and cultural context for land use issues and the impact of human activities on the environment. In addition, an iconic long span bridge could help educate visitors about the value of restoring gravel bed floodplain ecosystems.

Works Cited

Anderson, Kat. *Tending the Wild: Native American Knowledge and Management of California's Natural Resources.* University of California Press, 2013

Arguello, Leonel. (July 6, 2018) *"Parks Hold Meeting for Prairie Creek Forest and Stream Restoration."* National Parks Service, Website Accessed 11/11/2018 https://www.nps.gov/redw/learn/news/pcrestorationscoping.htm

Barlow, Savina., et al. *Oreck Then and Now*, Historical Committee of Orick Chamber of Commerce. Map.

Cannata, S., R. Henly, J. Erler, J. Falls, D. McGuire and J. Sunahara. 2006. *"Redwood Creek Watershed Assessment Report."* Coastal Watershed Planning and Assessment Program and North Coast Watershed Assessment Program. California Resources Agency and California Environmental Protection Agency, Sacramento California.

Cashman, S. M., Kelsey, H.M and Harden D. R.,1995. "Geology of the Redwood Creek Basin, Humboldt County, California", U.S. Geological Survey.

Corbaley, Su. June 25, 2015 *"Orick Mill Site Restoration,"* Project No. 14-055-01 Coastal Conservancy Staff Recommendation

Del Norte Triplicate, (October 2013) *"Redwood League buys old mill site"* Published Oct. 9, 2013 / Updated February 13, 2016 Accessed November 18, 2018. https://www.triplicate.com/csp/mediapool/sites/Triplicate/News/story.csp?cid=4389236&sid=923&fid=151

Hauer, F Richard et al. *"Gravel-bed river floodplains are the ecological nexus of glaciated mountain landscapes"* Sci.Adv. 2016; 2:e1600026 24 June 2016.

Jensen, David W et al. *"Impact of Fine Sediment on Egg-to-Fry Survival of Pacific Salmon: A Meta-analysis of Published Studies."* Reviews in Fisheries Science, 2009

Most, Stephen (2006) *"River of Renewal, Myth & Mystery in the Klamath Basin."* Oregon Historical Society Press, 2006

National Parks Service (NPS) (November 2017) *"Salmonids Common to Redwood National and State Parks"* Redwood National and State Parks California https://www.nps.gov/redw/learn/nature/coho-salmon.htm Accessed November 18, 2018.

Save the Redwoods League (SRL) (September 2017) *"Praire Creek Scenic Corridor."* https://www.savetheredwoods.org/project/prairie-creek-scenic-corridor/ Accessed 11/12/2018

National Park Service (NPS) (July 2018) *"Public Scoping for the Greater Prairie Creek Ecosystem Restoration Project."*

Opperman, Jeffrey J., et al. "Ecologically Functional Floodplains: Connectivity, Flow Regime, and Scale 1." *JAWRA Journal of the American Water Resources Association* 46.2 (2010): 211-226.

Waterman, T.T., *Yurok Geography.* University of California Publications in American Archaeology and Ethnology. May 31, 1920.

Welsh Jr, Hartwell H., and Lisa M. Ollivier. "Stream amphibians as indicators of ecosystem stress: a case study from California's redwoods." *Ecological Applications* 8.4 (1998): 1118-1132.

Appendices

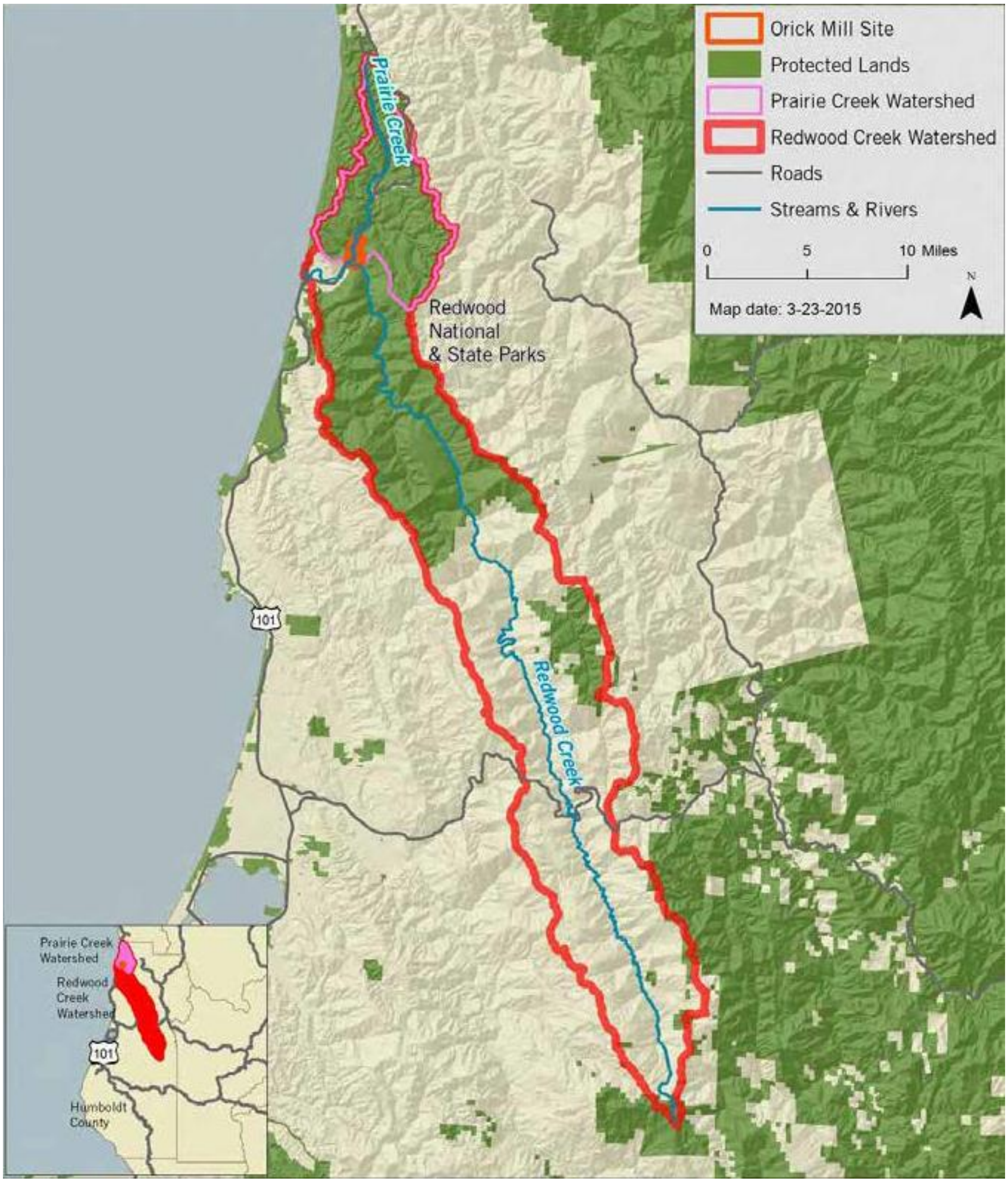


Figure 1. Redwood Creek Watershed and Prairie Creek Sub-Watershed map from Save the Redwoods League

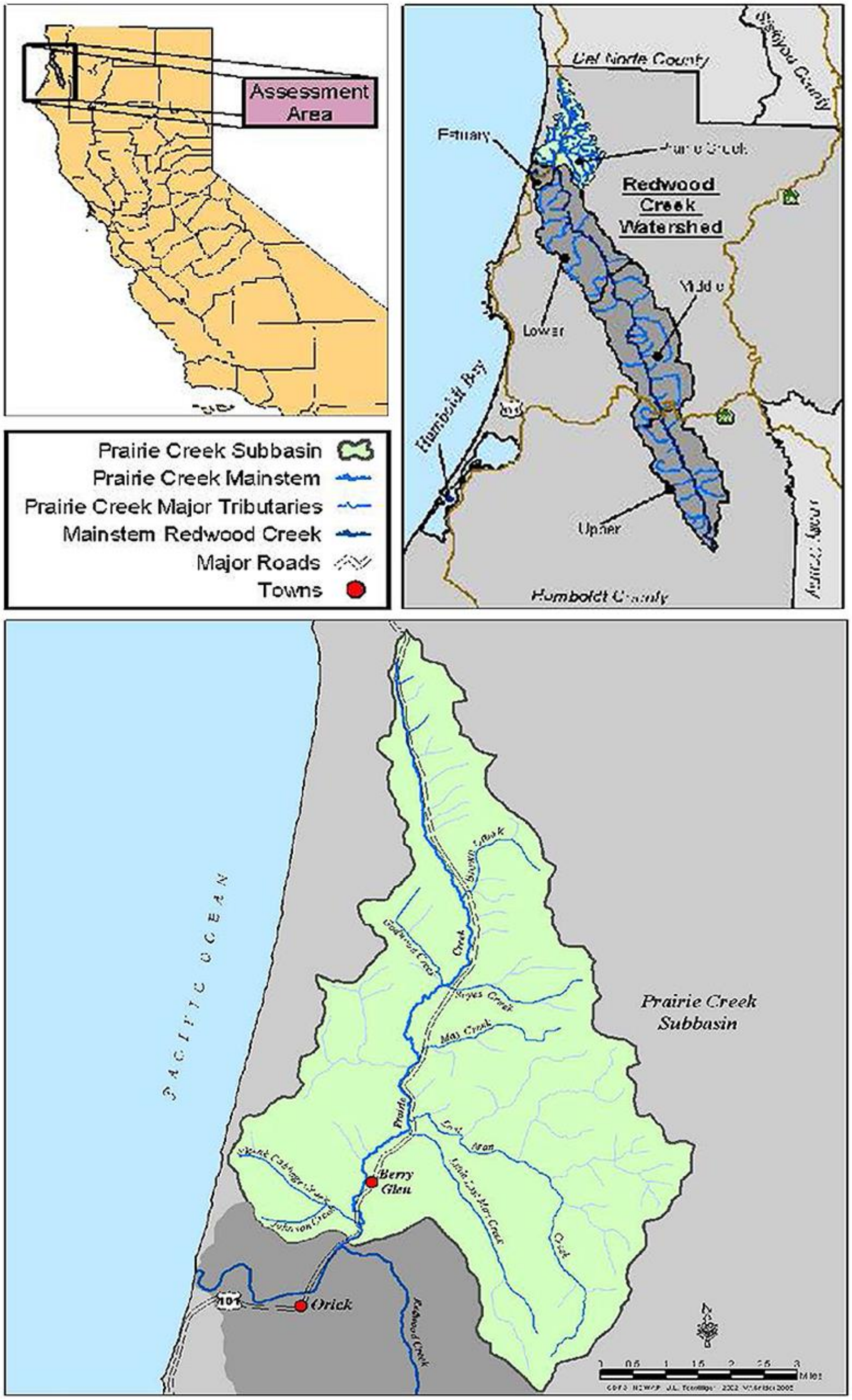


Figure 2. Prairie Creek Subbasin and Tributaries, from “Redwood Creek Basin Assessment” Cannata et al (2006)

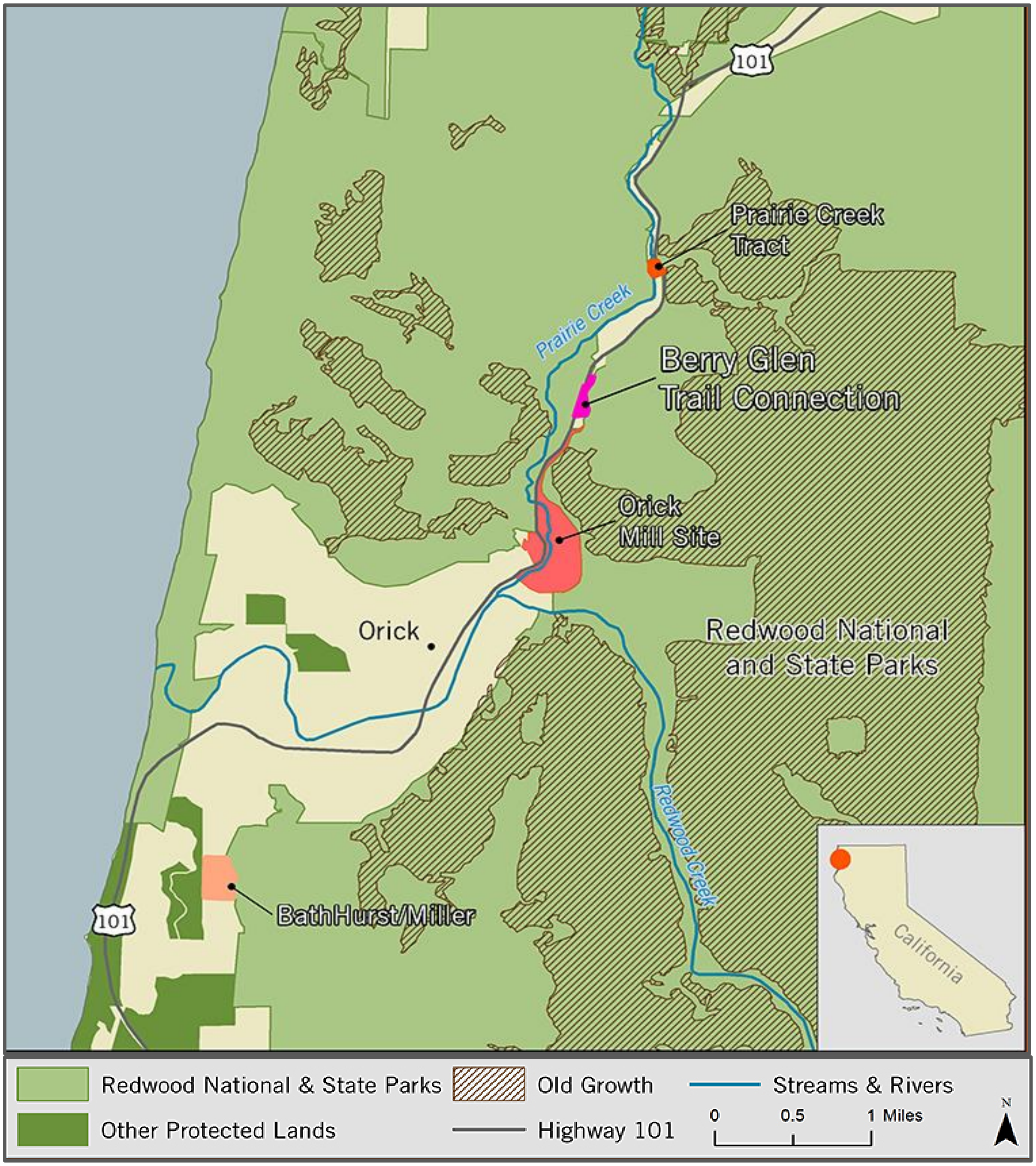


Figure 3. Orick Mill Site, from Save the Redwoods League and Redwood National and State Parks

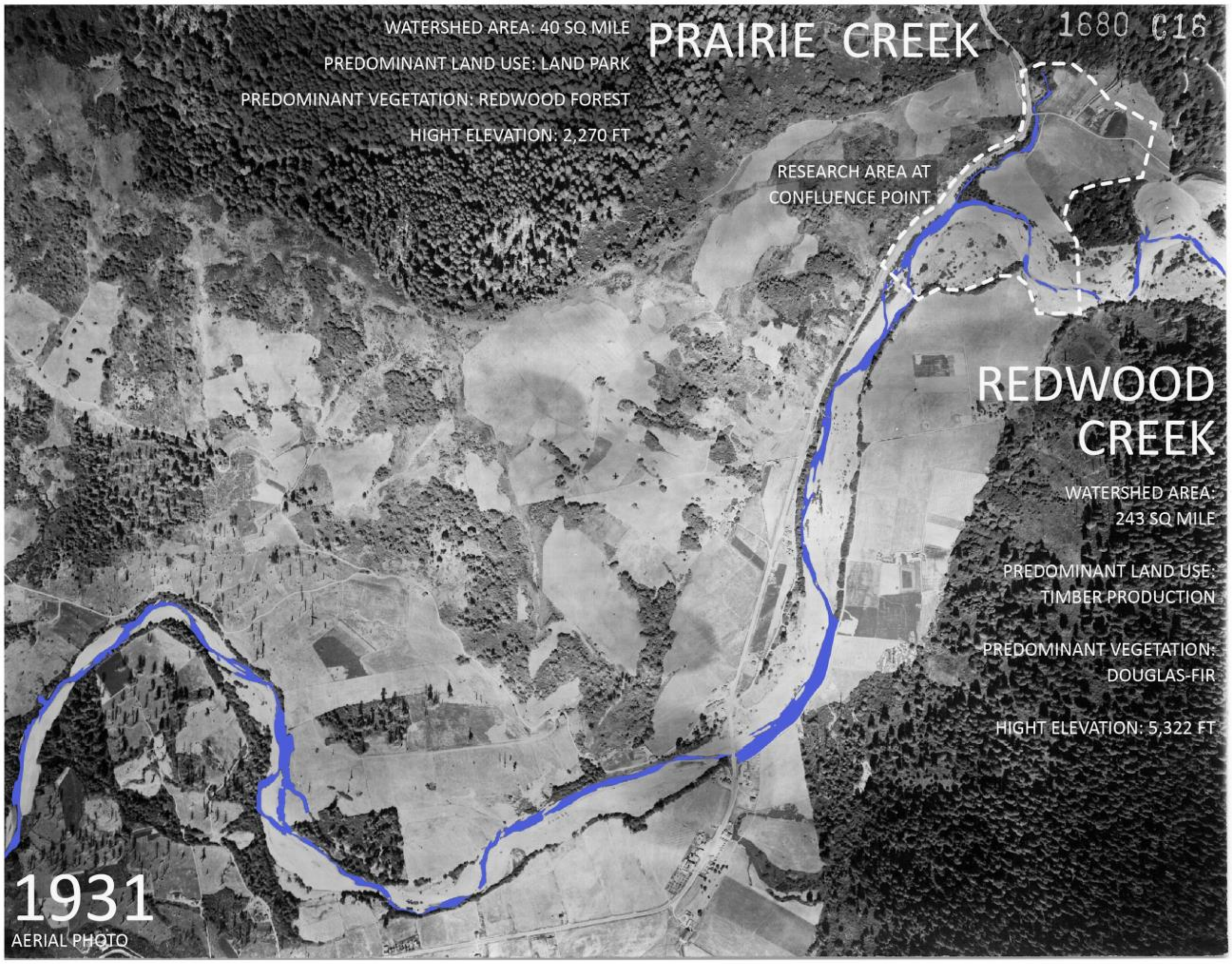
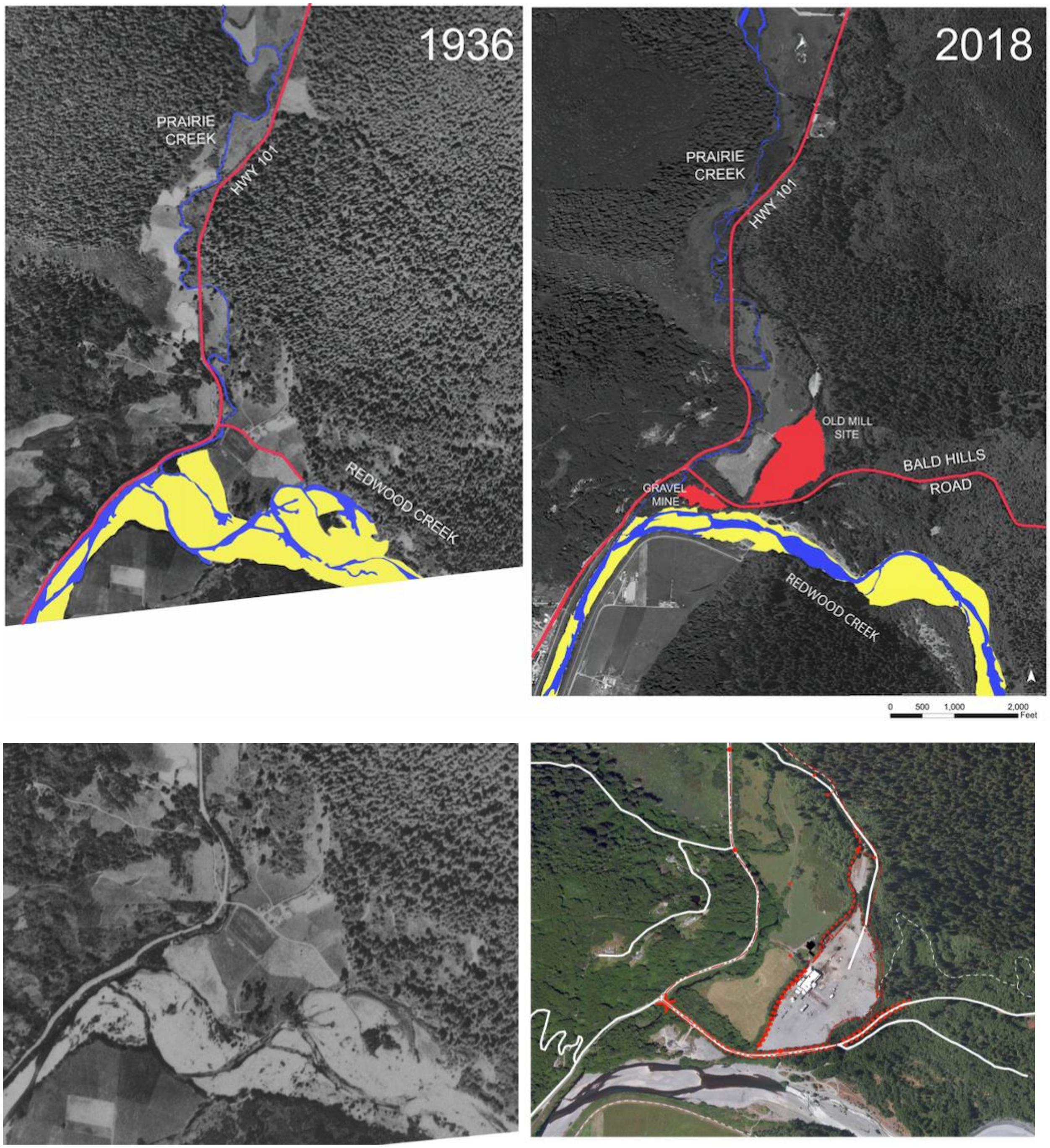


Figure 4. Lower Redwood Creek and Prairie Creek Project Area



Figures 5 & 6. Aerial photos depicting changes to the floodplain. Left: 1936 Aerial Photo, Right: 2016 Aerial photo with infrastructure highlighted. The range of floodplain was markedly decreased and vegetation took over the edge of floodplain.

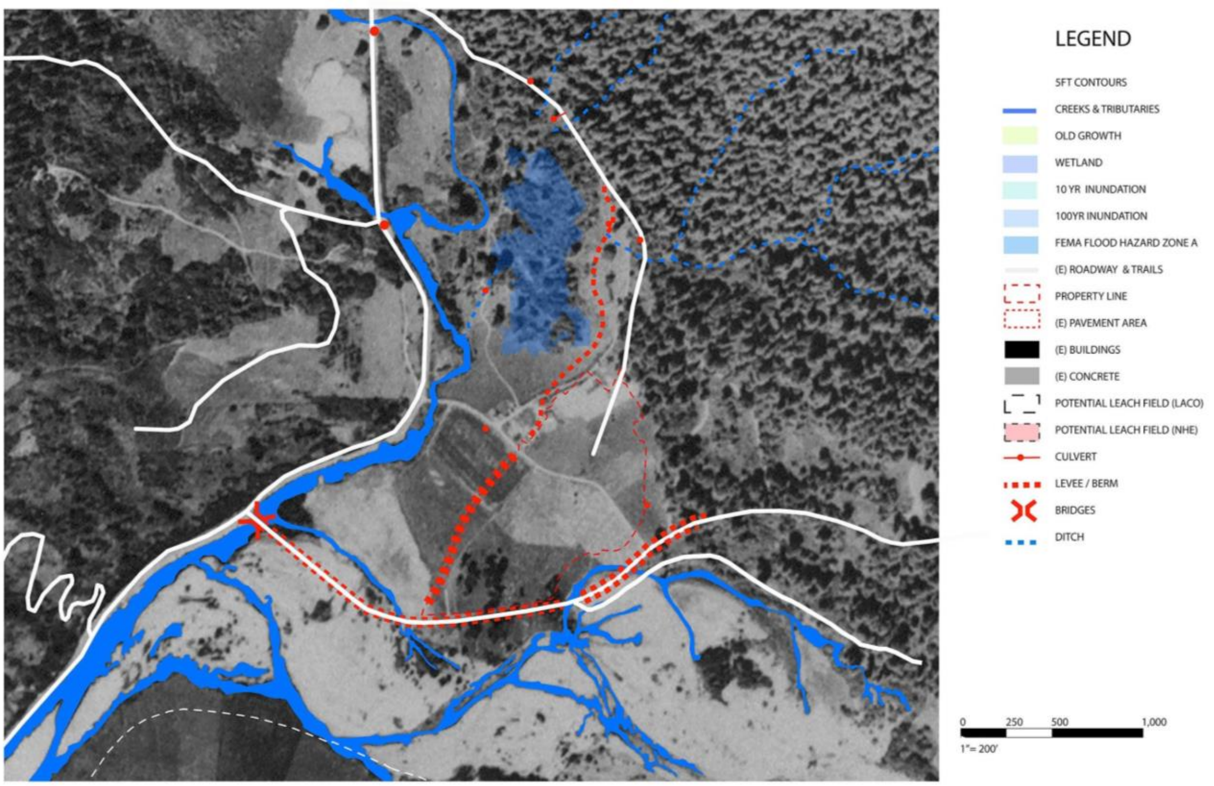


Figure 7. 1936 Aerial photo overlain with hydrology and contemporary condition of infrastructure

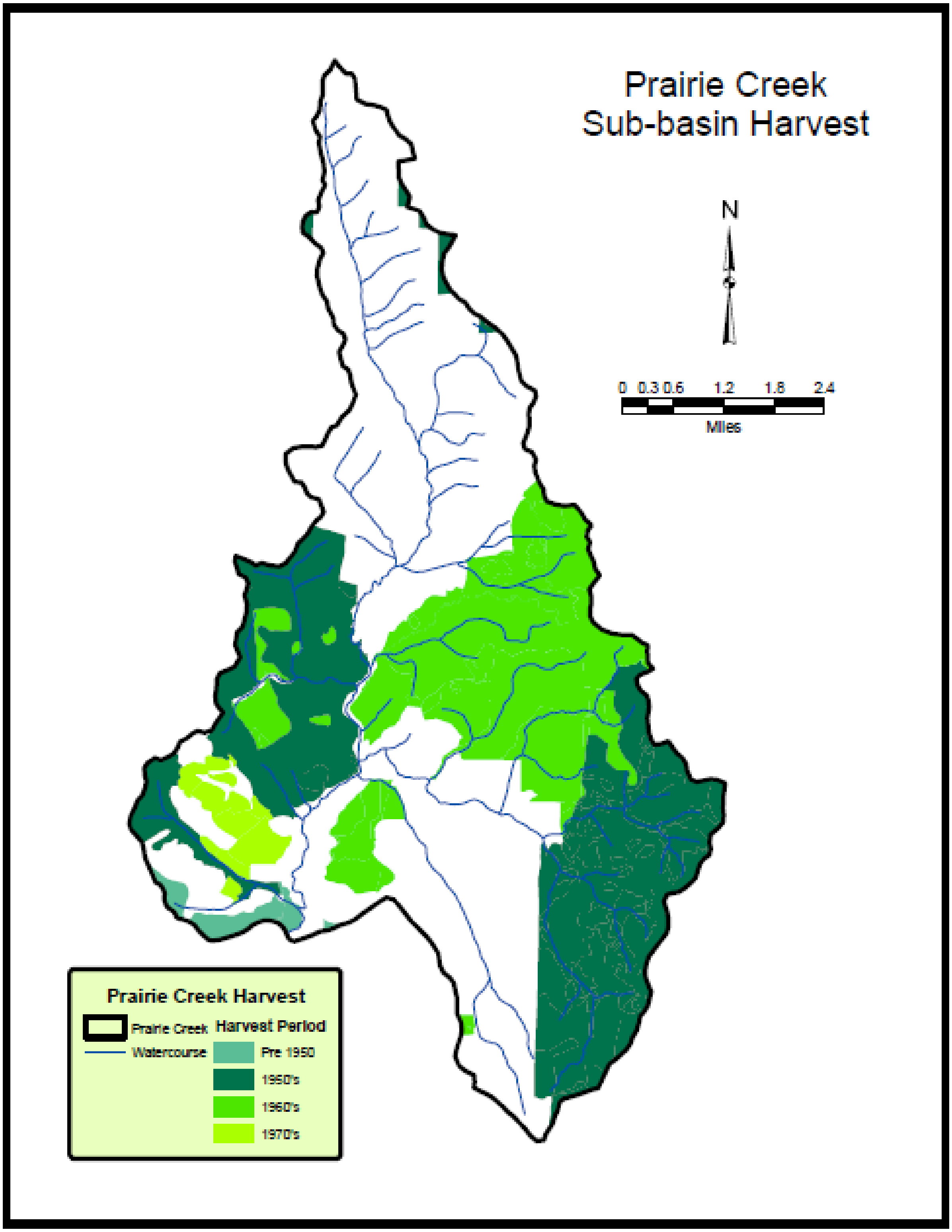


Figure 8. Prairie Creek subbasin timber harvest, from "Redwood Creek Basin Assessment" Cannata et al (2006)

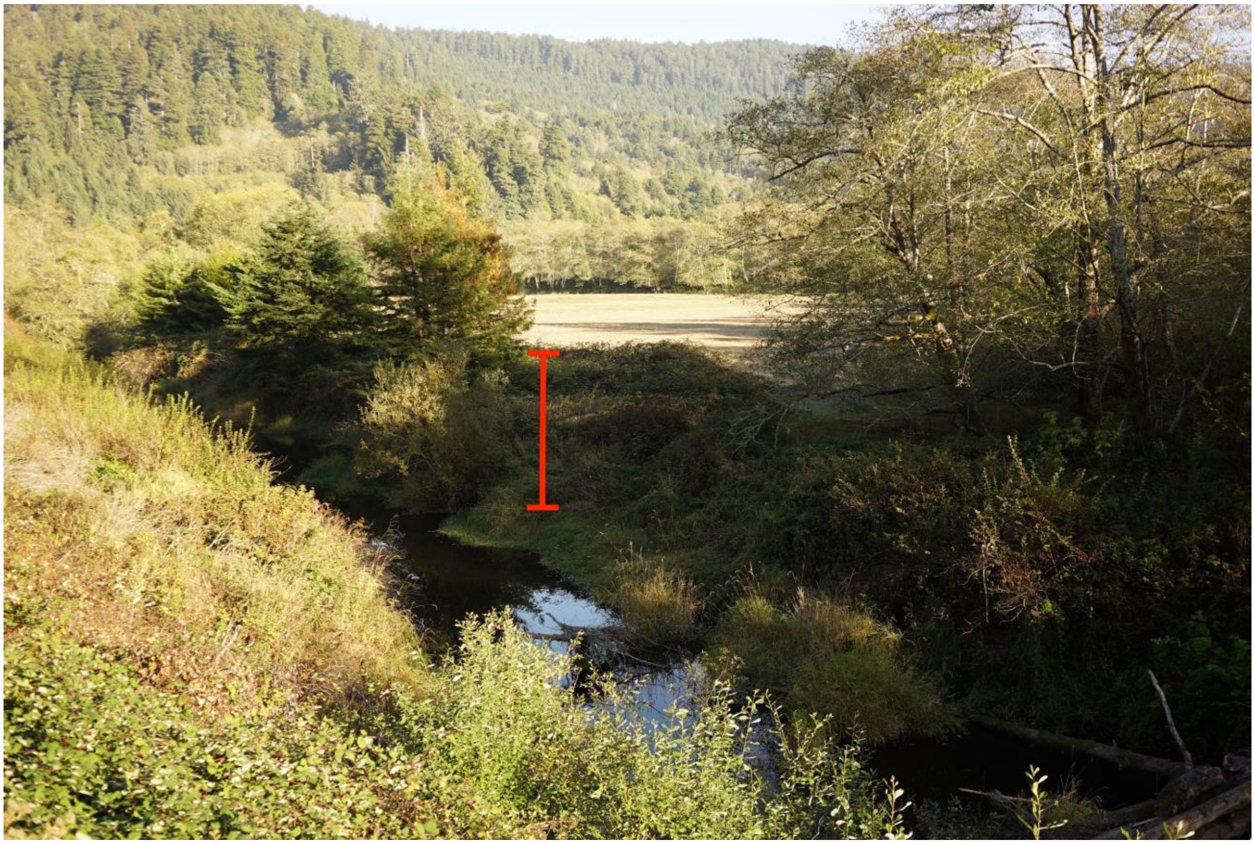


Figure 9. Height drop between floodplain and the Prairie Creek channel

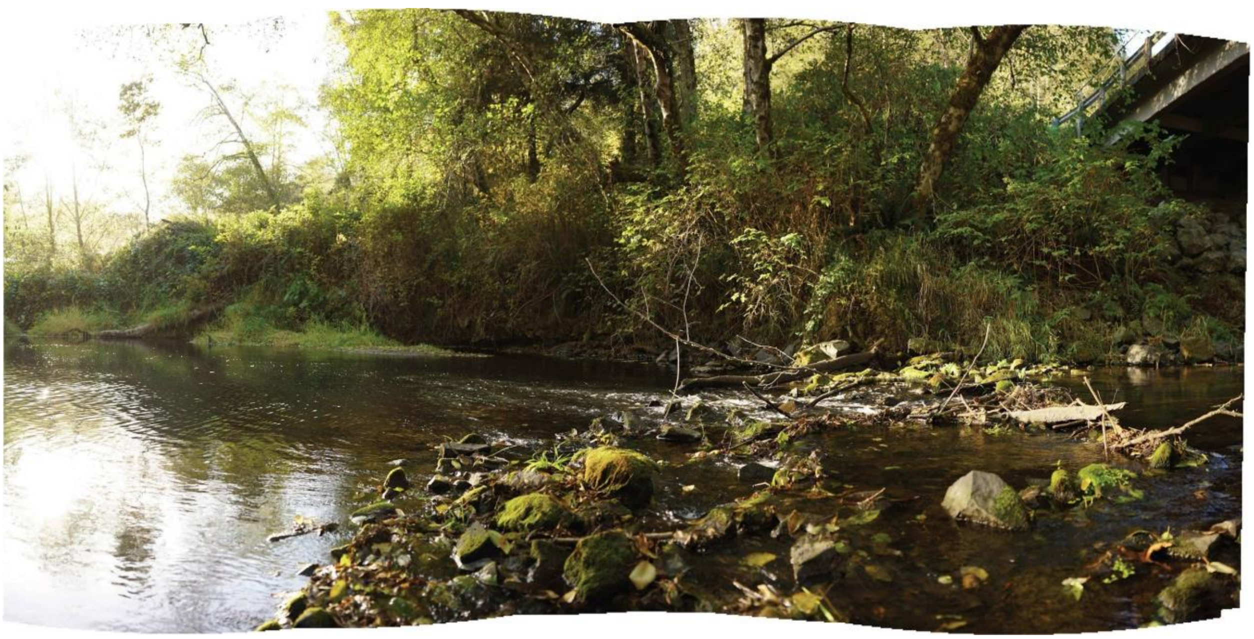


Figure 10. Confined by Hwy 101 and Bald Hills Road overpass, flow velocity in Prairie Creek is relatively large due to channel incision.

Figure 11. The narrowed Prairie Creek channel and confining structures of New Bald Hill Road overpass from both sides

Figure 12. One of the envisioned alternatives to New Bald Hills Road overpass